QUALIFICATION HANDBOOK

Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (1712)

September 2011
Version 1.2 (February 2013)

City & Guilds

Qualification at a glance

Subject area	Mechanical Manufacturing Engineering
City & Guilds number	1712
Age group approved	16+
Entry requirements	None
Assessment	Portfolio of evidence
Support materials	Centre handbook
Registration and certification	Consult the Walled Garden/online catalogue for last dates

***** For registrations from August 1st 2013 – please refer to new Level 3 1712-70 Extended diploma handbook found on **cityandguilds.com**

Title and level	City & Guilds number	Accreditation number
Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering	1712-60/61/62/63/64/65/66/67/68	600/2096/9

Version and date	Change detail	Section
1.1 (Jan 2012)	Unit numbers amended for 818-820 to reflect the Walled Garden	Structure of units
1.2 (Feb 2013)	Amend typographical error in structure title	Structure


London
Budapest
Cape Town
Kingston
Rio de Janeiro
Shanghai
Auckland

Contents

1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who are the qualifications for?	For candidates who work or want to work in the mechanical manufacturing engineering sector.
What do the qualifications cover?	Allow candidates to learn, develop and practise the skills required for employment and/or career progression in the engineering sector.
Are the qualifications part of a framework or initiative?	Serve as a competence qualification, in the engineering Apprenticeship framework.
Who are the qualifications for?	For candidates who work or want to work in the mechanical manufacturing engineering sector.
What do the qualifications cover?	Allow candidates to learn, develop and practise the skills required for employment and/or career progression in the engineering sector.

Structure

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (1712)**, learners must achieve 15 credits from the Mandatory Unit group, then a minimum of 27 credits from at least 3 units from PEO unit group 1, or a minimum of 51 credits from the PEO unit sub-groups in group 2 consisting of the following: a minimum of 11 credits from PEO group 2A, a minimum of 16 credits from PEO group 2B and a minimum of 24 credits from PEO group 2C. Learners must then achieve the minimum number of credits required from the selected pathways detailed below.

Note only one unit can be taken from 804, 832 and 861.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Mandatory			
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	303	Working efficiently and	5

		effectively in engineering	
Optional Group 1			
J/6005794	804	Producing mechanical engineering drawings using a CAD system	11
Y/600/5797	805	Producing components using hand fitting techniques	14
H/600/5799	806	Producing mechanical assemblies	15
T/600/5855	807	Forming and assembling pipework systems	14
A/600/5856	808	Carrying out aircraft detail fitting activities	14
F/600/5857	809	Installing aircraft mechanical fasteners	11
J/600/5858	810	Producing aircraft detail assemblies	14
L/600/5859	811	Preparing and using lathes for turning operations	15
F/600/5860	812	Preparing and using milling machines	15
J/600/5861	813	Preparing and using grinding machines	15
R/600/5863	814	Preparing and proving CNC machine tool programs	14
Y/600/5864	815	Preparing and using CNC turning machines	14
D/600/5865	816	Preparing and using CNC milling machines	14
H/600/5866	817	Preparing and using CNC machining centres	14
K/600/5870	818	Assembling and testing fluid power systems	14
M/600/5868	819	Preparing and using industrial robots	14
T/600/5869	820	Maintaining mechanical devices and equipment	14
F/600/5874	821	Maintaining fluid power equipment	14
Y/600/5878	822	Producing sheet metal components and assemblies	14
R/600/5880	823	Producing platework components and assemblies	14
H/600/5883	824	Cutting and shaping materials using thermal cutting equipment	14
M/600/5885	825	Preparing and proving CNC fabrication machine tool	14

		programs	
A/600/5887	826	Preparing and using CNC fabrication machinery	14
J/600/5889	827	Preparing and using manual metal arc welding equipment	15
F/600/5891	828	Preparing and using manual TIG or plasma-arc welding equipment	15
R/600/5894	829	Preparing and using manual MIG, MAG and other continuous wire welding equipment	15
H/600/5897	830	Preparing and using manual gas welding equipment	14
Y/600/5900	831	Preparing and using manual flame brazing and bronze welding equipment	11
M/600/5904	832	Producing electrical or electronic engineering drawings using a CAD system	11
J/600/5908	833	Wiring and testing electrical equipment and circuits	14
J/600/5911	834	Forming and assembling electrical cable enclosure and support systems	13
R/600/5913	835	Assembling, wiring and testing electrical panels/components mounted in enclosures	14
K/600/5917	836	Assembling, wiring and testing electrical panels/components mounted in enclosures	14
A/600/5923	837	Maintaining electrical equipment/systems	15
J/600/5925	838	Maintaining electronic equipment/systems	15
D/600/5932	839	Maintaining and testing process instrumentation and control devices	15
K/600/5934	840	Wiring and testing programmable controller based systems	15
T/600/5936	841	Using wood for pattern, modelmaking and other engineering applications	15
A/600/5937	842	Assembling pattern, model and engineering woodwork components	14
J/600/5939	843	Producing composite mouldings using wet lay-up techniques	14
L/600/5943	844	Producing composite mouldings using pre-preg	14

		laminating techniques	
Y/600/5945	845	Producing composite mouldings using resin infusion techniques	14
K/600/5948	846	Producing composite assemblies	14
M/600/5949	847	Producing components by rapid prototyping techniques	11
M/600/5952	848	Producing and preparing sand moulds and cores for casting	14
M/600/5954	849	Producing and preparing molten materials for casting	14
J/600/5956	850	Producing cast components by manual means	13
L/600/5960	851	Fettling, finishing and checking cast components	11
R/600/5961	852	Finishing surfaces by applying coatings or coverings	9
H/600/5964	853	Finishing surfaces by applying treatments	9
T/600/5967	854	Carrying out heat treatment of engineering materials	9
A/600/5968	855	Carrying out hand forging of engineering materials	9
T/600/5970	856	Stripping and rebuilding motorsport vehicles (pre-competition)	14
F/600/5972	857	Inspecting a motorsport vehicle during a competition	14
H/600/5978	858	Diagnosing and rectifying faults on motorsport vehicle systems (during competition)	15
H/600/5981	859	Carrying out maintenance activities on motorsport vehicle electrical equipment	15
L/600/5988	860	Stripping and rebuilding motorsport engines (pre-competition)14	14
Y/600/5993	861	Producing CAD models (drawings) using a CAD system	11
Optional Group 2A			
J/600/5794	804	Producing mechanical engineering drawings using a CAD system	11
M/600/5904	832	Producing electrical or electronic engineering drawings using a CAD system	11
t/600/5993	861	Producing CAD models (drawings) using a CAD system	11

Optional Group 2B			
H/600/5995	862	Producing engineering project plans	8
K/600/5996	863	Using computer software packages to assist with engineering activities	8
M/600/5997	864	Conducting business improvement activities	8
Optional Group 2C			
M/600/6003	865	General machining, fitting and assembly applications	12
T/600/6004	866	General fabrication and welding applications	12
F/600/6006	867	General electrical and electronic engineering applications	12
J/600/6007	868	General maintenance engineering applications	12

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Machining) (1712-60)**, learners must achieve the mandatory and PEO units above and a minimum of **111** credits from **1** of the optional groups available.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional			
Group 1			
T/600/5385	Unit 304	Setting centre lathes for production	91
A/600/5386	Unit 305	Machining components using centre lathes	77
Group 2			
F/600/5387	Unit 306	Setting turret lathes for production	91
J/600/5388	Unit 307	Machining components using turret lathes	77
Group 3			
J/600/5391	Unit 308	Setting milling machines for production	91
L/600/5392	Unit 309	Machining components using milling machines	77
Group 4			
R/600/5393	Unit 310	Setting shaping, planing or slotting machines for	78

		production	
Y/600/5394	Unit 311	Machining components using shaping, planing or slotting machines	69
Group 5			
D/600/5395	Unit 312	Setting gear cutting machines for production	91
K/600/5397	Unit 313	Machining components using gear cutting machines	77
Group 6			
M/600/5398	Unit 314	Setting gear grinding machines for production	91
D/600/5400	Unit 315	Machining components using gear grinding machines	77
Group 7			
K/600/5402	Unit 316	Setting horizontal boring machines for production	91
L/600/5411	Unit 317	Machining components using horizontal boring machines	77
Group 8			
F/600/5423	Unit 318	Setting vertical boring machines for production	91
Y/600/5430	Unit 319	Machining components using vertical boring machines	77
Group 9			
H/600/5432	Unit 320	Setting electro-discharge machines for production	91
L/600/5439	Unit 321	Machining components using electro-discharge machines	77
Group 10			
M/600/5448	Unit 322	Setting grinding machines for production	91
Y/600/5458	Unit 323	Machining components using grinding machines	77
Group 11			
L/600/5473	Unit 324	Setting honing and lapping machines for production	78
L/600/5487	Unit 325	Machining components using honing and lapping machines	33
Group 12			
L/600/5490	Unit 326	Setting broaching machines for production	78
A/600/5503	Unit 327	Machining components using broaching machines	33
Group 13			

D/600/5509	Unit 328	Setting metal spinning machines for production	78
K/600/5514	Unit 329	Producing components using metal spinning machines	77

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (CNC Machining) (1712-61)**, learners must achieve the mandatory and PEO units above and a minimum of **24** credits from the optional units in group A and a minimum of one pair of units for a minimum of **133** credits from the optional units in group B-K.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional Group A			
L/600/5523	Unit 330	Loading and proving CNC machine tool programs	24
M/600/5529	Unit 331	Carrying out CNC machine tool programming	84
Optional Group B			
H/600/5561	Unit 332	Setting CNC turning machines for production	70
F/600/5566	Unit 333	Machining components using CNC turning machines	63
Optional Group C			
R/600/5572	Unit 334	Setting CNC milling machines for production	70
K/600/5576	Unit 335	Machining components using CNC milling machines	63
Optional Group D			
J/600/5584	Unit 336	Setting CNC grinding machines for production	70
R/600/5622	Unit 337	Machining components using CNC grinding machines	63
Optional Group E			
K/600/5643	Unit 338	Setting CNC punching machines for production	70
T/600/5662	Unit 339	Machining components using CNC punching machines	63
Optional Group F			
R/600/5670	Unit 340	Setting CNC laser profiling machines for production	70
H/600/5916	Unit 341	Machining components using CNC laser profiling machines	63
Optional Group G			

M/600/5921	Unit 342	Setting CNC electro-discharge machines for production	70
F/600/5924	Unit 343	Machining components using CNC electro-discharge machines	63
Optional Group H			
R/600/5927	Unit 344	Setting CNC vertical boring machines for production	70
Y/600/5928	Unit 345	Machining components using CNC vertical boring machines	63
Optional Group I			
K/600/5951	Unit 346	Setting CNC horizontal boring machines for production	70
K/600/5965	Unit 347	Machining components using CNC horizontal boring machines	63
Optional Group J			
L/600/5974	Unit 348	Setting CNC gear cutting machines for production	70
D/600/5980	Unit 349	Machining components using CNC gear cutting machines	63
Optional Group K			
L/600/5991	Unit 350	Setting CNC machining centres for production	78
D/600/5994	Unit 351	Machining components using CNC machining centres	63

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Machine Tool Setting) (1712-62)**, learners must achieve the mandatory and PEO units above, **38** credits from the mandatory unit below and a minimum of **70** credits from the optional units available.

Unit accreditation number	**City & Guilds unit number**	**Unit title**	**Credit value**
Mandatory			
A/600/5436	Unit 352	Handing over machine tools to production operators	38
Optional			
J/600/5391	Unit 308	Setting milling machines for production	91
R/600/5393	Unit 310	Setting shaping, planing or slotting machines for production	78
D/600/5395	Unit 312	Setting gear cutting machines for production	91

M/600/5398	Unit 314	Setting gear grinding machines for production	91
H/600/5432	Unit 320	Setting electro-discharge machines for production	91
M/600/5448	Unit 322	Setting grinding machines for production	91
L/600/5473	Unit 324	Setting honing and lapping machines for production	78
L/600/5490	Unit 326	Setting broaching machines for production	78
H/600/5561	Unit 332	Setting CNC turning machines for production	70
R/600/5572	Unit 334	Setting CNC milling machines for production	70
J/600/5584	Unit 336	Setting CNC grinding machines for production	70
K/600/5643	Unit 338	Setting CNC Punching Machines for Production	70
R/600/5670	Unit 340	Setting CNC laser profiling machines for production	70
M/600/5921	Unit 342	Setting CNC electro-discharge machines for production	70
L/600/5974	Unit 348	Setting CNC gear cutting machines for production	70
L/600/5991	Unit 350	Setting CNC machining centres for production	70
Y/600/5444	Unit 353	Setting capstan and turret lathes for production	91
K/600/5450	Unit 354	Setting single-spindle automatic turning machines for production	91
T/600/5452	Unit 355	Setting multi-spindle automatic turning machines for production	77
J/600/5455	Unit 356	Setting single and multi-spindle drilling machines for production	77
Y/600/5461	Unit 357	Setting tool and cutter grinding machines for production	77
D/600/5462	Unit 358	Setting special-purpose machines for production	91
A/600/5467	Unit 359	Setting power presses for production	91

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Fitting and Assembly) (1712-63)**, learners must achieve the mandatory and PEO units above and a minimum of **150** credits from a minimum of 3 units from the optional units available.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional			
A/600/5470	Unit 360	Producing components using hand fitting techniques	70
J/600/5472	Unit 361	Assembling mechanical products	70
H/600/5477	Unit 362	Producing components by manual machining	70
H/600/5480	Unit 363	Fitting fluid power components to mechanical assemblies	60
F/600/5485	Unit 364	Fitting pipework systems to mechanical assemblies	60
R/600/5488	Unit 365	Fitting electrical and electronic components to mechanical assemblies	60
Y/600/5492	Unit 366	Producing power turbine combustion assemblies	70
A/600/5498	Unit 367	Producing power turbine compressor assemblies	70
F/600/5504	Unit 368	Producing turbine assemblies	70
R/600/5510	Unit 369	Producing power turbine gearbox assemblies	70
M/600/5515	Unit 370	Producing power turbine major assemblies	70
J/600/5522	Unit 371	Producing piston engine assemblies	70
H/600/5527	Unit 372	Repairing and modifying mechanical assemblies	70
L/600/5537	Unit 373	Checking that completed assemblies comply with specification	30

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Pipe Fitting and Assembly) (1712-64)**, learners must achieve the mandatory and PEO units above, a minimum of **46** credits from the optional units available in group A and a minimum of **60** credits from a minimum of 2 units from the optional units in group B.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional Group A			
Y/600/5542	Unit 374	Pipe Bending and Forming by Hand Methods	46
T/600/5547	Unit 375	Pipe Bending and Forming using Bending Machines	46
Optional Group B			
L/600/5554	Unit 376	Assembling Screwed Pipework	30
D/600/5557	Unit 377	Assembling Small Bore Non-Ferrous Pipework	30
K/600/5562	Unit 378	Assembling Non-Metallic Pipework	30
J/600/5567	Unit 379	Preparing and Testing Pipework Systems	46
L/600/5571	Unit 380	Producing Socket and Flange Fillet Welded Joints in Pipe using a Manual Welding Process	86

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Composite Manufacture) (1712-65)**, learners must achieve the mandatory and PEO units above, a minimum of **86** credits from the optional units available in group A and a minimum of **30** credits from the optional units available in group B. Note, two different units must be selected from group A and B.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional group A			
D/600/5574	Unit 381	Producing composite mouldings using pre-preg laminating techniques	86
T/600/5578	Unit 382	Producing composite mouldings using wet lay-up techniques	86
M/600/5580	Unit 383	Producing composite assemblies	86
Optional group B			
D/600/5574	Unit 381	Producing composite mouldings using pre-preg	86

		laminating techniques	
T/600/5578	Unit 382	Producing composite mouldings using wet lay-up techniques	86
M/600/5580	Unit 383	Producing composite assemblies	86
F/600/5583	Unit 384	Bonding composite mouldings	30
Y/600/5587	Unit 385	Repairing composite mouldings	77
D/600/5588	Unit 386	Applying finishes to composite mouldings	46
K/600/5593	Unit 387	Trimming composite mouldings using hand tools	46
A/600/5596	Unit 388	Identifying defects in composite mouldings	30

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Mechanical Overhaul and Test) (1712-66)**, learners must achieve the mandatory and PEO units above, a minimum of **48** credits from a minimum of 2 units from the optional units available in group A and a minimum of **70** credits from the optional units available in group B.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional group A			
T/600/5600	Unit 389	Slinging, lifting and moving equipment, components or materials for overhauling activities	24
R/600/5605	Unit 390	Dismantling mechanical equipment in preparation for overhaul	49
H/600/5611	Unit 391	Checking mechanical components for serviceability during overhauling activities	24
A/600/5615	Unit 392	Carrying out non-destructive flaw detection on components during overhauling activities	24
R/600/5619	Unit 393	Restoring mechanical components to usable condition by repair	49
D/600/5624	Unit 394	Producing replacement components for overhauling activities	49
A/600/5629	Unit 395	Checking that overhauled mechanical assemblies comply with specification	30

Optional group B

T/600/5631	Unit 396	Overhauling industrial power turbines by module replacement	86
R/600/5636	Unit 397	Overhauling industrial power turbine compressor assemblies	86
Y/600/5640	Unit 398	Overhauling industrial power turbine combustion assemblies	86
A/600/5646	Unit 399	Overhauling turbine assemblies from industrial power turbines	86
F/600/5650	Unit 400	Overhauling piston engines	86
Y/600/5654	Unit 401	Overhauling gearbox assemblies	86
K/600/5657	Unit 402	Overhauling industrial clutch and brake assemblies	77
F/600/5468	Unit 403	Overhauling pump assemblies	77
K/600/5478	Unit 404	Overhauling valve assemblies	77
J/600/5486	Unit 405	Overhauling components of hydraulic equipment	77
D/600/5493	Unit 406	Overhauling components of pneumatic, vacuum or compressed air equipment	77
K/600/5500	Unit 407	Carrying out tests on overhauled industrial power turbines	70
D/600/5512	Unit 408	Carrying out tests on overhauled piston engines (fixed dynamometer)	70

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Spring Making) (1712-67)**, learners must achieve the mandatory and PEO units above and a minimum of **64** credits from a minimum of 4 units from the optional units available.

Unit accreditation number	**City & Guilds unit number**	**Unit title**	**Credit value**
Optional			
F/600/5521	Unit 409	Making compression springs using hand forming methods	46
K/600/5531	Unit 410	Making torsion springs using hand forming methods	46
Y/600/5539	Unit 411	Making extension springs using hand forming methods	46
A/600/5548	Unit 412	Making spring wire forms using hand forming methods	46
D/600/5560	Unit 413	Grinding spring ends by hand	16

H/600/5575	Unit 414	Setting automatic cold wire compression spring making machines for production	46
L/600/5635	Unit 415	Setting automatic cold wire torsion spring making machines for production	46
J/600/5648	Unit 416	Setting automatic cold wire extension spring making machines for production	46
R/600/5653	Unit 417	Setting automatic spring making machines for the production of clock, power, scroll and volute springs	46
M/600/5661	Unit 418	Setting automatic cold wire forming machines to produce spring wire forms	46
D/600/5672	Unit 419	Setting automatic hot wire compression spring making machines for production	46
L/600/5683	Unit 420	Setting automatic spring end grinding machines for production	16
H/600/5687	Unit 421	Programming CNC spring making machines	84
H/600/5690	Unit 422	Setting CNC spring making machines for production	46
T/600/5693	Unit 423	Operating CNC spring making machines	30
F/600/5695	Unit 424	Setting and using a fly press for spring making activities	30
Y/600/5699	Unit 425	Making strip spring components using shearing machines	30
L/600/5702	Unit 426	Forming strip spring components using power rolling machines	30
Y/600/5704	Unit 427	Bending strip spring components using press brakes	30
M/600/5708	Unit 428	Forming strip spring components using power presses	30
M/600/5711	Unit 429	Drilling and finishing holes in strip spring components	16
L/600/5716	Unit 430	Using heat to assist with the bending and forming of spring components	16
D/600/5719	Unit 431	Carrying out heat treatment of springs	30
H/600/5723	Unit 432	Carrying out shot peening of springs	30
M/600/5725	Unit 433	Carrying out quality control of spring making activities	46

M/600/5739	Unit 434	Manufacturing one-off tooling for spring making activities	77
A/600/5744	Unit 435	Setting and operating CNC laser profiling machines for strip spring making	77

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (Photonics Engineering) (1712-68)**, learners must achieve the mandatory and PEO units above and a minimum of **76** credits from a minimum of 3 units from the optional units available.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Optional			
J/600/5746	Unit 436	Machining infra-red/special material lenses	77
R/600/5751	Unit 437	Machining optical glass lenses	77
H/600/5754	Unit 438	Machining optical prism and flat components	77
A/600/5758	Unit 439	Setting CNC aspheric glass and diamond turning machines	78
F/600/5762	Unit 440	Machining components using CNC aspheric glass and diamond turning machines	46
Y/600/5766	Unit 441	Setting CNC optical grinding and polishing machines for production	78
D/600/5770	Unit 442	Machining components using CNC optical grinding and polishing machines	46
J/600/5813	Unit 443	Machining optical cylinders and domes	77
L/600/5814	Unit 444	Machining optical plastic components	77
R/600/5815	Unit 445	Polishing and smoothing of lens or mirror surfaces	77
Y/600/5816	Unit 446	Vacuum coating optical materials	30
D/600/5817	Unit 447	Inspecting optical components using mechanical instruments	30
K/600/5819	Unit 448	Inspecting optical components using co-ordinate measuring machines (CMM)	46
D/600/5820	Unit 449	Carrying out laser/optical metrology	46
K/600/5822	Unit 450	Terminating fibre-optic cables	30

M/600/5823	Unit 451	Building optical systems	78
F/600/5826	Unit 452	Performing laser optical system alignment	46
J/600/5827	Unit 453	Aligning and setting up holographic equipment	77
R/600/5829	Unit 454	Following clean room and clean work area protocols	16

2 Centre requirements

Approval

To offer this qualification new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual - Supporting Customer Excellence for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing

Staff delivering this qualification must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the areas for which they are delivering training and/or have experience of providing training; this knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Centre staff may undertake more than one role, e.g. tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors and internal verifier

Assessor Requirements to Demonstrate Effective Assessment Practice
Assessment must be carried out by competent Assessors that as a minimum must hold the QCF Level 3 Award in Assessing Competence in the Work Environment. Current and operational assessors that hold units D32 and/or D33 or A1 and/or A2 as appropriate for the assessment requirements set out in this Unit Assessment Strategy. However, they will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace assessment to the most up to date National Occupational Standards (NOS).

Assessor Technical Requirements
Assessors must be able to demonstrate that they have verifiable, relevant and sufficient technical competence to evaluate and judge performance and knowledge evidence requirements as set out in the relevant QCF unit learning outcomes and associated assessment criteria.

This will be demonstrated either by holding a relevant technical qualification or by proven industrial experience of the technical areas to be assessed. The assessor's competence must, at the very least, be at the same level as that required of the learner(s) in the units being assessed.

Assessors must also be fully conversant with the Awarding Organisation's assessment recording documentation used for the QCF NVQ units against which the assessments and verification are to be carried out, other relevant documentation and system and procedures to support the QA process.

Verifier Requirements (internal and external)
Internal quality assurance (**Internal Verification**) must be carried out by competent Verifiers that as a minimum must hold the QCF Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External quality assurance **(External Verification)** must be carried out by competent External Verifiers that as a minimum must hold the QCF Level 4 Award in the External Quality Assurance of Assessment Processes and Practices**.** Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up to date National Occupational Standards (NOS) Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the QCF NVQ units against which the assessments and verification are to be carried out, the appropriate Regulatory Body's systems and procedures and the relevant Awarding Organisation's documentation.

Continuing Professional Development (CPD)
Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Candidate entry requirements

City & Guilds does not set entry requirements for this qualification. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully so should have the opportunity to gather work based evidence.

The SEMTA Engineering Manufacture apprenticeship framework suggests that employers would be interested in candidates that:

- Are keen and motivated to work in an engineering environment
- Are willing to undertake a course of training both on-the-job and off-the-job and apply this learning in the workplace
- Have previous work experience or employment in the sector
- Have completed a 14 to 19 Diploma in Engineering or Manufacturing
- Have completed a Young Apprenticeship in Engineering or other related area
- Have GCSEs in English, Maths and Science
- Have completed tests in basic numeracy, literacy and communication skills and have spatial awareness.

As a guide, the Engineering Manufacturing framework is suitable for applicants who have five GCSEs grades D to E in English, Maths and Science. The selection process on behalf of employers may include initial assessment where applicants will be asked if they have any qualifications or experience that can be accredited against the requirements of the apprenticeship. They may also be required to take tests in basic numeracy and literacy, communications skills and spatial awareness. There may also be an interview to ensure applicants have selected the right occupational sector and are motivated to become an apprentice, as undertaking an apprenticeship is a major commitment for both the individual and the employer.

Assessment Environment (extract from SEMTA QCF Unit Assessment Strategy 1 January 2011)
The evidence put forward for this qualification can only be regarded valid, reliable, sufficient and authentic if achieved and obtained in the working environment and be clearly attributable to the learner. However, in certain circumstances, simulation/replication of work activities may be acceptable.

The use of high quality, realistic simulations/replication, which impose pressures which are consistent with workplace expectations, should only be used in relation to the assessment of the following:

- rare or dangerous occurrences, such as those associated with health, safety and the environment issues, emergency scenarios and rare operations at work
- the response to faults and problems for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence
- aspects of working relationships and communications for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence.

Simulations/replications will require prior approval from centres City & Guilds external verifier/qualification consultant and should be designed in relation to the following parameters:

- the environment in which simulations take place must be designed to match the characteristics of the working environment
- competencies achieved via simulation/replication must be transferable to the working environment

- simulations which are designed to assess competence in dealing with emergencies, accidents and incidents must be verified as complying with relevant health, safety and environmental legislation by a competent health and safety/environmental control officer before being used
- simulated activities should place learners under the same pressures of time, access to resources and access to information as would be expected if the activity was real
- simulated activities should require learners to demonstrate their competence using plant and/or equipment used in the working environment
- simulated activities which require interaction with colleagues and contacts should require the learner to use the communication media that would be expected at the workplace
- for health and safety reason simulations need not involve the use of genuine substances/materials. Any simulations which require the learner to handle or otherwise deal with materials substances/should ensure that the substitute takes the same form as in the workplace.

Age restrictions

City & Guilds cannot accept any registrations for candidates under 16 as this qualification is not approved for under 16s.

Legal restrictions apply to candidates under the age of 18 working unsupervised with children. Centres and candidates should be fully aware of minimum age requirements in their home nation and any implications for completing assessments.

3 Delivering the qualification

Initial assessment and induction

An initial assessment of each candidate should be made before the start of their programme to identify:

- if the candidate has any specific training needs
- support and guidance they may need when working towards their qualifications
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualifications, their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

Recommended delivery strategies

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualifications before designing a course programme.

Centres may design course programmes of study in any way which:

- best meets the needs and capabilities of their candidates
- satisfies the requirements of the qualifications.

When designing and delivering the course programme, centres might wish to incorporate other teaching and learning that is not assessed as part of the qualifications. This might include the following:

- literacy, language and/or numeracy
- personal learning and thinking
- personal and social development
- employability

Where applicable, this could involve enabling the candidate to access relevant qualifications covering these skills.

Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, Learning Assistant, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: **www.cityandguilds.com/eportfolios**.

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate.

Recording forms are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre.

Amendable (MS Word) versions of the forms are available on the City & Guilds website.

4 Assessment

Assessment of the qualification

Candidates must have a completed portfolio of evidence for each unit chosen.

Evidence requirements

Carrying Out Assessments
The NVQ units were specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the learners choice of “bulleted items” listed in the unit assessment criteria.

Where the assessment criteria gives a choice of bulleted items (for example ‘any three from five’), assessors should note that learners do not need to provide evidence of the other items to complete the unit (in this example, two) items, particularly where these additional items may relate to other activities or methods that are not part of the learners normal workplace activity or area of expertise.

Minimum Performance Evidence Requirements
Performance evidence must be the main form of evidence gathered. In order to demonstrate consistent, competent performance for a unit, a minimum of 3 different examples of performance must be provided, and must be sufficient to show that the assessment criteria have been achieved to the prescribed standards. It is possible that some of the bulleted items in the assessment criteria may be covered more than once. The assessor and learner need to devise an assessment plan to ensure that performance evidence is sufficient to cover all the specified assessment criteria and which maximises the opportunities to gather evidence. Where applicable, performance evidence may be used for more than one unit.

The most effective way of assessing competence, is through direct observation of the learner. Assessors must make sure that the evidence provided reflects the learner’s competence and not just the achievement of a training programme.

Evidence that has been produced from team activities, for example, maintenance or installation activities is only valid when it clearly relates to the learners specific and individual contribution to the activity, and not to the general outcome(s).

Each example of performance evidence will often contain features that apply to more than one unit, and can be used as evidence in any unit where appropriate.

Performance evidence must be a combination of:

- outputs of the learner's work, such as items that have been manufactured, installed, maintained, designed, planned or quality assured, and documents produced as part of a work activity
- evidence of the way the learner carried out the activities such as witness testimonies, assessor observations or authenticated learner reports, records or photographs of the work/activity carried out, etc.

Competent performance is more than just carrying out a series of individual set tasks. Many of the units contain statements that require the learner to provide evidence that proves they are capable of combining the various features and techniques. Where this is the case, separate fragments of evidence would not provide this combination of features and techniques and will not, therefore, be acceptable as demonstrating competent performance.

If there is any doubt as to what constitutes valid, authentic and reliable evidence, the internal and/or external verifier (qualifications consultant) should be consulted.

Assessing knowledge and understanding
Knowledge and understanding are key components of competent performance, but it is unlikely that performance evidence alone will provide enough evidence in this area. Where the learners knowledge and understanding (and the handling of contingency situations) is not apparent from performance evidence, it must be assessed by other means and be supported by suitable evidence.

Knowledge and understanding can be demonstrated in a number of different ways. Semta (the Sector Skills Council) expects oral questioning and practical demonstrations to be used, as these are considered the most appropriate for these units. Assessors should ask enough questions to make sure that the learner has an appropriate level of knowledge and understanding, as required by the unit.

Evidence of knowledge and understanding will **not** be required for those bulleted items in the assessment criteria that have not been selected by the learner.

The achievement of the specific knowledge and understanding requirements of the units cannot simply be inferred by the results of tests or assignments from other units, qualifications or training programmes. Where evidence is submitted from these sources, the assessor must, as with any assessment, make sure the evidence is valid, reliable, authentic, directly attributable to the learner, and meets the full knowledge and understanding requirements of the unit. Where oral questioning is used the assessor must retain a record of the questions asked, together with the learner's answers.

Witness testimony
Where observation is used to obtain performance evidence, this must be carried out against the unit assessment criteria. Best practice would require that such observation is carried out by a qualified Assessor. If this is not practicable, then alternative sources of evidence may be used.

For example, the observation may be carried out against the assessment criteria by someone else that is in close contact with the learner. This could be a team leader, supervisor, mentor or line manager who may be regarded as a suitable witness to the learners' competency. However, the witness must be technically competent in the process or skills that they are providing testimony for, to at least the same level of expertise as that required of the learner. It will be the responsibility of the assessor to make sure that any witness testimonies accepted as evidence of the learner's competency are reliable, auditable and technically valid.

Recognition of Prior Learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification. RPL is allowed and is also sector specific.

5 Units

Availability of units

Below is a list of the learning outcomes for all the units. If you want to download a complete set of units, go to **www.cityandguilds.com**

Structure of units

These units each have the following:

- City & Guilds unit number
- Title
- Unit Accreditation Number (UAN)
- Level
- Credit value
- Recommended Guided Learning Hours (GLH)
- Relationship to National Occupational Standards (NOS), other qualifications and frameworks
- Endorsement by a sector or other appropriate body
- Unit aim(s)
- Learning outcomes which are comprised of a number of assessment criteria.

Unit 201 Complying with statutory regulations and organisational safety requirements

UAN:	**A/601/5013**
Level:	Level 2
Credit value:	5
GLH:	35
Relationship to NOS:	This unit has been derived from national occupational standard: Complying with statutory regulations and organisational safety requirements (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to deal with statutory regulations and organisational safety requirements. It does not deal with specific safety regulations or detailed requirements, it does, however, cover the more general health and safety requirements that apply to working in an industrial environment. The learner will be expected to comply with all relevant regulations that apply to their area of work, as well as their general responsibilities as defined in the Health and Safety at Work Act. The learner will need to be able to identify the relevant qualified first aiders and know the location of the first aid facilities. The learner will have a knowledge and understanding of the procedures to be adopted in the case of accidents involving injury and in situations where there are dangerous occurrences or hazardous malfunctions of equipment, processes or machinery. The learner will also need to be fully conversant with their organisation's procedures for fire alerts and the evacuation of premises. The learner will also be required to identify the hazards and risks that are associated with their job. Typically, these will focus on their working environment, the tools and

equipment that they use, the materials and substances that they use, any working practices that do not follow laid-down procedures, and manual lifting and carrying techniques.

The learner's responsibilities will require them to comply with all relevant statutory and organisational policy and procedures for health and safety in the workplace. The learner must act in a responsible and safe manner at all times, and present themselves in the workplace suitably prepared for the activities to be undertaken. The learner will be expected to report any problems with health and safety issues, to the relevant authority.

The learner's knowledge will provide a good understanding of the relevant statutory regulations and organisational requirements associated with their work, and will provide an informed approach to the procedures used. The learner will need to understand their organisation's health and safety requirements and their application, in adequate depth to provide a sound basis for carrying out their activities in a safe and competent manner.

Learning outcome

The learner will:

1. Comply with statutory regulations and organisational safety requirements

Assessment criteria

The learner can:

1.1 Comply with their duties and obligations as defined in the Health and Safety at Work Act

1.2 Demonstrate their understanding of their duties and obligations to health and safety by:
- applying in principle their duties and responsibilities as an individual under the Health and Safety at Work Act
- identifying, within their organisation, appropriate sources of information and guidance on health and safety issues, such as:
  - eye protection and Personal Protective Equipment (PPE)
  - COSHH regulations
  - Risk assessments

1.3 identifying the warning signs and labels of the main groups of hazardous or dangerous substances

1.4 complying with the appropriate statutory regulations at all times

1.5 Present themselves in the workplace suitably prepared for the activities to be undertaken

1.6 Follow organisational accident and emergency procedures

1.7	Comply with emergency requirements, to include: • identifying the appropriate qualified first aiders and the location of first aid facilities • identifying the procedures to be followed in the event of injury to themselves or others • following organisational procedures in the event of fire and the evacuation of premises • identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment
1.8	Recognise and control hazards in the workplace
1.9	Identify the hazards and risks that are associated with the following: • their working environment • the equipment that they use • materials and substances (where appropriate) that they use • working practices that do not follow laid-down procedures
1.10	Use correct manual lifting and carrying techniques
1.11	Demonstrate one of the following methods of manual lifting and carrying: • lifting alone • with assistance of others • with mechanical assistance
1.12	Apply safe working practices and procedures to include: • maintaining a tidy workplace, with exits and gangways free from obstruction • using equipment safely and only for the purpose intended • observing organisational safety rules, signs and hazard warnings • taking measures to protect others from any harm resulting from the work that they are carrying out

Learning outcome	
The learner will:	
2.	Know how to comply with statutory regulations and organisational safety requirements
Assessment criteria	
The learner can:	
2.1	Describe the roles and responsibilities of themselves and others under the Health and Safety at Work Act, and other current legislation (such as The Management of Health and Safety at Work Regulations, Workplace Health and Safety and Welfare Regulations, Personal Protective Equipment at Work Regulations, Manual Handling Operations Regulations, Provision and Use of Work Equipment Regulations, Display Screen at Work Regulations, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations)
2.2	Describe the specific regulations and safe working practices and procedures that apply to their work activities
2.3	Describe the warning signs for the seven main groups of hazardous substances defined by Classification, Packaging and Labelling of

	Dangerous Substances Regulations
2.4	Explain how to locate relevant health and safety information for their tasks, and the sources of expert assistance when help is needed
2.5	Explain what constitutes a hazard in the workplace (such as moving parts of machinery, electricity, slippery and uneven surfaces, poorly placed equipment, dust and fumes, handling and transporting, contaminants and irritants, material ejection, fire, working at height, environment, pressure/stored energy systems, volatile, flammable or toxic materials, unshielded processes, working in confined spaces)
2.6	Describe their responsibilities for identifying and dealing with hazards and reducing risks in the workplace
2.7	Describe the risks associated with their working environment (such as the tools, materials and equipment that they use, spillages of oil, chemicals and other substances, not reporting accidental breakages of tools or equipment and not following laid-down working practices and procedures)
2.8	Describe the processes and procedures that are used to identify and rate the level of risk (such as safety inspections, the use of hazard checklists, carrying out risk assessments, COSHH assessments)
2.9	Describe the first aid facilities that exist within their work area and within the organisation in general; the procedures to be followed in the case of accidents involving injury
2.10	Explain what constitute dangerous occurrences and hazardous malfunctions, and why these must be reported even if no-one is injured
2.11	Describe the procedures for sounding the emergency alarms, evacuation procedures and escape routes to be used, and the need to report their presence at the appropriate assembly point
2.12	Describe the organisational policy with regard to fire fighting procedures; the common causes of fire and what they can do to help prevent them
2.13	Describe the protective clothing and equipment that is available for their areas of activity
2.14	Explain how to safely lift and carry loads, and the manual and mechanical aids available
2.15	Explain how to prepare and maintain safe working areas; the standards and procedures to ensure good housekeeping
2.16	Describe the importance of safe storage of tools, equipment, materials and products
2.17	Describe the extent of their own authority, and to whom they should report in the event of problems that they cannot resolve

Unit 202 Using and interpreting engineering data and documentation

UAN:	**Y/601/5102**
Level:	Level 2
Credit value:	5
GLH:	25
Relationship to NOS:	This unit has been derived from national occupational standard: Using and interpreting engineering data and documentation (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to make effective use of text, numeric and graphical information, by interpreting and using technical information extracted from documents such as engineering drawings, technical manuals, reference tables, specifications, technical sales/marketing documentation, charts or electronic displays, in accordance with approved procedures. The learner will be required to extract the necessary information from the various documents, in order to establish and carry out the work requirements, and to make valid decisions about the work activities based on the information extracted. The learner's responsibilities will require them to comply with organisational policy and procedures for obtaining and using the documentation applicable to the activity. They will be expected to report any problems with the use and interpretation of the documents that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions if necessary, with an appropriate level of supervision or as a member of a team, and take personal responsibility for their own actions and for the quality and accuracy of

the work that they carry out.

The learner's underpinning knowledge will provide a good understanding of the types of documentation used, and will provide an informed approach to applying instructions and procedures. They will be able to read and interpret the documentation used and will know about the conventions, symbols and abbreviations, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

Learning outcome
The learner will: 1. Use and interpret engineering data and documentation
Assessment criteria
The learner can: 1.1 Use the approved source to obtain the required data and documentation 1.2 Use the data and documentation and carry out all of the following: • check the currency and validity of the data and documentation used • exercise care and control over the documents at all times • correctly extract all necessary data in order to carry out the required tasks • seek out additional information where there are gaps or deficiencies in the information obtained • deal with or report any problems found with the data and documentation • make valid decisions based on the evaluation of the engineering information extracted from the documents • return all documents to the approved location on completion of the work • complete all necessary work related documentation such as production documentation, installation documentation, maintenance documentation, planning documentation 1.3 Correctly identify, interpret and extract the required information 1.4 Extract information that includes three of the following: • materials or components required • dimensions • tolerances • build quality • installation requirements • customer requirements • time scales • financial information • operating parameters • surface texture requirements

- location/orientation of parts
- process or treatments required
- dismantling/assembly sequence
- inspection/testing requirements
- number/volumes required
- repair/service methods
- method of manufacture
- weld type and size
- operations required
- connections to be made
- surface finish required
- shape or profiles
- fault finding procedures
- safety/risk factors
- environmental controls
- specific data (such as component data, maintenance data, electrical data, fluid data)
- resources (such as tools, equipment, personnel)
- utility supply details (such as electricity, water, gas, air)
- location of services, including standby and emergency backup systems
- circuit characteristics (such as pressure, flow, current, voltage, speed)
- protective arrangements and equipment (such as containment, environmental controls, warning and evacuation systems and equipment)
- other specific related information

1.5 Use the information obtained to ensure that work output meets the specification

1.6 Use information extracted from documents to include one from the following:

- drawings (such as component drawings, assembly drawings, modification drawings, repair drawings, welding/fabrication drawings, distribution and installation drawings)
- diagrams (such as schematic, fluid power diagrams, piping, wiring/circuit diagrams)
- manufacturers manuals/drawings
- approved sketches
- technical illustrations
- photographic representations
- visual display screen information
- technical sales/marketing documentation
- contractual documentation
- other specific drawings/documents

1.7 Use information extracted from related documentation, to include two from the following:

- instructions (such as job instructions, drawing instructions, manufacturers instructions)

- specifications (such as material, finish, process, contractual, calibration)
- reference materials (such as manuals, tables, charts, guides, notes)
- schedules
- operation sheets
- service/test information
- planning documentation
- quality control documents
- company specific technical instructions
- national, international and organisational standards
- health and safety standards relating to the activity (such as COSHH)
- other specific related documentation

1.8 Deal promptly and effectively with any problems within their control and report those which cannot be solved

1.9 Report any inaccuracies or discrepancies in documentation and specifications

Learning outcome

The learner will:

2. Know how to use and interpret engineering data and documentation

Assessment criteria

The learner can:

2.1 Explain what information sources are used for the data and documentation that they use in their work activities

2.2 Explain how documents are obtained, and how to check that they are current and valid

2.3 Explain the basic principles of confidentiality (including what information should be available and to whom)

2.4 Describe the different ways/formats that data and documentation can be presented (such as such as drawings, job instructions product data sheets, manufacturers' manuals, financial spreadsheets, production schedules, inspection and calibration requirements, customer information)

2.5 Explain how to use other sources of information to support the data (such as electronic component pin configuration specifications, reference charts, standards, bend allowances required for material thickness, electrical conditions required for specific welding rods, mixing ratios for bonding and finishing materials, metal specifications and inspection requirements, health and safety documentation)

2.6 Describe the importance of differentiating fact from opinion when reviewing data and documentation

2.7 Describe the importance of analysing all available data and documentation before decisions are made

2.8 Describe the different ways of storing and organising data and documentation to ensure easy access

2.9 Describe the procedures for reporting discrepancies in the data or documentation, and for reporting lost or damaged documents

2.10 Describe the importance of keeping all data and documentation up to date during the work activity, and the implications of this not being done

2.11 Explain the care and control procedures for the documents, and how damage or graffiti on documents can lead to scrapped work

2.12 Explain the importance of returning documents to the designated location on completion of the work activities

2.13 Explain what basic drawing conventions are used and why there needs to be different types of drawings (such as isometric and orthographic, first and third angle, assembly drawings, circuit and wiring diagrams, block and schematic diagrams

2.14 Explain what types of documentation are used and how they interrelate (such as production drawings, assembly drawings, circuit and wiring diagrams, block and schematic diagrams)

2.15 Explain the imperial and metric systems of measurement; tolerancing and fixed reference points

2.16 Describe the meaning of the different symbols and abbreviations found on the documents that they use (such as surface finish, electronic components, weld symbols, linear and geometric tolerances, pressure and flow characteristics)

2.17 Describe the extent of their own responsibility, when to act on their own initiative to find, clarify and evaluate information, and to whom they should report if they have problems that they cannot resolve

Unit 303 Working efficiently and effectively in engineering

UAN:	**K/601/5055**
Level:	Level 3
Credit value:	5
GLH:	25
Relationship to NOS:	This unit has been derived from national occupational standard: Working efficiently and effectively in engineering (Suite 3).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to work efficiently and effectively in the workplace, in accordance with approved procedures and practices. Prior to undertaking the engineering activity, the learner will be required to carry out all necessary preparations within the scope of their responsibility. This may include preparing the work area and ensuring that it is in a safe condition to carry out the intended activities, ensuring they have the appropriate job specifications and instructions and that any tools, equipment, materials and other resources required are available and in a safe and usable condition. On completion of the engineering activity, the learner will be required to return their immediate work area to an acceptable condition before recommencing further work requirements. This may involve placing completed work in the correct location, returning and/or storing any tools and equipment in the correct area, identifying any waste and/or scrapped materials and arranging for their disposal, and reporting any defects or damage to tools and equipment used. In order to be efficient and effective in the workplace, the learner will also be required to demonstrate that they can create and maintain effective working relationships with colleagues and line management. The

learner will also be expected to review objectives and targets for their personal development and make recommendations to, and communicate any opportunities for, improvements that could be made to working practices and procedures.

The learner's responsibilities will require them to comply with organisational policy and procedures for the engineering activities undertaken, and to report any problems with the activities, or the tools and equipment that are used that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to take personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to working efficiently and effectively in an engineering environment. The learner will understand the need to work efficiently and effectively, and will know about the areas they need to consider when preparing and tidying up the work area, how to contribute to improvements, deal with problems, maintain effective working relationships and agree their development objectives and targets, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

The learner will understand the safety precautions required when carrying out engineering activities. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Work efficiently and effectively in engineering
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 Prepare the work area to carry out the engineering activity 1.3 Prepare to carry out the engineering activity, taking into consideration all of the following, as applicable to the work to be

undertaken:

- the work area is free from hazards and is suitably prepared for the activities to be undertaken
- any required safety procedures are implemented
- any necessary personal protection equipment is obtained and is in a usable condition
- tools and equipment required are obtained and checked that they are in a safe and useable condition
- all necessary drawings, specifications and associated documentation is obtained
- job instructions are obtained and understood
- the correct materials or components are obtained
- storage arrangements for work are appropriate
- appropriate authorisation to carry out the work is obtained

1.4 Check that there are sufficient supplies of materials and/or consumables and that they meet work requirements

1.5 Ensure that completed products or resources are stored in the appropriate location on completion of the activities

1.6 Complete work activities, to include all of the following:

- completing all necessary documentation accurately and legibly
- returning tools and equipment
- returning drawings and work instructions
- identifying, where appropriate, any unusable tools, equipment or components
- arranging for disposal of waste materials

1.7 Tidy up the work area on completion of the engineering activity

1.8 Deal promptly and effectively with problems within their control and report those that cannot be resolved

1.9 Deal with problems affecting the engineering process, to include two of the following:

- materials
- tools and equipment
- drawings
- job specification
- quality
- people
- timescales
- safety
- activities or procedures

1.10 Contribute to and communicate opportunities for improvement to working practices and procedures

1.11 Make recommendations for improving to two of the following:

- working practices
- working methods
- quality
- safety
- tools and equipment

- supplier relationships
- internal communication
- customer service
- training and development
- teamwork
- other

1.12 Maintain effective working relationships with colleagues to include two of the following:
- colleagues within own working group
- colleagues outside normal working group
- line management
- external contacts

1.13 Review personal training and development as appropriate to the job role

1.14 Review personal development objectives and targets to include one of the following:
- dual or multi-skilling
- training on new equipment / technology
- increased responsibility
- understanding of company working practices, procedures, plans and policies
- other specific requirements

Learning outcome
The learner will: 2. Know how to work efficiently and effectively in engineering
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed whilst preparing and tidying up their work area 2.2 Describe the correct use of any equipment used to protect the health and safety of themselves and their colleagues 2.3 Describe the procedure for ensuring that all documentation relating to the work being carried out is available and current, prior to starting the activity 2.4 Describe the action that should be taken if documentation received is incomplete and/or incorrect 2.5 Describe the procedure for ensuring that all tools and equipment are available prior to undertaking the activity 2.6 Describe the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity 2.7 Describe the action that should be taken if tools and equipment are not in full working order 2.8 Describe the checks to be carried out to ensure that all materials required are correct and complete, prior to undertaking the activity 2.9 Describe the action that should be taken if materials do not meet the requirements of the activity 2.10 Explain whom to inform when the work activity has been completed

2.11	Describe the information and/or documentation required to confirm that the activity has been completed
2.12	Explain what materials, equipment and tools can be reused
2.13	Explain how any waste materials and/or products are transferred, stored and disposed of
2.14	Explain where tools and equipment should be stored and located
2.15	Describe the importance of making recommendations for improving working practices
2.16	Describe the procedure and format for making suggestions for improvements
2.17	Describe the benefits to organisations if improvements can be identified
2.18	Describe the importance of maintaining effective working relationships within the workplace
2.19	Describe the procedures to deal with and report any problems that can affect working relationships
2.20	Describe the difficulties that can occur in working relationships
2.21	Describe the regulations that affect how they should be treated at work (such as Equal Opportunities Act, Race and Sex Discrimination, Working Time Directive)
2.22	Describe the benefits of continuous personal development
2.23	Describe the training opportunities that are available in the workplace
2.24	Describe the importance of reviewing their training and development
2.25	Explain with whom to discuss training and development issues
2.26	Describe the extent of their own responsibility and to whom they should report if they have any problems that they cannot resolve

Unit 804 Producing mechanical engineering drawings using a CAD system

UAN:	**J/600/5794**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 4: Producing mechanical engineering drawings using a CAD system (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to set up and operate a computer aided drawing system to produce detailed drawings for mechanical engineering activities. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will act as a basis for the development of additional skills and occupational competences in the working environment. The type of drawings produced will include detail component drawings for manufacturing, assembly and sub-assembly drawings, installation drawings, fault location aids such as flow diagrams, and modification drawings. The learner will be given a specific drawing brief or a request for a change/modification to a drawing, and they will be required to access these requirements and extract all necessary information in order to carry out the drawing operations. The learner will need to select the appropriate equipment and drawing software to use, based on the type and complexity of the drawing functions to be carried out. The learner will be expected to use current British, European and company standards to produce a drawing template for a range of paper sizes, that must include the drawing title, scale

used, date of drawing, material to be used and other relevant information. The learner will then be expected to produce fully detailed drawings to enable the manufacture, assembly, installation or modification of the product to take place. On completion of the drawing activities, the learner will be expected to return all documentation, reference manuals or specifications to the designated location, to shut down the CAD system correctly and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for working with the CAD equipment. The learner will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or drawing procedures, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate computer aided drawing procedures and techniques for generating mechanical engineering drawings. The learner will understand the computer system and software used, and its application, and will know about the various tools and techniques used to produce the drawings, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the computer drawing system. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce mechanical engineering drawings using a CAD system
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare the CAD system for operation by carrying out all of the following: • check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed) • power up the equipment and activate the appropriate drawing software • set up the drawing system to be able to produce the drawing to the appropriate scale • set up and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter) • set the drawing datum at a convenient point (where applicable) • set up drawing parameters (to include layers, line types, colour, text styles) to company procedures or to suit the drawing produced • create a drawing template to the required standards, which includes all necessary detail (such as title, drawing number, scale, material, date, etc) 1.3 Plan the drawing activities before they start them 1.4 Use appropriate sources to obtain the required information for the drawing to be created 1.5 Use three of the following to obtain the necessary data to produce the required drawings: • drawing brief • drawing change or modification request • manuals • calculations • sketches • specifications • regulations • sample component • existing drawings/designs • other available data • standards reference documents (such as limits and fits, tapping drill charts) • notes from meetings/discussions 1.6 Take into account three of the following design features, as appropriate to the drawing being produced: • function

- quality
- manufacturing method
- ergonomics
- materials
- cost
- life of the product
- tolerances
- clearance
- aesthetics
- physical space
- operating environment
- interfaces
- safety

1.7 Carry out all of the following before producing the engineering drawing:
- ensure that the data and information they have is complete and accurate
- review the data and information to identify the drawing requirements
- recognise and deal with problems (such as information-based and technical)

1.8 Access and use the correct drawing software

1.9 Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed

1.10 Interpret and produce drawings, using two of the following methods of projection:
- first angle orthographic projections
- isometric/oblique projections
- third angle orthographic projections

1.11 Produce two of the following types of drawing:
- detail drawings
- general arrangement drawings
- sub-assembly drawings
- installation drawings

1.12 Produce mechanical drawings which include ten of the following:
- straight lines
- dimensions
- angled lines
- text
- insertion of standard components
- symbols and abbreviations
- curved/contour lines
- circles or ellipses
- geometrical tolerancing
- hidden detail
- sectional detail
- parts lists

- other specific detail

1.13 Use codes and other references that follow the required conventions

1.14 Produce drawings which comply with the following:
- BS and ISO standards

Plus one more from the following:
- organisational guidelines
- statutory regulations and codes of practice
- CAD software standards
- other international standard

1.15 Make sure that drawings are checked and approved by the appropriate person

1.16 Save the drawings in the appropriate medium and location to include all of the following:
- ensure that their drawing has been checked and approved by their supervisor
- check that the drawing is correctly titled and referenced
- save the drawing to an appropriate storage medium (such as hard drive, disc, CD, external storage device)
- create a separate backup copy and place it in safe storage
- produce a hard copy printout of the drawing for file purposes
- register and store the drawings in the appropriate company information system (where appropriate)
- record and store any changes to the drawings in the company information system (where appropriate)

1.17 Produce hard copies of the finished drawings

1.18 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the CAD system to a safe condition on completion of the drawing activities

Learning outcome
The learner will: 2. Know how to produce mechanical engineering drawings using a CAD system
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of Visual Display Unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), Repetitive Strain Injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections) 2.2 Describe good housekeeping arrangements (such as cleaning down work surfaces; putting disks, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition) 2.3 Describe the relevant sources and methods for obtaining any required technical information relevant to the drawing being

produced (such as drawing briefs, specification sheets, request for changes or modifications to drawings; technical information such as limits and fits, contraction allowances, bearing selection, surface finish)

2.4 Describe the basic principles of engineering manufacturing operations, assembly and installation methods, and limitations of the equipment/processes that are used to produce the drawn item (such as machining methods, joining processes, fabrication, casting and forging), and how these can influence the way they present the drawing

2.5 Describe the functionality of the component being drawn, and its interrelationship with other components and assemblies

2.6 Describe the correct start-up and shutdown procedures to be used for the computer systems

2.7 Describe the identification of the correct drawing software package from the menu or operating environment; the various techniques that are available to access and use the CAD software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners)

2.8 Describe the use of software manuals and related documents to aid efficient operation of the relevant drawing system

2.9 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)

2.10 Describe the types of drawings that may be produced by the software (such as first and third angle drawings, sectional elevations, isometric or oblique drawings)

2.11 Explain how to set up the viewing screen to show multiple views of the drawing to help with drawing creation (to include isometric front and side elevations)

2.12 Describe the national, international and organisational standards and conventions that are used for the drawings

2.13 Explain how to set up the drawing template parameters (such as layers of drawings, scale, paper size, colour setup, line types, dimension system and text styles)

2.14 Describe the application and use of drawing tools (such as for straight lines, curves and circles; how to create hatching and shading on drawings; how to add dimensions and text to drawings; producing layers of drawings)

2.15 Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

2.16 Describe the need for document control (such as ensuring that completed drawings are approved, labelled and stored on a suitable storage medium)

2.17 Explain how to save and store drawings, (such as determining document size; how to check that there is sufficient space to save the file in their chosen destination; saving and naming the file/drawing)

2.18 Describe the need to create backup copies, and to file them in a separate and safe location away from electromagnetic sources

2.19 Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

2.20 Explain when to act on their own initiative and when to seek help and advice from others

2.21 Describe the importance of leaving the work area and equipment in

a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 805 Producing components using hand fitting techniques

UAN:	**Y/600/5797**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 5: Producing components using hand fitting techniques (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic hand fitting activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the hand fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required fitting activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required. In producing the components, the learner will be expected to use appropriate tools and equipment to mark out the material for a range of features to be produced, and then to use hand tools, portable power tools, and shaping and fitting techniques appropriate to the type of material and operations being performed. These activities will include such things as hand sawing, band sawing, filing, drilling, chiselling, threading, scraping, lapping and off-hand grinding. The

components produced will have features that include flat, square, parallel and angular faces, radii and curved profiles, drilled holes, internal and external threads, and sliding or mating parts.

During, and on completion of, the fitting operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the fitting activities, the learner will be expected to return all tools and equipment to the correct locations, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fitting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the fitting activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate hand fitting techniques safely. The learner will understand the hand fitting process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when using hand fitting techniques, and when using hand and power tools. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce components using hand fitting techniques

Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the hand fitting activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on completion of the fitting activities • check that all measuring equipment is within calibration date 1.3 Plan the fitting activities before they start them 1.4 Obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition 1.5 Mark out the components for the required operations, using appropriate tools and techniques 1.6 Mark out a range of material forms, to include two of the following: • square/rectangular (such as bar stock, sheet material, machined components) • circular/cylindrical (such as bar stock, tubes, turned components, flat disks) • sections (such as angles, channel, tee section, joists, extrusions) • irregular shapes (such as castings, forgings, odd shaped components) 1.7 Use marking out methods and techniques, to include: • direct marking using instruments Plus one more of the following: • use of templates • tracing/transfer methods 1.8 Use a range of marking out equipment, to include all of the following: • rules/tapes • dividers/trammels • scribers • punches • scribing blocks • squares • protractor • vernier instruments 1.9 Mark out workpieces which include all of the following features: • datum/centre lines • square/rectangular profiles

- circles
- radial profiles
- linear hole positions

Plus one more from the following:

- angles/angular profiles
- radial hole positions
- allowances for bending
- simple pattern development

1.10 Cut and shape the materials to the required specification, using appropriate tools and techniques

1.11 Cut and shape two different types of material from the following:

- low carbon/mild steel
- high carbon steel
- cast iron
- stainless steel
- aluminium/aluminium alloys
- brass/brass alloys
- plastic/nylon/synthetic
- composite
- other specific material

1.12 Use a range of hand fitting methods, to include all of the following:

- filing
- hand sawing
- drilling
- threads external
- threads internal

Plus one more from the following:

- power sawing
- off hand grinding
- scraping
- chiselling
- lapping

1.13 Produce components which combine different operations and have features that cover all of the following:

- flat datum faces
- faces which are square to each other
- curved profiles
- drilled through holes
- reamed holes
- internal threads
- external threads

Plus three more from the following:

- faces that are parallel to each other
- faces angled to each other
- holes drilled to a depth
- chamfers and radii

- counterbore, countersink, or spot face
- sliding or mating parts

1.14 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.15 Use all of the following measuring equipment during the hand fitting and checking activities:
- external micrometers
- Vernier calliper
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:
- rules
- squares
- callipers
- protractors
- depth micrometers
- depth verniers
- feeler gauges
- bore/hole gauges
- slip gauges
- radius/profile gauges
- thread gauges
- Dial Test Indicators (DTI)

1.16 Carry out the necessary checks for accuracy, to include all of the following:
- linear dimensions
- flatness
- squareness
- angles
- profiles
- hole position
- hole size/fit
- depths
- thread size and fit
- surface finish

1.17 Produce components to all of the following standards, as applicable to the process:
- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010”
- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”
- flatness and squareness within 0.125mm per 25mm or 0.005” per inch
- angles within +/- 1 degree
- screw threads to BS Medium fit
- reamed and bored holes within H8

- surface finish 63 µin or 1.6µm

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Leave the work area in a safe and tidy condition on completion of the fitting activities

Learning outcome
The learner will: 2. Know how to produce components using hand fitting techniques
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements and safe working practices and procedures required for the hand fitting activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy 2.3 Describe the hazards associated with the hand fitting activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles), and how they can be minimised 2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.5 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards), in relation to work undertaken 2.6 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.7 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium) 2.8 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum 2.9 Describe the methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used (such as surface plates, angle plates, vee blocks and clamps, parallel bars, screw jacks) 2.10 Describe the use of marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes which are linearly positioned, boxed and on pitch circles) 2.11 Describe the ways of laying out the marking out shapes or patterns to maximise use of materials 2.12 Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements 2.13 Explain how to set and adjust tools (such as squares, protractors and Verniers) 2.14 Describe the importance of using tools only for the purpose intended; the care that is required when using the equipment and

tools; the proper way of storing tools and equipment between operations

2.15 Describe the cutting and shaping methods to be used, and the sequence in which the operations are to be carried out

2.16 Describe the various types of file that are available, and the cut of files for different applications

2.17 Describe the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits

2.18 Explain how to prepare the components for the filing operations (cleaning, de-burring, marking out)

2.19 Describe the use of vice jaw plates to protect the workpiece from damage

2.20 Explain how to file flat, square and curved surfaces, and how to achieve a smooth surface finish (such as by draw filing, the use of abrasive cloth, lapping using abrasive pastes)

2.21 Explain how to select saw blades for different materials, and how to set the saw blades for different operations (such as cutting externally and internally)

2.22 Explain how to cut external threads using hand dies, and the method of fixing and adjusting the dies to give the correct thread fit

2.23 Explain how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence

2.24 Explain how to prepare drilling machines for operations (such as adjustment of table height and position; mounting and securing drills, reamers, countersink and counterbore tools in chucks or Morse taper sockets; setting and adjusting spindle speeds; setting and adjusting guards/safety devices)

2.25 Explain how to mount the workpiece (such as in a machine vice, clamped to table, clamped to angle brackets); techniques of positioning drills to marking out, use of centre drills and taking trial cuts and checking accuracy, and how to correct holes which are off centre

2.26 Explain how to produce a sliding or mating fit using filing, scraping and lapping techniques

2.27 Describe the problems that can occur with the hand fitting activities, and how these can be overcome (such as defects caused by incorrectly ground drills, inappropriate speeds, damage by workholding devices)

2.28 Explain when to act on their own initiative and when to seek help and advice from others

2.29 Describe the importance of leaving the work area in a safe and clean condition on completion of the fitting activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 806 Producing mechanical assemblies

UAN:	**H/600/5799**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 6: Producing mechanical assemblies (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic mechanical assembly activities that will prepare the learner for entry into the engineering or manufacturing sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment. The learner will be expected to prepare for the assembly activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the operations to be carried out and the type of components to be assembled. In carrying out the assembly operations, the learner will be required to follow specified assembly techniques, in order to produce the required mechanical assembly. The assembly activities will also include making all necessary checks and adjustments, to ensure that components are correctly orientated, positioned and aligned, that moving parts have the correct working clearances, that all fasteners are tightened

to the correct torque, and that the assembled parts are checked for completeness and they function as per the specification.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate assembly techniques safely. The learner will understand the assembly process, and its application, and will know about the mechanical equipment being assembled, the components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the assembly activities, and when using assembly tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce mechanical assemblies
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the assembly activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, assembly drawings and procedures • ensure that all power tool cables, extension leads or air supply

hoses are in a safe and serviceable condition

- check that tools and measuring instruments to be used are within calibration date
- use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where appropriate)
- ensure that the components used are free from foreign objects, dirt or other contamination
- return all tools and equipment to the correct locations on completion of the assembly activities

1.3 Plan the assembly activities before they start them

1.4 Obtain and prepare the appropriate components, tools and equipment

1.5 Use the appropriate methods and techniques to assemble the components in their correct positions

1.6 Produce assemblies using six of the following methods and techniques:

- assembling of components by expansion/contraction
- fitting (such as filing, scraping, lapping or polishing)
- securing by using mechanical fasteners/threaded devices
- applying sealants/adhesives
- electrical bonding of components
- assembling of products by pressure
- setting and adjusting
- drilling
- reaming
- balancing components
- applying bolt locking methods
- shimming and packing
- blue-bedding of components
- aligning components
- riveting
- torque setting

1.7 Assemble products to meet the required specification, using nine of the following types of component:

- assembly structure (framework, support, casings, panels)
- pre-machined components
- fabricated components
- bearings
- seals
- bushes
- shafts
- chains
- couplings
- sprockets
- cams and followers
- levers/linkages
- keys

- pulleys
- gears
- pipework/hoses
- springs
- belts
- gaskets
- other

1.8 Assemble products using two of the following assembly aids and equipment:
- workholding devices
- lifting and moving equipment
- specialised assembly tools/equipment
- jigs and fixtures
- shims and packing
- rollers or wedges
- supporting equipment

1.9 Secure the components using the specified connectors and securing devices

1.10 Secure the components using both of the following categories of fastening devices:
- threaded fasteners (such as nuts, bolts, machine screws, cap screws)
- locking and retaining devices (such as tab washers, locking nuts, wire locks, special purpose types)

Plus one more from the following:
- pins (such as parallel/dowels, hollow/roll, tapered, split)
- spring clips (such as external circlips, internal circlips, special clips)
- rivets (such as countersunk, roundhead, blind, special purpose types)

1.11 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification

1.12 Carry out the required quality checks, to include eight from the following, using appropriate equipment:
- positional accuracy
- freedom of movement
- component security
- completeness
- dimensions
- orientation
- alignement
- function
- bearing end float
- operating/working clearances
- freedom from damage or foreign objects

1.13 Produce mechanical assemblies which comply with all of the following:

- all components are correctly assembled and aligned in accordance with the specification
- moving parts are correctly adjusted and have appropriate clearances
- where appropriate, assemblies meet required geometric tolerances (such as square, straight, angles free from twists)
- all fastenings have appropriate washers and are tightened to the required torque
- where appropriate, bolt locking methods are applied

1.14 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome

The learner will:

2. Know how to produce mechanical assemblies

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the assembly activities undertaken

2.2 Describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy

2.3 Describe the hazards associated with the assembly activities (such as use of power tools, trailing leads or air hoses, damaged or badly maintained tools and equipment, lifting and handling heavy items), and how they can be minimised

2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications

2.5 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

2.6 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

2.7 Explain how to prepare the components in readiness for the assembly activities (such as visually checking for defects, cleaning the components, removing burrs and sharp edges)

2.8 Describe the general principles of mechanical assembly, and the purpose and function of the components and materials used (including component identification systems such as codes and component orientation indicators)

2.9 Describe the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures

2.10 Explain how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this

2.11 Describe the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins,

	locking and retaining devices)
2.12	Describe the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
2.13	Explain where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
2.14	Explain how to conduct any necessary checks to ensure the accuracy, position, security, function and completeness of the assembly (such as checking for correct operation where the assembly has moving parts, checking the torque figures to which critical fastenings have been tightened, checking the end float on shafts, checking operating clearance on actuating mechanisms)
2.15	Explain how to detect assembly defects, and what to do to rectify them (such as ineffective joining techniques, foreign objects, component damage)
2.16	Describe the methods and equipment used to transport, lift and handle components and assemblies
2.17	Explain how to check that the tools and equipment to be used are correctly calibrated and are in a safe and serviceable condition
2.18	Describe the importance of ensuring that all tools are used correctly and within their peritted operating range
2.19	Describe the importance of ensuring that all tools, equipment and components are accounted for and returned to their correct location on completion of the assembly activities
2.20	Describe the problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances
2.21	Explain when to act on their own initiative and when to seek help and advice from others
2.22	Explain how to leave the work area in a safe and clean condition on completion of the assembly activities (such as removing and storing power leads, returning hand tools and equipment to the designated location, cleaning the work area and removing and disposing of waste)

Unit 807 Forming and assembling pipework systems

UAN:	**T/600/5855**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 7: Forming and assembling pipework systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic pipe fitting activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the pipe fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required pipe fitting activities and the sequence of operations they intend to use. The learner will be expected to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required. In producing the pipework systems, the learner will be expected to select and use a range of hand tools, pipe bending and forming equipment and pipe assembly techniques, appropriate to the type of material and operations being performed. Activities will include cutting the pipes to the required lengths using hand saws, power saws or pipe cutters; bending pipes using hand bending machines, springs, fillers or heating techniques; and the use of templates or set wires to check bend profiles which will

include angular bends, offsets, bridge sets and expansion loops. The learner will then be expected to assemble the pipes, using a range of different connectors such as straight connectors, elbows, tee pieces, reducers, tank connectors and valves.

During, and on completion of, the pipe fitting operations, the learner will be expected to check the quality of the work, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise pipe bending and fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished system is within the drawing requirements. On completion of the pipe fitting activities, the learner will be expected to return all tools and equipment to the correct locations, and to leave the work area in a safe and tidy condition.

The learner’s responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the pipe bending, forming and fitting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner’s knowledge will provide an understanding of their work, and will enable them to apply appropriate pipe bending, forming and fitting techniques safely. The learner will understand the pipe bending, forming and fitting equipment and techniques, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the pipe bending, forming and fitting activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the

	responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Form and assemble pipework systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the pipe bending, forming and fitting activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check that the bending and forming equipment is in a safe and usable condition • return all tools and equipment to the correct location on completion of the pipe fitting activities • apply safe working practices at all times 1.3 Plan the pipe fitting activities before they start them 1.4 Produce pipework assemblies using two of the following types of pipe: • carbon steel • stainless steel • copper • brass • aluminium • plastic 1.5 Mark out pipework, using the following method: • direct marking using tapes and markers Plus one more from the following: • set-outs of pipework using templates • producing set wires • set-outs of pipework onto floor 1.6 Cut the pipes to the appropriate lengths making allowances for bending and attachment of fittings 1.7 Cut and prepare the pipes for forming and assembly, to include carrying out all of the following: • cutting pipes to length with appropriate allowance for fittings • removing all external and internal burrs • cleaning pipe ends for soldering or gluing (where appropriate) • cutting threads on pipe ends to the appropriate length (where appropriate) • checking that prepared pipes are the correct length 1.8 Cut and prepare pipework using the following: • saws (hand or power) Plus two more from the following:

- pipe/tube cutter
- de-burring reamers
- abrasive cloth
- wire pipe cleaners

1.9 Bend and form the pipes using the appropriate tools and equipment for the types and sizes of pipe

1.10 Bend and form pipe using the following method:

- hand operated pipe bender

Plus one more of the following:

- bending springs
- hydraulic pipe bending equipment
- pipe expander
- heating methods
- swaging kit
- fillers

1.11 Produce pipework bends/forms that include both of the following:

- angular bends
- offsets

Plus one more from the following:

- bridge sets
- expansion loops
- radii
- external swaged ends
- internal swaged ends

1.12 Assemble and secure the pipework, using the correct fittings and joining techniques

1.13 Produce pipework assemblies which combine a range of different fittings, covering all of the following:

- straight couplings
- elbows
- tee pieces

Plus three more from the following:

- flanges
- unions
- reduction pieces
- valves
- drain/bleeding devices
- blanking caps
- screwed fittings (such as tank, tap, pump, gauges)

1.14 Assemble pipes using three of the following methods:

- compression fittings
- snap-on/push fittings
- screwed connections
- soldered fittings
- brazed fittings
- cemented/glued fittings
- welded joints

1.15 Assemble pipework using all of the following methods and techniques:
- securing pipework supports to structures
- fitting pipework supports
- connecting pipe-to-pipe
- connecting pipe-to-equipment
- using gaskets, seals/sealing tapes or jointing compounds
- alignment/levelling equipment

1.16 Produce pipework assemblies which comply with all of the following:
- pipes are bent to the appropriate shape/form and position
- all pipe bends are free from buckling or deformation
- appropriate fittings are used, and are secure and leak free
- soldered and glued fittings are free from excessive residues
- the completed assembly meets the specific system requirements

1.17 Check the completed assembly to ensure that all operations have been completed and that the finished pipe assembly meets the required specification

1.18 Test the completed pipe assembly, using the appropriate techniques, tools and equipment

1.19 Carry out tests on the assembled pipework, to include one of the following:
- hydraulic pressure testing
- water testing
- soap and water bubble test

1.20 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.21 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to form and assemble pipework systems
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the pipe fitting activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with the pipe fitting activities (such as handling long pipe lengths, using damaged or badly maintained tools and equipment, using pipe bending equipment, using heating and soldering equipment), and how they can be minimised 2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.5 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and

conventions to appropriate BS or ISO standards) in relation to work undertaken

2.6 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

2.7 Describe the principles and methods of marking out pipework, and the type of equipment used (such as direct marking, use of templates, use of set wires)

2.8 Explain how to prepare the pipes in readiness for the marking out activities (visually checking for defects, cleaning the materials, removing burrs and sharp edges)

2.9 Explain how to determine the overall length of the pipework required, taking into account allowances for pipe fittings and (where appropriate) screwed connections

2.10 Describe the tools and equipment used in the cutting and preparing the pipes (such as saws, pipe and tube cutters)

2.11 Describe the characteristics of the various materials that are to be used with regard to the bending operations, and why some materials may require the addition of heat/hot air to aid the bending process

2.12 Describe the methods used to hand bend and form the pipe (including the use of bending springs, hand bending machines, fillers, heating methods)

2.13 Explain how to produce the various bends required (such as angled bends, dog-leg sets, bridge sets and expansion loops)

2.14 Describe the reasons for incorporating expansion loops in a system, and where they should be positioned

2.15 Explain how to prepare pipework and fittings for the assembly operation (such as checking for damage, removing foreign objects, dirt and swarf from bore of pipe, removing burrs)

2.16 Describe the range of pipe fittings that can be used, and how to identify them (such as straight connectors, elbows, tee pieces, reduction pieces, flanged fittings, valves, blanking pieces/cap ends)

2.17 Describe the different types of fittings available, such as screwed fittings, soldered fittings, compression fittings, push fit fittings and glued/cemented fittings

2.18 Explain how to produce screw threads on the pipe ends, and the tools and equipment that can be used (such as stocks and dies, pipe threading machines)

2.19 Describe the methods used to seal screwed joints (such as tapes and sealing compounds)

2.20 Describe the use of flanges to connect pipes; use of gaskets; and torque loading of flange bolts

2.21 Describe the methods used to prepare pipe ends and fittings for soldering or brazing, and why it is necessary to ensure that these preparations are carried out

2.22 Describe the various types of soldered connectors available (such as solder ring types and capillary fittings)

2.23 Describe the methods used to solder the joints, and how to recognise when the fitting is correctly soldered

2.24 Describe the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint

2.25 Describe the methods used to prepare pipe ends and fittings when using adhesives, and why it is necessary to ensure that these

	preparations are carried out
2.26	Describe the methods used to glue the joints, and how to recognise when the fitting is correctly secured
2.27	Describe the various adhesives and sealing compounds that are used on non-metallic pipework
2.28	Describe the precautions to be taken when using the adhesives and sealing compounds (such as adequate ventilation, away from naked flames, avoiding skin contact)
2.29	Describe the use of compression fittings; how the pipes are sealed; and the effects of over tightening the fittings
2.30	Describe the use of push-fit connectors, and their advantages and disadvantages
2.31	Explain how to identify the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation
2.32	Describe the supporting methods that are used when assembling pipework, and the type of fittings that are used
2.33	Describe the methods of testing pipework systems for leaks (using air, water or hydraulic testing methods)
2.34	Describe the extent of their own responsibility and whom they should report to if they have problems that they cannot resolve
2.35	Describe the importance of leaving the work area in a safe and clean condition on completion of the pipework assembly activities (such as removing and storing power leads, returning hand tools and equipment to is designated location, cleaning the work area and removing and disposing of waste)

Unit 808 Carrying out aircraft detail fitting activities

UAN:	**A/600/5856**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 8: Carrying out aircraft detail fitting activities (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic aircraft detail fitting activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the detail fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required detail fitting activities and the sequence of operations they intend to use. The learner will be expected to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required. The learner will be expected to use a range of different materials, ensuring efficient use of them and, when applicable, to ensure that grain flow is taken into account. In carrying out the detail fitting activities, the learner will need to use a range of hand tools, portable power tools and simple machines to produce a variety of shapes and profiles. During, and on completion of, the detail

fitting operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. The learner will need to be able to recognise fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the detail fitting activities, the learner will be expected to return all tools and equipment used to its correct location and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the detail fitting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the detail fitting activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate aircraft detail fitting techniques safely. The learner will understand the aircraft detail fitting process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when using aircraft detail fitting techniques, and when using hand tools, power tools and machines. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out aircraft detail fitting activities
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the aircraft detail fitting activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check that all measuring equipment is within calibration date • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on completion of the detail fitting activities 1.3 Plan the aircraft detail fitting activities before they start them 1.4 Obtain the appropriate tools and equipment for the aircraft detail fitting operations, and check that they are in a safe and usable condition 1.5 Mark out the components for the required operations, using appropriate tools and techniques 1.6 Mark out a range of material forms, to include three from: • square/rectangular (such as bar stock, sheet material, machined components) • circular/cylindrical (such as bar stock, tubes, turned components, flat disks, rolled cylinders/cones) • sections (such as angle, channel, tee section, joists, extrusions) • irregular shapes (such as castings, forgings, odd shaped components) • detail assemblies 1.7 Use two types of material from: • aluminium • titanium • stainless steel • composite material • Glass Reinforced Plastic (GRP) • carbon fibre 1.8 Use marking out methods and techniques which include the following: • direct marking using instruments Plus one more from the following: • use of templates • tracing/transfer methods 1.9 Use a range of marking out equipment, to include all of the following: • marking tools

- rules/tapes
- squares
- protractors
- Vernier instruments
- dividers/compass

1.10 Mark out workpieces, to include all of the following features:
- datum/centre lines
- square/rectangular profiles
- circles and radial profiles
- linear hole positions

Plus two more from the following:
- angles/angular profiles
- radial hole positions
- allowances for bending
- simple pattern development

1.11 Cut and shape the materials to the required specification, using appropriate tools and techniques

1.12 Cut and shape the materials, using four of the following:
- saws (hand or mechanical)
- guillotines
- bench knives
- tin snips
- drills and hole saws
- nibblers
- cropping machines
- files
- abrasive discs

1.13 Bend and form the materials, using the appropriate tools and equipment

1.14 Bend and form materials using four of the following:
- bench folding machines
- box pan folding machines
- pinch or pyramid rolling machines
- presses
- hand tools
- heating techniques
- shrinking techniques
- stretching techniques

1.15 Produce components which combine different operations and have features that cover all of the following:
- edges/faces that are square to each other
- edges/faces that are parallel
- curved or circular forms
- holes linearly pitched

Plus two more of the following:
- edges/faces that are angled
- internal profiles

- external profiles
- holes radially pitched

1.16 Produce a range of components with features that cover five of the following:
- right angled bends
- angled bends
- square flanges
- tray sections and channels
- curved/circular flanges
- curved profile
- cylindrical shape
- conical shape
- dished profile

1.17 Assemble and secure the components, using the correct fastening devices and joining techniques

1.18 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.19 Produce components to all of the following standards, as applicable to the process:
- components to be free from false tool cuts, burrs and sharp edges
- finished components meet the required shape/geometry (to the template profile)
- completed components are free from excessive tooling marks, deformation or cracking
- dimensional tolerance +/- 0.25mm or +/- 0.010"
- flatness and squareness 0.125mm per 25mm or 0.005" per inch
- angles within +/- degree
- screw threads to BS Medium fit
- reamed and bored holes within H8
- surface finish 63 µin or 1.6µm

1.20 Use both of the following types of measuring equipment during the detail fitting and checking activities:
- external micrometers
- Vernier calliper

Plus four more of the following:
- rules
- squares
- callipers (external and internal)
- Vernier protractors
- depth micrometers
- depth Verniers
- slip gauges
- feeler gauges
- bore/hole gauges
- radius/profile gauges
- thread gauges

• Dial Test Indicators (DTI) • surface finish equipment (such as comparison plates, machines) 1.21 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve 1.22 Leave the work area in a safe and tidy condition on completion of the fitting activities

Learning outcome
The learner will: 2. Know how to carry out aircraft detail fitting activities
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the aircraft detail fitting activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with the aircraft detail fitting activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, use of forming and bending equipment, using hand shears and guillotines), and how they can be minimised 2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.5 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.6 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.7 Explain how to identify the materials to be used; material identification systems; codes used and grain flow indicators 2.8 Describe the principles of marking out, and the equipment used in the aerospace industry 2.9 Explain how to clean and prepare the surfaces to be marked out ensuring, where appropriate, that grain flow is taken into account 2.10 Explain how to calculate bending allowances when marking out 2.11 Explain how to select and establish suitable datums; the importance of ensuring that marking out is undertaken from the selected datums, and the possible effects of working from different datums 2.12 Explain how to mark out the workpiece (including datums; cutting guidelines; square and rectangular profiles; circular and radial profiles; angles; holes which are linearly positioned, boxed and on pitch circles) 2.13 Describe the various methods of pattern development that can be used (such as parallel line; radial line; triangulation), and typical applications of each method 2.14 Describe the ways of laying out the marking-out shapes or patterns

	to maximise use of materials
2.15	Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements
2.16	Describe the importance of using tools only for the purpose intended; the care that is required when using the equipment and tools; the proper way of storing tools and equipment between operations
2.17	Describe the shaping methods and techniques that can be used to produce a range of shapes/profiles on the various section materials (such as sawing, shearing, drilling, filing, abrading), and the sequence in which the operations will need to be carried out
2.18	Explain how to select saw blades for different applications and materials, and methods of setting saw blades for cutting externally and internally (such as hand saws, mechanical saws, band saws)
2.19	Describe the various shearing methods that can be used (such as tin snips, bench shears, guillotines, cropping machines and nibbling machines)
2.20	Describe the range of hand tools and associated equipment that is used to produce a variety of shapes, bends, curved surfaces, dished profiles
2.21	Describe the range of bending and forming machines to be used (such as fly presses, bending machines, rolling machines, flanging machines)
2.22	Explain how to set up a bending machine to produce a range of forms (such as right-angled bends, angled bends, tray sections, channel sections)
2.23	Explain how to set up pinch/pyramid forming rolls to produce a variety of forms (such as curved profiles, cylinders, cones)
2.24	Explain how to produce flanges on curved/cylindrical components (using machines and hand tools)
2.25	Describe the methods of drilling and finishing holes in sheet and stock materials (such as drills, reamers, countersinks, hole saws)
2.26	Describe the various types of files that are available; the cut of files for different applications; the importance of ensuring that file handles are safe and free from embedded foreign bodies
2.27	Describe the preparations and or treatments that may need to be carried out on the materials before and after the cutting and shaping operations
2.28	Explain how to conduct any necessary checks to ensure the accuracy and quality of the components produced
2.29	Describe the problems that can occur with the cutting, shaping and forming operations, and how these can be overcome
2.30	Explain when to act on their own initiative and when to seek help and advice from others
2.31	Describe the importance of leaving the work area in a safe and clean condition on completion of the aircraft detail fitting activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 809 Installing aircraft mechanical fasteners

UAN:	**F/600/5857**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 9: Installing aircraft mechanical fasteners (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to install aircraft mechanical fasteners which will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the installation activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required installation activities and the sequence of operations they intend to use. The learner will be expected to select the appropriate equipment to use, based on the types of fastener to be installed and the accuracy required. The mechanical fasteners to be installed will include devices such as hollow and solid rivets, threaded fasteners, anchor nuts, pins and other locking devices. The learner will need to use a range of different techniques to prepare, install and check that the mechanical fasteners are installed to the required specification. During, and on completion of, the installation

operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. The learner will need to be able to recognise installation defects, to take appropriate action to remedy any faults that occur and to ensure that the finished installation meets the drawing requirements. On completion of the installation activities, the learner will be expected to return all tools and equipment used to the correct locations, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the installation activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the installation activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate techniques, for the installation of the aircraft mechanical fasteners, safely. The learner will understand the fastener installation process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when using aircraft mechanical fastener installation techniques, and when using hand and power tools. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Install aircraft mechanical fasteners
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following activities during the installation of the mechanical fasteners: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check that all measuring equipment is within calibration date • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on completion of the installation activities 1.3 Plan the installation of the mechanical fasteners before they start the activity 1.4 Obtain the appropriate tools and equipment for the installation operations, and check that they are in a safe and usable condition 1.5 Use both of the following types of equipment: • riveting guns (appropriate to rivet type) • gripping pins and location dowels Plus two more from the following: • gauges for intrusions • drills and tools with attachments • redline templates • jigs • clamps 1.6 Assemble and secure the components, using the correct fastening devices and joining techniques 1.7 Install a range of mechanical fasteners, to include all of the following: • hollow rivets • solid rivets • threaded fasteners Plus three more from the following: • collared fasteners • anchor nuts • split pins • NAPP pins • pin clips • PIT pins • wire locks • other locking devices 1.8 Use all of the following installation methods and techniques: • countersinking

- milling rivets
- solid riveting (single and double handed)
- wire locking
- through-hole
- blind riveting

1.9 Make three types of connection from:
- wet assembly
- dry assembly
- panels
- skins
- structures
- repairs

1.10 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.11 Use four of the following to carry out appropriate checks during, and on completion of, the installation activities:
- rules
- squares
- callipers
- protractors
- micrometers
- Verniers
- slip gauges
- feeler gauges
- bore/hole gauges
- radius/profile gauges
- Dial Test Indicators (DTI)
- torque wrenches/gauges
- rivet intrusion gauges

1.12 Install aircraft mechanical fasteners to comply with all of the following requirements:
- all components are correctly assembled and aligned, in accordance with the specification
- overall dimensions are within specification tolerances
- assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)
- where appropriate, pitches of rivets/fasteners meet specification requirements
- completed assemblies have secure and firm joints, and are clean and free from burrs/flash, deformation or cracking

1.13 Check that the installation is complete, and that all components are free from damage

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Leave the work area in a safe and tidy condition on completion of the fitting activities

Learning outcome
The learner will: 2. Know how to install aircraft mechanical fasteners
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the installation of the aircraft mechanical fasteners 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with installing aircraft mechanical fasteners, and with the tools and equipment used (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised 2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.5 Describe the importance of working to the installation instructions and appropriate specifications 2.6 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Describe the process for the control of materials, and the need for component control and quarantine 2.9 Explain how to identify the mechanical fasteners to be used; material identification systems; codes used and grain flow indicators 2.10 Explain why they must obtain design approval before removing and replacing faulty fasteners 2.11 Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them 2.12 Describe the regulations concerning electrical bonding and anti-electrolysis barriers 2.13 Describe the various types and range of screwed fasteners used on aircraft fittings, and the methods of installing them 2.14 Describe the types and applications of aircraft rivets, and the advantages of hollow rivets over solid rivets 2.15 Describe the reasons for using screw fastenings rather than rivets 2.16 Describe the purpose and use of a countersink cage 2.17 Describe the various locking devices used with fastenings 2.18 Describe the purpose and use of locating dowels, gripping pins and gauges, when carrying out fastening operations 2.19 Describe the procedures to be adopted when removing rivets and other fasteners 2.20 Describe the term 'quilting', its occurrence and avoidance 2.21 Describe bolt break-offs, and where they occur 2.22 Explain how to check that riveting guns, power tools and attachments are in a safe and usable condition, and the action to be taken in the event of identifying defective equipment

2.23	Describe the types of gauges used to measure angles, depths, countersinks and torque
2.24	Explain how and why tools are calibrated, and how to check that the tools they are using are within calibration dates
2.25	Explain how to conduct any necessary checks to ensure the accuracy and quality of the installations produced
2.26	Describe the problems that can occur with the installation of the mechanical fasteners, and how these can be overcome
2.27	Explain when to act on their own initiative and when to seek help and advice from others
2.28	Describe the importance of leaving the work area in a safe and clean condition on completion of the activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 810 Producing aircraft detail assemblies

UAN:	**J/600/5858**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 10: Producing aircraft detail assemblies (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required for a broad range of basic activities that the learner will need to assemble components to produce aircraft detail assemblies, and which will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the assembly activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. The learner will be expected to select the appropriate equipment to use, based on the assembly operations to be carried out and the accuracy required. In carrying out the assembly operations, the learner will be required to follow laid-down procedures and specific assembly techniques, in order to assemble the various components into detail assemblies. The learner will need to produce a range of assemblies, which could include stringers, frames, panels, trays, skins, ribs, tanks and other small assemblies, as appropriate.

During, and on completion of, the assembly operations, the learner will be expected to check the quality of the assembly, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. The learner will need to be able to recognise assembly defects, to take appropriate action to remedy any faults that occur and to ensure that the finished assembly is within the drawing requirements. On completion of the assembly activities, the learner will be expected to return all tools and equipment used to the correct locations, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the aircraft detail assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate aircraft detail assembly techniques safely. The learner will understand the aircraft detail assembly process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when using aircraft detail assembly techniques, and when using hand tools, power tools and machines. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce aircraft detail assemblies

Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following activities during assembly: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check that all tools, test and measuring equipment are within calibration date • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on completion of the assembly activities 1.3 Plan the aircraft detail assembly activities before they start them 1.4 Obtain the appropriate tools and equipment for the aircraft detail assembly operations, and check that they are in a safe and usable condition 1.5 Obtain the specified components and check that they are in a usable condition 1.6 Produce aircraft detail assemblies, which includes seven of the following components: • skins • stringers • cleats • tanks • frames • ribs • panels • brackets • trays • angles • pipes, unions and joints • jumper braids, bonding clips, earthing straps • aircraft general supplies • other small assemblies, as applicable 1.7 Use the appropriate methods and techniques to assemble the components in their correct positions 1.8 Apply all of the following assembly methods and techniques: • drilling and riveting • ensuring that correct part numbers are used • applying sealants/adhesives • electrical bonding of components • ensuring that correct hand of components is used (left or right handed) • positioning and aligning components for cosmetic appearance and skin lines • securing components using mechanical fasteners and threaded devices

- applying bolt locking methods (such as split pins, wire locking, lock nuts, stiff nuts)

1.9 Secure the components using the specified connectors and securing devices

1.10 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.11 Produce assemblies which comply with all of the following:
- all components are correctly assembled and aligned in accordance with the specification
- overall dimensions are within specification tolerances
- assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)
- where appropriate, pitches of rivets/fasteners meet specification requirements
- completed assemblies have secure and firm joints, and are clean and free from burrs/flash, deformation or cracking

1.12 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification

1.13 Carry out quality and accuracy checks which include three from the following:
- cosmetic appearance
- accuracy of skin lines
- freedom from damage
- torque loading checks
- electrical bonding and continuity

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Leave the work area in a safe and tidy condition on completion of the fitting activities

Learning outcome

The learner will:

2. Know how to produce aircraft detail assemblies

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken whilst carrying out the detail assembly operations (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)

2.2 Describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy

2.3 Describe the hazards associated with producing aircraft detail assemblies, and with the tools and equipment used (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised

2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications

2.5 Describe the importance of working to the assembly instructions and appropriate specifications

2.6 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

2.8 Explain how to identify the components to be used; component identification systems; codes used and component orientation indicators

2.9 Describe the preparations to be undertaken on the components prior to fitting them into the assembly

2.10 Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures

2.11 Explain how the components are to be aligned and positioned, and the tools and equipment that are used (including jigs and fixtures)

2.12 Describe the methods used to hold the components in their correct position prior to securing them with the appropriate fasteners

2.13 Describe the various mechanical fasteners that will be used, and their method of installation (including open and blind rivets, threaded fasteners, special securing devices)

2.14 Describe the importance of using the specified fasteners for the particular assembly, and why they must not use substitutes

2.15 Explain what to do if the components or fastening devices are not assembled correctly, are damaged, or have other faults

2.16 Explain why they must obtain design approval before removing and replacing faulty fasteners

2.17 Describe the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with the various adhesives and sealants

2.18 Describe the quality control procedures to be followed during the assembly operations

2.19 Explain how to conduct any necessary checks to ensure the accuracy and quality of the assemblies produced

2.20 Explain how and why tools are calibrated, and how to check that the tools they are using are within calibration dates

2.21 Describe the importance of using all tools in the correct manner and within their permitted operating range

2.22 Describe the importance of ensuring that the completed assembly is free from dirt, swarf and foreign objects

2.23 Describe the problems that can occur with the detail assembly operations, and how these can be overcome

2.24 Explain when to act on their own initiative and when to seek help and advice from others

2.25 Describe the importance of leaving the work area in a safe and clean condition on completion of the aircraft detail assembly activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 811 Preparing and using lathes for turning operations

UAN:	**L/600/5859**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 11: Preparing and using lathes for turning operations (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic turning activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The turning operations may be carried out on machines such as centre lathes, capstan or turret lathes, automatic or other specific turning machines. The learner will be expected to prepare for the turning activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required turning activities and the sequence of operations they intend to use. The learner will be required to prepare for the turning activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and cutting tools and to set and use cutting feeds/speeds and techniques appropriate to the type of material, tooling, workpiece rigidity and operations being performed. The learner will be expected to produce components that combine a

number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, and special forms/profiles.

During, and on completion of, the turning operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise turning defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the turning activities, the learner will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the turning activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the turning activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate turning techniques safely. The learner will understand the turning process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the lathe, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use lathes for turning operations
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the turning activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and are correctly adjusted • components are held securely (without damage or distortion) • cutting tools are maintained in a suitable/safe condition • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the machining activities before they start them 1.4 Obtain and prepare the appropriate materials, tools and equipment 1.5 Machine components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic/nylon/composite • other specific material 1.6 Mount and set the required workholding devices, workpiece and cutting tools 1.7 Mount, secure and machine components using three of the following workholding devices: • three-jaw chucks with hard jaws • three-jaw chucks with soft jaws • four-jaw chucks • collet chucks • drive plate and centres • fixtures • faceplates • magnetic or pneumatic devices • fixed steadies or traveling steadies • special purpose workholding devices (such as wax chucks) 1.8 Mount and use eight of the following types of tool: • turning • facing • boring

- knurling
- parting off
- forming
- recessing/grooving
- chamfering
- centre drills
- twist/core drills
- reamers
- taps
- thread forming tools
- dies

1.9 Set and adjust the machine tool speeds and feeds to achieve the component specification

1.10 Use the machine tool controls safely and correctly, in line with operational procedures

1.11 Produce machined components which combine different operations and have features that cover all of the following:

- flat faces
- parallel diameters
- stepped diameters
- tapered diameters
- drilled holes
- reamed holes
- chamfers
- grooves/undercuts

Plus four more of the following:

- bored holes
- profile forms
- internal threads
- external threads
- eccentric diameters
- parting off
- knurls or special finishes

1.12 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.13 Carry out the necessary checks for accuracy, to include all of the following:

- external diameters
- parallelism
- bore/hole size/fit
- angle/taper
- surface finish
- linear dimensions (such as lengths, depths)
- grooves/undercuts (such as position, width, depth)

Plus two more of the following:

- internal diameters
- concentricity

- eccentricity
- ovality
- thread fit

1.14 Use all of the following measuring equipment during the machining and checking activities:
- external micrometers
- Vernier/digital/dial callipers
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:
- rules
- internal micrometers
- depth micrometers
- depth Verniers
- slip gauges
- bore/hole gauges
- thread gauges (such as ring, plug, profile)
- plug gauges
- radius/profile gauges
- protractors

1.15 Produce components to all of the following quality and accuracy standards, as applicable to the operation:
- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010"
- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004"
- surface finish 63 µin or 1.6µm
- reamed holes within H8
- screw threads BS medium fit
- angles within +/- 0.5 degree

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome
The learner will: 2. Know how to prepare and use lathes for turning operations
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using lathes (such as ensuring the correct isolation of the machine before mounting workholding devices; fitting and adjusting machine guards, ensuring that the workpiece is secure and that tooling is free from the workpiece before starting

the machine)

2.2 Describe the hazards associated with the turning operations (such as revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be worn for the turning activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)

2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency treadle brakes), and the procedure for checking that they function correctly

2.5 Describe the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.6 Explain how to plan and prepare to carry out the machining operations (such as obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)

2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)

2.8 Describe the main features of the lathe and the accessories that can be used (such as saddle, capstan/turret head, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)

2.9 Explain how to position and secure workholding devices to the machine spindle, and the checks to be made (such as ensuring that all seating/location faces are clean and undamaged, that (where appropriate) the workholding device location marks are lined up with those on the machine spindle, and checking that all bolts, cam locks or other securing devices are tightened securely)

2.10 Describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components

2.11 Describe the various turning operations that can be performed, and the shapes and types of tooling that can be used (such as solid high-speed tooling, brazed tip tooling, interchangeable tipped tooling)

2.12 Explain how to mount and secure the cutting tools in the tool holding devices (such as front or rear tools posts; mounting drills in chucks or by the use of Morse taper sockets; the importance of ensuring that the tool is at the correct centre height and that tool overhang is kept to a minimum)

2.13 Explain how to check that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly

2.14 Describe the effects of backlash in machine slides and screws, and how this can be overcome

2.15 Describe the techniques of taking trial cuts and checking

	dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
2.16	Describe the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
2.17	Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
2.18	Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, Verniers and surface texture comparison methods)
2.19	Explain how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring internal and external dimensions (such lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)
2.20	Describe the problems that can occur with the turning activities (such as defects caused by incorrectly ground tools, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome
2.21	Explain when to act on their own initiative and when to seek help and advice from others
2.22	Describe the importance of leaving the work area and machine in a safe condition on completion of the turning activities

Unit 812 Preparing and using milling machines

UAN:	**F/600/5860**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 12: Preparing and using milling machines (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic milling activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The milling operations may be carried out on horizontal, vertical or universal milling machines. The learner will be expected to prepare for the machining activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required milling activities and the sequence of operations they intend to use. The learner will be required to prepare for the milling activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and cutting tools and to set and use cutting feeds/speeds and techniques appropriate to the type of material, tooling, workpiece rigidity and operations being performed. The learner will be expected to produce components that combine a number of different features, such as flat

faces, parallel faces, faces square to each other, angular faces, steps, open and enclosed slots, drilled, bored and reamed holes, internal threads, and special forms/profiles.

During, and on completion of, the milling operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise milling defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the machining activities, the learner will be expected to remove cutters and workholding devices, and to leave the milling machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the milling activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the milling activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate milling techniques safely. The learner will understand the milling process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the milling machine, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use milling machines
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the machining activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and correctly adjusted • components are held securely (without damage or distortion) • cutting tools are maintained in a suitable/safe condition • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the machining activities before they start them 1.4 Obtain and prepare the appropriate materials, tools and equipment 1.5 Machine components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic/nylon/composite • other specific material 1.6 Mount and set the required workholding devices, workpiece and cutting tools 1.7 Mount, secure and machine components, using two of the following workholding devices: • fixed vice • swivel or universal vice • fixtures • direct clamping to machine table • angle plates • vee block and clamps • magnetic or pneumatic devices • chucks • indexing device 1.8 Mount and use four of the following types of milling cutters/tools tools: • face mills • slab/cylindrical cutters • end mills • slot drills

- side and face cutters
- slot cutters
- slitting saws
- vee cutters
- other form cutters
- twist/core drills
- reamers
- boring bars
- taps

1.9 Set and adjust the machine tool speeds and feeds to achieve the component specification

1.10 Use the machine tool controls safely and correctly, in line with operational procedures

1.11 Produce machined components that combine different operations and have features that cover all of the following:

- flat faces
- square faces
- parallel faces
- steps/shoulders
- open ended slots
- enclosed slots

Plus two more of the following:

- angular faces
- recesses
- drilled holes
- tee slots
- bored holes
- indexed or rotated forms
- profile forms (such as vee, concave, convex, gear forms, serrations, special forms)

1.12 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.13 Carry out the necessary checks for accuracy, to include all of the following:

- linear dimensions
- depths
- flatness
- squareness
- surface finish
- slots (such as position, width, depth)
- angles (where appropriate)
- hole size/fit (where appropriate)

1.14 Use the following measuring equipment during the machining and checking activities:

- external micrometers
- Vernier/digital/dial callipers
- Dial Test Indicators (DTI)

- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:

- rules
- squares
- internal micrometers
- depth micrometers
- depth Verniers
- feeler gauges
- bore/hole gauges
- slip gauges
- radius/profile gauges
- protractors

1.15 Produce components to all of the following quality and accuracy standards, as applicable to the operation:
- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010"
- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004"
- flatness and squareness within 0.125mm per 25mm or 0.005" per inch
- reamed holes within H8
- surface finish 63 µin or 1.6µm
- angles within +/- 1 degree

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome
The learner will: 2. Know how to prepare and use milling machines
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using milling machines (such as ensuring the correct isolation of the machine before mounting cutters and workholding devices; fitting and adjusting machine guards, ensuring that the workpiece is secure and that cutters are free from the workpiece before starting the machine) 2.2 Describe the hazards associated with the milling operations (such as revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the milling activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become

entangled in the machinery)

2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

2.5 Describe the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.6 Describe the planning and preparing to carry out the machining operations (such as obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)

2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)

2.8 Describe the main features of the milling machine, and the accessories that can be used (such as vertical heads, indexing devices)

2.9 Explain how to position and secure workholding devices to the machine table, and the checks to be made (such as ensuring all seating/location faces are clean and undamaged, ensuring that the device is suitably aligned using instruments or tenons, as appropriate, and checking that all bolts or other securing devices are tightened securely)

2.10 Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

2.11 Describe the various milling operations that can be performed, and the types of cutters that are used (such as face mills, slab/cylindrical cutters, side and face cutters, end mills, slot drills, form cutters, twist drills)

2.12 Explain how to mount and secure the cutting tools in the tool holding devices and to the machine spindle (such as face mills on stub arbors or direct to the machine spindle; slab mills/cylindrical cutters and side and face cutters on long arbors; end mills and slot drills in collet chucks; mounting drills in chucks or by the use of Morse taper sockets)

2.13 Explain how to position the workpiece in relation to the milling cutters to give conventional or climb milling conditions

2.14 Explain how to check that the milling cutters are in a safe and usable condition, and how to handle and store cutters safely

2.15 Describe the effects of backlash in machine slides and screws, and how this can be overcome

2.16 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy

2.17 Describe the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and

	tolerance required)
2.18	Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
2.19	Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, Verniers and surface texture comparison methods)
2.20	Explain how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (such as lengths, depths, slots, positions, angles, profiles); measuring geometric features (such as flatness, squareness, parallelism); how to check surface finish (such as by using comparison blocks or instruments)
2.21	Describe the problems that can occur with the milling activities (such as defects caused by worn cutters, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome
2.22	Explain when to act on their own initiative and when to seek help and advice from others
2.23	Describe the importance of leaving the work area and machine in a safe condition on completion of the milling activities

Unit 813 Preparing and using grinding machines

UAN:	**J/600/5861**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 13: Preparing and using grinding machines (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic grinding activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The grinding operations may be carried out on horizontal or vertical surface grinding machines, cylindrical or universal grinding machines. The learner will be expected to prepare for the grinding activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required grinding activities and the sequence of operations they intend to use. The learner will be required to prepare for the grinding activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and use grinding techniques appropriate to the type of material, type of grinding wheel, workpiece rigidity and operations being performed. The learner will be expected to grind components that combine a number of different features,

such as flat faces, parallel faces, faces square to each other, angular faces, steps and slots or parallel, stepped and tapered diameters, faces, bores and special forms/profiles.

During, and on completion of, the grinding operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise grinding defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the grinding activities, the learner will be expected to remove the workholding devices and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the grinding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the grinding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate grinding techniques safely. The learner will understand the grinding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the grinding machine, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use grinding machines
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the grinding activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and are correctly adjusted • components are held securely (without damage or distortion) • grinding wheels are maintained in a suitable/safe condition • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the grinding activities before they start them 1.4 Obtain and prepare the appropriate materials, tools and equipment 1.5 Prepare grinding wheels to include carrying out two of the following: • dressing and 'trueing up' grinding wheels • wheel forming (such as chamfers, radii, angular forms, profiles) • relieving the wheel sides 1.6 Grind components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic/nylon/composite • other specific material 1.7 Mount and set the required workholding devices, and set and secure the workpiece 1.8 Mount, secure and machine components using two of the following workholding devices: • magnetic chuck or blocks • fixed vice • swivel or universal vice • angle plates • vee block and clamps • fixtures • chucks • centres • mandrels 1.9 Set and adjust the machine tool speeds and feeds to achieve the component specification (where appropriate)

1.10 Use the machine tool controls safely and correctly in line with operational procedures

1.11 Produce ground components that combine different operations and have features that cover five of the following:

- flat faces
- parallel faces
- faces square to each other
- vertical faces
- angular faces
- steps and shoulders
- slots
- parallel diameters
- stepped diameters
- tapered diameters
- counterbores
- tapered bores
- parallel bores
- profile forms

1.12 Measure and check all dimensional and geometrical aspects of the component are to the specification

1.13 Carry out the necessary checks for accuracy, to include all of the following:

- dimensions
- parallelism
- surface texture

Plus two more from the following:

- flatness
- squareness
- profile
- angle/taper
- concentricity
- ovality/lobing

1.14 Use the following measuring equipment during the machining and checking activities:

- external micrometers
- vernier/digital/dial callipers
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)

Plus two more of the following:

- squares
- internal micrometers
- depth micrometers
- depth verniers
- comparators (external or internal)
- feeler gauges
- bore/hole gauges

- slip gauges
- radius/profile gauges
- protractors

1.15 Produce components to all of the following quality and accuracy standards, as applicable to the operation:
- components to be free from false grinding cuts, wheel marks, burrs and sharp edges
- general dimensional tolerance +/- 0.125mm or +/- 0.005”
- there must be one or more specific dimensional tolerances within +/- 0.025mm or +/- 0.001”
- flatness and squareness within 0.025mm per 25mm or 0.001” per inch
- surface texture 8 µin or 0.2µm
- angles/tapers within +/- 30 minutes

1.16 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

1.17 Shut down the equipment to a safe condition on completion of the grinding activities

Learning outcome

The learner will:

2. Know how to prepare and use grinding machines

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using grinding machines (such as ensuring the correct isolation of the machine before mounting the workholding devices and workpiece; fitting and adjusting machine guards and dust extraction equipment, ensuring that the workpiece is secure and grinding wheels are free from damage and clear of the workpiece before starting the machine)

2.2 Describe the hazards associated with the grinding operations (such as revolving/moving parts of machinery, sparks/airborne particles, bursting grinding wheels, insecure components, burrs and sharp edges on component), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be worn for the grinding activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)

2.4 Describe the safety mechanisms on the machine, and the procedure for checking that they function correctly

2.5 Describe the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.6 Explain how to plan and prepare to carry out the grinding operations (such as obtaining the component drawing, determining the machines required, selecting workholding methods and devices, selecting grinding wheels, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)

2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)

2.8 Describe the main features of the grinding machine, and the accessories that can be used

2.9 Describe the range of workholding methods and devices that are used on grinding machines (such as magnetic chucks and blocks, vices, angle plates, fixtures, centres, mandrels, collets and chucks)

2.10 Explain how to position and secure workholding devices and the workpiece to the machine table, and the checks to be made (such as ensuring that all seating/location faces are clean and undamaged, the device is suitably aligned using instruments or tenons, as appropriate, checking that all bolts or other securing devices are tightened securely)

2.11 Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

2.12 Describe the various grinding operations that can be performed, and the types of grinding wheels that are used (such as surface grinding using solid, segmented and cup wheels; cylindrical grinding wheels and internal grinding wheels)

2.13 Explain how to check that the grinding wheels are in a safe and serviceable condition (such as free from damage, cracks, correctly balanced)

2.14 Describe the importance of 'trueing up' and dressing wheels to prevent glazing and burning of the workpiece, and methods of forming the wheels to the required profile (such as use of pantograph, diamond dressing units)

2.15 Describe the effects of backlash in machine slides and screws, and how this can be overcome

2.16 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on wheel life, surface finish and dimensional accuracy

2.17 Describe the factors that affect the selection of grinding feeds and speeds, and the depth of cut that can be taken (such as type of material, type of grinding wheel, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

2.18 Describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require cutting fluids to be used

2.19 Explain how to recognise grinding faults, and how to identify when grinding wheels need dressing

2.20 Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, Verniers and surface texture comparison methods)

2.21 Explain how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (such as diameters, lengths,

	depths, slots, positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism); how to check surface finish (such as by using comparison blocks or instruments)
2.22	Describe the problems that can occur with the grinding activities (such as defects caused by glazed wheels, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome
2.23	Explain when to act on their own initiative and when to seek help and advice from others
2.24	Describe the importance of leaving the work area and machine in a safe condition on completion of the grinding activities

Unit 814 Preparing and proving CNC machine tool programs

UAN:	**R/600/5863**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 14: Preparing and proving CNC machine tool programs (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC programming activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment. The learner will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program on magnetic tape, disc or by downloading it into the machine controller from the computer. The learner will be expected to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes, and to use repetitive programs and canned cycles, to reduce program size and input time. The learner will prepare component programs that combine a number of different operations, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, flat, square and parallel faces, angular faces, slots and recesses, special forms and profiles.

The learner will need to check the program using single block run and program edit facilities. The learner will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. The learner must ensure that any edited programs are saved safely and correctly.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the programming activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the programming activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC programming and proving techniques safely. The learner will understand the CNC programming process, and its application, and will know about the machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the programming activities to the required specification.

The learner will understand the safety precautions required when working with the CNC machines, and with their associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and prove CNC machine tool programs
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

1.2 Ensure that they apply all of the following checks and practices at all times during the programming activities:
- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- the correct component drawings are obtained and checked for currency and validity
- the appropriate reference manuals and programming codes are used to suit the machine controller
- the machine controller is prepared ready to accept the operating program
- the prepared program is input/loaded into the controller safely and correctly
- programs are stored safely and correctly in the appropriate format
- program media is stored safely and correctly, away from contaminants or electromagnetic sources

1.3 Prepare and prove programs for one of the following types of CNC machine tool:
- two axis machine
- three axis machine
- multiple axis machines (5 or more)
- machining centres

1.4 Plan the programming activities before they start them

1.5 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes

1.6 Develop component programs using appropriate programming codes and techniques

1.7 Produce CNC programs using one of the following methods:
- written
- entered directly into the machine controller
- using computer software

1.8 Develop part programs which contain all of the following, as applicable to the machine type:
- all necessary positional information
- appropriate letter address codes
- machine management commands (preparatory/auxiliary functions)
- repetitions within programs (using features such as subroutines, canned cycles, labels)
- absolute or incremental co-ordinates
- tool/cutter change positions
- tool information (such as lengths, offsets, radius compensation)

1.9 Develop programs to produce components which cover eight of the following features:
- parallel diameters
- stepped diameters
- tapered diameters
- flat faces

- internal undercuts
- external undercuts
- steps/shoulders
- parallel faces
- faces that are square to each other
- angular faces
- internal profiles
- external profiles
- reamed holes
- tapped holes
- drilled holes
- holes on pitched circles
- holes linearly pitched
- parting-off
- enclosed slots/recesses
- open ended slots
- eccentric diameters
- external screw threads
- internal screw threads
- chamfers and radii
- bored holes
- special forms (such as concave, convex)

1.10 Develop part programs to machine components made from two of the following types of material:

- low carbon/mild steel
- high carbon steel
- aluminium/aluminium alloys
- cast iron
- brass/brass alloys
- plastic/nylon/composite
- other specific material

1.11 Specify positional information and machine axes that are consistent with the requirements of each stage/operation

1.12 Load/input the program to the machine controller, and check/prove the program for errors using approved procedures

1.13 Confirm that the program operates safely and correctly, by checking all of the following:

- datums for each machine axis are set in relation to all equipment and tooling used
- all operations are carried out to the program co-ordinates
- tool change positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program
- tool offsets are correctly entered into the machine controller
- tool cutter paths are executed safely and correctly
- auxiliary functions operate at the correct point in the program

(cutter start/stop, coolant flow)
- programs have been saved in the appropriate format

1.14 Prove the part program using six of the following:
- single block mode
- graphic simulation
- data input facilities
- full dry run (in air)
- search facilities
- edit facilities
- program override controls (spindle speed, feed rate, tool data)
- program save/store facilities

1.15 Save and store the program in line with organisational procedures

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Shut down the equipment to a safe condition on completion of the programming activities

Learning outcome
The learner will: 2. Know how to prepare and prove CNC machine tool programs
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when developing and proving CNC machine tool programs 2.2 Describe the hazards associated with using CNC machine tools (such as automatic machine operations, power operated chucks, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised 2.3 Describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly 2.5 Describe the correct operation of the various hand and automatic modes of machine control (such as handwheels, joysticks, program operating and control buttons) 2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency 2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing 2.9 Describe the computer coding language used in CNC programs (with

regard to machine axes, positional information, machine management and auxiliary functions)

2.10 Explain how to prepare part programs (using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes)

2.11 Describe the use of features that enable reductions in program size and input time (such as canned cycles, subroutines and labels)

2.12 Describe the function keys and operating system of the machine computer control system being operated

2.13 Explain how to set machine datums for each of the machine axes being used

2.14 Explain how to set the machine control system in the programming and editing mode, download (input) and upload (output) modes

2.15 Explain how to deal with error messages and faults on the program or equipment

2.16 Explain how to access the program edit facility, in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

2.17 Describe the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program

2.18 Explain how to conduct trial runs (using single block run, dry run and feed and spindle speed override controls)

2.19 Describe the factors that may affect the feeds and spindle speeds being used, and why they may need to be adjusted from the programmed values (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)

2.20 Describe the checks to be made before allowing the CNC machine to operate in full program run mode

2.21 Explain how to save the completed programs in the appropriate format, and the need to store program tapes and disks safely and correctly, away from contaminants and electromagnetic sources

2.22 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

2.23 Explain when to act on their own initiative and when to seek help and advice from others

2.24 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine and removing and disposing of waste)

Unit 815 Preparing and using CNC turning machines

UAN:	**Y/600/5864**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 15: Preparing and using CNC turning machines (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC turning activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. In preparing the machine, the learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine spindle. The learner will be required to select the appropriate cutting tools, to mount and secure them to the appropriate tool holding devices, and to place the cutting tools in the relevant positions within the tool posts, turrets, slides or tool change magazine/carousel, where this is applicable. The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking component programs, checking for errors/faults, and editing and saving program changes. The learner will also be required to adjust the machine tool

equipment and program, following editing procedures, to achieve component specification. The learner will be expected to produce components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, and special forms/profiles.

During, and on completion of, the turning operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the turning activities, the learner will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC turning activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the turning activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC setting and turning techniques safely. The learner will understand the CNC turning process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the turning activities to the required specification.

The learner will understand the safety precautions required when working with the CNC lathe, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use CNC turning machines
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the turning activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and correctly adjusted • components are held securely (without damage or distortion) • cutting tools are maintained in a suitable/safe condition • the work area is maintained and left in a safe and tidy condition 1.3 Plan the CNC machining activities before they start them 1.4 Load/input the program to the machine controller and check the program for errors using the approved procedures 1.5 Mount and set the required workholding devices, workpiece and cutting tools 1.6 Position and secure workpieces, using two of the following workholding methods and devices: • chucks with hard jaws • chucks with soft jaws • fixtures • drive centres • collet chucks • faceplates • magnetic/pneumatic devices • other workholding devices 1.7 Machine components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic or composite • other specific material 1.8 Select and mount the appropriate tool holding device and six of the following types of cutting tool: • roughing tool • finishing tool • parting-off tool • screw-thread tool • profiling tools

- form tools
- centre drills
- twist/core drills
- boring tools
- reamers
- maxi-tipped drills
- carbide insert drills

1.9 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations

1.10 Prepare the tooling for operation by carrying out all the following activities, as applicable to the machine type:

- positioning tools in the correct location in the tool posts, turrets, magazine or carousel
- checking the tool numbers in relation to the CNC program
- entering relevant tool data (such as tool lengths, tool offsets, radius compensation) into the CNC program or control system, as appropriate
- pre-setting tooling using setting jigs/fixtures
- setting tool datum
- saving changes to the program

1.11 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification

1.12 Confirm that the machine and program operate safely and correctly, by checking all of the following:

- datums for each machine axis are set in relation to all equipment and tooling used
- the machining carried out meets the drawing specification
- tool change positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program
- tool offsets are correctly entered
- tool cutter paths are executed safely and correctly
- auxiliary/miscellaneous functions operate at the correct point in the program (cutter start/stop, coolant flow)
- programs have been saved in the appropriate format

1.13 Produce machined components that combine different operations and have features that cover all of the following:

- parallel diameters
- stepped diameters
- flat faces
- drilled holes
- chamfers and radii

Plus four more from the following:

- tapered diameters
- undercuts
- internal profiles
- external profiles

- reamed holes
- tapped holes
- parting-off
- eccentric diameters
- external screw threads
- internal screw threads
- bored holes

1.14 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.15 Carry out the necessary checks for accuracy, to include all of the following:
- external diameters
- linear dimensions (such as lengths, depths)
- parallelism/cylindricity
- surface finish

Plus four more from the following:
- internal diameters
- bore/hole size/fit
- angle/taper
- thread fit
- concentricity/coaxiality
- grooves/undercuts (such as position, width, depth)
- eccentricity
- ovality

1.16 Use all of the following measuring equipment during the machining and checking activities:
- external micrometers
- Vernier/digital/dial callipers
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:
- rules
- internal micrometers
- depth micrometers
- depth Verniers
- slip gauges
- bore/hole gauges
- thread gauges (such as ring, plug, profile)
- plug gauges
- radius/profile gauges
- protractors

1.17 Produce components to all of the following quality and accuracy standards, as applicable to the operation:
- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010”

- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”
- surface finish 63 µin or 1.6µm
- reamed holes within H8
- screw threads BS medium fit
- angles/tapers within +/- 0.5 degree

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome
The learner will: 2. Know how to prepare and use CNC turning machines
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC lathes (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and tooling is free from the workpiece before starting the machine) 2.2 Describe the hazards associated with the using CNC lathes, (such as automatic machine operations, power operated chucks, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools, and burrs and sharp edges on components), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the CNC turning activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery) 2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly 2.5 Describe the correct operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons) 2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency 2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing 2.9 Describe the computer coding language used in CNC programs, with regard to machine axes, positional information, machine management and auxiliary/miscellaneous functions

2.10	Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program
2.11	Explain how to deal with error messages and faults on the program or equipment
2.12	Describe the range of workholding methods and devices that are used on CNC lathes
2.13	Explain why it is important to set the workholding device in relationship to the machine datums and reference points
2.14	Describe the methods of setting the workholding devices, and the tools and equipment that can be used
2.15	Describe the range of cutting tools that are used on CNC lathes, and typical applications
2.16	Explain how to check that the cutting tools are in a safe and serviceable condition
2.17	Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
2.18	Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
2.19	Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures
2.20	Describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
2.21	Explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
2.22	Explain how to conduct trial runs using single block run, dry run, and feed and speed override controls
2.23	Describe the things that they need to check before allowing the machine to operate in full program run mode
2.24	Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
2.25	Describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
2.26	Explain how to save the completed programs in the appropriate format, and the importance of storing program tapes and disks safely and correctly, away from contaminants and electromagnetic sources
2.27	Describe the typical problems that can occur with the CNC turning activities, and what to do if they occur
2.28	Explain when to act on their own initiative and when to seek help and advice from others
2.29	Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 816 Preparing and using CNC milling machines

UAN:	**D/600/5865**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 16: Preparing and using CNC milling machines (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC milling activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. In preparing the milling machine, the learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine table. The learner will be required to select the appropriate milling cutters/cutting tools, to mount and secure them to the appropriate tool holding devices and machine spindle, or to place the cutting tools in the relevant positions within the turrets, slides or tool change magazine/carousel, where this is applicable. The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking component programs, checking for errors/faults, and editing and saving program changes. The learner will also be

required to adjust the machine tool equipment and program, following editing procedures, to achieve component specification. The learner will be expected to produce components that combine a number of different features, such as flat faces, parallel faces, faces square to each other faces at an angle, steps/shoulders, open and enclosed slots, drilled, bored and reamed holes, internal threads, and special forms/profiles.

During, and on completion of, the milling operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the milling activities, the learner will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC milling activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the milling activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC setting and milling techniques safely. The learner will understand the CNC milling process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the milling activities to the required specification.

The learner will understand the safety precautions required when working with the CNC milling machine, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use CNC milling machines
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the milling activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and correctly adjusted • components are held securely (without damage or distortion) • cutting tools are maintained in a suitable/safe condition • the work area is maintained and left in a safe and tidy condition 1.3 Plan the CNC machining activities before they start them 1.4 Load/input the program to the machine controller and check the program for errors using the approved procedures 1.5 Mount and set the required workholding devices, workpiece and cutting tools 1.6 Position and secure workpieces, using two of the following workholding methods and devices: • machine vices • fixtures • chucks • angle plate • direct clamping to machine table • pneumatic or magnetic table • ancillary indexing devices • other workholding devices 1.7 Machine components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic/nylon/composite • other specific material 1.8 Select and mount four of the following types of milling cutters to the appropriate tool holding device: • face mills • end mills • twist/core drills

- boring tools
- reamers
- slot drills
- special profile cutters

1.9 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations

1.10 Prepare the tooling for operation, by carrying out all of the following activities, as applicable to the machine type:
- securing tools to the machine spindle or positioning tools in the correct position in the tool magazine/carousel
- checking that tools have specific tool number in relation to the operating program
- entering all relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)
- pre-setting tooling using setting jigs/fixtures (where appropriate)
- setting tool datum
- saving changes to the program

1.11 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification

1.12 Confirm that the machine and program operates safely and correctly, by checking all of the following:
- datums for each machine axis are set in relation to all equipment and tooling used
- all operations are carried out to the program co-ordinates
- tool change positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program
- tool offsets are correctly entered into the machine controller
- tool cutter paths are executed safely and correctly
- auxiliary functions operate at the correct point in the program (such as cutter start/stop, coolant flow)
- programs have been saved in the appropriate format

1.13 Produce machined components that combine different operations and have features that cover all of the following:
- flat faces
- steps/shoulders
- open ended slots
- enclosed slots/recesses
- drilled holes linearly pitched

Plus three more from the following:
- parallel faces
- square faces
- angular faces
- internal profiles
- external profiles
- drilled holes on pitched circles

- bored holes
- reamed holes
- tapped holes
- circular/curved profiles
- special forms (such as concave, convex)

1.14 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.15 Carry out the necessary checks for accuracy, to include all of the following:

- linear dimensions (such as lengths, depths)
- slots (such as position, width, depth)
- flatness
- surface finish

Plus four more from the following:

- squareness
- parallelism
- hole size/fit
- angles
- recesses
- thread fit

1.16 Use all of the following measuring equipment during the machining and checking activities:

- external micrometers
- Vernier/digital/dial callipers
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:

- rules
- internal micrometers
- depth micrometers
- depth Verniers
- slip gauges
- bore/hole gauges
- thread gauges
- plug gauges
- radius/profile gauges
- Vernier protractors

1.17 Produce components to all of the following quality and accuracy standards, as applicable to the operation:

- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010”
- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”
- surface finish 63 µin or 1.6µm
- reamed holes within H8

- screw threads BS medium fit
- angles/tapers within +/- 0.5 degree
- flatness and squareness 0.001” per inch or 0.025mm per 25mm

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome
The learner will: 2. Know how to prepare and use CNC milling machines
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC milling machines (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and that tooling is free from workpiece before starting the machine) 2.2 Describe the hazards associated with the using CNC milling machines (such as automatic machine operations, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools, lifting and handling workholding devices, and burrs and sharp edges on component), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the CNC milling activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery) 2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly 2.5 Describe the correct operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons) 2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency 2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing 2.9 Describe the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions) 2.10 Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program

2.11 Explain how to deal with error messages and faults on the program or equipment
2.12 Describe the range of workholding methods and devices that are used on NC/CNC milling machines
2.13 Explain why it is important to set the workholding device in relationship to the machine axis and reference points
2.14 Describe the methods of setting the workholding devices, and the tools and equipment that can be used
2.15 Describe the range of milling cutters/cutting tools that are used on NC/CNC milling machines, and their typical applications
2.16 Explain how to check that the cutting tools are in a safe and serviceable condition
2.17 Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors which will determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
2.18 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders and machine spindle
2.19 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures
2.20 Describe the use of tool magazines and carousels, and how to position and identify the tools in relationship to the operating program
2.21 Explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
2.22 Explain how to conduct trial runs (using single block run, dry run, and feed and speed override controls)
2.23 Describe the things that they need to check before allowing the machine to operate in full program run mode
2.24 Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
2.25 Describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
2.26 Explain how to save the completed programs in the appropriate format, and the importance of storing program tapes and disks safely and correctly, away from contaminants and electromagnetic sources
2.27 Describe the typical problems that can occur with the CNC milling activities, and what to do if they occur
2.28 Explain when to act on their own initiative and when to seek help and advice from others
2.29 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 817 Preparing and using CNC machining centres

UAN:	**H/600/5866**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 17: Preparing and using CNC machining centres (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC machining activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. In preparing the machining centre, the learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine. The learner will also be required to select the appropriate cutting tools, to mount and secure them to the appropriate tool holding devices, and to place the cutting tools in the relevant positions within the tool posts, turrets, slides or tool change magazine/carousel, where this is applicable. The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking component programs, checking for errors/faults, and editing and saving program changes. The learner will also be

required to adjust the machine tool equipment and program, following editing procedures, to achieve component specification. The learner will be expected to produce components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, and special forms/profiles.

During, and on completion of, the machining operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the machining activities, the learner will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC machining activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the machining activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC setting and machining techniques safely. The learner will understand the CNC machining centre process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the machining activities to the required specification.

The learner will understand the safety precautions required when working with the CNC machining centre, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use CNC machining centres
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the machining activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • machine guards are in place and correctly adjusted • components are held securely (without damage or distortion) • cutting tools are maintained in a suitable/safe condition • the work area is maintained and left in a safe and tidy condition 1.3 Plan the CNC machining activities before they start them 1.4 Load/input the program to the machine controller, and check the program for errors using the approved procedures 1.5 Mount and set the required workholding devices, workpiece and cutting tools 1.6 Position and secure workpieces, using two of the following workholding methods and devices: • clamping direct to machine table • machine vice • chucks with hard jaws • chucks with soft jaws • collet chucks • jigs and fixtures • faceplates • angle plate • indexing/rotating device • magnetic or pneumatic devices • other workholding devices 1.7 Machine components made from two of the following types of material: • low carbon/mild steel • high carbon steel • aluminium/aluminium alloys • cast iron • brass/brass alloys • plastic/nylon/composite • other specific material 1.8 Select and mount the appropriate tool holding device and six of the following types of cutting tool:

- turning tools
- boring tools
- facing tools
- profiling tools
- parting-off tool
- thread cutting tools
- centre drills
- twist/core drills
- reamers
- recessing/undercutting tools
- face mills
- slotting cutters
- slitting saws
- end mills
- slot drills
- grinding wheels
- taps
- dies

1.9 Check that all safety mechanisms are in place and that the equipment is set correctly for the required operations

1.10 Prepare the tooling for operation, by carrying out all of the following activities, as applicable to the machine type:

- positioning tools in the correct position in the tool posts, turrets, magazine or carousel
- checking that tools have a specific tool number in relation to the operating program
- entering relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)
- pre-setting tooling by using setting jigs/fixtures
- setting tool datum
- saving changes to the program

1.11 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification

1.12 Confirm that the machine and program operates safely and correctly, by checking all of the following:

- datums for each machine axis are set in relation to all equipment and tooling used
- all operations are carried out to the program co-ordinates
- tool change positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program
- tool offsets are correctly entered into the machine controller
- tool cutter paths are executed safely and correctly
- auxiliary functions operate at the correct point in the program (cutter start/stop, coolant flow)
- programs have been saved in the appropriate format

1.13 Produce machined components that combine different operations, and have features that cover ten of the following:

- parallel diameters
- stepped diameters
- tapered diameters
- eccentric diameters
- drilled holes
- reamed holes
- bored holes
- tapped holes
- external screw threads
- internal screw threads
- parting-off
- chamfers and radii
- tapered holes
- flat faces
- square faces
- parallel faces
- angular faces
- shoulders and steps
- drilled holes linearly pitched
- drilled holes on pitched circles
- indexed or rotated forms
- internal profiles
- external profiles
- open ended slots
- enclosed slots/recesses
- grooves/undercuts
- special forms (such as concave, convex)

1.14 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.15 Carry out the necessary checks for accuracy, to include eight of the following:

- external diameters
- internal diameters
- linear dimensions (such as lengths, depths)
- bore/hole size/fit
- surface finish
- angle/taper
- thread fit
- grooves/undercuts (such as position, width, depth)
- slots (such as position, width, depth)
- concentricity
- eccentricity
- flatness
- parallelism

- squareness
- ovality

1.16 Use all of the following measuring equipment during the machining and checking activities:

- external micrometers
- Vernier/digital/dial callipers
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:

- rules
- internal micrometers
- depth micrometers
- depth Verniers
- slip gauges
- bore/hole gauges
- thread gauges (such as ring, plug, profile)
- plug gauges
- radius/profile gauges
- protractors

1.17 Produce components to all of the following quality and accuracy standards, as applicable to the operation:

- components to be free from false tool cuts, burrs and sharp edges
- general dimensional tolerance +/- 0.25mm or +/- 0.010"
- there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004"
- surface finish 63 µin or 1.6µm
- reamed holes within H8
- screw threads BS medium fit
- angles/tapers within +/- 0.5 degree
- flatness and squareness 0.001" per inch or 0.025mm per 25mm

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome

The learner will:

2. Know how to prepare and use CNC machining centres

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC machining centres (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and that tooling is free from the workpiece before starting the machine)

2.2 Describe the hazards associated with the using CNC machining centres (such as automatic machine operations, power operated workholding devices, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools, and burrs and sharp edges on components), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be worn for the CNC machining activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)

2.4 Describe the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

2.5 Describe the correct operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)

2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

2.9 Describe the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)

2.10 Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program

2.11 Explain how to deal with error messages and faults on the program or equipment

2.12 Describe the range of workholding methods and devices that are used on NC/CNC machining centres

2.13 Explain why it is important to set the workholding device in relationship to the machine datum/axis and reference points

2.14 Describe the methods of setting the workholding devices, and the tools and equipment that can be used

2.15 Describe the range of cutting tools that are used on NC/CNC machining centres, and their typical applications

2.16 Explain how to check that the cutting tools are in a safe and serviceable condition

2.17 Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)

2.18 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders

2.19 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

2.20	Describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
2.21	Explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
2.22	Explain how to conduct trial runs (using single block run, dry run and feed and speed override controls)
2.23	Describe the things that they need to check before allowing the machine to operate in full program run mode
2.24	Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
2.25	Describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
2.26	Explain how to save the completed programs in the appropriate format, and the importance of storing program tapes and disks safely and correctly, away from contaminants and electromagnetic sources
2.27	Describe the typical problems that can occur with the CNC machining activities, and what to do if they occur
2.28	Explain when to act on their own initiative and when to seek help and advice from others
2.29	Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 818 Assembling and testing fluid power systems

UAN:	**K/600/5870**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 20: Assembling and testing fluid power systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic fluid power assembly activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the assembly activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the assembly operations to be carried out and the type of fluid power equipment being assembled, which will include hydraulic, pneumatic or vacuum systems. In carrying out the fluid power assembly operations, the learner will be required to follow specific assembly techniques in order to assemble the various components, which will include rigid and flexible pipework, hoses, valves, actuators and cylinders, regulators, switches and sensors. The

assembly activities will also include making all necessary checks and adjustments to ensure that fluid power components are correctly positioned and aligned, are dimensionally accurate and secure; pipework is dimensionally accurate and free from ripples, creases and damage; and joints are checked for security, with threaded devices tightened correctly. The learner will also be expected to carry out appropriate test procedures (such as leak or pressure) to confirm that the fluid power assembly meets the operational performance required.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fluid power assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate fluid power assembly techniques and procedures safely. The learner will understand the assembly process, and its application, and will know about the fluid power equipment being assembled, the system components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the assembly activities, and when using assembly tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Assemble and test fluid power systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the assembly of the fluid power system: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids) • follow job instructions, assembly drawings and procedures • check that assembly tools and test instruments to be used are within calibration date and are in a safe and usable condition • ensure that the fluid power system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the assembly activities 1.3 Assemble one of the following types of fluid power system: • pneumatic • hydraulic • vacuum 1.4 Plan the assembly activities before they start them 1.5 Obtain all the information they need for the safe assembly of the fluid power system 1.6 Obtain and prepare the appropriate components, assembly tools and test equipment 1.7 Produce fluid power assemblies that contain a range of components, including all of the following: • rigid pipework • hoses • valves • cylinders/actuators Plus six more from the following: • pumps • compressors • accumulators • reservoirs/storage devices • motors • lubricators • pressure intensifiers • regulators • gauges/indicators • switches

- sensors
- receivers
- filters
- bearings
- cables and wires
- gaskets and seals
- other specific components

1.8 Use the appropriate methods and techniques to assemble the components in their correct positions

1.9 Apply fluid power assembly methods and techniques to include all of the following:

- checking components for serviceability
- positioning equipment/components
- aligning pipework and connections
- dressing and securing pipes and hoses
- setting, aligning and adjusting system components
- securing by using mechanical fixings
- applying screw fastener locking devices
- tightening fastenings to the required torque
- applying hose/cable clips and fasteners
- making de-energised checks before filling and/or pressurising the system

1.10 Secure the components, using the specified connectors and securing devices

1.11 Check the completed assembly to ensure that all operations have been completed and that the finished system meets the required specification

1.12 Carry out quality checks, to include all of the following, using appropriate equipment:

- the system is complete, as per specification
- dimensions are within specification requirements
- components are correctly positioned
- components are correctly aligned
- direction and flow indicators on components are correct
- components are securely held in place
- connections to components are tightened to the required torque
- pipework is free from ripple and creases
- electrical connections are correctly made (where applicable)

1.13 Carry out tests on the assembled system, in accordance with the test schedule/defined test procedures

1.14 Carry out all of the following checks to ensure the accuracy and quality of the tests carried out:

- the test equipment is correctly calibrated
- the test equipment used is appropriate for the tests being carried out
- test procedures used are as recommended in the appropriate specifications
- test readings are taken at the appropriate points, and where

- appropriate components are adjusted to give the required readings
- test equipment is operated within its specification range

1.15 Carry out tests and adjustments on the assembled system, to include:
- leak test

Plus one more from the following:
- pressure line pressure tests
- return line pressure test
- flow
- speed
- sequence
- operational performance

1.16 Produce fluid power assemblies which meet all of the following:
- all components are correctly assembled and aligned, in accordance with the specification
- moving parts are correctly adjusted and have appropriate clearances
- the system functions in line with the specification requirements
- the system is leak free

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to assemble and test fluid power systems
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the fluid power assembly activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with carrying out assembly activities on fluid power equipment (such as handling fluids, stored energy/force, misuse of tools), and how these can be minimised 2.4 Explain how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, symbols used in fluid power, and other documents needed in the assembly activities 2.5 Describe the procedure for obtaining drawings, job instructions, related specifications, components, materials and other consumables necessary for the assembly activities 2.6 Describe the basic principles of how the fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

2.7 Describe the different types of pipework, fittings and manifolds, and their application
2.8 Describe the identification and application of different types of valve (such as poppet, spool, piston, disc)
2.9 Describe the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)
2.10 Describe the identification and application of different types of cylinder (such as single acting, double acting)
2.11 Describe the identification and application of different types of pump (such as positive and non-positive displacement)
2.12 Describe the application and fitting of static and dynamic seals
2.13 Describe the techniques used to assemble/install fluid power equipment (such as marking out the positions of components; making pipe bends using fittings and by hand bending methods; connecting components using rigid and flexible pipework; using gaskets/seals and jointing/sealing compounds)
2.14 Describe the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections
2.15 Describe the need to ensure cleanliness of the fluid power system, and the ways of purging pipework before connection to components and pressure sources
2.16 Describe the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
2.17 Describe the methods of testing the fluid power system; the types of test equipment to be used, and their selection for particular tests
2.18 Explain how to make safety checks of the system before carrying out tests, to ensure that all pipes and components are secure and that moving parts are chocked or parked
2.19 Explain how to connect suitably calibrated test equipment into the circuit, and how to connect the circuit to a suitable pressure source containing appropriate ancillary equipment
2.20 Explain how to carry out the tests (such as applying test pressures in incremental stages; checking for leaks; taking appropriate test readings; adjusting appropriate components to give required operating conditions)
2.21 Explain how to determine pressure settings, and their effect on the system
2.22 Explain how to display/record test results, and the documentation used
2.23 Explain how to interpret the test readings obtained, and the significance of the readings gained
2.24 Describe the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits
2.25 Explain how to check that tools and test equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose
2.26 Describe the problems associated with the fluid power assembly and testing activity, and how they can be overcome
2.27 Explain when to act on their own initiative and when to seek help and advice from others
2.28 Describe the importance of leaving the work area in a safe and

	clean condition on completion of the assembly activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 819 Preparing and using industrial robots

UAN:	**M/600/5868**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 18: Preparing and using industrial robots (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce, load and prove programs on industrial robot controllers, and which will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be required to produce the control programs, by using a teach pendant and by producing and downloading programs from a computer. The learner will need to check/prove the program, using single block run and program edit facilities. The learner will also be required to adjust the robot program, following proving/editing procedures to achieve the control specification. The learner must ensure that any edited programs are saved and backed up safely and correctly. In preparing the robot, the learner will be expected to select the appropriate workholding devices, and to mount and secure them in the appropriate location. The learner will also be required to select the appropriate tools or accessories, and to mount and secure them to the robot arm. The learner will need to ensure that all the

tools/accessories have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the robot's operating program.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for preparing and using industrial robots. The learner will need to take account of any potential difficulties or problems that may arise with the robot related activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate robot programming and operating techniques safely. The learner will understand the robotic process, and its application, and will know about the sensors and actuators used in the process, the programming, editing and proving process, workholding devices, tooling/accessories and setting-up procedures, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with industrial robots, and with their associated tools and equipment. The learner will be required to demonstrate safe working practices for any robotic cell they are working on, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use industrial robots
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices during the robot programming activities:

- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- check that all the teach pendant/computer equipment is correctly connected, and is in a safe and usable working condition (such as cable undamaged, safely routed)
- power up the equipment and activate the programming software
- set up the computer system to produce the program
- ensure that the correct process input/output and control data to produce the program is obtained and checked for currency and validity
- store completed program media safely and correctly, away from contaminants or electromagnetic sources

1.3 Produce operating programs for one of the following engineering applications:
- welding
- surface coating
- gluing/sealing
- machine loading/unloading
- assembly
- logistics movement/control
- packaging
- stud welding
- other specific activity

1.4 Prepare and use one of the following types of industrial robot:
- gantry
- floor mounted
- ceiling mounted
- other specific type

1.5 Prepare, load and prove programs for one of the following types of robot controller:
- SCARA
- jointed arm
- parallel

1.6 Plan the programming activities before they start them

1.7 Determine an operational sequence that avoids wasted robot arm movements and tool/accessory changes

1.8 Produce industrial robot control programs, in the appropriate formats, containing all the relevant and necessary data for the engineering activity to be carried out

1.9 Produce control programs for robots with digital and analogue inputs/outputs from four of the following:
- proximity sensors
- barcode scanners
- optical sensors
- colour sensors
- counters
- hydraulic actuators

- limit switches
- timer switches
- temperature sensors
- pneumatic actuators
- pressure switches
- liquid flow switches
- air flow switches
- liquid level sensors
- other actuator

1.10 Develop programs that contain all of the following, as applicable to the robot type:
- safe start and stop positions
- all necessary positional information
- type of motion (such as joint interpolated, linear, circular)
- preparatory commands and process management/auxiliary functions
- repetitive programs (sub-routines, canned cycles, labels)
- speed/acceleration parameters
- sensor information
- part programs downloaded from a computer (such as patch programs)
- use of workframes (such as tool, global, joint, user)

1.11 Load/input the program to the robot controller, and check the program for errors using the approved procedures

1.12 Make sure that codes and other references used in the programs are applicable to the type of controller used

1.13 Prove the robot program using four of the following:
- single block run
- search facilities
- program override controls
- all modes (such as auto, T1, T2 and remote)
- full dry run
- edit facilities
- data input facilities

1.14 Save and store the program, in line with organisational procedures

1.15 Mount and set the required workholding devices and robot tooling

1.16 Run the operating program, and check and adjust the operating parameters to achieve the component specification

1.17 Carry out operations for one of the applications identified in assessment criteria 1.3, to include all of the following:
- checking that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- positioning work in relation to the robot parameters (such as securing in the workholding device)
- running the operating program in accordance with operating procedures
- checking that all operations are carried out safely and correctly

- editing programs using the correct procedure (where appropriate)
- examining the completed work visually and/or using suitable test/measuring instruments, gauges or checking fixtures, as appropriate to the operations performed
- determining if the completed setup completes the operations to the required specification

1.18 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.20 Shut down the equipment to a safe condition on completion of the robotic activities

Learning outcome
The learner will: 2. Know how to prepare and use industrial robots
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when developing and proving industrial robot operating programs 2.2 Describe the hazards associated with using industrial robots (such as automatic/sudden movements of arm, power operated accessories), and how they can be minimised 2.3 Describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.4 Describe the safety mechanisms on the robot and operating envelope (such as emergency stop buttons, movement/hazard sensors), and the procedure for checking that they function correctly 2.5 Explain how to stop the robot in both normal and emergency situations, and the procedure for restarting after an emergency 2.6 Describe the correct operation of all available modes (such as automatic operation, teach pendant, program operating and control buttons) 2.7 Explain how to drive the robot in each type of coordinate frame (such as tool, global, joint, user) 2.8 Explain how to drive the robot at different speeds, including jog mode 2.9 Describe the main robot types that are available, and the importance of understanding that a different robot may use a completely different syntax for similar functions 2.10 Describe the information and data required in order to produce complete and accurate robot programs 2.11 Explain how to extract and interpret general and technical data and information from different sources (such as drawings, computer models, symbols and conventions, BS or ISO standards) in order to produce the robot program 2.12 Describe the factors to be taken into account when producing robot programs (including the type of robot (SCARA, jointed-arm,

parallel) and its control capabilities, safety, the product/environment being controlled)

2.13 Explain how to produce effective and efficient programs to avoid unnecessary operations (including the use of macro programs and canned cycles, to reduce program size)

2.14 Describe the methods and procedures used to check that the completed program will perform safely, accurately and efficiently (such as conducting trial runs, using single block run, dry run and speed override controls)

2.15 Explain how to save the completed programs in the appropriate format, and the importance of storing program safely and correctly, away from contaminants and electromagnetic sources

2.16 Explain how to back up completed or edited programs, and the implications if this is not carried out effectively

2.17 Describe the problems that can occur with the downloading and running of the robot program, and how these can be overcome

2.18 Describe the various workholding devices that are used for robot applications, and the methods of positioning and setting them in relation to the robot's operating parameters (such as jigs and fixtures)

2.19 Describe the various tools and equipment that are used for the particular robot operations (such as mechanical grippers, welding torches, stud guns, spray guns, drilling attachments)

2.20 Explain why they need to ensure that tools are positioned correctly in relationship to the robot's reference points and tool centre points

2.21 Describe the importance of checking that the tool change positions (where appropriate) are clear of the workpiece and can be safely and quickly achieved

2.22 Describe the need to ensure that all guards are in place and that the interlock systems are in correct working order

2.23 Explain how to run the robot operating program and check that all operations are carried out safely and correctly

2.24 Explain how to check that the finished operations meet the work specification

2.25 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

2.26 Explain when to act on their own initiative and when to seek help and advice from others

2.27 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)

Unit 820 Maintaining mechanical devices and equipment

UAN:	**T/600/5869**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 19: Maintaining mechanical devices and equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic mechanical maintenance activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of mechanical equipment being maintained. This will include equipment such as gearboxes, pumps, machine tools, conveyor systems, workholding arrangements, engines, processing plant and equipment, and other organisation-specific equipment. The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports,

using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

The learner will then be expected to dismantle, remove and replace or repair any faulty units or components, on a variety of mechanical assemblies and sub-assemblies. This will include components such as shafts, bearings, couplings, gears, pulleys, clutches, brakes, levers and linkages, cams and followers, and other specific mechanical components. The learner will be expected to cover a range of maintenance activities, such as draining and removing fluids, releasing stored energy, labelling/proof marking to aid reassembly, dismantling components to the required level, dismantling components requiring pressure or expansion/contraction techniques, checking components for serviceability, replacing faulty components and 'lifed' items, setting, aligning and adjusting components, tightening fasteners to the required torque and making 'off-load' checks of the maintained equipment.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the mechanical maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate mechanical maintenance techniques and procedures safely. The learner will understand the maintenance process, and its application, and will know about the mechanical equipment being maintained, the equipment components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Maintain mechanical devices and equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the maintenance activity: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids), where appropriate • follow job instructions, maintenance drawings and procedures • check that the tools and test instruments are within calibration date, and are in a safe and usable condition • ensure that the system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the maintenance activities 1.3 Carry out maintenance activities on two of the following types of mechanical equipment: • gearboxes • compressors • process control valves • machine tools • processing plant • mechanical structures • engines • transfer equipment • pumps • workholding devices • lifting and handling equipment • company-specific equipment 1.4 Plan the maintenance activities before they start them 1.5 Obtain all the information they need for the safe removal and replacement of the equipment components 1.6 Obtain and prepare the appropriate tools and equipment 1.7 Apply appropriate maintenance diagnostic techniques and procedures 1.8 Use four of the following maintenance diagnostic techniques, tools and aids: • fault finding techniques (such as half-split, input/output, unit

substitution)

- diagnostic aids (such as manuals, flowcharts, troubleshooting guides, maintenance records)
- information gathered from fault reports
- visual checks (such as signs of leakage, damage, missing parts, wear/deterioration)
- alignment checks
- movement checks (such as excessive movement or clearance, loose fittings and connections)
- force/pressure checks (such as spring pressure, belt or chain tension)
- overheating checks (such as bearings, friction surfaces)
- sensory input (such as sight, sound, smell, touch)
- information from monitoring equipment or gauges
- operating (such as manual operation, timing and sequencing)
- test instrumentation measurement (such as pressure, flow, timing, sequence, movement)
- measuring instruments (such as Dial Test Indicators, torque measuring devices, feeler gauges)

1.9 Use appropriate methods and techniques to remove and replace the required components

1.10 Carry out all of the following maintenance activities, as applicable to the equipment being maintained:

- dismantling equipment to unit/sub-assembly level
- dismantling units to component level
- proof marking/labelling of components
- checking components for serviceability
- replacing all 'lifed' items (such as seals, bearings, gaskets)
- replacing damaged/defective components
- setting, aligning and adjusting replaced components
- tightening fastenings to the required torque
- making 'off-load' checks before starting up
- replenishing oils and greases
- functionally testing the completed system

1.11 Remove and replace a range of mechanical components, to include eight of the following:

- shafts
- couplings
- gears
- clutches
- valves and seats
- pistons
- brakes
- splines
- bearing and seals
- fitting keys
- springs

- diaphragms
- cams and followers
- chains and sprockets
- pulleys and belts
- levers and links
- slides
- rollers
- housings
- actuating mechanisms
- structural components
- locking and retaining devices (such as circlips, pins)
- other specific components

1.12 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

1.13 Carry out checks on the maintained equipment, to include three of the following:

- correct operation of moving parts
- correct working clearance of parts
- backlash in gears
- belt/chain tension
- bearing loading
- torque loading of fasteners

1.14 Maintain mechanical equipment in compliance with one or more of the following:

- organisational guidelines and codes of practice
- equipment manufacturers' operation range
- BS and/or ISO standards

1.15 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.16 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome
The learner will: 2. Know how to maintain mechanical devices and equipment
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the mechanical maintenance activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy 2.3 Describe the hazards associated with carrying out mechanical maintenance activities (such as handling oils, greases, stored energy/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them

2.4 Describe the system isolation procedures or permit-to-work procedure that applies
2.5 Explain how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process
2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
2.7 Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact
2.8 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
2.9 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)
2.10 Explain how to evaluate sensory information (sight, sound, smell, touch)
2.11 Describe the sequence to be adopted for the dismantling/re-assembly of various types of assemblies
2.12 Describe the methods and techniques used to dismantle/assemble mechanical equipment (such as release of pressures/force, proof marking, extraction, pressing, alignment)
2.13 Describe the methods of checking that components are fit for purpose, and how to identify defects and wear characteristics
2.14 Describe the identification, application, fitting and removal of different types of bearings (such as roller, ring, thrust)
2.15 Describe the methods and techniques of fitting keys and splines
2.16 Describe the identification, application, fitting and removal of different types of gears
2.17 Explain how to correctly tension belts and chains
2.18 Describe the identification and application of different types of locking device
2.19 Describe the methods of checking that removed components are fit for purpose, and the need to replace 'lifed' items (such as seals and gaskets)
2.20 Describe the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)
2.21 Explain how to check that tools and equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose
2.22 Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as setting working clearance, setting travel, setting backlash in gears, preloading bearings)
2.23 Describe the importance of making 'off-load' checks before running the equipment under power
2.24 Describe the importance of completing maintenance documentation and/or reports following the maintenance activity
2.25 Explain how to use lifting and handling equipment in the maintenance activity
2.26 Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

2.27	Explain when to act on their own initiative and when to seek help and advice from others
2.28	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to the designated locations, cleaning the work area, and removing and disposing of waste)

Unit 821 Maintaining fluid power equipment

UAN:	**F/600/5874**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 21: Maintaining fluid power equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic fluid power maintenance activities which will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of fluid power equipment being maintained, which will include hydraulic, pneumatic or vacuum equipment and circuits. The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the

equipment. The learner will then be expected to dismantle, remove and replace, or repair any faulty units or components, including pumps, valves, actuators, sensors, intensifiers, regulators, compressors, pipes and hoses, and other specific fluid power equipment. The learner will be expected to cover a range of maintenance activities, such as draining and removing fluids, removing stored pressure, labelling/proof marking to aid reassembly, dismantling components to the required level, checking components for serviceability, replacing faulty components and 'lifed' items, setting and adjusting components, tightening fasteners to the required torque and making 'off-load' checks, before starting up and testing the maintained equipment, using appropriate techniques and procedures.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fluid power maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate fluid power maintenance techniques and procedures safely. The learner will understand the maintenance process, and its application, and will know about the fluid power equipment being maintained, the system components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Maintain fluid power equipment

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

1.2 Carry out all of the following during the maintenance activity:

- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids)
- follow job instructions, maintenance drawings and procedures
- check that tools and test instruments to be used are within calibration and are in a safe and usable condition
- ensure that the system is kept free from foreign objects, dirt or other contamination
- return all tools and equipment to the correct location on completion of the maintenance activities

1.3 Carry out maintenance activities on one of the following types of fluid power equipment:

- pneumatic
- hydraulic
- vacuum

1.4 Plan the maintenance activities before they start them

1.5 Obtain all the information they need for the safe isolation, removal and replacement of the system components

1.6 Obtain and prepare the appropriate tools and test equipment

1.7 Apply appropriate maintenance diagnostic techniques and procedures

1.8 Use four of the following maintenance diagnostic techniques, tools and aids:

- fault finding techniques (such as six point, half-split, input/output, unit substitution, emergent sequence)
- diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
- information gathered from fault reports
- inspecting (such as checking for damage, wear/deterioration, leaks, loose fittings and connections)
- sensory input (such as sight, sound, smell, touch)
- monitoring equipment or gauges
- operating the equipment (such as manual operation, timing and sequencing)
- test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

1.9 Use two of the following types of fluid power test instruments:

- measuring devices
- pressure indicators

- flow indicators
- test rigs
- self-diagnostic equipment

1.10 Use the appropriate methods and techniques to remove and replace the required components

1.11 Carry out all of the following maintenance activities, as applicable to the equipment being maintained:

- chocking/supporting cylinders/rams/components
- releasing stored energy
- draining and removing fluids (as applicable)
- disconnecting/removing hoses and pipes
- removing and replacing units/components (such as pumps, cylinders, valves, actuators)
- proof marking/labelling of removed components
- checking components for serviceability
- replacing damaged/defective components
- replacing all 'lifed' items (such as seals, filters, gaskets)
- tightening fastenings to the required torque
- setting, aligning and adjusting replaced components
- making de-energised checks before re-pressurising the system

1.12 Remove and replace a range of fluid power components, to include all of the following:

- pipework/hoses
- valves
- cylinders/actuators

Plus five more of the following:

- reservoirs/storage devices
- accumulators
- pressure intensifiers
- compressors
- receivers
- regulators
- gauges/indicators
- pumps
- motors
- gaskets and seals
- pistons
- spools
- bearings
- switches
- sensors
- lubricators
- filters
- cables and wires
- other specific components

1.13 Carry out tests on the maintained system in accordance with the test schedule/defined test procedures

1.14 Carry out all of the following checks to ensure the accuracy and quality of the tests carried out:
- the test equipment is correctly calibrated
- the test equipment used is appropriate for the tests being carried out
- test procedures used are as recommended in the appropriate specifications
- test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings
- test equipment is operated within its specification range

1.15 Carry out tests on the maintained equipment, to include both of the following:
- leak test
- operational performance

Plus one more from the following:
- pressure line pressure tests
- return line pressure test
- flow
- speed
- sequence
- fluid contamination test

1.16 Maintain fluid power equipment in compliance with one or more of the following:
- organisational guidelines and codes of practice
- specific system requirements
- equipment manufacturers' operation range
- BS and/or ISO standards

1.17 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome
The learner will: 2. Know how to maintain fluid power equipment
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the fluid power maintenance activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with carrying out maintenance activities on fluid power equipment (such as handling fluids, stored energy/force, misuse of tools), and how these can be minimised 2.4 Describe the system isolation procedures or permit-to-work

procedure that applies

2.5 Explain how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, history/maintenance reports, symbols used in fluid power, and other documents needed in the maintenance activities

2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities

2.7 Describe the basic principles of how the fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

2.8 Describe the different types of pipework, fittings and manifolds, and their application

2.9 Describe the identification and application of different types of valve (such as poppet, spool, piston, disc)

2.10 Describe the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)

2.11 Describe the identification and application of different types of cylinder (such as single acting, double acting)

2.12 Describe the identification and application of different types of pump (such as positive and non-positive displacement)

2.13 Describe the application and fitting of static and dynamic seals

2.14 Describe the techniques used to dismantle/assemble fluid power equipment (such as release of energy/force, proof marking, extraction)

2.15 Describe the methods of checking that components are fit for purpose

2.16 Explain how to make adjustments to components/assemblies to ensure that they function correctly

2.17 Explain how to determine pressure settings, and their effect on the system

2.18 Describe the selection of fluids for the system

2.19 Describe the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system

2.20 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)

2.21 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

2.22 Explain how to evaluate sensory information (sight, sound, smell, touch)

2.23 Explain how to use a range of fault diagnostic equipment to investigate the problem

2.24 Describe the care, handling and application of mechanical measuring/test equipment (such as measuring instruments, pressure and flow indicators and self-diagnostic equipment)

2.25 Describe the types of test equipment to be used, and their selection for particular tests

2.26 Explain how the test equipment is connected into the circuit, and the methods of doing this

2.27 Describe the techniques, methods and procedures to be used during the tests

2.28 Explain how to display/record test results, and the documentation used

2.29 Explain how to interpret the test readings obtained, and the significance of the readings gained

2.30 Describe the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits

2.31 Explain how to check that tools and test equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose

2.32 Describe the problems associated with maintaining fluid power equipment, and how they can be overcome

2.33 Explain when to act on their own initiative and when to seek help and advice from others

2.34 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 822 Producing sheet metal components and assemblies

UAN:	**Y/600/5878**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 22: Producing sheet metal components and assemblies (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic sheet (up to and including 3 mm) metalworking activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the sheet metalworking activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required cutting, forming and assembly activities, and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the type and thickness of material, the operations to be carried out and the accuracy to be achieved. In carrying out the cutting and shaping activities, the learner will need to use a range of hand tools, portable power tools and simple machines to produce a variety of shapes, profiles and forms. The learner will also be expected to produce simple sheet metal assemblies, using self-secured joints, thermal methods or

mechanical fastening devices.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the sheet metalworking activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate sheet metalworking techniques and procedures safely. The learner will understand the cutting, forming and assembly process, and its application, and will know about the tools and equipment used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out sheet metalworking activities, and when using the various tools and equipment, especially with the use of guillotines and bending/forming equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce sheet metal components and assemblies
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the sheet metalworking activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on

completion of the sheet metalworking activities

- check that all measuring equipment is within calibration date

1.3 Plan the sheet metalworking activities before they start them

1.4 Use sheet metal (up to and including 3 mm) in two different materials from the following:

- black mild steel
- bright mild steel
- coated mild steel (such as tinned, galvanised)
- stainless steel
- aluminium
- brass
- copper
- lead
- titanium

1.5 Obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition

1.6 Use a range of marking out equipment, to include all of the following:

- scriber
- punch
- rule or tape
- straight edge
- square
- protractor
- dividers or trammels
- chalk, blueing or paint

1.7 Mark out the components for the required operations, using appropriate tools and techniques

1.8 Use marking out methods and techniques, including:

- direct marking using instruments

Plus one more from the following:

- use of templates
- tracing/transfer methods

1.9 Mark out material, to include all of the following features:

- datum and centre lines
- square/rectangular profiles
- angles
- circles
- curved profiles
- cutting and bending detail (including allowances)
- hole centring and outlining (such as circular or linear)

1.10 Cut and shape the materials to the required specification, using appropriate tools and techniques

1.11 Cut and finish material to the marked out shape, using both of the following hand tools:

- tin snips
- bench shears

Plus two more from the following:

- hacksaw
- hand power tools (such as drill, nibbling, saw)
- trepanning
- files
- pneumatic tools
- plasma burner

1.12 Cut and finish material to the marked out shape, using the following machine tool:

- guillotine

Plus two more of the following:

- pillar drill
- bench saw
- punch/cropping machine
- nibbling machine
- trepanning machine
- band saw

1.13 Perform cutting operations to produce components with all three of the following shapes:

- square or rectangular profiles
- angled profiles
- external curved profiles

Plus two more from the following:

- notches
- internal curved contours
- round holes
- square holes

1.14 Use both of the following types of forming equipment/techniques:

- bending machine (hand or powered)
- rolling machine (hand or powered)

Plus two more from the following:

- hammers/panel beating equipment
- stakes and formers
- presses
- jenny/wiring machine
- wheeling machine
- swaging machine
- shrinking techniques
- stretching techniques

1.15 Carry out forming operations which produce components having all of the following shapes:

- bends/upstands
- folds/safe edges
- tray/box sections
- cylindrical sections

Plus one more from the following:

- wired edges
- swages

- curved panels
- ribbed components
- cowlings and rounded covers
- square to round trunking
- lobster-back trunking
- concertina ducting or trunking

1.16 Use the appropriate methods and techniques to assemble and secure the components in their correct positions

1.17 Assemble sheet metal components, using two of the following methods:
- temporary tack welding
- soldering or brazing
- resistance spot welding
- riveting (such as hollow or solid)
- adhesive bonding
- flanged and mechanically fastened (such as bolts, screws)
- self securing joints (such as knocked up, paned down, swaged, joggled)

1.18 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.19 Produce sheet metal components which meet all of the following:
- all dimensions are within +/- 3.0mm or +/- 0.125"
- finished components meet the required shape/geometry (square, straight, angles free from twists)
- completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
- all components are correctly assembled and have secure and firm joints

1.20 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.21 Leave the work area in a safe and tidy condition on completion of the fitting activities

Learning outcome
The learner will: 2. Know how to produce sheet metal components and assemblies
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the sheet metalworking activities undertaken 2.2 Describe the personal protective clothing and equipment to be worn when carrying out the sheet metal activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy 2.3 Describe the correct methods of moving or lifting sheet materials 2.4 Describe the safe working practices and procedures to be observed when using manual and power operated tools

2.5 Describe the hazards associated with carrying out sheet metalworking activities (such as handling sheet materials, using dangerous or badly maintained tools and equipment, operating guillotines and bending machines, and when using hand and bench shears), and how they can be minimised
2.6 Describe the procedure for obtaining the required drawings, job instructions and other related specifications
2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
2.9 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium)
2.10 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum
2.11 Describe the use of marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles)
2.12 Describe the ways of laying out the marking-out shapes or patterns to maximise use of materials
2.13 Describe the tools and techniques available for cutting and shaping sheet metal (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws)
2.14 Describe the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose - such as sharp, undamaged, plugs and cables secure and free from damage, machine guards or safety devices operating correctly)
2.15 Describe the hand tools used in sheet metal forming activities (such as range of hammers, stakes, formers, sand bags), and typical operations that they are used for
2.16 Describe the various machine tool forming equipment that can be used to produce a range of shapes (such as bends, box sections, cylinders and curved sections, wired edges and swages)
2.17 Describe the methods of stretching and shrinking materials, and the tools, equipment and techniques used for this
2.18 Explain how to set up the various machines to produce the required forms (setting up of rolls; setting fingers on bending machines; setting forming tools for swaging)
2.19 Describe the ways of limiting distortion, marking, creases, flats (in curved sections)
2.20 Describe the characteristics of the various materials used (with regard to the bending and forming process)
2.21 Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming
2.22 Describe the importance of using tools or equipment only for the purpose intended; the care that is required when using the tools or

	equipment; the proper way of preserving tools or equipment between operations
2.23	Describe the various methods of securing the assembled components, and the range of mechanical fastening devices that are used (such as nuts and bolts, rivets, screws, special fasteners), resistance and tack welding methods and techniques, adhesive bonding of components and self secured joints (such as knocked up, paned down, swaged and joggled)
2.24	Describe the preparations to be carried out on the components prior to assembling them
2.25	Explain how to set up and align the various components, and the tools and equipment that are used for this
2.26	Describe the methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)
2.27	Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits
2.28	Describe the problems that can occur with the sheet metalworking activities (such as defects caused by incorrectly set or blunt shearing blades), and how these can be overcome
2.29	Explain when to act on their own initiative and when to seek help and advice from others
2.30	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the sheet metal activities (such as storing power leads, isolating machines, cleaning the equipment and removing and disposing of waste)

Unit 823 Producing platework components and assemblies

UAN:	**R/600/5880**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 23: Producing platework components and assemblies (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic heavy platework (above 3 mm) activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the plateworking activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required cutting, forming and assembly activities, and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the type and thickness of material, the operations to be carried out and the accuracy to be achieved. In carrying out the cutting and shaping activities, the learner will need to use a range of hand tools, portable power tools and machines to produce a variety of shapes, profiles and forms. The learner will also be expected to produce simple platework assemblies, using mechanical fastening devices and tack welding.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the plate working activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate plateworking techniques and procedures safely. The learner will understand the cutting, forming and assembly process, and its application, and will know about the tools and equipment used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out plateworking the activities, and when using the various tools and equipment, especially those involved in using guillotines and bending/forming equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce platework components and assemblies
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the plateworking activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition • return all tools and equipment to the correct location on completion of the plateworking activities

- check that all measuring equipment is within calibration date

1.3 Plan the plateworking activities before they start them

1.4 Use the following materials:
- flat plate

Plus one more from the following:
- pipe/tube
- solid bar (such as square, round, hexagonal)
- rolled sections (angle, channel, RSJ, rail section)
- non-ferrous materials

1.5 Obtain the appropriate tools and equipment for the plateworking operations, and check that they are in a safe and usable condition

1.6 Use a range of marking out equipment, to include all of the following:
- scriber
- punch
- rule or tape
- straight edge
- square
- protractor
- dividers or trammels
- chalk, blueing or paint

1.7 Mark out the components for the required operations, using appropriate tools and techniques

1.8 Use marking out methods and techniques, including:
- direct marking using instruments

Plus one more from the following:
- use of templates
- tracing/transfer methods

1.9 Mark out material, to include all of the following features:
- datum and centre lines
- square/rectangular profiles
- angles
- circles
- curved profiles
- cutting and bending detail (including allowances)
- hole centring and outlining (such as circular or linear)

1.10 Cut and shape the materials to the required specification, using appropriate tools and techniques

1.11 Cut and finish material to the marked out shape, using both of the following:
- guillotine
- drill (such as bench, pillar, radial)

Plus two more from the following:
- abrasive disk
- cropping machine
- machine saw

1.12 Perform cutting operations to produce components that combine operations and cover all of the following features:

- components with parallel sides
- components with sides square to each other
- holes linearly pitched

Plus two more from the following:

- components with angled sides
- bevelled edges or weld preps
- components with curved contours
- holes radially pitched

1.13 Use two of the following types of forming equipment/techniques:

- bending machine (hand or powered)
- rolling machine (hand or powered)
- presses
- heating techniques

1.14 Perform forming operations to produce components that combine operations and cover all of the following features:

- bends at 90□
- bends of various angles
- cylinders

Plus two more of the following:

- set plate ends
- box square and rectangular sections
- curved plates
- pipe sections
- cones
- segments of a cylindrical tank
- curved section or sector of an otherwise flat plate
- counter-curved sections
- flattening or straightening plate

1.15 Use the appropriate methods and techniques to assemble and secure the components in their correct positions

1.16 Assemble platework components using two of the following methods:

- temporary tack welding
- riveting (hot or cold)
- adhesive bonding
- mechanically fastened (such as bolts, screws)

1.17 Measure and check that all dimensional and geometrical aspects of the components are to the specification

1.18 Produce platework components which meet all of the following:

- all dimensions are within +/- 3.0mm or +/- 0.125”
- finished components meet the required shape/geometry (such as square, straight, angles free from twists)
- completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
- all components are correctly assembled, and have secure and firm joints

1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have

problems that they cannot resolve 1.20 Leave the work area in a safe and tidy condition on completion of the platework activities

Learning outcome
The learner will: 2. Know how to produce platework components and assemblies
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the plateworking activities undertaken 2.2 Describe the personal protective clothing and equipment to be worn when carrying out the plateworking activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy 2.3 Describe the correct methods of moving or lifting long and heavy sheet and section materials 2.4 Describe the hazards associated with carrying out heavy plateworking activities (such as handling sheet materials, using dangerous or badly maintained tools and equipment, operating guillotines, cropping and bending machines, and when using power saws, drilling machines and abrasive cutting discs), and how they can be minimised 2.5 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.6 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium) 2.9 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum 2.10 Describe the use of marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles) 2.11 Describe the ways of laying out the marking-out shapes or patterns to maximise use of materials 2.12 Describe the tools and techniques available for cutting and shaping heavy plate and section materials (such as guillotines, cropping machines, abrasive discs (such as hand held portable machines and bench type radiac cutting machines), drilling machines, machine saws and thermal cutting equipment) 2.13 Describe the selection and fitting of abrasive cutting discs, cutting disc identification markings, how to identify the correct type of disc

for the type of material being cut; statutory regulations regarding the fitting and use of abrasive discs

2.14 Describe the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose - such as cutting blades are sharp and undamaged, setting and adjusting guillotine blades for the material thickness, ensuring machine guards, interlocks or other safety devices are operating correctly)

2.15 Describe the various shearing machine cutting methods and techniques (such as cutting to marking out; using machine back-stops; setting plate at an angle to the machine slides)

2.16 Describe the various machine tool forming equipment that can be used to produce a range of shapes (such as bends, box sections, cylinders and curved sections)

2.17 Explain how to set up the various machines to produce the required forms (setting up of rolls; releasing formed work from rolls; setting up bending machines and setting forming tools)

2.18 Describe the ways of limiting distortion, marking, creases, flats (in curved sections)

2.19 Describe the characteristics of the various materials used (with regard to the bending and forming process); how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming

2.20 Describe the various methods of securing the assembled components; the range of mechanical fastening devices that are used (such as nuts and bolts, rivets, screws, special fasteners); tack welding methods and techniques

2.21 Describe the preparations to be carried out on the components prior to assembling them

2.22 Explain how to set up and align the various components, and the tools and equipment that are used for this

2.23 Describe the methods of temporarily holding the joints together to aid the assembly activities

2.24 Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits

2.25 Describe the problems that can occur with the heavy plateworking activities, and how these can be overcome (such as defects caused by incorrectly set or blunt shearing blades)

2.26 Explain when to act on their own initiative and when to seek help and advice from others

2.27 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the platework activities (such as removing and storing power leads, isolating machines, cleaning the equipment, and removing and disposing of waste)

Unit 824 Cutting and shaping materials using thermal cutting equipment

UAN:	**H/600/5883**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 24: Cutting and shaping materials using thermal cutting equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic activities that the learner will need for cutting and shaping plate (3mm thickness and above), rolled sections, pipe and tube using thermal cutting equipment. This will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The thermal cutting will include equipment such as hand-held oxy-fuel gas cutting equipment, plasma cutting equipment, simple portable machines running on tracks, and fixed bench cutting machines. The learner will be expected to prepare for the cutting activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required cutting operations. The learner will be required to assemble and set up the appropriate equipment for the material and thickness to be cut, the type of operation to be carried out and the accuracy

to be achieved. Materials to be cut and shaped may include mild steel, stainless steel, special steels and other appropriate materials, and the work will include guided cuts, vertical cuts, overhead cuts, external curved contours, round and square holes, as appropriate.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the thermal cutting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate thermal cutting techniques and procedures safely. The learner will understand the cutting process, and its application, and will know about the tools, equipment, materials and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the thermal cutting activities, and when using the various tools and equipment, especially with regard to fire and potential explosion, and the necessary safeguards for undertaking the activities safely and correctly. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Cut and shape materials using thermal cutting equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

1.2 Confirm that the equipment is safe and fit for purpose, by carrying out all of the following checks:
- the equipment selected is suitable for the operations to be performed
- regulators, hoses and valves are securely connected and free from leaks and damage
- the correct gas nozzle is fitted to the cutting torch
- a flashback arrestor is fitted to the gas equipment
- appropriate gas pressures are set
- the correct procedure is used for lighting, adjusting and extinguishing the cutting flame
- hoses are safely routed and protected at all times
- gas cylinders are handled and stored safely and correctly

1.3 Plan the thermal cutting activities before they start them

1.4 Produce thermal cuts in the following form of material (metal of 3mm and above):
- plate

Plus one more from the following:
- rolled sections
- pipe/tube
- structures

1.5 Produce cut profiles for one type of material from the following:
- mild steel
- high tensile/special steel
- stainless steel
- other appropriate metal

1.6 Obtain the appropriate tools and equipment for the cutting operations, and check that they are in a safe and usable condition

1.7 Set up the thermal cutting equipment for the operations to be performed

1.8 Use the following thermal cutting method:
- hand-held oxy-fuel gas cutting equipment

Plus one more from the following:
- hand-held plasma gas cutting equipment
- simple, portable, track-driven cutting equipment (electrical or mechanical)
- fixed bench gas cutting equipment

1.9 Where appropriate, mark out the components for the required operations, using appropriate tools and techniques

1.10 Operate the thermal cutting equipment to produce items/cut shapes to the dimensions and profiles specified

1.11 Perform thermal cutting operations, to include all of the following:
- down-hand straight cuts (freehand)
- cutting regular shapes
- making radial cuts

Plus three more from the following:
- making straight cuts (track guided)
- making vertical cuts
- making overhead cuts

- cutting irregular shapes
- making angled cuts
- cutting chamfers
- gouging/flushing
- bevelled edge – weld preparations
- cutting out holes

1.12 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.13 Produce thermally-cut components which meet all of the following:
- dimensional accuracy is within the tolerances specified on the drawing/specification, or within +/- 3mm
- angled/radial cuts are within specification requirements
- cuts are clean and smooth, without adhering dross and with minimal drag lines

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Shut down the equipment to a safe condition on conclusion of the machining activities

1.16 Leave the work area in a safe and tidy condition on completion of the thermal cutting activities

Learning outcome

The learner will:

2. Know how to cut and shape materials using thermal cutting equipment

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when working with thermal cutting equipment in a fabrication environment (including general workshop safety; protecting other workers by siting protective screens; fire and explosion prevention; safety in enclosed/confined spaces; fume control)

2.2 Describe the personal protective clothing and equipment to be worn when working with thermal cutting equipment (such as leather aprons and gloves, eye protection)

2.3 Describe the correct methods of moving or lifting plate and section materials

2.4 Describe the hazards associated with carrying out thermal cutting activities (including trailing hoses, naked flames, fumes and gases, explosive gas mixtures, oxygen enrichment, spatter, hot metal, enclosed spaces), and how they can be minimised

2.5 Describe the safe working practices and procedures for using thermal equipment, in line with British Compressed Gas Association (BCGA) codes of practice (to include setting up procedures, and emergency shutdown procedures)

2.6 Describe the procedure for obtaining the required drawings, job instructions and other related specifications

2.7 Explain how to extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
2.9 Describe the basic principles of thermal cutting, the various types of thermal cutting equipment available, and typical applications
2.10 Describe the accessories that can be used with hand-held thermal cutting equipment to aid cutting operations (such as cutting guides, trammels, templates); arrangements for attaching cutting aids to the equipment
2.11 Describe the gases used in thermal cutting; gas identification and colour codes; their particular characteristics and safety procedures
2.12 Explain how to set up the thermal cutting equipment (including connection of hoses, regulators and flashback arrestors, selection of cutting torch and nozzle size in relationship to material thickness and operations performed)
2.13 Describe the preparations prior to cutting (including checking connections for leaks, setting gas pressures, setting up the material/workpiece, and checking the cleanliness of materials used)
2.14 Describe the holding methods that are used to aid thermal cutting, and the equipment that can be used
2.15 Describe the setting of operating conditions (including flame control, and the effects of mixtures and pressures associated with thermal cutting)
2.16 Describe the correct procedure for lighting and extinguishing the flame (to include lighting the cutting torch and adjusting gas controls to produce a neutral flame; methods of starting the cut and controlling the cutting speed, direction and angle of cut; the procedure for extinguishing the flame and the importance of following the procedure)
2.17 Describe the procedures to be followed for cutting specific materials, and why these procedures must always be adhered to
2.18 Describe the problems that can occur with thermal cutting (including causes of distortion during thermal cutting and methods of controlling distortion), and how they can be avoided
2.19 Describe the effects of oil, grease, scale or dirt on the cutting process
2.20 Describe the causes of cutting defects, how to recognise them, and methods of correction and prevention
2.21 Explain when to act on their own initiative and when to seek help and advice from others
2.22 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the thermal cutting activities (such as safely storing gas cylinders and cutting equipment, removing and disposing of waste)

Unit 825 Preparing and proving CNC fabrication machine tool programs

UAN:	**M/600/5885**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 25: Preparing and proving CNC fabrication machine tool programs (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC fabrication machine tool programming activities, that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The fabrication machinery to be programmed will include machines such as shearing, punching, forming and bending; plasma, laser and gas cutting. The learner will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program on magnetic tape, disc or by downloading it into the machine controller from the computer. The learner will be expected to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool movements or tool changes, and to use repetitive programs and canned cycles, to reduce program size and input time. The learner will prepare component programs that combine a

number of different operations, such as cutting, punching, profiling, bending and forming.

The learner will need to check the program using single block run and program edit facilities. The learner will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. The learner must ensure that any edited programs are saved safely and correctly.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the programming activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the programming activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC fabrication machine programming and proving techniques safely. The learner will understand the CNC programming process, and its application, and will know about the machine operating programmes and setting-up procedures, to the required depth to provide a sound basis for carrying out the programming activities to the required specification.

The learner will understand the safety precautions required when working with the CNC fabrication machines, and with the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and prove CNC fabrication machine tool programs
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the programming activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • obtain the correct component drawings, and check them for currency and validity • use the appropriate reference manuals and programming codes to suit the machine controller • prepare the machine controller to accept the operating program • input/load the prepared program into the controller safely and correctly • store the programs safely and correctly in the appropriate format • store program media safely and correctly, away from contaminants or electromagnetic sources 1.3 Prepare and prove programs for one of the following types of CNC machine tool: • shearing machine • punching machine • forming machine • bending machine • plasma cutting • laser cutting • gas cutting 1.4 Plan the programming activities before they start them 1.5 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes 1.6 Develop component programs, using appropriate programming codes and techniques 1.7 Produce CNC programs using one of the following methods: • written • entered directly into the machine controller • using computer software 1.8 Develop part programs that contain all of the following, as applicable to the machine type: • all necessary positional information • appropriate letter address codes • machine management commands (preparatory/auxiliary functions)

- repetitions within programs (using features such as sub-routines, canned cycles, labels)
- absolute or incremental co-ordinates
- tool/cutter change positions
- tool information (such as lengths, offsets, radius compensation)

1.9 Develop programs to produce components combining several different operations, covering four of the following:

- straight cuts
- square/rectangular profiles
- curved profiles
- internal profiles
- holes linearly pitched
- holes radially pitched
- louvres
- swages
- bends at 90□
- bends of various angles
- multi-bend platework
- curved plates
- other specific operations

1.10 Develop part programs to produce components made from two of the following types of material:

- ferrous
- non-ferrous
- stainless
- special alloys

1.11 Specify positional information and machine axes that are consistent with the requirements of each stage/operation

1.12 Load/input the program to the machine controller, and check the program for errors using the approved procedures

1.13 Confirm that the program operates safely and correctly, by checking all of the following:

- all operations are carried out to the program co-ordinates
- tool change/park positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program (where applicable)
- tool offsets are correctly entered into the machine controller
- tool cutter head paths are executed safely and correctly
- auxiliary functions operate at the correct point in the program
- programs have been saved in the appropriate format

1.14 Prove the part program using six of the following:

- single block run
- graphic displays
- data input facilities
- full dry run
- search facilities

- edit facilities
- program override controls (speed, feed, tool data)
- program save/store facilities

1.15 Save and store the program in line with organisational procedures

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people when they have problems they cannot resolve

1.17 Shut down the equipment to a safe condition on completion of the programming activities

Learning outcome
The learner will: 2. Know how to prepare and prove CNC fabrication machine tool programs
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when developing and proving CNC fabrication machine tool programs 2.2 Describe the hazards associated with using CNC fabrication machine tools (such as automatic machine operations, power operated workholding devices, moving parts of machinery, sharp cutting tools and burrs and sharp edges on components), and how they can be minimised 2.3 Describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area safe and tidy 2.4 Describe the safety mechanisms on the machine, and the procedure for checking that they function correctly (such as emergency stop buttons, emergency brakes) 2.5 Describe the correct operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons) 2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency 2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing 2.9 Describe the computer coding language used in CNC fabrication machine programs (with regard to machine axes, positional information, machine management and auxiliary functions) 2.10 Explain how to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool/cutter head movements or tool changes 2.11 Describe the use of repetitive programs and canned cycles to reduce program size and input time 2.12 Describe the function keys and operating system of the machine computer control system being operated 2.13 Explain how to set machine datums for each of the machine axes

	being used
2.14	Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program
2.15	Explain how to deal with error messages and faults on the program or equipment
2.16	Explain how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
2.17	Describe the use of tool posts, magazines and carousels, and how to identify the tools in relationship to the operating program
2.18	Explain how to conduct trial runs, using single block run, dry run and feed and speed override controls
2.19	Describe the factors affecting the feeds and speeds that can be used, and why they may need to be adjusted from the program setting (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)
2.20	Describe the things that they need to check before allowing the machine to operate in full program run mode
2.21	Explain how to save the completed programs in the appropriate format, and the importance of storing program tapes and disks safely and correctly, away from contaminants and electromagnetic sources
2.22	Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
2.23	Explain when to act on their own initiative and when to seek help and advice from others
2.24	Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)

Unit 826 Preparing and using CNC fabrication machinery

UAN:	**A/600/5887**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 26: Preparing and using CNC fabrication machinery (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic CNC fabrication machining activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The fabrication machinery to be prepared and used will include machines such as shearing, punching, forming and bending; plasma, laser and gas cutting. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine. The learner will also be required to select the appropriate cutting heads or forming tools, to mount and secure them to the appropriate tool holding devices, and to place the cutting/forming tools in the relevant positions within the tool-posts, slides or tool change magazine/carousel, where this is applicable. The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking

component programs, checking for errors/faults, and editing and saving program changes. The learner will also be required to adjust the machine tool equipment and program, following editing procedures, to achieve component specification. The learner will be expected to produce components that combine a number of different features, such as straight cuts, square and rectangular profiles, curved profiles, internal profiles, louvers, swages, holes radially and linearly pitched, bends of various angles and curved plates.

During, and on completion of, the machining operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the machining activities, the learner will be expected to remove all tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC fabrication machining activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the turning activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC fabrication machine setting and operating techniques safely. The learner will understand the CNC machining process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the

CNC fabrication machinery, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use CNC fabrication machinery
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Ensure that they apply all of the following checks and practices at all times during the CNC fabrication machining activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that machine guards are in place and are correctly adjusted • ensure that components are held securely (without damage or distortion) • ensure that tooling is maintained in a suitable/safe condition • make sure that the work area is maintained and left in a safe and tidy condition 1.3 Prepare one of the following CNC fabrication machines in readiness for production: • shearing machine • punching machine • forming machine • bending machine • plasma cutting • laser cutting • gas cutting 1.4 Plan the CNC machining activities before they start them 1.5 Load/input the program to the machine controller, and check the program for errors using the approved procedures 1.6 Mount and set the required workholding devices, workpiece and tooling 1.7 Position and secure workpieces, using two of the following workholding methods and devices: • jigs and fixtures • clamps and stops • pneumatic/magnetic devices • other workholding devices 1.8 Set up the machine to produce components, combining several different operations and covering four of the following: • straight cuts

- square/rectangular profiles
- curved profiles
- internal profiles
- holes linearly pitched
- holes radially pitched
- louvres
- swages
- bends at 90 degrees
- bends of various angles
- multi-bend platework
- curved plates
- other specific operations

1.9 Produce components using one of the following types of material:

- ferrous
- non-ferrous
- stainless
- special alloys

1.10 Select and mount, in the appropriate holding device, one of the following types of cutting/forming tool:

- shearing blades
- hole punching tools
- forming tools
- nibbling tools
- bending tools
- cutting heads/nozzles

1.11 Check that all safety mechanisms are in place and that the equipment is set correctly for the required operations

1.12 Prepare the tooling by carrying out all of the following activities, as applicable to the machine type:

- pre-setting tooling, using setting jigs/fixtures
- setting tool datums
- mounting tools in the correct position in the tool-posts, turrets, magazine or carousel
- checking that tools have a specific tool number in relationship to the operating program
- entering all relevant tool data into the operating program (such as tool lengths, tool offsets, radius compensation)
- saving changes to the program

1.13 Run the operating program, and check and adjust the machine tool speeds/feeds and operating parameters to achieve the component specification

1.14 Confirm that the machine and program operate safely and correctly, by checking all of the following:

- all operations are carried out to the program co-ordinates
- tool change positions are safe and clear of the workpiece and machine equipment
- the correct tools are selected at the appropriate points in the program

- tool offsets are correctly entered into the machine controller
- tool cutter paths are executed safely and correctly
- auxiliary functions operate at the correct point in the program (cutter start/stop, coolant flow)
- programs have been saved in the appropriate format

1.15 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.16 Carry out the necessary checks for accuracy of three of the following:
- linear dimensions
- position of features
- accuracy of profiles
- flatness/freedom from excessive distortion
- accuracy of louvres and swages

1.17 Produce components that meet all of the following:
- dimensional accuracy is within specification tolerance
- components are free from deformity, burrs and sharp edges
- profiles conform to specification/template requirements

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the equipment to a safe condition on completion of the machining activities

Learning outcome
The learner will: 2. Know how to prepare and use CNC fabrication machinery
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC fabrication machines 2.2 Explain how to start and stop the machine, in normal and emergency situations 2.3 Describe the importance of ensuring that the machine is isolated from the power supply before mounting the cutting and forming tools and workholding devices 2.4 Describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area safe and tidy 2.5 Describe the hazards associated with working on CNC fabrication machines (such as moving machinery, automatic machine operation, handling of cutting and forming tools, lifting and handling workholding devices, handling sheet materials), and how they can be minimised 2.6 Explain how to handle and store cutting and forming tools, and verified tapes and programs, safely and correctly 2.7 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.8 Explain how to interpret first and third angle drawings, imperial and

metric systems of measurement, workpiece reference points and system of tolerancing

2.9 Explain how to carry out currency/issue checks of the specifications they are working with

2.10 Describe the range of workholding methods and devices that are used on CNC fabrication machines

2.11 Explain why it is important to set the workholding device/workpiece in relationship to the machine datums and reference points

2.12 Describe the methods of setting the workholding devices/workpieces, and the tools and equipment that can be used

2.13 Describe the range of cutting and forming tools that are used on the CNC fabrication machine

2.14 Explain how to check that the cutting and forming tools are in a safe and serviceable condition

2.15 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting and forming tools to the tool holders

2.16 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

2.17 Describe the use of tool-posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

2.18 Explain how to set and secure the workpiece to the machine/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece

2.19 Explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

2.20 Explain how to interpret the visual display and the various messages displayed

2.21 Describe the function of error messages, and what to do when an error message is displayed

2.22 Explain how to find the correct restart point in the program, when the machine has been stopped before completion of the program

2.23 Describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)

2.24 Explain how to operate the machine using single-block run, full program run and feed/speed override controls

2.25 Explain how to make adjustments to the program operating parameters

2.26 Explain how to conduct trial runs using single block run, dry run, and feed and speed override controls

2.27 Describe the things that they need to check before allowing the machine to operate in full program run mode

2.28 Explain how the various types of materials used will affect the feeds/speeds that can be used

2.29 Describe the typical problems that can occur with the setting up and operating of the machine and workholding devices, and what to do if they occur

2.30 Explain when to act on their own initiative and when to seek help and advice from others

2.31	Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, ensuring that any spilt cutting fluids are correctly dealt with, and removing and disposing of waste)

Unit 827 Preparing and using manual metal arc welding equipment

UAN:	**J/600/5889**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 27: Preparing and using manual metal arc welding equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic manual metal arc welding competences that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare the welding equipment, and to ensure that all the leads/cables, electrode holder and workpiece earthing arrangements are securely connected and free from damage. The learner will also need to obtain and check that all the workholding equipment and manipulating devices are in a safe and usable condition. In preparing to weld, the learner will need to set and adjust the welding conditions in line with instructions and/or the welding procedure specification. The learner must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded joints to the required specification.

On completion of the welding operations, the learner will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. The learner will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, the learner will be expected to return the workholding devices to their designated location, and to leave the welding equipment and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate manual metal arc welding techniques safely. The learner will understand the welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the manual metal arc welding equipment, and with the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use manual metal arc welding equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare for the manual metal arc welding process by carrying out all of the following: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check the condition of, and correctly connect, welding leads, earthing arrangements and electrode holder • set and adjust the welding conditions/parameters, in accordance with the welding procedure specification • prepare the work area for the welding activities (such as positioning welding screens and fume extraction) • prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint) • make sure that the work area is maintained and left in a safe and tidy condition 1.3 Plan the welding activities before they start them 1.4 Obtain and prepare the appropriate welding equipment and welding consumables 1.5 Use manual metal-arc welding and related equipment to include either of the following: • Alternating Current (AC) equipment • Direct Current (DC) equipment 1.6 Use two types of electrode from the following: • rutile • basic • cellulosic • other suitable electrodes 1.7 Prepare and support the joint, using the appropriate methods 1.8 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding 1.9 Weld the joint to the specified quality, dimensions and profile 1.10 Produce three of the following welded joints, of at least 150mm long, using single or multi-run welds (as appropriate), with at least one stop and start included: • fillet lap joints • Tee fillet joints • corner joints • butt joints 1.11 Produce joints as follows: One type of material from the following:

- carbon steel
- stainless steel

And one form of material from the following:

- sheet (less than 3mm)
- plate
- section
- pipe/tube
- other forms

1.12 Weld joints in good access situations, in two of the following EN ISO 6947 positions:

- Flat (PA)
- Horizontal vertical (PB)
- Horizontal (PC)
- Vertical upwards (PF)
- Vertical downwards (PG)

1.13 Use appropriate methods and equipment to check the quality, and check that all dimensional and geometrical aspects of the weld are to the specification

1.14 Check that the welded joint conforms to the specification by checking all of the following:

- dimensional accuracy
- alignment/squareness
- size and profile of weld
- number of runs

1.15 Carry out non destructive testing of the welds, using one of the following:

- dye penetrant
- fluorescent penetrant
- magnetic particle

1.16 Carry out destructive tests on weld specimens, using one of the following:

- macroscopic examination
- nick break test
- bend tests (such as face, root or side, as appropriate)

1.17 Identify all of the following weld defects:

- lack of continuity of the weld
- uneven and irregular ripple formation
- incorrect weld size or profile

Plus four more of the following:

- undercutting
- overlap
- inclusions
- porosity
- surface cracks
- internal cracks
- lack of fusion
- lack of penetration

1.18 Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):

- welds meet the required dimensional accuracy
- fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
- the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple formation
- the welds are adequately fused, and with minimal undercut, overlap and surface inclusions
- weld finishes are built up to the full section of the weld
- joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- tack welds are blended in to form part of the finished weld, without excessive hump
- corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint
- the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.20 Shut down and make safe the welding equipment on completion of the welding activities

Learning outcome
The learner will: 2. Know how to prepare and use manual metal arc welding equipment
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using MMA welding equipment (such as general workshop safety; appropriate Personal Protective Equipment; fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control) 2.2 Describe the hazards associated with MMA welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; spatter; hot slag and metal; grinding and mechanical metal/slag removal; elevated working; welding in enclosed spaces; slips, trips and falls), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter) 2.4 Describe the manual metal arc welding process (such as basic principles of fusion welding, AC and DC power sources, power ranges) 2.5 Describe the types of electrodes used, and the correct control,

storage and drying of electrodes

2.6 The types of welded joints to be produced (such as lap joints, corner joints, tee joints, butt welds, single and multi-run welds)

2.7 Describe the terminology used for the appropriate welding positions

2.8 Explain how to prepare the materials in readiness for the welding activity (such as ensuring that the material is free from excessive surface contamination such as rust, scale, paint, oil/grease and moisture); ensuring that edges to be welded are correctly prepared (such as made flat, square or bevelled)

2.9 Explain how to set up and restrain the joint, and the tools and techniques to be used (such as the use of jigs and fixtures, restraining devices - such as clamps and weights/blocks; setting up the joint in the correct position and alignment)

2.10 Describe the tack welding size and spacing in relationship to material thickness

2.11 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; condition of electrical connections, welding return and earthing arrangements; checking operating parameters)

2.12 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as striking and initiating the arc; fine adjustment of parameters; correct manipulation and welding speed of electrode; blending in stops/starts and tack welds)

2.13 Explain how to close down the welding equipment safely and correctly

2.14 Explain how to control distortion (such as welding sequence; deposition technique)

2.15 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

2.16 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

2.17 Explain how to prepare the welds for examination (such as removing slag, spatter and surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be fracture tested)

2.18 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile

2.19 Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

2.20 Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

2.21 Describe the methods of removing a specimen of weld from a suitable position in the joint (such as a stop/start position using a non-thermal process, such as hand saws, power saws, abrasive discs)

2.22 Explain how to examine the welds after the tests and check for such things as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

2.23 Explain when to act on their own initiative and when to seek help

	and advice from others
2.24	Describe the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies; safely storing welding cables and electrode holders; storing electrodes; removing and disposing of waste)

Unit 828 Preparing and using manual TIG or plasma-arc welding equipment

UAN:	**F/600/5891**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 28: Preparing and using manual TIG or plasma-arc welding equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic manual TIG or plasma-arc welding activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare the welding equipment and to ensure that all the leads/cables, hoses and torches are securely connected and free from damage. The learner will also need to obtain and check that all the workholding equipment is in a safe and usable condition. In preparing to weld, the learner will need to set and adjust the welding conditions in line with instructions and/or the welding procedure specification. The learner must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded joints to the required specification. On completion of the welding operations,

the learner will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. The learner will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, the learner will be expected to return all tools, equipment and workholding devices to their designated location and to leave the welding equipment and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate manual TIG or plasma-arc welding techniques safely. The learner will understand the welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the TIG or plasma-arc welding equipment, and with the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use manual TIG or plasma-arc welding equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare for the TIG or plasma-arc welding process by carrying out all of the following: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check the condition of and correctly connect welding leads, earthing arrangements, hoses and welding torch • set and adjust the welding conditions/parameters, in accordance with the welding procedure specification • prepare the work area for the welding activities (such as positioning welding screens and fume extraction) • prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint) • make sure that the work area is maintained and left in a safe and tidy condition 1.3 Plan the welding activities before they start them 1.4 Obtain and prepare the appropriate welding equipment and welding consumables 1.5 Use manual welding and related equipment, to include one of the following welding processes: • TIG • Plasma-arc 1.6 Use welding consumables appropriate to the material and application, to include one of the following: • AC current types • DC current types 1.7 Prepare and support the joint, using the appropriate methods 1.8 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding 1.9 Weld the joint to the specified quality, dimensions and profile 1.10 Produce three of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included: • fillet lap joints • Tee fillet joints • corner joints • butt joints And using one of the following methods: • with filler wire • without filler wire (autogenously)

1.11 Produce joints in the following:

One type of material from the following:

- carbon steel
- stainless steel
- aluminum

And two forms of material from the following:

- sheet (less than 3mm)
- plate
- section
- pipe/tube
- other forms

1.12 Weld joints in good access situations, in two of the following EN ISO 6947 positions:

- Flat (PA)
- Horizontal vertical (PB)
- Horizontal (PC)
- Vertical upwards (PF)
- Vertical downwards (PG)

1.13 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

1.14 Check that the welded joint conforms to the specification, by checking all of the following:

- dimensional accuracy
- alignment/squareness
- size and profile of weld
- number of runs

1.15 Carry out non-destructive testing of the welds, using one of the following:

- dye penetrant
- fluorescent penetrant
- magnetic particle

1.16 Carry out destructive tests on weld specimens, using one of the following :

- macroscopic examination
- nick break test
- bend tests (such as face, root or side, as appropriate)

1.17 Identify all of the following weld defects:

- lack of continuity of the weld
- uneven and irregular ripple formation
- incorrect weld size or profile

Plus four more of the following:

- undercutting
- overlap
- inclusions
- porosity
- internal cracks

- surface cracks
- lack of fusion
- lack of penetration

1.18 Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):
- welds meet the required dimensional accuracy
- fillet welds are equal in leg length and slightly convex in profile (where applicable), with the size of the fillet equivalent to the thickness of the material welded
- the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple formation
- the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- weld finishes are built up to the full section of the weld
- joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- tack welds are blended in to form part of the finished weld, without excessive hump
- corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint
- the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.20 Shut down and make safe the welding equipment on completion of the welding activities

Learning outcome
The learner will: 2. Know how to prepare and use manual TIG or plasma-arc welding equipment
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be followed when preparing and using TIG or plasma-arc welding equipment (such as general workshop safety; appropriate Personal Protective Equipment; fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control) 2.2 Describe the hazards associated with TIG and plasma-arc welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; hot metal; welding in enclosed spaces; slips, trips and falls), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter)

2.4 Describe the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)
2.5 Describe the manual TIG or plasma-arc welding process (such as basic principles of fusion welding; the major parts of the welding equipment and their function)
2.6 Describe the types, selection and application of filler wires and welding electrodes
2.7 Describe the reasons for using shielding gases, and the types and application of the various gases
2.8 Describe the gas pressures and flow rates (in relationship to the type of material being welded)
2.9 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)
2.10 Describe the terminology used for the appropriate welding positions
2.11 Explain how to prepare the materials in readiness for the welding activity (such as ensuring that the material is free from excessive surface contamination - such as rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)
2.12 Explain how to set up and restrain the joint, and the tools and techniques to be used (such as the use of jigs and fixtures, restraining devices such as clamps and weights/blocks; setting up the joint in the correct position and alignment)
2.13 Describe the tack welding size and spacing (in relationship to material thickness)
2.14 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; operating parameters)
2.15 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as fine adjustment of parameters; correct manipulation of the torch; blending in stops/starts and tack welds)
2.16 Explain how to control distortion (such as welding sequence; deposition technique)
2.17 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
2.18 Explain how to close down the welding equipment safely and correctly
2.19 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)
2.20 Explain how to prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be fracture tested)
2.21 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile
2.22 Describe the various procedures for visual examination of the

welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

2.23 Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

2.24 Describe the methods of removing a specimen of weld from a suitable position in the joint (such as a stop/start position) using a non thermal process (such as hand saws, power saws, abrasive discs)

2.25 Explain how to examine the welds after the tests and how to check for such things as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

2.26 Explain when to act on their own initiative and when to seek help and advice from others

2.27 Describe the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies, safely storing equipment and consumables, removing and disposing of waste)

Unit 829 Preparing and using manual MIG, MAG and other continours wire welding equipment

UAN:	**R/600/5894**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 29: Preparing and using manual MIG, MAG and other continuous wire welding equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic manual MIG, MAG or cored-wire arc welding equipment activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare the welding equipment and to ensure that all leads/cables, shielding gas system, hoses and wire feed mechanisms are securely connected and free from damage. The learner will also need to obtain and check that all the workholding equipment is in a safe and usable condition. In preparing to weld, the learner will need to set and adjust the welding conditions, in line with instructions and/or the welding procedure specification. The learner must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded

joints to the required specification.

On completion of the welding operations, the learner will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. The learner will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, the learner will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the welding equipment and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate manual MIG, MAG or cored-wire welding techniques safely. The learner will understand the welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the MIG, MAG or cored-wire welding equipment, and with the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use manual MIG, MAG and other continuous wire welding equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare for the MIG, MAG or cored-wire welding process by carrying out all of the following: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check the condition of, and correctly connect, welding leads/cables, hoses, shielding gas supply and wire feed mechanisms • set and adjust the welding conditions/parameters, in accordance with the welding procedure specification • prepare the work area for the welding activities (such as positioning welding screens and fume extraction) • prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint) • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the welding activities before they start them 1.4 Obtain and prepare the appropriate welding equipment and welding consumables 1.5 Use manual welding and related equipment to include one of the following: • MIG • MAG • other continuous wire welding equipment 1.6 Use consumables appropriate to the material and application, to include: One of the following wire types: • solid wire • cored wire Plus one of the following types of shielding gas: • inert • active 1.7 Prepare and support the joint, using the appropriate methods 1.8 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding 1.9 Weld the joint to the specified quality, dimensions and profile 1.10 Produce three of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included: • fillet lap joints

- Tee fillet joints
- corner joints
- butt joints

1.11 Produce joints as follows:

One type of material from the following:

- carbon steel
- stainless steel
- aluminium

And two forms of material from the following:

- plate
- section
- sheet (less than 3mm)
- pipe/tube
- other forms

1.12 Weld joints in good access situations in two of the following EN ISO 6947 positions:

- Flat (PA)
- Horizontal vertical (PB)
- Horizontal (PC)
- Vertical upwards (PF)
- Vertical downwards (PG)

1.13 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

1.14 Check that the welded joint conforms to the specification, by checking all of the following:

- dimensional accuracy
- alignment/squareness
- size and profile of weld
- number of runs

1.15 Carry out non-destructive testing of the welds, using one of the following:

- dye penetrant
- fluorescent penetrant
- magnetic particle

1.16 Carry out destructive tests on weld specimens using one of the following :

- macroscopic examination
- nick break test
- bend tests (such as face, root or side, as appropriate)

1.17 Identify all of the following weld defects:

- lack of continuity of the weld
- uneven and irregular ripple formation
- incorrect weld size or profile

Plus four more of the following:

- undercutting
- overlap

- inclusions
- porosity
- internal cracks
- surface cracks
- lack of fusion
- lack of penetration

1.18 Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):
- welds meet the required dimensional accuracy
- fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
- the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple formation
- the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- weld finishes are built up to the full section of the weld
- joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- tack welds are blended in to form part of the finished weld, without excessive hump
- corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint
- the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.20 Shut down and make safe the welding equipment on completion of the welding activities

Learning outcome

The learner will:

2. Know how to prepare and use manual MIG, MAG and other continuous wire welding equipment

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using MIG, MAG or cored wire arc welding equipment (such as general workshop safety; appropriate Personal Protective Equipment; fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control)

2.2 Describe the hazards associated with MIG, MAG or cored-wire arc welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; spatter; hot slag and metal; grinding and mechanical metal/slag removal; elevated working; enclosed spaces; slips, trips and falls), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter) 2.4 Describe the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features) 2.5 Describe the manual MIG, MAG or cored wire arc welding process (such as basic principles of fusion welding, AC and DC power sources, the major parts of the welding equipment and their function) 2.6 Describe the types, selection and application of electrode wires (such as solid and cored) 2.7 Describe the reasons for using shielding gases, and the types and application of the various gases 2.8 Describe the gas pressures and flow rates (in relation to the type of material being welded) 2.9 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds) 2.10 Describe the terminology used for the appropriate welding positions 2.11 Explain how to prepare the materials in readiness for the welding activity (such as ensuring that the material is free from excessive surface contamination - such as rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled) 2.12 Explain how to set up and restrain the joint, and the tools and techniques to be used (such as the use of jigs and fixtures, restraining devices - such as clamps and weights/blocks; setting up the joint in the correct position and alignment) 2.13 Describe the tack welding size and spacing (in relation to material thickness) 2.14 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; wire feed mechanisms; gas supply; operating parameters) 2.15 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as fine adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds) 2.16 Describe the methods/modes of metal transfer and their uses (such as dip' globular, free flight, spray and pulsed) 2.17 Explain how to close down the welding equipment safely and correctly 2.18 Explain how to control distortion (such as welding sequence; deposition technique) 2.19 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome 2.20 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using

	equipment to fracture welds)
2.21	Explain how to prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)
2.22	Explain how to check the welded joints for uniformity, alignment, position, weld size and profile
2.23	Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)
2.24	Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)
2.25	Describe the methods of removing a specimen of weld from a suitable position in the joint (such as a stop/start position), using a non thermal process (such as hand saws, power saws, abrasive discs)
2.26	Explain how to examine the welds after the tests, and how to check for such things as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation
2.27	Explain when to act on their own initiative and when to seek help and advice from others
2.28	Describe the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies; safely storing welding cables and electrode holders; storing electrodes; removing and disposing of waste)

Unit 830 Preparing and using manual gas welding equipment

UAN:	**H/600/5897**
Level:	Level 2
Credit value:	14
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 30: Preparing and using manual gas welding equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic gas welding equipment activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare the welding equipment to ensure that the regulators, hoses, check valves, flashback arrestor and welding torch are securely connected and are free from leaks or damage. The learner will also need to obtain and check that all the workholding equipment is in a safe and usable condition. In preparing to weld, the learner will need to set and adjust the gas pressures/welding conditions, in line with instructions and/or the welding procedure specification. The learner must operate the equipment safely and correctly, and make any necessary adjustments to settings, in line with their permitted authority, in order to produce the welded joints to the required specification. On completion of the welding operations,

the learner will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. The learner will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, the learner will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the welding equipment and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate oxy-fuel gas welding techniques safely. The learner will understand the gas welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the oxy-fuel gas welding equipment, and with its associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use manual gas welding equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare for the gas welding process by carrying out all of the following: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check regulators, hoses and check that valves are securely connected and free from leaks and damage • check/fit the correct gas nozzle to the torch • check that a flashback arrestor is fitted • set appropriate gas pressures • use the correct procedure for lighting, adjusting and extinguishing the welding flame • use appropriate and safe procedures for handling and storing of gas cylinders • prepare the work area for the welding activities (such as positioning welding screens and fume extraction) • prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint) • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the welding activities before they start them 1.4 Obtain and prepare the appropriate welding equipment and welding consumables 1.5 Prepare and support the joint, using the appropriate methods 1.6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding 1.7 Weld the joint to the specified quality, dimensions and profile 1.8 Produce three of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included: • fillet lap joints • Tee fillet joints • corner joints • butt joints • welds made without filler wire (autogenously) 1.9 Using one of the following methods: • with filler wire • without filler wire (autogenously) 1.10 Produce joints in one form of material from the following: • sheet (less than 3mm)

- plate
- section
- pipe/tube
- other forms

1.11 Weld joints in good access situations in two of the following EN ISO 6947 positions:
- Flat (PA)
- Horizontal vertical (PB)
- Horizontal (PC)
- Vertical upwards (PF)
- Vertical downwards (PG)

1.12 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

1.13 Check that the welded joint conforms to the specification, by checking all of the following:
- dimensional accuracy
- alignment/squareness
- size and profile of weld
- number of runs

1.14 Carry out non-destructive testing of the welds, using one of the following:
- dye penetrant
- fluorescent penetrant
- magnetic particle

1.15 Carry out destructive tests on weld specimens using one of the following:
- macroscopic examination
- nick break test
- bend tests (such as face, root or side, as appropriate)

1.16 Identify all of the following weld defects:
- lack of continuity of the weld
- uneven and irregular ripple formation
- incorrect weld size or profile

Plus four more of the following:
- undercutting
- overlap
- inclusions
- porosity
- surface cracks
- internal cracks
- lack of fusion
- lack of penetration

1.17 Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):
- welds meet the required dimensional accuracy
- fillet welds are equal in leg length and slightly convex in profile (where appropriate), with the size of the fillet equivalent to the

thickness of the material welded

- the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple formation
- the welds are adequately fused, and there is minimal undercut and overlap
- weld finishes are built up to the full section of the weld
- joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- tack welds are blended in to form part of the finished weld, without excessive hump
- corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint
- the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- the weld surface and adjacent parent metal is substantially free from spatter or chipping marks

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down and make safe the welding equipment on completion of the welding activities

Learning outcome

The learner will:

2. Know how to prepare and use manual gas welding equipment

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using manual gas welding equipment (such as general workshop safety; appropriate Personal Protective Equipment; fire and explosion prevention, protecting other workers, safety in enclosed/confined spaces; fume extraction/control)

2.2 Describe the hazards associated with manual gas welding (such as naked flames, fumes and gases, explosive gas mixtures, oxygen enrichment, spatter, hot metal, elevated working, welding in enclosed spaces, slips trips and falls), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct grade of filter)

2.4 Describe the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

2.5 Describe the manual gas welding process (such as basic principles of gas welding and related equipment; care of the equipment)

2.6 Describe the consumables associated with gas welding (such as types of filler wire, fluxes, the types of gas and its supply and control)

2.7 Explain how to prepare the welding equipment, and the checks to be made to ensure that it is safe and ready to use (such as connection of hoses, torch, flashback arrestors, hose check valves and regulators)

2.8 Explain how to check connections for leaks, and the methods that are used

2.9 Explain how to set gas working pressures; reading the gauges to establish content and pressures

2.10 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

2.11 Describe the terminology used for the appropriate welding positions

2.12 Explain how to prepare the materials in readiness for the welding activity (such as ensuring that the material is free from excessive surface contamination - such as rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)

2.13 Explain how to set up and restrain the joint, and the tools and techniques to be used (such as the use of jigs and fixtures, restraining devices - such as clamps and weights/blocks; setting up the joint in the correct position and alignment)

2.14 Describe the tack welding size and spacing (in relation to material thickness)

2.15 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as selection of nozzle, lighting and adjusting the flame, correct manipulation of torch and filler rods)

2.16 Describe the safe and correct sequence for shutting down the equipment (such as sequence of turning off the gases, extinguishing the flame and closing valves on the gas supply/cylinders)

2.17 Describe the control of heat input to prevent filler material and parent material faults (such as welding sequence; deposition technique)

2.18 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

2.19 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

2.20 Explain how to prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)

2.21 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile

2.22 Describe the various procedures for visual examination of the welds for cracks, porosity and inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

2.23 Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

2.24 Describe the methods of removing a specimen of weld from a

	suitable position in the joint (such as a stop/start position), using a non thermal process (such as hand saws, power saws, abrasive discs)
2.25	Explain how to examine the welds after the tests, and how to check for such things as the degree of penetration and fusion, inclusions, porosity, cracks
2.26	Explain when to act on their own initiative and when to seek help and advice from others
2.27	Describe the importance of leaving the work area and equipment in a safe condition on completion of the gas welding activities (such as isolation of gas cylinders; safely storing cylinders, hoses and torches; storing filler rods; removing and disposing of waste)

Unit 831 Preparing and using manual flame brazing and bronze welding equipment

UAN:	**Y/600/5900**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 31: Preparing and using manual flame brazing and bronze welding equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic manual flame brazing and bronze welding activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare the manual flame brazing or bronze welding equipment, and to check that all hoses and equipment are correctly connected, free from leaks or damage, and are ready for use. The learner will also need to obtain and check that all the workholding equipment required is in a safe and usable condition. The learner must operate the equipment safely and correctly, and set and adjust the brazing or bronze welding conditions, in line with instructions and safe operating procedures. The learner will be expected to check the quality of the brazed or bronze welded joints by visual examination and destructive testing techniques, as appropriate to the aspects being checked. The learner will need to be able to recognise

brazing or bronze welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the brazing or bronze welding activities, the learner will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the brazing or bronze welding equipment and work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the brazing or bronze welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the brazing or bronze welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate manual flame brazing or bronze welding techniques safely. The learner will understand the brazing or bronze welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the manual flame brazing or bronze welding equipment, and with the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Prepare and use manual flame brazing and bronze welding equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare for the manual flame brazing or bronze welding process by carrying out all of the following: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • check that hoses, regulators and valves are securely connected and free from leaks and damage • check/fit the correct size gas nozzle to the torch • check that a flashback arrestor and check valves are fitted • set appropriate gas pressures • use the correct procedure for lighting, adjusting and extinguishing the flame • use appropriate and safe procedures for handling and storing of gas cylinders (where appropriate) • prepare the work area for the activities (such as positioning screens and fume extraction equipment) • prepare the materials and joint in readiness for brazing or bronze welding (such as cleaning of joint faces, setting up the joint, supporting the joint) • make sure the work area is maintained and left in a safe and tidy condition 1.3 Plan the brazing or bronze welding activities before they start them 1.4 Obtain and prepare the appropriate manual flame brazing or bronze welding equipment and consumables 1.5 Set up, check, adjust and use two of the following manual flame processes and related equipment: • brazing • bronze welding • braze welding 1.6 Use specified consumables appropriate to the parent metals, to include one of the following: • self fluxing rods • flux coated/impregnated rods • powder/paste flux and rods 1.7 Prepare and support the joint, using the appropriate methods 1.8 Tack the joint at appropriate intervals, and check the joint for accuracy before final brazing or bronze welding 1.9 Produce the brazed or bronze welded joints of the required quality and of specified dimensional accuracy 1.10 Produce joints in two of the following materials: • copper to copper

- brass to brass
- copper to brass
- copper to carbon
- other appropriate materials

1.11 Produce joints in good access situations, covering two of the following:
- lap joints
- Tee joints
- corner joints
- butt joints
- socket joints

1.12 Produce joints in the following positions:

For brazing, use one of the following:
- horizontal flow
- vertical down flow
- vertical up flow

For bronze or braze welding, use one of the following:
- flat position
- horizontal-vertical position

1.13 Produce joints in both of the following:
- sheet/plate
- pipe/tube

1.14 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the joint are to the specification

1.15 Carry out destructive tests on weld specimens, using one of the following:
- macroscopic examination
- nick break test

1.16 Identify all of the following brazing and bronze/braze welding defects:
- lack of continuity of the brazed or bronze welded joint
- uneven and irregular ripple formation
- incorrect joint size or profile

Plus three more of the following:
- overlap
- inclusions
- porosity
- surface cracks
- lack of penetration

1.17 Produce brazed or bronze/braze welded components which meet all of the following:
- achieve the specified joint quality
- meet the required dimensional accuracy within specified tolerance
- are of good appearance, free from flux residues and excess filler metal

1.18 Deal promptly and effectively with problems within their control,

and seek help and guidance from the relevant people if they have problems that they cannot resolve 1.19 Shut down and make safe the brazing or bronze welding equipment on completion of the activities

Learning outcome
The learner will: 2. Know how to prepare and use manual flame brazing and bronze welding equipment
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be observed when working with manual flame gas brazing and bronze/braze welding equipment (such as general workshop safety; appropriate Personal Protective Equipment; fire and explosion prevention, protecting other workers, safety in enclosed/confined spaces; fume extraction/control) 2.2 Describe the hazards associated with flame brazing and bronze/braze welding (such as naked flames, explosive gas mixes, oxygen enrichment, fumes and gasses, hot metal, enclosed spaces), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be worn for the brazing and bronze/braze welding activities (such as correctly fitting overalls; leather aprons, eye protection with the appropriate shade of filter) 2.4 Describe the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features) 2.5 Describe the manual flame brazing and bronze/braze welding process (such as basic principles of the process, wetting and capillary flow, deposition of brazed/bronze beads, role of fluxes) 2.6 Describe the types of filler metal and fluxes; forms of filler metal 2.7 Describe the types of joints to be produced (such as lap, tee, corner, butt) 2.8 Explain how to set up and support the joint (such as methods of cleaning joint faces; use of jigs and fixtures, restraining devices; self-locating joints; pre-placement of filler metal and flux) 2.9 Explain how to prepare the brazing and bronze welding equipment, and the checks to be made to ensure that it is safe and ready to use (such as connection of hoses, torch, flashback arrestors, hose check valves and regulators) 2.10 Explain how to check hose connections for leaks, and the methods that are used 2.11 Explain how to set gas working pressures; reading the gauges to establish content and pressures 2.12 Explain how to prepare the materials in readiness for the brazing and bronze welding activity (such as ensuring that the material is free from surface contamination -such as rust, scale, paint, oil/grease and moisture; ensuring edges to be brazed/bronze welded are correctly prepared - such as made flat, square) 2.13 Describe the correct use of the torch to produce a range of joints (such as selection of nozzle, adjustment of the flame, application of

	flux and the correct manipulation of torch and filler wire)
2.14	Describe the control of heat input to prevent filler material and parent material faults (such as brazing/bronze welding sequence; deposition technique)
2.15	Describe the safe and correct sequence for shutting down the brazing or bronze welding equipment (such as sequence of turning off the gases, extinguishing the flame and closing valves on gas supply/cylinders)
2.16	Describe the importance of complying with job instructions and the joining procedure specification
2.17	Describe the problems that can occur with the joining activities (such as incorrect heat pattern (hot or cold spots); fluxing technique; formation of oxides during the process; distortion of the joint due to overheating), and how these can be overcome
2.18	Describe the methods of removing flux residues and cleaning the finished joint
2.19	Describe the safe working practices and procedures to be adopted when preparing the brazed and bronze/braze welded joints for examination (such as handling hot materials, using chemicals for cleaning, using equipment to fracture joints)
2.20	Explain how to prepare the joints for examination (such as removing surface irregularities; cleaning and degreasing the brazed or bronze/braze welded joint, making saw cuts on joints to be fracture tested)
2.21	Explain how to check the brazed or bronze welded joints for uniformity, alignment, position, joint size and profile
2.22	Describe the various procedures for carrying out destructive tests on the joints (such as macroscopic examination and nick break tests)
2.23	Explain how to examine the joints after the tests and check for such things as the degree of penetration, inclusions, porosity, cracks
2.24	Explain when to act on their own initiative and when to seek help and advice from others
2.25	Describe the importance of leaving the work area and equipment in a safe condition on completion of the brazing or bronze welding activities (such as isolation of gas cylinders; safely storing cylinders, hoses and torches; storing filler rods; removing and disposing of waste)

Unit 832 Producing electrical or electronic engineering drawings using a CAD system

UAN:	**M/600/5904**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 32: Producing electrical or electronic engineering drawings using a CAD system (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to set up and operate a computer aided drawing system to produce detailed drawings for electrical or electronic engineering activities. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The types of drawing produced will include circuit and wiring diagrams, block diagrams, schematics, electrical cabling/routeing, installation, assembly of panels and sub-assemblies and system design/modification. The learner will be given a specific drawing brief or a request for change/modification to an existing design, and they will be required to access these requirements and to extract all necessary information in order to carry out the drawing operations. The learner will need to select the appropriate equipment and drawing software to use, based on the type and complexity of the drawing functions to be carried out. The learner will

be expected to use current British, European, International and company standards to produce a drawing template for a range of paper sizes, and must include the drawing title, scale used, date of drawing, and other relevant information.

The learner will then be expected to produce fully detailed drawings to enable the electrical or electronic circuits to be assembled, installed, maintained, commissioned or modified. On completion of the drawing activities, the learner will be expected to return all documentation, reference manuals or specifications to the designated location, to shut down the CAD system correctly and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for working with the CAD equipment. The learner will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or drawing procedures, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply safely the appropriate computer aided drawing procedures and techniques for electrical or electronic engineering drawings. The learner will understand the computer system and software used, and its application, and will know about the various tools and techniques used to produce the drawings, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the computer drawing system. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce electrical or electronic engineering drawings using a CAD system
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare the CAD system for operation by carrying out all of the following: • check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed) • power up the equipment and activate the appropriate drawing software • set up the drawing system to be able to produce the drawing to the appropriate scale • set up and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter) • set the drawing datum at a convenient point (where applicable) • set up drawing parameters (to include layers, lines type, colour, text styles) to company procedures or to suit the drawing produced • create a drawing template to the required standards, which includes all necessary detail (such as title, drawing number, scale, material, date) 1.3 Plan the drawing activities before they start them 1.4 Use appropriate sources to obtain the required information for the drawing to be created 1.5 Use three of the following to obtain the necessary data to produce the required drawings: • drawing brief/request • drawing change or modification request • manuals • calculations (such as Ohm's law) • sketches • specifications • electrical regulations • previous drawings/designs • standards • other available data • standard reference documents (such as current carrying capacity of cables, electrical or electronic component catalogues) • notes from meetings/discussions 1.6 Take into account four of the following design features, as appropriate to the drawing being produced:

- function
- operating environment
- tolerances
- physical space/dimensions of circuit
- component orientation
- operating voltages
- cost
- interfaces
- power supplies
- connectors/test point access
- ergonomics
- lifetime of the product
- aesthetics
- safety
- types of components available/to be used
- position of circuit elements/components
- connections between components
- method of installation (such as conduit, trunking, traywork)
- type of cables (such as PVC, Mineral Insulated)
- uses an appropriate type of circuit (such as digital, analogue, hybrid)
- uses appropriate technology of circuit design (such as single sided, double sided, multi-layer, flexi-rigid)
- meets signal integrity parameters (such as capacitance, inductance, resistance, insulation voltages)
- meets specified operating conditions (such as temperature, humidity, shock and vibration)
- any assembly/manufacturing schedule constraints (such as high profile components mounted after low profile SMT ones)

1.7 Carry out all of the following before producing the engineering drawing:

- ensure that data and information are complete and accurate
- review the data and information to identify the drawing requirements
- recognise and deal with problems (such as information based, technical)

1.8 Access and use the correct drawing software

1.9 Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed

1.10 Produce three of the following types of electrical or electronic engineering drawings:

- circuit diagrams
- wiring diagrams
- block diagrams
- schematics
- system drawings
- general assembly drawings
- panel assembly

- cable and routeing
- circuit board assembly
- circuit board layout
- installation/commissioning
- manufacture of cable looms
- fault diagnostics (such as flow diagrams)
- modifications to equipment/systems (such as cable looms, cable routeing and clipping, panels/sub-assemblies, installation of electrical systems)

1.11 Produce electrical or electronic drawings which include ten of the following:

- straight lines
- dimensions
- angled lines
- text
- insertion of standard electrical or electronic components
- type and size of cables
- connection/termination details
- electrical/electronic symbols and abbreviations
- fault diagnosis (such as flow diagrams)
- curved/contour lines
- circles or ellipses
- hidden detail
- parts lists
- test points
- colour/component coding
- parts lists
- other specific electrical or electronic detail

1.12 Use codes and other references that follow the required conventions

1.13 Produce drawings which comply with the following:

- BS and ISO standards and procedures

Plus one more from the following:

- organisational guidelines
- statutory regulations and codes of practice
- CAD software standards
- other international standard

1.14 Make sure that the drawings are checked and approved by the appropriate person

1.15 Save and store drawings in appropriate locations, to include carrying out all of the following:

- ensure that their drawing has been checked and approved by the appropriate person(s)
- check that the drawing is correctly titled and referenced
- save the drawing to an appropriate storage medium (such as hard drive, disc, CD, external storage device)
- create a separate backup copy, and place it in safe storage

- produce a hard copy printout of the drawing for file purposes
- register and store the drawings in the appropriate company information system (where appropriate)
- where appropriate, record and store any changes to the drawings in the appropriate company information system

1.16 Save the drawings in the appropriate medium and location

1.17 Produce hard copies of the finished drawings

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the CAD system to a safe condition on completion of the drawing activities

Learning outcome
The learner will: 2. Know how to produce electrical or electronic engineering drawings using a CAD system
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when working with computer systems (to include such things as safety guidance relating to the use of Visual Display Unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), Repetitive Strain Injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections) 2.2 Describe good housekeeping arrangements (such as cleaning down work surfaces; putting disks, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition) 2.3 Describe the relevant sources and methods for obtaining any required technical information relevant to the drawing being produced (such as drawing briefs, specification sheets, request for changes or modifications to drawings; technical information such as cable current carrying capacity, component values or coding systems, component pin configurations) 2.4 Describe the functionality of the circuit being drawn, and its interrelationship with other circuits and assemblies 2.5 Describe the correct startup and shutdown procedures to be used for the computer systems 2.6 Describe the identification of the correct drawing software package from the menu or windows environment; the various techniques that are available to access and use the CAD software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners) 2.7 Describe the use of software manuals and related documents to aid efficient operation of the relevant drawing system 2.8 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads) 2.9 Describe the types of electrical drawings that may be produced by the software (such as circuit and wiring diagrams, block and schematic diagrams, assembly and installation drawings)

2.10	Describe the national, international and organisational standards and conventions that are used for the drawings
2.11	Explain how to set up the drawing template parameters (such as layers of drawings, scale, paper size, colour set-up, line types, dimension system and text styles)
2.12	Describe the application and use of drawing tools (such as for straight lines, curves and circles; how to add dimensions and text to drawings, producing layers of drawings)
2.13	Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
2.14	Describe the factors to be taken into account when producing electrical drawings (such as safety requirements, operating parameters of components, position of components in relation to other sources or circuits, possibility of external interference)
2.15	Describe their understanding of the electrical or electronic equipment and circuits being worked on, and the function of the individual components within the circuits
2.16	Describe the selection of the various components and cables being used (with regard to their operating ranges and current carrying capacity)
2.17	Describe the use of specific regulations and standard reference tables when selecting components and cables
2.18	Explain how power cables might affect/corrupt signal transmission, and the need to consider this in siting and routeing cables
2.19	Describe the basic calculations that may be required to be carried out to verify the acceptability of components and circuits (such as Ohm's Law)
2.20	Explain how to save and store drawings (such as determining document size; how to check that there is sufficient space to save the file in their chosen destination; saving and naming the file/drawing)
2.21	Describe the need to create backup copies, and to file them in a separate and safe location away from electromagnetic sources
2.22	Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters
2.23	Explain when to act on their own initiative and when to seek help and advice from others
2.24	Describe the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 833 Wiring and testing electrical equipment and circuits

UAN:	**J/600/5908**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 33: Wiring and testing electrical equipment and circuits (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to wire up and test electrical equipment and circuits. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will include the wiring and termination of a range of cables, such as single and multicore cables, screened cables, fire resistant and armoured cables. The learner will be required to make a variety of terminations and to connect a range of electrical components, such as switches/switchgear, distribution panels, motors and starters, control systems, sensors and actuators, safety devices, and luminaires. The learner will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components to be connected. The learner will be expected to use appropriate tools and techniques for the wiring of the various electrical components and connectors that make up the electrical system/circuit. In addition, the learner will be expected to make all necessary electrical

connections to the switches, relays, sensors/actuators and other devices, as appropriate to the equipment and circuit being produced. The wiring and testing activities will include making all necessary checks and adjustments to the circuit, including continuity, polarity, insulation resistance values, and ensuring that the equipment functions to the specification.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the wiring and testing activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the wiring and testing activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical wiring and testing procedures and techniques safely. The learner will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Wire and test electrical equipment and circuits
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation,

regulations and other relevant guidelines

1.2 Carry out all of the following activities during the wiring and testing activities:

- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- ensure the safe isolation of services during the wiring and testing activities
- follow job instructions, circuit drawings and test procedures at all times
- check that tools and test instruments to be used are within calibration date, and are in a safe and usable condition
- ensure that the electrical system is kept free from foreign objects, dirt or other contamination
- where appropriate, apply procedures and precautions to eliminate Electrostatic Discharge (ESD) hazards
- return all tools and equipment to the correct location on completion of the wiring and testing activities

1.3 Wire up three of the following electrical systems:

- domestic lighting circuits
- domestic power circuits
- motor start and control
- vehicle heating or ventilating
- vehicle lighting
- vehicle starting and ignition
- instrumentation and control circuits
- alarm systems (such as fire, intruder, process control)
- electro-pneumatic or electro-hydraulic control circuits
- other control circuits (such as pumps, fans, blowers, extractors)
- air conditioning control circuits
- refrigeration control circuits
- heating/boiler control circuits
- aircraft lighting circuits
- power generation and control circuits
- avionic circuits and systems
- emergency lighting systems
- communication systems
- computer systems
- other specific electrical circuits

1.4 Plan the wiring and testing activities before they start them

1.5 Use appropriate sources to obtain the required specifications, circuit diagrams and test information

1.6 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition

1.7 Use two of the following test instruments during the wiring and testing activities:

- multimeter
- insulation resistance tester

- polarity tester/indicator
- earth-loop impedance tester
- other specific test equipment

1.8 Mount and secure the electrical components safely and correctly, to meet specification requirements

1.9 Wire circuits using three of the following types of cables:

- single core
- multicore
- PVC twin and earth
- flexible (such as cotton or rubber covered)
- data/communication
- fibre-optics
- screened
- coaxial
- ribbon cables
- Mineral Insulated
- armoured
- wiring loom/harness

1.10 Connect up ten of the following electrical modules/components to produce circuits:

- isolators
- switches
- sockets
- contactors
- motor starters
- solenoids
- relays
- alarm devices
- motors
- pumps
- heaters
- blowers
- lamp holders
- panel lamps
- luminaires
- ballast chokes
- consumer units
- Residual Current Device (RCD)
- instruments
- transformers
- panels or sub-assemblies
- control devices
- cable connectors
- fuses
- circuit breakers
- sensors

- actuators
- junction boxes
- terminal blocks
- electronic modules/units
- other electrical equipment

1.11 Install and terminate the cables to the appropriate connections on the components

1.12 Apply wiring methods and techniques to include six of the following:
- positioning and securing of equipment and components
- levelling and alignment of components
- determining sizes and lengths of cables required
- securing by using mechanical fixings (such as screws, nuts and bolts)
- laying in cables without twisting or plaiting
- feeding cables into conduit without twisting or plaiting
- leaving sufficient slack for termination and movement

1.13 Carry out eight of the following cable termination activities:
- stripping cable sheaths without damage to conductor insulation
- removing cable insulation
- connecting accessories (such as plugs, sockets multi-way connectors)
- making mechanical/screwed/clamped connections
- crimping (such as spade end, loops, tags and pins)
- soldering and de-soldering
- terminating armoured cables
- terminating Mineral Insulated cables
- sealing/protecting cable connections
- attaching suitable cable identification
- securing wires and cables (such as clips, plastic strapping, lacing, harnessing)
- heat shrinking (devices and boots)
- earth bonding

1.14 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification

1.15 Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include three of the following:
- making visual checks (such as completeness, signs of damage, incorrect termination)
- movement checks (such as loose fittings and connections)
- testing that the equipment operates to the circuit specification
- carrying out fault finding techniques (such as half-split, input/output, unit substitution)

Plus three more from the following:
- protective conductor resistance values
- insulation resistance values
- continuity

- voltage levels
- load current
- polarity
- resistance
- capacitance
- power rating
- frequency values
- inductance
- RCD disconnection time
- specialised tests (such as speed, sound, light, temperature)

1.16 Produce electrical circuits in accordance with one or more of the following standards:
- BS 7671/IEE wiring regulations
- other BS and/or ISO standards
- company standards and procedures

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Learning outcome
The learner will: 2. Know how to wire and test electrical equipment and circuits
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when wiring and testing electrical equipment (including any specific legislation, regulations or codes of practice for the activities, equipment or materials) 2.2 Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, (such as using sharp instruments for stripping cable insulation), and how they can be minimised 2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.4 Describe the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology) 2.5 Describe the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used 2.6 Describe the different types of cabling and their application (such as multicore cables, single core cables, solid and multi-stranded cables, Steel Wire Armoured (SWA), Mineral Insulated (MI), screened cables, data/communications cables, fibre-optics) 2.7 Describe the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors

and actuators)

2.8 Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, Residual Current Device (RCD))

2.9 Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)

2.10 Describe the methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)

2.11 Explain how to check that the positions selected for mounting the components do not interfere with or damage existing services (such as cable harnesses, pipework or electricity supplies)

2.12 Describe the methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited

2.13 Describe the techniques used to terminate electrical equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)

2.14 Describe the use of BS7671/IEE wiring regulations when selecting wires and cables and when carrying out tests on systems

2.15 Describe the methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)

2.16 Describe the tools and equipment used in the wiring and testing activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)

2.17 Explain how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition

2.18 Describe the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)

2.19 Describe the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments)

2.20 Explain how to apply approved test procedures; the safe working practices and procedures required when carrying out the various tests, and the need to use suitably fused test probes and clips

2.21 Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components

2.22 Explain how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters

2.23 Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure

2.24 Describe the problems that can occur with the wiring and testing operations, and how these can be overcome

2.25 Describe the fault-finding techniques to be used if the equipment fails to operate correctly

2.26 Explain when to act on their own initiative and when to seek help and advice from others

2.27	Describe the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 834 Forming and assembling electrical cable enclosure and support systems

UAN:	**J/600/5911**
Level:	Level 2
Credit value:	13
GLH:	65
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 34: Forming and assembling electrical cable enclosure and support systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to form and assemble electrical cable enclosure and support systems such as conduit, trunking and traywork systems. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competencies in the working environment. The activities will include the forming and assembly of metallic and non-metallic systems, and will cover the selection of the appropriate materials, cutting and bending/forming the appropriate pieces that make up the enclosure. The learner will need to assemble the prepared pieces, using a range of connection devices, and to position, align and secure them in the correct locations, using the specified/appropriate techniques, wall/screen penetration and fastening devices. The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the cable enclosure forming and assembly activities undertaken. The

learner will need to take account of any potential difficulties or problems that may arise with the activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate cutting, bending forming and installation techniques and procedures safely. The learner will understand the forming and assembly methods and procedures used, and their application, and will know about the various enclosure systems and components used to produce the assemblies, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the assembly and installation activities, especially those for handling long lengths of conduit or trunking. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Form and assemble electrical cable enclosure and support systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the electrical cable enclosure forming and assembly activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions and assembly/installation drawings at all times • ensure that the electrical cable enclosure system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the installation activities

1.3 Form and assemble the following types of electrical cable enclosures/support systems:

- metal conduit systems

Plus one more from the following:

- non-metallic conduit systems
- non-metallic trunking systems
- metal trunking system
- traywork systems

1.4 Plan the assembly and installation of the cable enclosure system before they start

1.5 Obtain the correct tools and equipment for the cutting, forming and assembly operations, and check that they are in a safe and usable condition

1.6 Cut and form the cable enclosure components to the required size and shape, using appropriate tools and techniques

1.7 Construct cable enclosures/support system components, to include carrying out all of the following:

- selecting the correct type and size of conduit, trunking or traywork (with regard to number of cables and climatic conditions)
- cutting the materials to the correct lengths (taking into account allowances for bends or joints required)
- removing all burrs and sharp edges
- producing external threads on conduit
- producing or fabricating bends, up to and including 90 degrees
- producing or fabricating bends over 90 degrees
- making tee/multiple junctions in trunking/traywork (where applicable)
- producing or fabricating offsets
- producing or fabricating bridge/saddle sets

1.8 Assemble the cable enclosure system, using the appropriate connectors

1.9 Assemble cable enclosure/support systems that include all of the following:

- bends/elbows (solid or inspection type)
- boxes (such as circular or square, terminal or multi branch)
- horizontal runs
- vertical drops

Plus three more from the following:

- straight connectors/couplings
- tee pieces (such as solid or inspection type)
- reducers
- conversion units and adaptors
- cross over units (such as bridge or saddle sets)
- off sets

1.10 Mount and secure the cable enclosure components safely and correctly to meet the specification requirements

1.11 Apply all of the following installation methods and techniques:

- marking out the location of the trunking, traywork or conduit
- positioning and securing the trunking, traywork or conduit using mechanical fixings
- drilling and preparing holes for the trunking, traywork or conduit
- levelling and alignment of the wiring enclosures and components

1.12 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly is secure and meets the required specification

1.13 Check the completed assembly, to include carrying out all of the following:

- checking for level and alignment
- checking that all connections are secure
- checking that sufficient supports are used and that they are correctly spaced
- checking that correct outlets are used (such as for sockets, switches, light fittings, wire junction and inspection fittings)

1.14 Produce cable enclosure/support systems in accordance with one or more of the following standards:

- BS 7671/IEE wiring regulations
- other BS and/or ISO standards
- company standards and procedures

1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.16 Leave the work area in a safe and tidy condition on completion of the forming and assembly activities

Learning outcome

The learner will:

2. Know how to form and assemble electrical cable enclosure and support systems

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when forming and assembling cable enclosure/support systems (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)

2.2 Describe the hazards associated with forming and assembling cable enclosure/support systems, and with the tools and equipment used (such as using bending and forming equipment, handling long lengths of pipe and trunking, using solvents and adhesives), and how they can be minimised

2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy

2.4 Describe the interpretation of circuit and wiring diagrams, and specifications used for the installation (including BS and ISO schematics, wiring regulations, symbols and terminology)

2.5 Describe the various types of electrical cable enclosure and support systems used, and their typical applications

2.6 Describe the factors to be taken into account when choosing metallic or non-metallic systems, and the effects of ambient temperatures within conduit and trunking systems
2.7 Describe the marking out lengths to be cut, taking into account any allowances (such as for bending, screwing, gluing)
2.8 Describe the methods of holding workpieces without damaging them (such as the use of a pipe vice)
2.9 Describe the tools and equipment used in the cutting, bending and forming operations (such as the use of conduit bending machines, threading equipment, hot air torches and bending springs)
2.10 Describe the methods of producing bends and sets in conduit materials (such as 90 degree bends, offsets, bridge sets)
2.11 Describe the methods of bending plastic conduit (such as using hot air guns and springs)
2.12 Explain how to produce fabricated bends in trunking and traywork section material (such as bends, Tee junctions, double and saddle sets)
2.13 Describe the methods of forming screw threads on ends of conduit, and of using appropriate tools to remove all sharp edges and burrs
2.14 Describe the various fittings used to assemble conduit, trunking and traywork systems (including screwed fittings, cemented fittings, straight connectors, bends, Tees, inspection fittings, light, power and control outlet boxes)
2.15 Describe the importance and use of inspection fittings (such as elbows and junction boxes)
2.16 Describe the things to look for when checking finished components/installations (such as dimensional checks, position and angle of bends/sets, out of alignment, loose connections, insufficient supports, damaged threads, deformed pipe around area of bend, burrs and sharp edges that could damage cables, ensuring that trunking lengths are free from swarf or other obstructions before connecting into the system)
2.17 Explain how to join the system components (such as using screw fittings, cemented fittings, fabricated components, nuts and bolts)
2.18 Explain how to check alignment of components (including use of plumb bobs, levels and by visual means)
2.19 Describe the methods of supporting and securing the components (such as position and spacing of supporting brackets and devices, using pipe clips, saddles and supports)
2.20 Describe drilling masonry, and the types and application of masonry fixing devices used in installation work
2.21 Describe the need to ensure that components are clear of services (such as gas water or electricity) before drilling walls
2.22 Describe the problems that can occur with the installation operations, and how these can be overcome
2.23 Explain when to act on their own initiative and when to seek help and advice from others
2.24 Describe the importance of leaving the work area in a safe and clean condition on completion of the assembly/installation activities (such as returning tools and equipment to its designated location, cleaning the work area, and removing and disposing of waste)

Unit 835 Assembling, wiring and testing electrical panels/components mounted in enclosures

UAN:	**R/600/5913**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 35: Assembling, wiring and testing electrical panels/components mounted in enclosures (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to assemble, wire and test electrical panels and components mounted in enclosures. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will include the assembly of a range of electrical components such as component panels, isolator switches, fuses and circuit breakers, contactors and relays, bases for plug-in devices, rail-mounted terminal blocks, trunking, earthing bonding, and sub-assemblies such as power supplies, card racks, and process controller units. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques. The assembly activities will also include making all necessary checks and adjustments to ensure that components are free from damage, correctly positioned and secured, are terminated correctly and pass the

required insulation and resistance checks.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical component assembly and wiring activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the assembly and wiring activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical assembly, wiring and testing procedures and techniques safely. The learner will understand the assembly methods and procedures used, and their application, and will know about the various components used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when mounting electrical components in enclosures, and with using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Assemble, wire and test electrical panels/components mounted in enclosures
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the mounting of the electrical components: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations

- follow job instructions, assembly drawings and test procedures at all times
- ensure that the components are free from damage, foreign objects, dirt or other contamination
- check that the tools and test instruments are within calibration date and are in a safe and usable condition
- prepare the electrical components and enclosures for the assembly operations
- use safe and approved techniques to mount the electrical components in the enclosures
- where appropriate, apply procedures and precautions to eliminate Electrostatic Discharge (ESD) hazards (such as the use of grounded wrist straps)
- return all tools and equipment to the correct location on completion of the assembly activities

1.3 Plan the electrical assembly, wiring and testing activities before they start them

1.4 Use appropriate sources to obtain the required specifications, circuit diagrams, components, assembly and test information

1.5 Obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition

1.6 Use the appropriate methods and techniques to assemble the components in their correct positions

1.7 Mount electrical components on panels or into enclosures, to include twelve of the following items:

- enclosure partitions
- component mounting plates
- component marking
- trunking
- conduit
- contactors
- overload and other relays
- transformers/chokes
- circuit breakers/fuses
- panel meters (voltage, current)
- terminal blocks/junction boxes
- safety interlocks
- isolators
- bases for plug-in devices
- switches (push button, toggle)
- capacitors
- resistors
- rectifiers
- timers
- power supplies
- circuit boards
- thermistors/thermocouples
- indicators (lamps, LEDs)

- thermostats
- busbars
- soft starters
- variable speed drives
- limit switches
- sensors
- programmable controllers
- plugs/sockets
- grommets/grommet strip
- lighting fixtures
- batteries
- connector rails
- solenoids
- other specific components

1.8 Use ten of the following methods and techniques (and the appropriate tools) during the wiring activities:

- cable forming/bending
- cable supporting/tying
- cable/wire clamping
- cable protection (such as sleeving, grommets)
- cable/wire crimping
- insulation stripping
- making screwed connections
- soldering (where appropriate)
- cable routeing
- connecting pre-formed looms
- wire marking/colour coding

1.9 Carry out eight of the following activities during the mounting of the electrical components:

- setting working clearance
- drilling
- filing
- riveting
- sawing/cutting
- forming
- aligning components
- torque setting fasteners
- earth bonding
- securing using mechanical fasteners/threaded devices
- punching
- applying sealants/adhesives
- clamping
- crimping
- component marking
- making screw connections
- measuring

1.10 Wire up electrical components on panels or in enclosures, using two of the following cable/wire types:

- single core cable
- multicore cable
- laminated copper
- data/communication cable
- Mineral Insulated cable
- screened cable
- fibre-optic
- braided copper
- twisted pair/ribbon cable
- other specialist cable

1.11 Secure the components, using the specified connectors and securing devices

1.12 Wire and terminate cables to the appropriate connections on the components

1.13 Use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification

1.14 Carry out quality checks, to include all of the following:

- positional accuracy of all components
- correct orientation
- correct alignment
- component security
- security of all terminations
- correct termination of all wires to components
- completeness
- ensuring enclosure is free of debris (such as cable offcuts/insulation, enclosure/trunking breakouts)
- ensuring freedom from damage

Plus all of the following electrical checks:

- continuity of cable/wiring connections (such as battery and lamp checks)
- earth continuity
- polarity
- protective conductor resistance values
- insulation resistance

1.15 Assemble electrical components on panels or in enclosures, in accordance with one or more of the following standards:

- BS7671/IEE wiring regulations
- other BS or ISO standards and procedures
- company standards and procedures

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Leave the work area in a safe and tidy condition on completion of the electrical assembly and testing activities

Learning outcome
The learner will: 2. Know how to assemble, wire and test electrical panels/components mounted in enclosures
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when assembling, wiring and testing electrical components mounted in enclosures (including any specific legislation, regulations or codes of practice for the activities, equipment or materials) 2.2 Describe the hazards associated with assembling, wiring and testing electrical panels (such as using sharp instruments for stripping cable insulation, use of soldering irons, carrying out insulation tests), and how they can be minimised 2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.4 Describe the precautions to be taken to prevent Electrostatic Discharge (ESD) damage to circuits and sensitive components (such as use of earthed wrist straps, anti-static mats, special packaging and handling areas) 2.5 Explain how to obtain and interpret drawings, circuit and physical layouts, charts, specifications, graphical electrical symbols, BS and ISO wiring regulations, and other documents needed for the electrical component mounting, wiring and testing activities 2.6 Describe the basic principle of operation of the equipment/circuits being assembled and wired, and the purpose of individual components within the circuit 2.7 Describe the assembly methods and techniques to be used when wiring electrical panels or components mounted in enclosures (such as cable stripping, soldering, crimping, securing cables using cable ties, lacing/strapping of wires) 2.8 Describe the type of components and sub-assemblies that are used in the assembly activities (such as contactors, relays, circuit breakers/fuses, solenoids, switches, transformers, ballast chokes, terminal blocks, sub-assemblies) 2.9 Describe the preparations to be undertaken on the components and enclosure, prior to the mounting activities 2.10 Explain how the components are to be aligned and positioned prior to securing, and the tools and equipment that are used 2.11 Explain how to identify any orientation requirements, values or polarity for the components used in the electrical wiring activities 2.12 Describe the methods of attaching identification markers/labels during electrical assembly activities 2.13 Describe the different types of cabling, and their application (such as multicore cables, single core cables, single insulated, double insulated, Steel Wire Armoured (SWA), Mineral Insulated (MI), screened cables) 2.14 Describe the use of BS7671/IEE wiring, and other regulations, when selecting wires and cables and when carrying out tests on electrical circuits 2.15 Explain how to conduct any necessary checks to ensure the accuracy and quality of the assembly produced (such as visual checks for completeness and freedom from damage to conductors

	or components, mechanical checks for security of components and connections, electrical checks for electrical continuity and earth continuity, insulation resistance and polarity checks)
2.16	Explain how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are configured correctly for the intended purpose
2.17	Explain when to act on their own initiative and when to seek help and advice from others
2.18	Describe the importance of leaving the work area in a safe and clean condition on completion of the electrical assembly and wiring activities (such as returning hand tools and test equipment to the designated locations, cleaning the work area, removing and disposing of waste)

Unit 836 Assembling and testing electronic circuits

UAN:	**K/600/5917**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 36: Assembling and testing electronic circuits (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to assemble and test electronic circuits. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will include the assembly of a range of electronic components such as resistors (fixed and variable), capacitors (fixed and variable), diodes, transistors and other semiconductor devices, integrated circuits (analogue and digital), miniature transformers, switches, indicators, wire links and a range of connectors, spacers and brackets to form various types of circuits. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques. The assembly activities will include making all necessary checks and adjustments to the circuits, including continuity checks, voltage and resistance values, waveform and ensuring that the circuit functions to the specification. The learner's responsibilities will require

them to comply with health and safety requirements and organisational policy and procedures for the electronic assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the assembly and wiring activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electronic assembly, wiring and testing procedures and techniques safely. The learner will understand the assembly methods and procedures used, and their application, and will know about the various components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the electronic component assembly activities, and with using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Assemble and test electronic circuits
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the electronic assembly and testing activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, assembly drawings and test procedures at all times • ensure that the components are free from damage, dirt or other contamination

- prepare the electronic components for the assembly operations (such as pre-forming pins)
- use safe and approved techniques to mount the electronic components on the circuit boards
- check that the tools and test instruments are within calibration date and are in a safe and usable condition
- where appropriate, apply procedures and precautions to eliminate Electrostatic Discharge (ESD) hazards (such as the use of grounded wrist straps)
- follow clean work area protocols, where appropriate
- return all tools and equipment to the correct location on completion of the assembly activities

1.3 Assemble one of the following circuit types:
- single-sided circuit
- flexible circuit
- thick film circuit
- double-sided circuit
- thin film circuit
- hybrid circuit

1.4 Plan the electronic assembly, wiring and testing activities before they start them

1.5 Use appropriate sources to obtain the required specifications, circuit diagrams, component assembly and test information

1.6 Obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition

1.7 Assemble circuits using four of the following tools:
- heat shunts/tweezers
- snipe or long nosed pliers
- sleeving pliers
- component forming devices
- wire strippers
- side or end cutters
- bolt fasteners (screwdriver, spanners)
- anti-static packaging, mats and straps
- specialised assembly tools/equipment

1.8 Use the appropriate methods and techniques to assemble the components in their correct positions

1.9 Assemble electronic components using two of the following:
- manual soldering techniques
- surface mount techniques
- mechanical fixing methods

1.10 Assemble circuits to the required specification, to include using fifteen of the following types of component:
- fixed resistors
- variable resistors
- potentiometers
- sensing resistors (such as temperature or light operated)
- fixed capacitors

- variable capacitors
- electrolytic capacitors
- diodes
- Zener diodes
- Light Emitting Diodes (LEDs)
- transistors
- thyristors
- thermistors
- analogue or digital integrated circuits
- surface mount packages
- rectifiers
- switches
- mini transformers
- decoders
- regulators
- encoders or resolvers
- inverters or servo controllers
- edge connectors
- wiring pins/tags/wire links
- fixing spacers
- insulators
- small heat sinks
- cables
- cable connectors
- protection devices
- opto-electronics/optical fibre components

1.11 Assemble electronic components to produce five of the following types of circuit:

- audio amplifiers
- signal converters
- signal generators
- counter/timers
- oscillators
- filters
- microprocessor based applications
- comparators
- power amplifiers
- motor control
- regulated power supplies
- logic function controls
- display circuits
- other specific circuit
- sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
- digital circuit (such as process control, microprocessor, logic devices, display devices)

- signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
- alarms and protection circuits
- ADC and DAC hybrid circuits

1.12 Secure the components, using the specified connectors, securing devices and soldering techniques

1.13 Wire and terminate cables to the appropriate connections on the circuit boards

1.14 Use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification

1.15 Carry out visual checks on the completed circuits, to include all of the following:

- soldered joints are clean, shiny, free from solder spikes, bridges, holes, excess solder and flux
- components are correctly mounted for best physical support, and are correctly orientated
- excess component leads have been trimmed off to the standard required
- circuit tracks are free from faults (such as lifting, breaks, bridges, hot spots)
- there are no obvious signs of damage, to components or to the substrate
- all required connectors, wire links, spacers and other ancillary items are in place

1.16 Use five of the following types of test equipment:

- multimeter
- oscilloscope
- logic probe/clip
- logic analyser
- pulse sequencing analyser
- counter/timers
- signature analysers
- protocol analyser
- signal generator
- signal tracer
- stabilised power supplies
- measuring bridges
- software diagnostic programs
- data communications test set
- bus exerciser

1.17 Carry out checks and adjustments, appropriate to the circuits being assembled, to include six of the following:

- logic states
- dc voltage/current levels
- ac voltage/current levels
- clock/timer switching
- oscillations
- attenuation

• pulse width/rise time • open/short circuit • resistance • capacitance • waveform analysis • inductance • frequency modulation/demodulation • amplification • signal noise/interference levels 1.18 Produce electronic circuits in accordance with one of the following: • BS or ISO standards and procedures • customer standards and requirements • company standards and procedures • other international standard 1.19 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve 1.20 Leave the work area in a safe and tidy condition on completion of the electronic assembly and testing activities

Learning outcome
The learner will: 2. Know how to assemble and test electronic circuits
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when assembling and testing electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials) 2.2 Describe the hazards associated with assembling and testing electronic circuits (such as heat, toxic fumes, spilled/splashed chemicals/solder, static electricity, using sharp instruments for stripping cable insulation, connecting clips/probes into circuits), and how they can be minimised 2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.4 Describe the precautions to be taken to prevent Electrostatic Discharge (ESD) damage to electronic circuits and components (such as use of earthed wrist straps, anti-static mats, special packaging and handling areas) 2.5 Explain how to use and extract information from circuit diagrams, block and schematic diagrams, equipment manuals, data sheets, test procedures and instructions (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.6 Describe the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry) 2.7 Explain how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, resistors, inductors, diodes, transistors, integrated circuit chips, and other

discrete through-hole or surface-mounted components)

2.8 Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)

2.9 Describe the basic principles of operation of the electronic circuits being assembled, and the purpose of the individual modules/components within the circuits

2.10 Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices)

2.11 Describe the preparation requirements for components to be used in the assembly (such as pre-forming component pins/legs)

2.12 Describe the methods of mounting and securing electronic components to various surfaces (such as the use of manual soldering techniques, surface mount technologies and mechanical fixing devices, use of heat sinks/shunts)

2.13 Describe the methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)

2.14 Describe the use of BS7671/IEE wiring, and other regulations, when selecting wires and cables and when carrying out tests on electronic circuits

2.15 Describe the importance of making visual checks of the completed assembly (such as examination for excessive solder or solder spikes which may allow short circuits to occur, correct orientation of components for pin configuration or polarity, obvious signs of damage (such as heat damage) or strain on terminations)

2.16 Describe the tools and equipment used in the electronic assembly activities (including the use of cable stripping tools, crimping tools, soldering irons, specialist assembly tools)

2.17 Describe the importance of ensuring that all tools are in a safe and serviceable condition, are used correctly and are returned to their correct location on completion of the assembly activities

2.18 Describe the care, handling and application of electronic test and measuring instruments (such as multimeter, oscilloscope, signal generators, stabilised power supplies, logic probes/analyzers, measuring bridges)

2.19 Explain how to check that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); how to check that equipment is within current calibration approval dates; checking that the test equipment is suitable for the tests they are to carry out and can cover the range and values they are to measure

2.20 Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results

2.21 Explain how to make adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components

2.22 Describe the fault-finding techniques to be used when the equipment fails to operate correctly

2.23	Explain when to act on their own initiative and when to seek help and advice from others
2.24	Describe the importance of leaving the work area in a safe and clean condition on completion of the electronic assembly and testing activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, removing and disposing of waste)

Unit 837 Maintaining electrical equipment/systems

UAN:	**A/600/5923**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 37: Maintaining electrical equipment/systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic electrical maintenance activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the electrical maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of electrical equipment/systems being maintained. This will include electrical equipment that uses single, three-phase or direct current power supplies, and includes equipment such as control systems, motors and starters, switchgear and distribution panels, electrical plant, pumps, fans, alternators, generators, transformers, wiring enclosures and luminaires, portable

appliances and other specific electrical equipment. The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

The learner will be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting electrical components, wires and cables, attaching cable identification markers, replacing damaged or defective components, cables and wires, setting and adjusting components, and making 'off-load' checks before testing the equipment, using appropriate techniques and procedures.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical maintenance techniques and procedures safely. The learner will understand the electrical maintenance process, and its application, and will know about the electrical equipment and systems being maintained, the components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Maintain electrical equipment/systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the electrical maintenance activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of equipment (such as electrical, mechanical, gas, air or fluids), where appropriate • follow job instructions, maintenance drawings and procedures • check that the tools and test instruments are within calibration date and are in a safe and usable condition • ensure that the system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the maintenance activities 1.3 Carry out maintenance/repair activities on two of the following types of electrical equipment: • electrical plant • wiring enclosures • portable appliances • generators • alternators • motors and starters • heaters • luminaires • switchgear • distribution panels • transformers • pumps • fans/blowers • other specific electrical equipment 1.4 Plan the maintenance activities before they start them 1.5 Obtain all the information they need for the safe removal and replacement of the equipment/system components 1.6 Obtain and prepare the appropriate tools and equipment 1.7 Apply appropriate maintenance diagnostic techniques and procedures 1.8 Use four of the following maintenance diagnostic techniques, tools and aids: • fault finding techniques (such as six point, half-split,

input/output, unit substitution)
- diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
- information gathered from fault reports
- visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)
- movement checks (such as loose fittings and connections)
- monitoring equipment or gauges
- test instrumentation measurement (such as voltage, resistance, current)

1.9 Use the appropriate methods and techniques to remove and replace the required components

1.10 Carry out maintenance/repair activities on three of the following electrical systems:
- single phase lighting circuits
- single phase power circuits
- three-phase power supplies
- direct current power supplies
- motor start and control
- vehicle heating or ventilating
- vehicle lighting
- vehicle starting and ignition
- instrumentation and control circuits
- alarm systems (such as fire, intruder, process control)
- electro-pneumatic or electro-hydraulic control circuits
- air conditioning control circuits
- refrigeration control circuits
- heating/boiler control circuits
- aircraft lighting circuits
- power generation and control circuits
- avionic circuits and systems
- emergency lighting systems
- communication systems
- computer systems
- other control systems
- other specific electrical systems

1.11 Carry out all of the following maintenance activities:
- removing excessive dirt and grime
- dismantling/disconnecting equipment to the required level
- disconnecting and reconnecting wires and cables
- stripping cable insulation/protection
- attaching suitable cable identification markers
- removing electrical units/components
- removing/replacing cable end fittings
- checking components for serviceability
- making mechanical/screwed/clamped connections
- soldering and de-soldering

- crimping (such as tags and pins)
- replacing damaged/defective components
- removing and replacing damaged wires and cables
- setting and adjusting replaced components
- making de-energised checks before reconnecting power supply

1.12 Maintain and/or replace a range of electrical components, to include six of the following:

- cables and connectors
- locking and retaining devices
- overload protection devices
- inverter and servo controllers
- relay components
- rectifiers
- capacitors
- circuit boards
- luminaires
- switches or sensors
- contactors
- encoders or resolvers
- batteries
- transformers
- solenoids
- thermistors or thermocouples
- other specific components

1.13 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

1.14 Carry out checks and tests on the maintained equipment, to include:

- making visual checks for completeness and freedom from damage

Plus three more from the following:

- protective conductor resistance values
- insulation resistance values
- continuity
- voltage levels
- load current
- polarity
- resistance
- capacitance
- power rating
- frequency values
- inductance
- RCD disconnection time
- specialised tests (such as speed, sound, light, temperature)

1.15 Maintain electrical equipment, in accordance with one or more of the following quality and accuracy standards:

- BS 7671/IEE wiring regulations
- other BS and/or ISO standards
- company standards and procedures
- equipment manufacturer's requirements

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome
The learner will: 2. Know how to maintain electrical equipment/systems
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the electrical maintenance activities undertaken 2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to electrical maintenance activities (to include electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured) 2.3 Describe the hazards associated with carrying out electrical maintenance activities (such as dangers of electric shock, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them 2.4 Explain how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and methods of first aid resuscitation) 2.5 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities 2.7 Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities (such as drawings, specifications, manufacturers' manuals, BS and ISO wiring regulations, symbols and terminology) 2.8 Describe the basic principles of how the equipment functions, and the working purpose of individual units/components 2.9 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing) 2.10 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics) 2.11 Explain how to use a range of fault diagnostic equipment to investigate the problem 2.12 Describe the care, handling and application of electrical measuring

	instruments
2.13	Describe the different types of cabling used in the maintenance activities, and their methods of termination
2.14	Describe the techniques used to dismantle/assemble electrical equipment (such as unplugging, de-soldering, removal of screwed, clamped and crimped connections)
2.15	Describe the methods of removing and replacing cables and wires in wiring enclosures without causing damage to existing cables
2.16	Describe the use of BS 7671/IEE wiring, and other regulations, when selecting wires and cables and when carrying out tests on systems
2.17	Describe the methods of attaching identification markers/labels to removed components or cables, to assist with re-assembly
2.18	Describe the tools and equipment used in the maintenance activities (such as the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
2.19	Describe the methods of checking that components are fit for purpose, and the need to replace 'lifed' items (such as seals and gaskets overload protection devices)
2.20	Explain how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition
2.21	Describe the importance of completing documentation and/or reports following the maintenance activity
2.22	Describe the importance of making 'off-load' checks before proving the equipment with the electrical supply on
2.23	Explain how to use appropriate lifting and handling equipment in the maintenance activity
2.24	Describe the problems that can occur during the electrical maintenance activity, and how they can be overcome
2.25	Explain when to act on their own initiative and when to seek help and advice from others
2.26	Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 838 Maintaining electronic equipment/systems

UAN:	**J/600/5925**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 38: Maintaining electronic equipment/systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic electronic maintenance activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the electronic maintenance activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of electronic equipment or systems being maintained. This will include power supplies, motor control systems, alarm and protection circuits, sensors and actuator circuits, digital circuits and systems, analogue circuits and systems, and hybrid circuits and systems. The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such

as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

The learner will be expected to apply a range of dismantling and reassembly methods and techniques at circuit board and component level, such as soldering, de-soldering, crimping, harnessing, securing cables and components, replacing damaged or defective components, cables and wires, setting and adjusting components, and making de-energised checks before testing the equipment, using appropriate techniques and procedures. The learner will be expected to take care that they do not cause further damage to the equipment/circuit during the repair activities and, therefore, the application of Electrostatic Discharge (ESD) procedures will be a critical part of their role.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electronic maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electronic maintenance techniques and procedures safely. The learner will understand the electronic maintenance process, and its application, and will know about the electronic equipment and systems being maintained, the equipment components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the repair activities, especially those for isolating the equipment, and for taking the necessary safeguards to protect themselves, and others, against direct and indirect electric shock. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Maintain electronic equipment/systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the maintenance activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of equipment (where appropriate) • follow job instructions, maintenance drawings and procedures • take Electrostatic Discharge (ESD) precautions when handling sensitive components and circuit boards • check that the tools and test instruments are within calibration date and are in a safe and usable condition • ensure that the system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the maintenance activities • leave the work area in a safe and tidy condition 1.3 Carry out maintenance/repair activities on three of the following types of electronic equipment: • power supplies (such as switched mode, series regulation, shunt regulation) • motor control systems (such as closed loop servo/proportional control, inverter control) • sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure) • digital circuit (such as process control, microprocessor, logic devices, display devices) • signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters) • alarms and protection circuits • ADC and DAC hybrid circuits 1.4 Plan the maintenance activities before they start them 1.5 Obtain all the information they need for the safe removal and replacement of the equipment/system components 1.6 Obtain and prepare the appropriate tools and equipment 1.7 Apply appropriate maintenance diagnostic techniques and procedures 1.8 Use four of the following maintenance diagnostic techniques, tools

and aids:

- fault finding techniques (such as six point, input/output, half-split, unit substitution)
- diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
- information gathered from the person who reported the fault
- visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)
- movement checks (such as loose fittings and connections)
- monitoring equipment or gauges
- test instrumentation measurement (such as voltage, resistance, current, waveform)

1.9 Use the appropriate methods and techniques to remove and replace the required components

1.10 Carry out all of the following maintenance techniques and procedures during the repair activities:

- removing excessive dirt and grime
- dismantling/disconnecting equipment to the required level
- disconnecting and reconnecting wires and cables
- checking the condition/deterioration of components
- soldering and de-soldering
- repairing circuit board tracks
- removing and replacing electronic units/circuit boards
- removing and replacing electronic components
- making adjustments to components and/or connections
- re-assembling of units or sub-assemblies

1.11 Replace a range of electronic components, to include twelve of the following:

- cables and connectors
- printed circuit boards
- fixed resistors
- variable resistors
- potentiometers
- sensing resistors (such as temperature or light operated
- fixed capacitors
- variable capacitors
- electrolytic capacitors
- mini transformers
- rectifiers
- thermistors
- thyristors
- transistors
- diodes
- Zener diodes
- Light Emitting Diodes (LEDs)
- sensors
- heat sinks

- protection devices
- surface mount packages
- integrated circuits
- decoders
- regulators
- encoders or resolvers
- inverters or servo controllers
- analogue or digital integrated circuits
- edge connectors
- switches
- wiring pins/tags/wire links
- opto-electronics/optical fibre components

1.12 Use the correct joining/connecting techniques to deal with three of the following types of connection:

- push-fit connectors
- soldering or de-soldering
- clip assemblies
- threaded connections
- crimped connections
- zero insertion force (zif) connectors
- adhesive joints/assemblies
- edge connectors

1.13 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

1.14 Carry out checks and tests on the maintained equipment, to include both of the following:

- visual checks (such as for solder bridges, dry joints, incorrect value components, signs of damage, missing components)
- movement checks (such as loose wires and connections, incorrectly seated devices/packages)

Plus three more from the following:

- logic states
- dc voltage/current levels
- ac voltage/current levels
- clock/timer switching
- oscillations
- attenuation
- pulse width/rise time
- open/short circuit
- resistance
- capacitance
- wave form analysis
- inductance
- frequency modulation/demodulation
- amplification
- signal noise/interference levels

1.15 Use five of the follotypes of test equipment:

- multimeter
- oscilloscope
- logic probe/clip
- logic analyser
- pulse sequencing analyser
- counter-timers
- signature analysers
- protocol analyser
- signal generator
- signal tracer
- stabilised power supplies
- measuring bridges
- software diagnostic programs
- data communications test set
- bus exerciser

1.16 Carry out maintenance activities on electronic equipment, in accordance with one or more of the following:
- organisational guidelines and codes of practice
- equipment manufacturer's operation range
- BS and ISO standards

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome
The learner will: 2. Know how to maintain electronic equipment/systems
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the electrical maintenance activities undertaken 2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the electronic repair activities and the electronic equipment or circuits being worked on (such as electrical isolation, locking off switchgear, removal of fuses, placing maintenance warning notices, proving that isolation has been achieved and secured) 2.3 Describe the hazards associated with maintaining electronic equipment, and with the tools and equipment that are used (such as live electrical components, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how these can be minimised 2.4 Explain how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and methods of first aid

resuscitation)

2.5 Describe the importance of wearing appropriate protective clothing/equipment, and of keeping the work area safe and tidy

2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities

2.7 Explain how to extract information from job instructions, drawings and data (such as circuit diagrams, specifications, manufacturers' manuals, test procedures and other documents needed to carry out repairs)

2.8 Describe the procedures and precautions to be adopted to eliminate Electrostatic Discharge (ESD) hazards

2.9 Describe the basic principles of how the electronic circuit functions, and the working purpose of individual units/components

2.10 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing; fault location using techniques such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

2.11 Describe the care, handling and application of electrical measuring instruments/fault diagnostic equipment to investigate the problem (such as multimeter, oscilloscope, signal generators, logic probes/analyzers, measuring bridges)

2.12 Explain how to check that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); how to check that equipment is within current calibration approval dates; checking that the test equipment is suitable for the tests they are to carry out and can cover the range and values they are to measure

2.13 Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results

2.14 Describe the application of Ohm's Law and relevant calculations (including units of electronic measurement and their multiples and sub-multiples)

2.15 Describe the use of BS7671/IEE wiring, and other regulations, when selecting wires and cables and when carrying out tests on electrical circuits

2.16 Explain how to make adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components

2.17 Explain how to check that the replacement components meet the required specification/operating conditions (such as values, tolerance, current-carrying capacity, ambient temperatures)

2.18 Describe the methods of removing and replacing the faulty components from the equipment (such as unplugging, de-soldering, removal of screwed, clamped, edge connected, zero insertion force, and crimped connections) without causing damage to other components, wiring, circuit boards or the surrounding structure

2.19 Describe the tools and equipment used in the repair activities

	(including the use of wire-stripping tools, crimping tools, soldering irons, insertion devices and connecting tools); how to check that they are in a safe and usable condition
2.20	Describe the sequence for reconnecting the equipment, and the checks to be made prior to restoring power (such as checking components for correct polarity, ensuring that there are no exposed conductors, cable insulation is not damaged, all connections are mechanically and electrically secure, casings are free from loose screws, there are no wire ends or solder blobs/spikes that could cause short circuits, and all fuses/protection devices are installed)
2.21	Describe the importance of making de-energised checks before proving the equipment with the electrical supply on
2.22	Explain how to make adjustments to components/assemblies to ensure that they function correctly
2.23	Describe the documentation and/or reports to be completed following the repair activity, and the importance of ensuring that these reports are completed accurately and legibly
2.24	Describe the problems that can occur with the electronic equipment maintenance activity, and how they can be overcome
2.25	Explain when to act on their own initiative and when to seek help and advice from others
2.26	Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, removing and disposing of waste)

Unit 839 Maintaining and testing process instrumentation and control devices

UAN:	**D/600/5932**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 39: Maintaining and testing process instrumentation and control devices (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of activities covering the maintenance of process instrumentation and control devices. These competences will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or they will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the instrumentation and control maintenance activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of instrumentation and control equipment being maintained, such as pressure, flow, level and temperature instruments, fiscal monitoring equipment, fire and gas detection and alarm systems,

industrial weighing systems, speed measurement and control systems, vibration monitoring equipment, nucleonics and radiation measurement, telemetry systems and emergency shutdown systems.

The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment. The learner will also be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting instruments and faulty peripheral components, setting and adjusting components, and testing the equipment, using appropriate techniques and procedures.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the instrumentation maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply safely the appropriate maintenance techniques and procedures for process instrumentation and control equipment. The learner will understand the instrumentation maintenance process, and its application, and will know about the instrumentation and systems being maintained, and the tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities, (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Maintain and test process instrumentation and control devices
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the instrumentation maintenance activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • where appropriate, ensure the safe isolation of instruments (such as electrical, pneumatic, process) • follow job instructions, maintenance drawings and procedures • check that the tools and test instruments are within calibration date and are in a safe and usable condition • ensure that the equipment/system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the maintenance activities 1.3 Carry out maintenance activities on two of the following types of instrumentation and control systems: • pressure • fluid level • fluid flow • temperature measurement • fire detection • gas detection • emergency shutdown • speed measurement • noise • vibration monitoring • nucleonic and radiation measurement • telemetry systems • weight measurement • alarm systems 1.4 Plan the maintenance activities before they start them 1.5 Obtain all the information they need for the safe removal and replacement of the instruments and/or sensors 1.6 Obtain and prepare the appropriate tools and equipment 1.7 Apply appropriate maintenance diagnostic techniques and

procedures

1.8 Use four of the following maintenance diagnostic techniques, tools and aids:
- fault finding techniques (such as input/output, half-split, unit substitution)
- diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
- information gathered from the person who reported the fault
- visual checks (such as signs of damage, leaks, missing parts, wear/deterioration)
- movement checks (such as loose fittings and connections)
- monitoring equipment or gauges
- test instrumentation measurement (such as voltage, resistance, current)

1.9 Use the appropriate methods and techniques to remove and replace the required instruments/sensors

1.10 Carry out all of the following instrumentation maintenance activities:
- removing excessive dirt and grime
- taking Electrostatic Discharge (ESD) precautions (where appropriate)
- disconnecting supply/signal connections
- removing instruments from the system
- dismantling equipment to the required level
- labelling/marking of components
- checking components for serviceability
- replacing all 'lifed' items (such as seals, gaskets)
- replacing instruments in the system
- setting, aligning and adjusting components
- tightening fastenings to the required torque
- re-connecting instrumentation pipework and power supply
- checking signal transmission is satisfactory
- functionally testing the maintained equipment
- replacing or repairing damaged/defective components (such as electrical, mechanical and back-up batteries)

1.11 Use four of the following types of instrumentation test and calibration equipment:
- signal sources
- standard test gauges
- analogue and digital meters
- digital pressure indicators
- calibrated flow meters
- special-purpose test equipment
- pressure sources
- comparators
- manometers
- current injection devices
- calibrated weights

- logic probes
- temperature baths
- workshop potentiometers
- dead weight testers
- insulation testers

1.12 Carry out tests on sensing elements and associated instruments

1.13 Set up and test sensing elements and/or stand alone instruments, to include three of the following:

- pressure (such as bourdon tube gauge, capsule/diaphragm gauge, pressure transducers)
- temperature (such as thermocouple, resistance thermometers, liquid in steel thermometer)
- flow (such as differential pressure systems, balanced flow meters, positive displacement)
- level (such as displacer systems, purged dip leg, capacitance probes, differential pressure systems, ultrasonic probes)
- other instruments/sensing elements (such as fire or gas detection, noise or vibration, speed or weight)

1.14 Maintain instrumentation and control systems, in accordance with one or more of the following:

- organisational guidelines and codes of practice
- equipment manufacturer's operation range
- BS and ISO standards

1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.16 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome

The learner will:

2. Know how to maintain and test process instrumentation and control devices

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the instrumentation maintenance activities undertaken

2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the system and instruments being worked on, and how to check that any stored energy in pipework and instruments has been released

2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy

2.4 Describe the hazards associated with carrying out instrumentation and control maintenance activities (such as live electrical components, process controller interface, stored pressure/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them

2.5 Explain how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and methods of first aid resuscitation)

2.6 Describe the procedures and precautions to be adopted to eliminate Electrostatic Discharge (ESD)

2.7 Explain how to obtain and interpret information from job instructions and other documents needed for the maintenance activities (such as drawings, circuit and physical layouts, charts, specifications, manufacturers' manuals, history/maintenance reports, symbols and terminology, BS and ISO wiring regulations)

2.8 Describe the basic principles of operation of the instrumentation being maintained (to include pressure, temperature, level and flow instrument sensors)

2.9 Explain how to identify the various instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)

2.10 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)

2.11 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

2.12 Explain how to use a range of fault diagnostic equipment to investigate the problem

2.13 Describe the care, handling and application of instrumentation and control measuring instruments

2.14 Describe the reasons for making sure that control systems are isolated or put into manual control, and that appropriate trip locks or keys are inserted, before removing any sensors or instruments from the system, and the consequences of failing to do this

2.15 Describe the techniques used to dismantle/remove the equipment (such as release of pressures/force, proof marking to aid assembly, plugging exposed pipe/component openings, dealing with soldered joints, screwed, clamped and crimped connections)

2.16 Describe the methods of attaching identification marks/labels to removed components or cables, to assist with reassembly

2.17 Describe the methods of checking that components are fit for purpose, and the need to replace batteries, boards and other failed items

2.18 Describe the correct way of re-fitting instruments to avoid faulty readings (such as caused by head correction, poor flow past the sensor, blockages, incorrect wiring, poor insulation or incorrect materials)

2.19 Explain how to carry out visual checks of the instruments (such as security of joints and physical damage)

2.20 Describe the need to carry out tests and calibration checks on the various sensing elements and stand alone instruments, and the use of standard calibration charts and tables

2.21 Describe the types and application of standard test equipment (such as pressure sources, deadweight tester, temperature baths, signal sources and comparators)

2.22 Explain how to check that tools and equipment are free from damage or defects and are in a safe and usable condition

2.23 Describe the approved methods of carrying out the tests on each type of instrument/sensor; setting instrument zero readings;

	obtaining instrument readings and comparing them with the circuit parameters; making adjustments to instrument/circuit components
2.24	Describe the generation of maintenance documentation and/or reports following the maintenance activity
2.25	Describe the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome
2.26	Describe the organisational procedure to be adopted for the safe disposal of waste of all types of materials
2.27	Explain when to act on their own initiative and when to seek help and advice from others
2.28	Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 840 Wiring and testing programmable controller based systems

UAN:	**K/600/5934**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 40: Wiring and testing programmable controller based systems (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to wire and test programmable controller based systems. This will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the programmable controller wiring and testing activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the activities and the sequence of operations they intend to use. It involves connecting and wiring up the equipment and the development, editing, inputting, testing and de-bugging of simple programs. The learner will be expected to connect peripheral components and communication links, and to load/download process controller programs, check them for errors, and create back-up copies of completed programs. The learner's responsibilities will require them to comply with health and safety

requirements and organisational policy and procedures for the programmable controller maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply safely the appropriate wiring and connection techniques and procedures for programmable controller equipment. The learner will understand the programmable controller wiring and testing process, and its application, and will know about the controller and peripherals being wired and tested, and the tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the wiring and testing activities (especially those for ensuring the equipment is correctly isolated), and when using the various tools and test equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Wire and test programmable controller based systems
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the wiring and testing of the programmable controller equipment: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of services during the wiring activities • follow job instructions, wiring drawings and test procedures at

all times

- check that the tools and test instruments are within calibration date and are in a safe and usable condition
- ensure that the programmable controller system is kept free from foreign objects, dirt or other contamination
- where appropriate, apply procedures and precautions
- return all tools and equipment to the correct location on completion of the installation activities

1.3 Connect and test equipment for one of the following types of programmable controller systems:

- monitoring system
- process/product control system
- diagnostic system
- combination system
- building services system
- other specific system

1.4 Plan the programmable controller wiring and testing activities before they start them

1.5 Use appropriate sources to obtain the required circuit diagrams, wiring, programming and test information

1.6 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition

1.7 Use two of the following test instruments during the wiring and testing activities:

- multimeter
- signal generator
- other specific test equipment
- programming devices (such as loader terminal, hand held programmer, personal computer)

1.8 Position and secure the programmable controller components and peripheral devices safely and correctly, to meet specification requirements

1.9 Connect up and test one of the following types of programmable controller equipment/components:

- fixed input/output (I/O) units
- rack mounted controller units
- modular controller units

Plus five more items from the following:

- sensors (such as proximity, temperature, colour, optical)
- actuators (such as pneumatic or hydraulic)
- switches (such as limit, pressure, timer)
- safety interlocks
- motor starters
- barcode scanners
- PC peripheral devices
- modems
- printers panels and sub-assemblies
- electrical wires and cable connections
- signal transmission components/cables

- overload protection devices
- other devices

1.10 Connect and terminate the cables to the appropriate connections on the components

1.11 Apply wiring and connection methods and techniques, to include five of the following:
- locating and securing equipment in the correct positions
- making mechanical/screwed/clamped connections
- soldering and de-soldering connections
- sealing and protecting cable connections
- crimping (such as tags and pins)
- connecting all input and output devices
- attaching suitable cable identification
- routeing and securing wires and cables
- using heat shrinking devices or boots
- stripping cable insulation/protection
- adding cable end fittings

1.12 Develop programmable controller programs, using the appropriate techniques and programming language

1.13 Develop programs which use one of the following, as applicable to the type of controller:
- ladder and logic diagrams
- function diagrams
- statement lists

1.14 Use appropriate test methods and equipment to check and prove the program integrity

1.15 Prove and edit the programmable logic controller program, using five of the following:
- single block run
- program save/store facilities
- search facilities
- program override controls
- taking test measurements
- using monitoring mode
- using process simulation techniques (forcing contacts on/off)
- edit facilities
- data input facilities
- program full run
- graphic displays

1.16 Wire up and test programmable controllers, in accordance with one or more of the following standards:
- equipment manufacturer's specification/operation range
- BS7671/IEE wiring regulations
- other BS and/or ISO standards
- company standards and procedures

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Use three of the following diagnostic techniques, tools and aids:
- visual checks (such as signs of damage, missing parts, wear/deterioration)
- movement checks (such as loose fittings and connections)
- fault finding techniques (such as input/output, half-split, unit substitution)
- diagnostic aids (such as manuals, logic diagrams, troubleshooting guides)
- test instrumentation measurement (such as continuity, voltage, resistance, current)

1.19 Carry out all of the following on completion of the programming activity:
- check and review program format and content
- edit programs using the correct procedure (where appropriate)
- check that the program is correctly titled and referenced
- ensure that programs are stored safely and correctly in the correct format (such as disk, EPROM, hard copy)
- create a separate backup copy of the program in case of file corruption

1.20 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Learning outcome
The learner will: 2. Know how to wire and test programmable controller based systems
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required when wiring and testing programmable controller equipment 2.2 Describe the hazards associated with wiring and testing programmable controller equipment, and with the tools and equipment used (such as live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down procedures), and how they can be minimised 2.3 Describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy 2.4 Describe the interpretation of circuit and wiring diagrams, and specifications used for the wiring and testing activities (including BS and ISO schematics, wiring regulations, symbols and terminology) 2.5 Describe the basic principles of operation of the programmable controller equipment/circuits being connected and tested, and the purpose of the individual modules/components used (such input and output devices) 2.6 Describe the techniques used to connect programmable controller equipment (such as plugs, soldering, screwed, clamped and crimped connections) 2.7 Describe the use of BS 7671/IEE wiring, and other regulations, when selecting wires and cables, and when carrying out tests on systems

2.8 Describe the main programmable controller types that are available, and the importance of understanding that a different programmable controller may use completely different codes for similar functions
2.9 Describe the programming languages commonly used with programmable controller based systems (such as linear, structured, ladder, statement lists, logic function blocks, Boolean algebra)
2.10 Describe the common programmable controller numbering systems (such as binary, octal, decimal, hexadecimal, Binary Coded Decimal (BCD))
2.11 Describe the different programming codes used to identify factors such as sensor inputs, actuator and other outputs, process management and auxiliary functions
2.12 Describe the information and data required in order to produce a complete and accurate programmable controller program, and how to translate the operating criteria into logic programming format
2.13 Describe the factors to be taken into account when producing programs (including the type of programmable controller (fixed IO, modular, rack mounted) and its control capabilities); safety considerations and the product/environment being controlled by the process
2.14 Describe the methods and procedures used to check that the completed program will control the required parameters safely, accurately and efficiently (such as checking the program for errors against expected performance with regard to sequence of operations; checking that programmed instructions cover all operational requirements; using monitoring devices and test measurements to check inputs and outputs; using techniques such as 'force on- force off' to simulate process conditions; checking that failsafe devices and system emergency stops are operating correctly)
2.15 Explain how to identify system errors, and how to search a program within the programmable controller for specific elements and rectify the causes of the errors
2.16 Explain how to save the completed programs in the appropriate format (such as disks, tapes, EPROMS, hard copy), and the need to store the program safely and correctly, away from contaminants and electromagnetic sources
2.17 Explain how to back up completed or edited programs, and the implications if this is not carried out effectively
2.18 Describe the fault-finding techniques to be used when the equipment fails to operate correctly
2.19 Explain when to act on their own initiative and when to seek help and advice from others
2.20 Describe the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 841 Using wood for pattern, modelmaking and other engineering applications

UAN:	**T/600/5936**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 41: Using wood for pattern, modelmaking and other engineering applications (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic hand and wood machining activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the pattern, modelmaking or engineering woodworking activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the cutting and shaping activities and the sequence of operations they intend to use. The learner will be required to select the appropriate hand tools and machinery, based on the operations to be carried out and the accuracy to be achieved. The production of the components will involve roughing out the components using fixed or portable machine tools, and finishing them using hand tools. The components produced will be used to produce such things as patterns for sand castings, moulds

for composite manufacture, full size and scale models, frames, cases, storage units, furniture and other structures.

During, and on completion of, the cutting and shaping operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise material and cutting and shaping defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the activities, the learner will be expected to return all tools and equipment to the correct locations, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the woodworking activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate hand and wood machining techniques safely. The learner will understand the cutting and shaping process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the cutting and shaping activities, especially those for using woodworking machines and portable power tools. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Use wood for pattern, modelmaking and other engineering applications
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the cutting and shaping activities: • obtain all the necessary information to carry out the cutting and shaping activities (drawings, specifications) • check that the equipment to be used are fit for purpose, and is in a safe and usable condition (such as hand tools, machines and machine cutting tools) • ensure that the work area is free from hazards • ensure that all machine guards and safety devices are correctly positioned • check that dust extraction equipment is functioning correctly • set and adjust the machines to produce the components to the required specification • use safe and approved hand and machine shaping techniques at all times • maintain the cutting tools in a serviceable condition 1.3 Plan the pattern, model or engineering woodworking activities before they start them 1.4 Identify and isolate any materials that have defects, to include all of the following: • structural • cosmetic • dimensional • distortion 1.5 Obtain the appropriate tools and equipment for the operations, and check that they are in a safe and usable condition 1.6 Mark out the components for the required operations, using appropriate tools and techniques 1.7 Use marking out methods and techniques, including: • direct marking, using instruments Plus one more of the following: • use of templates • tracing/transfer methods 1.8 Use a range of marking out equipment, to include all of the following: • pencil • marking knife • rule or tape • straight edge • square • protractor or sliding bevel

- dividers, compass or trammels
- marking gauge

1.9 Mark out material, to include all of the following features:

- datum and centre lines
- square/rectangular profiles
- cutting detail
- circles
- hole centring and outlining

Plus two more from the following:

- angles
- joints
- curved profiles
- assembly positions

1.10 Cut and shape the materials to the required specification, using appropriate tools and techniques

1.11 Use hand tools to cut and shape materials, to include all of the following:

- rip saws
- tenon saws
- chisels/gouges
- jack or smoothing planes
- drills/braces
- sanding blocks/paper

Plus two more from the following:

- fret/bow saws
- rebating planes
- spokeshaves
- files/rasps
- portable powered hand tools
- other specific hand tools

1.12 Use fixed and portable machines, to include all of the following:

- circular saw
- planer/thicknesser
- bench or pedestal drill

Plus two more from the following:

- band saw
- sander (such as face, belt, bobbin)
- router
- morticer/tenoner
- combing machine
- lathe
- spindle moulder (single or double)
- other special purpose machine

1.13 Produce components which combine different features and cover all of the following profiles:

- flat faces
- parallel faces

- square faces
- angular/tapered faces
- curved profiles
- drilled holes
- countersunk/counterbored holes

Plus six more from the following:

- plain diameters
- stepped diameters
- tapered diameters
- slots/grooves
- rebates
- tenons
- mortices
- half lap joints
- combed joints
- dovetail joints
- concave profiles
- convex profiles
- other joints (such as dovetail, combed)

1.14 Produce components made from four of the following materials:

- soft woods
- hard woods
- plywood
- blockboard
- hardboard
- fibreboard (MDF)

1.15 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.16 Use appropriate measuring equipment and tools to check all of the following:

- dimensions
- flatness
- squareness
- angles/taper
- alignment
- position
- profile
- distortion/straightness

1.17 Produce components which meet all of the following requirements:

- components to be free from false tool cuts, and material defects
- the shape and general tolerances meet the drawing or specification requirements with some dimensional tolerances within +/- 1mm or +/- 0.040”
- flatness and squareness mm per 25mm or ” per inch
- angles within +/- 2 degrees
- interlocking components (joints) are secure

- components have an appropriate surface texture

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Leave the work area in a safe and tidy condition on completion of the pattern, modelmaking or engineering woodworking activities

Learning outcome
The learner will: 2. Know how to use wood for pattern, modelmaking and other engineering applications
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the pattern, modelmaking or engineering woodworking activities undertaken (including the use of hand tools; working with machinery; operation of machine safety devices; stopping the machine in an emergency; closing the machine down on completion of activities) 2.2 Describe the importance of wearing appropriate protective clothing/equipment, and of keeping the work area safe and tidy 2.3 Describe the hazards associated with cutting and shaping wood and composite materials, and with the tools and equipment that is used, (such as use of hand power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using tools with damaged or poor fitting handles, handling long or wide lengths of material), and how they can be minimised 2.4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications 2.5 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.6 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.7 Explain how to identify the materials that are to be used (to include colour, grain structure, size), and the common defects that occur in the wood to be used 2.8 Describe the types of defects that would render the materials unfit for use 2.9 Describe the material characteristics and process considerations to be taken into account when marking out wood (such as the importance of colour matching and grain convention when using wood and wood-based materials) 2.10 Describe the principles of marking out, and the types of equipment used (including the range of operations that the various items of marking out equipment are capable of performing) 2.11 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, preparing the materials, removing sharp corners and edges) 2.12 Describe the use of marking out conventions when marking out the

	workpiece (including datums, centre lines, cutting guidelines, square and rectangular profiles, joints, circular and curved profiles, angles, holes which are linearly positioned, boxed and on pitch circles)
2.13	Explain how to select and establish suitable datums; the importance of ensuring that marking out is undertaken from the selected datums; and the possible effects of working from different datums
2.14	Describe the use of geometrical construction methods applied to marking out
2.15	Describe the ways of laying out the marking out shapes or patterns to maximise the use of materials
2.16	Describe the various hand tools that are used to cut and shape the materials, and the range of operations they are capable of performing (such as rip saws, tenon saws, fret/bow saws; smoothing planes, jack planes, rebating planes; chisels and gouges; spokeshaves)
2.17	Explain how to check that the hand cutting tools are in a usable and safe condition; and the procedure for sharpening and adjusting these when required
2.18	Describe the various machines that are used in wood machining, and the range of operations they are capable of performing (such as sawing, planing, rebating, profiling)
2.19	Describe the importance of checking that the machinery used is complete and working correctly, that the cutting tools are undamaged and are in a safe and sharp condition, and the procedure for changing, sharpening and adjusting these when required
2.20	Describe the methods of setting up and operating the equipment and machinery, how to set up and use dust extraction equipment, and the importance of ensuring that this equipment is operating correctly
2.21	Describe the importance of ensuring that all machine and portable tools are used correctly and within their permitted operating range
2.22	Describe the various methods used to hold the components that are being shaped, formed or dressed by hand
2.23	Explain why they need to consider grain direction and construction when cutting and shaping wood and composites
2.24	Describe the methods used to cut square, angular and circular/curved profiles
2.25	Explain how different materials require changes to the machining methods (such as roughing and finishing cuts, changes in feed or speeds)
2.26	Explain how to conduct any necessary checks to ensure the accuracy and quality of the components produced, and the type of equipment that is used
2.27	Explain when to act on their own initiative and when to seek help and advice from others
2.28	Describe the importance of leaving the work area in a safe and clean condition on completion of the woodworking activities (such as removing and storing power leads, isolating machines, cleaning the equipment, and removing and disposing of waste)

Unit 842 Assembling pattern, model and engineering woodwork components

UAN:	**A/600/5937**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 42: Assembling pattern, model and engineering woodwork components (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to assemble pattern, model or engineering woodwork components. These will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or they will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the pattern, model or engineering woodworking, assembly activities by obtaining all the necessary information, documentation, components, tools and equipment required, and to plan how they intend to carry out the assembly activities and the sequence of operations they intend to use. The learner will be required to assemble pattern, model or engineering woodwork components, using mechanical fixing devices and adhesives. The assemblies produced will include such things as patterns for sand casting, moulds/formers for composite manufacture, furniture units, doors and door frames, transportation units, jigs/fixtures and other engineering

structures/assemblies.

The learner will be required to select the appropriate assembly tools and equipment to use, based on the operations to be performed and the types of component to be assembled, and to check that they are in a safe and serviceable condition. The learner will also be expected to align the components correctly, and to assemble them in the correct order, using the appropriate fixing devices and adhesives.

The learner will need to identify and/or create any datums that will be required to locate the components during the assembly process. The assembly activities will also include making all necessary visual and dimensional checks, to ensure that the assembly meets the required specification, that fasteners are securely tightened, and that the completed assembly is free from damage and has an appropriate cosmetic appearance.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the woodwork assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate woodwork assembly techniques safely. The learner will understand the assembly process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the assembly operations, especially those involved in the use of adhesives. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Assemble pattern, model and engineering woodwork components
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the pattern, model or engineering woodwork assembly activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, assembly drawings and procedures • ensure that all power tool cables, extension leads or air supply hoses are in a safe and serviceable condition • check that tools and measuring instruments to be used are within calibration date • use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where appropriate) • ensure that components used are free from damage, material defects, foreign objects, or other contamination • return all tools and equipment to the correct location on completion of the assembly activities 1.3 Plan the assembly activities before they start them 1.4 Obtain and prepare the appropriate components, tools and equipment 1.5 Use the appropriate methods and techniques to assemble the components in their correct positions 1.6 Produce pattern, model or engineering woodwork assemblies, which include three of the following: • flat backed patterns (with/without cores) • irregular joint patterns (with/without cores) • split patterns (with/without cores) • solid turnout coreboxes • split coreboxes • plated patterns (drags) • plated patterns (copes) • furniture units without drawers and doors • furniture units with drawers • furniture units with doors • doors and door frames • storage units • frames or bulkheads • structures

- show stands or cases
- transportation units
- consoles
- full-size models
- sectional full-size models
- scale models
- sectional scale models
- jigs or fixtures
- formers
- other specific assemblies

1.7 Apply all of the following assembly methods and techniques, as appropriate for the assemblies produced:
- ensuring that correct and undamaged components are used
- ensuring that the correct 'hand' of component is used at the appropriate position (left or right handed)
- ensuring the correct orientation, position and alignment of components
- using cramps and clamps to hold the components during the assembly activities
- drilling and countersinking/counterboring (where appropriate)
- securing components using mechanical fasteners (such as pins, screws, nails, special fasteners, dowels)
- securing components by using prepared joints
- securing components by using adhesives
- fitting of accessories (hinges, locks, handles, catches)

1.8 Secure the components, using the specified connectors and securing devices

1.9 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly meets the required specification

1.10 Carry out the required quality checks, to include ten from the following, using appropriate equipment:
- dimensions
- flatness
- squareness
- alignment
- orientation
- positional accuracy
- distortion/straightness
- profile (where appropriate)
- fit/component security
- finish
- completeness
- function (where appropriate)
- freedom from damage

1.11 Produce pattern, model or engineering woodwork assemblies which meet all of the following:
- all components are correctly assembled and aligned in

accordance with the specification

- assemblies are dimensionally accurate within specification tolerances
- where appropriate, assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)
- interlocking components (joints) are secure
- doors and drawers are correctly aligned and open freely (where applicable)
- moving parts are correctly adjusted and have appropriate clearances

1.12 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.13 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to assemble pattern, model and engineering woodwork components
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken whilst carrying out the woodwork assembly activities (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials) 2.2 Describe the importance of wearing appropriate protective clothing/equipment during the woodwork assembly activities, and of keeping the work area safe and tidy 2.3 Describe the hazards associated with producing wood and composite assemblies, and with the tools and equipment used, (such as use of hand power tools, trailing leads or hoses, using adhesives), and how they can be minimised 2.4 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.5 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.6 Explain how to identify the components to be used, component identification systems (such as codes and component orientation indicators, left and right handing) 2.7 Describe the preparations to be undertaken on the components prior to fitting them into the assembly 2.8 Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures 2.9 Describe the importance of assembling components in the correct order 2.10 Explain how to mark out the necessary datum lines for the assembly operations 2.11 Explain how the components are to be aligned, oriented and

positioned prior to securing them, and the tools and equipment that are used for this

2.12 Explain why some types of assembly require the use of jigs and gauges to aid the assembly

2.13 Describe the various mechanical fasteners that will be used to secure the components, and their method of installation (such as nails, screws and special securing devices)

2.14 Describe the application of adhesives within the assembly activities, and the precautions that must be taken when working with them

2.15 Explain how to conduct any necessary checks to ensure the accuracy and quality of the assembly produced, and the type of equipment that is used

2.16 Explain how to recognise defects, blemishes, poor alignment, ineffective fasteners and damaged components within the assembly

2.17 Explain how defects and variations should be dealt with, and what factors determine the actions to be taken (including the relative costs of reworking or discarding the defective item)

2.18 Explain how to check that the assembly tools and equipment to be used are in a safe and serviceable condition

2.19 Explain why it is important to keep the tools and equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area

2.20 Explain when to act on their own initiative and when to seek help and advice from others

2.21 Describe the importance of leaving the work area in a safe and clean condition on completion of the assembly activities (such as removing and storing clamps, isolating equipment, cleaning the equipment, and removing and disposing of waste)

Unit 843 Producing composite mouldings using wet lay-up techniques

UAN:	**J/600/5939**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 43: Producing composite mouldings using wet lay-up techniques (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce composite mouldings using wet-lay up techniques. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the wet-lay up moulding activities by obtaining all necessary information, documentation, materials, tools and equipment required, and to plan how they intend to carry out the moulding/laying up activities and the sequence of operations they intend to use. The learner will be expected to prepare the tooling, apply release agents and prepare the composite materials. The learner will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and

dimensional checks, to ensure that the mouldings meet the required specification and have an appropriate cosmetic appearance.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the wet lay-up production activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding wet lay-up techniques and procedures safely. The learner will understand the moulding/laying-up procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the wet lay-up moulding activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce composite mouldings using wet lay-up techniques
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the wet lay-up moulding activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, drawings, process specifications and

moulding/lay-up procedures

- ensure that all equipment and tools used are in a safe and serviceable condition
- return all tools and equipment to the correct location on completion of the moulding/lay up activities

1.3 Plan the moulding/laying-up activities before they start them

1.4 Prepare the moulds, jigs or formers ready for the manufacturing operations

1.5 Carry out all of the following activities when preparing the composite moulding/lay-up tooling:

- check that tooling is correct and complete
- clean the tooling and remove resin build-ups
- check for surface defects
- correctly apply sealers/release agents
- clean and store tooling suitably after use

1.6 Mix and prepare the required resins or polymers

1.7 Carry out all of the following activities to prepare the materials for use:

- obtain the correct materials for the activity
- check that materials are fit for purpose and 'in life'
- cut materials to the correct size and shape
- check that sufficient quantities of resins (etc) are available
- calculate the correct resin-to-fibre ratios
- check the correct measure and mix of resin/catalyst
- identify and protect materials in the work area

1.8 Carry out the moulding or laying-up activities, using the correct methods and techniques

1.9 Produce composite mouldings using three of the following application techniques:

- spray application of fibre/resin
- application of a gel coat
- brush application of fibre/resin
- roller application of fibre/resin
- removal of voids and air pockets

1.10 Produce composite mouldings incorporating two of the following in the lay-up:

- feathered joins
- overlap joins
- orientated plies
- inserts
- fixtures
- butt joins

1.11 Produce composite mouldings which combine operations and include four of the following shape features:

- internal corner
- external corner
- vertical surface
- return surfaces

- double curvature
- concave surface
- flanges
- convex surface
- joggle details
- nett edges

1.12 Produce composite mouldings using appropriate techniques for One of the following types of resin:

- polyester
- vinyl ester
- epoxy resin
- phenolic resin

Plus one of the following types of fibre:

- polyethylene
- glass
- aramid
- carbon
- hybrid

1.13 Produce composite mouldings using appropriate techniques for two of the following types of reinforcement:

- roving
- braids
- tapes
- chopped strand
- continuous filament
- woven

1.14 Produce composite mouldings using appropriate techniques for two of the following types of core material:

- solid timber
- core mat
- foam
- honeycomb
- end grain balsa

1.15 Remove the mouldings from the formers and trim/finish them to specification to include all of the following:

- visually check that the moulding is complete and free from defects
- use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)
- mark out the mouldings for trimming of excess material
- cut/trim the mouldings, using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)
- carry out edge filling (where appropriate)
- sand the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)
- produce and finish holes in the mouldings, using appropriate

tools and techniques (such as drills, hole saws, countersinks, counterbores, threading devices), where appropriate

- polish the mouldings, using appropriate tools and equipment (such as wet sanding, cutting compounds)

1.16 Check that all the required operations have been completed to specification

1.17 Produce composite mouldings which comply with all of the following:

- components are dimensionally accurate within specification requirements
- finished components meet the required shape/geometry (such as squareness, straightness, angularity and being free from twists)
- completed components are free from defects, sharp edges or slivers
- components meet company standards and procedures

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to produce composite mouldings using wet lay-up techniques
Assessment criteria
The learner can: 2.1 Describe the health and safety precautions to be taken and procedures to be used when working with composite materials, consumables, tools and equipment in the specific work area 2.2 Describe the hazards associated with using composite materials, consumables, tools and equipment, and how to minimise these in the work area 2.3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others 2.4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables 2.5 Describe the specific workshop environmental conditions that must be observed when producing composite mouldings (such as temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment) 2.6 Explain how to use and extract information from drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Describe the conventions and terminology used for wet lay-up techniques (such as resin and fibre weights/volumes, material orientation, material identification, material tailoring, mixing ratios, gel times, exotherm, consolidation)

2.9 Describe the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications
2.10 Describe the different types of fibre materials, weave patterns, orientations, their combinations and applications
2.11 Describe the visual identification systems of both raw and finished composite materials
2.12 Describe the different types of tooling used for producing composite mouldings, and the identification and rectification of defects in the mould tooling
2.13 Describe the methods of preparation for patterns, moulds and tooling, (including the correct selection and use of surface sealers and release agents)
2.14 Describe the methods for handling and preparing the reinforcing fibres
2.15 Describe the calculations of resin volume/weight/ratios required to wet-out the reinforcing fibres
2.16 Describe the mixing ratios for gel coats, resins, additives and catalysts, and the associated working times
2.17 Describe the methods used in the application of the resin/fibre during the lay-up activity
2.18 Describe the tools and equipment used in the lay-up activities, and their care, preparation and control procedures
2.19 Describe the problems that can occur during the lay-up process (including defects such as contamination, resin/fibre rich areas, distortion, poor consolidation, under-cure and exotherm), and how defects can be overcome during the lay-up activity
2.20 Describe the procedures and methods used for removing mouldings from production tooling
2.21 Describe the identification of defects in the composite moulding (such as de-lamination, voids, contaminants)
2.22 Explain how to mark out the mouldings in preparation for the trimming activities, and the tools and equipment to be used
2.23 Describe the methods and techniques used to trim mouldings, and the different types of manual and power tools used in the trimming operations
2.24 Describe the different types of resins, fibres and reinforcement that are used, how they effect the trimming activities, and the tools and equipment that may be used
2.25 Explain how to carry out drilling, hole sawing and finishing operations (such as countersinking), and the various tools that are used
2.26 Explain how to carry out polishing activities on the mouldings, and the equipment and compounds that are used
2.27 Explain why it is important to keep the tools and equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area
2.28 Explain when to act on their own initiative and when to seek help and advice from others
2.29 Describe the importance of leaving the work area in a safe and clean condition on completion of the wet lay-up activities (such as removing and storing moulds/tooling, cleaning the equipment, and removing and disposing of waste)

Unit 844 Producing composite mouldings using pre-preg laminating components

UAN:	**L/600/5943**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 44: Producing composite mouldings using pre-preg laminating techniques (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce composite mouldings using pre-preg laminating techniques. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the pre-preg laminating activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. The learner will be expected to prepare the tooling, apply release agents and prepare the composite materials. The learner will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and dimensional checks, to ensure that the

mouldings meet the required specification and have an appropriate cosmetic appearance.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the pre-preg laminating activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding pre-preg laminating techniques and procedures safely. The learner will understand the moulding/laminating procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the pre-preg laminating activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce composite mouldings using pre-preg laminating techniques
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following activities during the pre-preg laminating activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, drawings, process specifications and moulding/laminating procedures

- ensure that all equipment and tools used are in a safe and serviceable condition
- return all tools and equipment to the correct location on completion of the moulding/laminating activities

1.3 Plan the moulding/laminating activities before they start them

1.4 Prepare the moulds, jigs or formers ready for the manufacturing operations

1.5 Carry out all of the following activities when preparing the tooling:

- check that tooling is correct and complete
- clean the tooling and remove resin build-ups
- check for surface defects
- correctly apply sealers/release agents
- clean and store tooling suitably after use

1.6 Mix and prepare the required resins or polymers

1.7 Carry out all of the following activities to prepare the materials for use:

- obtain the correct materials for the activity
- thaw material removed from freezer storage
- identify defects in pre-preg materials
- check that materials are fit for purpose and 'in life'
- check the availability of ancillary materials required
- cut materials to the correct shape and orientation
- check the materials when provided in kit form
- identify and protect materials in the work area

1.8 Carry out the moulding/laminating activities, using the correct methods and techniques

1.9 Produce composite mouldings, using appropriate techniques for two of the following types of mould tool:

- metal
- wet lay-up
- glass pre-preg
- tooling block
- carbon pre-preg
- female tooling
- male tooling
- multi-part tools
- matched tooling
- closed tooling

1.10 Produce composite mouldings, incorporating two of the following in the lay-up:

- butt joins
- overlap joins
- staggered joins
- orientated plies
- inverted plies
- inserts

1.11 Produce composite mouldings which combine operations and include four of the following shape features:

- internal corners
- external corners
- vertical surfaces
- double curvature
- concave surface
- convex surfaces
- return surfaces
- joggle details
- nett edges
- flanges

1.12 Produce composite mouldings, using appropriate techniques for:
One of the following types of resin:

- epoxy resin
- phenolic resin
- bismaleimide
- cyanate ester
- acrylic resin

Plus one of the following types of fibre:

- polyethylene
- glass
- aramid
- carbon
- hybrid

1.13 Produce composite mouldings, using appropriate techniques for two of the following types of reinforcement:

- continuous
- uni-directional
- braids
- woven
- multi-axis
- tapes

1.14 Produce composite mouldings, using appropriate techniques for two of the following types of core material:

- solid timber
- syntactic core
- expanding core
- foam
- nomex honeycomb
- end grain balsa
- aluminium honeycomb

1.15 Use the following during the cure cycle:
1.16 Use one of the following for applying temperature:

- oven
- heater mats
- heated press
- heater lamps

- autoclave
- heated tools/moulds

Plus one of the following for applying pressure:

- pressure bags
- closed mould
- vacuum bags
- thermal mould expansion
- fibre tensioning

1.17 Remove the mouldings from the formers, and trim/finish them to specification to include all of the following:

- visually check that the moulding is complete and free from defects
- use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)
- mark out the mouldings for trimming of excess material
- cut/trim the mouldings using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)
- carry out edge filling (where appropriate)
- sand the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)
- produce and finish holes in the mouldings, using appropriate tools and techniques (such as drills, hole saws, countersinks, counterbores, threading devices), where appropriate
- polish the mouldings using appropriate tools and equipment (such as wet sanding , cutting compounds)

1.18 Check that all the required operations have been completed to specification

1.19 Produce composite mouldings which comply with all of the following:

- components are dimensionally accurate, within specification requirements
- finished components meet the required shape/geometry (such as square, straight, angle, free from twists)
- completed components are free from defects, sharp edges or slivers
- components meet company standards and procedures

1.20 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.21 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to produce composite mouldings using pre-preg laminating techniques
Assessment criteria
The learner can: 2.1 Describe the health and safety precautions to be taken, and procedures to be used, when working with composite materials, consumables, tools and equipment in the specific work area 2.2 Describe the hazards associated with composite materials, consumables, tools and equipment, and how to minimise these in the work area 2.3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others 2.4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables 2.5 Describe the specific workshop environmental conditions the must be observed when producing composite mouldings (such as temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment) 2.6 Explain how to use and extract information from drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Describe the conventions and terminology used for pre-preg laminating techniques (such as material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm) 2.9 Describe the different types of resin systems, fibres, reinforcements, and their applications 2.10 Explain how to build up laminates, including orientation and balance of plies to minimise spring and distortion in composite mouldings 2.11 Describe the different core, insert and filler materials, and their applications 2.12 Describe the visual identification of both raw and finished composite materials 2.13 Describe the different types of mould tools used for producing composite mouldings, and the identification and rectification of defects in mould tooling 2.14 Describe the methods of preparation for patterns, moulds and tooling (including the correct selection and use of surface sealers and release agents) 2.15 Describe the correct methods of storage, thawing and handling of pre-preg materials (including monitoring temperature, storage life and out-life) 2.16 Describe the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting) 2.17 Describe the selection, use, storage and handling of ancillary and consumable materials (such as release films, breather fabrics,

bagging films, tapes) to meet performance requirements (such as temperature and compatibility)

2.18 Describe the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures

2.19 Describe cure cycles, including temperature and pressure ramps, dwell times, post curing

2.20 Describe the need for monitoring the cure cycle using thermocouples, probes, chart recorders, thermometers and data logs

2.21 Describe the procedures and methods used for removing mouldings from production tooling

2.22 Describe the identification of defects in the composite moulding (such as de-lamination, voids, contaminants and distortion)

2.23 Explain how to mark out the mouldings in preparation for the trimming activities, and the tools and equipment to be used

2.24 Describe the methods and techniques used to trim mouldings, and the different types of manual and power tools used in the trimming operations

2.25 Describe the different types of resins, fibres and reinforcement that are used, how they effect the trimming activities, and the tools and equipment that may be used

2.26 Explain how to carry out drilling, hole sawing and finishing operations (such as countersinking), and the various tools that are used

2.27 Explain how to carry out polishing activities on the mouldings, and the equipment and compounds that are used

2.28 Explain why it is important to keep the tools and equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area

2.29 Explain when to act on their own initiative and when to seek help and advice from others

2.30 Describe the importance of leaving the work area in a safe and clean condition on completion of the pre-preg laminating activities (such as removing and storing moulds/tooling, cleaning the equipment, and removing and disposing of waste)

Unit 845 Producing composite moulsings using resin infusion techniques

UAN:	**Y/600/5945**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 45: Producing composite mouldings using resin infusion techniques (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce composite mouldings using resin infusion laminating techniques. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the resin infusion laminating activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. The learner will be expected to prepare the tooling, apply release agents and to prepare the composite materials. The learner will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and dimensional checks, to ensure that the

mouldings meet the required specification and have an appropriate cosmetic appearance.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the resin infusion laminating activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding resin infusion laminating techniques and procedures safely. The learner will understand the moulding/laminating procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the resin infusion laminating activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce composite mouldings using resin infusion techniques
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following activities during the resin infusion laminating activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, drawings, process specifications and

moulding/laminating procedures
- ensure that all equipment and tools used are in a safe and serviceable condition
- return all tools and equipment to the correct location on completion of the moulding activities

1.3 Plan the resin infusion laminating activities before they start them

1.4 Prepare the moulds, jigs or formers ready for the manufacturing operations

1.5 Carry out all of the following activities when preparing the tooling:
- check that tooling is correct and complete
- clean the tooling and remove resin build-ups
- check for surface defects
- correctly apply sealers/release agents
- clean and store tooling suitably after use

1.6 Mix and prepare the required resins or polymers

1.7 Carry out all of the following activities to prepare the materials for use:
- obtain correct materials for the activity
- either thaw material removed from freezer storage or check the correct measure and mix of resin/catalyst
- check that materials are fit for purpose and 'in life'
- obtain the correct infusion media and layout for the activity
- cut materials to correct shape and orientation
- check availability of ancillary materials required
- identify and protect materials in the work area

1.8 Carry out the resin infusion laminating activities, using the correct methods and techniques

1.9 Produce composite mouldings, using two of the following resin infusion methods:
- interlaminar distribution
- core channel distribution
- surface distribution
- pre-catalysed resin films

And applying two of the following techniques:
- trial runs/tracking
- full-scale runs
- repairs
- dry area rectification
- vacuum regulation
- resin flow regulation

1.10 Produce composite mouldings, incorporating two of the following in the lay-up:
- feathered joins
- butt joins
- overlap joins
- staggered joins
- orientated plies
- inverted plies

- inserts
- fixtures

1.11 Produce composite mouldings which combine operations and include four of the following shape features:

- internal corners
- external corners
- vertical faces
- double curvature
- concave surface
- convex surfaces
- return surfaces
- joggle details
- nett edges
- flanges

1.12 Produce composite mouldings, using appropriate techniques for:
One of the following types of resin:

- epoxy resin
- polyester
- phenolic resin
- vinyl ester
- bismaleimide
- cyanate ester
- acrylic resin

Plus one of the following types of fibre:

- polyethylene
- glass
- aramid
- carbon
- hybrid

1.13 Produce composite mouldings, using appropriate techniques for two of the following types of reinforcement:

- continuous
- chopped strand
- uni-directional
- knitted
- braids
- woven
- multi-axis
- tapes

1.14 Produce composite mouldings, using appropriate techniques for two of the following types of core material:

- solid timber
- syntactic core
- expanding core
- foam
- nomex honeycomb

- end grain balsa
- aluminium honeycomb
- coremat

1.15 Produce composite mouldings, using techniques for three types of resin distribution media:
- interlaminar
- channelled core
- meshes
- mats/fabrics
- peel ply
- perforated hose
- spiral wrap
- braid
- flow channels
- manifolds
- networks
- bleed plies
- breather fabric

1.16 Use three of the following vacuum bagging processes/methods:
- check vacuum integrity
- use of vacuum fittings
- surface bagging
- envelope bagging
- internal bagging
- pleats and tucks
- reusable bagging
- leak detection
- leak rectification
- catch pots/tanks
- localised resin injection
- release and breather plies

1.17 Remove the mouldings from the formers and trim/finish them to specification to include all of the following:
- visually check that the moulding is complete and free from defects
- use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)
- mark out the mouldings for trimming of excess material
- cut/trim the mouldings, using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)
- carry out edge filling (where appropriate)
- sand the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)
- produce and finish holes in the mouldings, using appropriate tools and techniques (such as drills, hole saws, countersinks, counterbores, threading devices), where appropriate

- polish the mouldings, using appropriate tools and equipment (such as wet sanding, cutting compounds)

1.18 Check that all the required operations have been completed to specification

1.19 Produce composite mouldings which comply with all of the following:
- components are dimensionally accurate within specification requirements
- finished components meet the required shape/geometry (such as square, straight, angle, free from twists)
- completed components are free from defects, sharp edges or slivers
- components meet company standards and procedures

1.20 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.21 Leave the work area in a safe and tidy condition on completion of the assembly activities

Learning outcome
The learner will: 2. Know how to produce composite mouldings using resin infusion techniques
Assessment criteria
The learner can: 2.1 Describe the health and safety precautions to be taken, and procedures to be used, when working with composite materials, consumables, tools and equipment in the specific work area 2.2 Describe the hazards associated with composite materials, consumables, tools and equipment, and how to minimise these in the work area 2.3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others 2.4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables 2.5 Describe the specific workshop environmental conditions the must be observed when producing composite mouldings (such as temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment) 2.6 Explain how to use and extract information from drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Describe the conventions and terminology used for resin infusion laminating techniques (such as material orientation, material identification, distribution media, resin viscosity, flow paths, ply lay-up, vacuum bagging, resin and fibre weights/volumes, gel times, exotherm, bleed plies) 2.9 Describe the different types of resin systems, fibres, reinforcements, and their applications

2.10	Explain how to build up laminates, including orientation and balance of plies to minimise spring and distortion in composite mouldings
2.11	Describe the different core, insert and filler materials, and their applications
2.12	Describe the visual identification of both raw and finished composite materials
2.13	Describe the different types of mould tools used for producing composite mouldings, and the identification and rectification of defects in mould tooling
2.14	Describe the methods of preparation for patterns, moulds and tooling (including the correct selection and use of surface sealers and release agents)
2.15	Describe the methods for handling, preparation and application of the reinforcing fibres and fabrics
2.16	Describe the correct methods of storage and handling of ancillary and consumable materials
2.17	Describe the methods used in the positioning and application of the resin distribution media
2.18	Describe the mixing ratios for resins and catalysts, and the associated working times for two-part resin systems
2.19	Describe cure cycles, including temperature and pressure ramps and dwell times for pre-catalysed resin films
2.20	Describe the need for monitoring the cure cycle using thermocouples, probes, chart recorders, thermometers and data logs
2.21	Describe the tools and equipment used in the resin infusion laminating activities, and their care, preparation and control procedures
2.22	Describe the different types of resin distribution media
2.23	Describe the problems that can occur during the lay-up process (including defects such as contamination, incomplete wet out, vacuum leaks, flow restrictions)
2.24	Describe the procedures and methods used for removing mouldings from production tooling
2.25	Explain how to mark out the mouldings in preparation for the trimming activities, and the tools and equipment to be used
2.26	Describe the methods and techniques used to trim mouldings, and the different types of manual and power tools used in the trimming operations
2.27	Describe the different types of resins, fibres and reinforcement that are used, how they effect the trimming activities, and the tools and equipment that may be used
2.28	Explain how to carry out drilling, hole sawing and finishing operations (such as countersinking), and the various tools that are used
2.29	Explain how to carry out polishing activities on the mouldings, and the equipment and compounds that are used
2.30	Explain why it is important to keep the tools and equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area
2.31	Explain when to act on their own initiative and when to seek help and advice from others
2.32	Describe the importance of leaving the work area in a safe and

	clean condition on completion of the resin infusion activities (such as cleaning the equipment, and removing and disposing of waste)

Unit 846 Producing composite assemblies

UAN:	**K/600/5948**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 46: Producing composite assemblies (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to assemble composite mouldings to produce assemblies/sub-assemblies. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the composite assembly activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. In carrying out the assembly operations, the learner will be required to use appropriate or specified assembly and joining techniques and methods for the composite components to be assembled. This will include a range of features such as loose and close fit tolerances, permanent and non-permanent fixing, shape location, staggered, return and overlap joins. The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and

procedures for the composite assembly activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate composite assembly techniques and procedures safely. The learner will understand the composite assembly techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the composite assembly activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce composite assemblies
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the composite assembly activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions, assembly drawings and procedures • ensure that all power tool cables, extension leads or air supply hoses are in a safe and serviceable condition • check that tools and measuring instruments to be used are within calibration date • use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where appropriate) • ensure that the components used are free from foreign

objects, dirt or other contamination

- return all tools and equipment to the correct location on completion of the assembly activities

1.3 Plan the composite assembly activities before they start them

1.4 Obtain and prepare the appropriate components, tools and equipment

1.5 Carry out all of the following when preparing for the composite assembly activity:

- check that mouldings are correct and complete
- check for any defects in the mouldings
- check that ancillary components are correct and complete
- obtain all consumable materials required
- select the correct equipment for the activity
- check that equipment is suitable for use
- identify and protect the moulding and components in the work area

1.6 Use the appropriate methods and techniques to assemble the components in their correct positions

1.7 Produce one of the following types of composite assembly:

- trial assemblies
- one-off assemblies
- batch assemblies
- assembly line

1.8 Produce composite assemblies that incorporate three of the following features:

- loose fit tolerances
- close fit tolerances
- non-permanent fixing
- permanent fixing
- shape location
- staggered joins
- return joins
- overlap joins
- butt joins
- joggle joins

1.9 Produce composite assemblies, using four of the following methods and techniques:

- trimming/fettling
- pinning
- clamping
- trial fitting
- aligning
- use of assembly jigs
- drilling
- countersinking/counterboring

1.10 Produce composite assemblies, using three of the following mechanical joining methods:

- thread inserts

- quick-release fasteners
- mechanical fasteners
- anchor nuts
- rivets
- pins

1.11 Bond composite components, using all of the following methods and techniques:
- preparing the surfaces to be bonded (such as water/solvent cleaning, abrading, priming)
- preparing correct quantities and ratios of adhesives (such as epoxy, acrylic, polyurethane, cyanate ester)
- applying adhesives using appropriate techniques (such as wetting-out by brush, applicator gun, hand tool applicator, laying film adhesives)
- restraining the joints during the curing process (such as weighting down, clamping, mechanical fasteners, pinning joins, press)
- curing the bonded joints using appropriate methods (such as by ambient temperature, oven curing, heated press, heated lamps/mats

1.12 Use three of the following types of composite components in the assemblies:
- trim
- closing panels
- body panels
- tubes
- structural components
- aerodynamic
- core materials
- sections
- housings
- inserts
- other specific components

1.13 Use three of the following types of non-composite components in the assemblies:
- brackets
- fixtures
- fittings
- trim
- tapes
- memory foam
- films
- other specific components

1.14 Secure the components, using the specified methods and securing devices

1.15 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly meets the required specification

1.16 Produce composite assemblies which comply with all of the

following:

- assemblies are dimensionally accurate within specification requirements
- all components are correctly assembled and aligned, in accordance with the specification
- all fastenings are correctly fitted and are secure
- where appropriate, moving parts are correctly adjusted and have appropriate clearances
- finished assemblies meet the required shape/geometry, and are free from defects (such as square, straight, angle, free from twists)

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the composite assembly activities

Learning outcome
The learner will: 2. Know how to produce composite assemblies
Assessment criteria
The learner can: 2.1 Describe the health and safety precautions to be taken, and procedures to be used, when producing composite assemblies and working with composite materials, consumables, tools and equipment in the specific work area 2.2 Describe the hazards associated with using composite materials, consumables, tools and equipment, and how to minimise these in the work area 2.3 Describe the protective equipment that is needed for personal protection and, where required, the protection of others 2.4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables 2.5 Describe the specific workshop environmental conditions the must be observed when producing composite assemblies (such as temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment) 2.6 Explain how to use and extract information from drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.7 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.8 Describe the conventions and terminology used for the composite assembly activities (such as types of components used, types of fittings and fasteners, materials and adhesives used) 2.9 Describe the conventions and terminology used for bonding (such as gel points, cure times, bond thickness, bond strength, peel strength) 2.10 Describe the preparations to be undertaken on the composite components prior to assembly 2.11 Describe the assembly/joining methods, techniques and

	procedures to be used, and the importance of adhering to these procedures
2.12	Explain how the components are to be aligned, adjusted, positioned and clamped prior to assembly, and the tools and equipment that is used
2.13	Describe the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
2.14	Explain where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
2.15	Describe the different types of composite resin and adhesive systems, fibres, reinforcements, and their merits
2.16	Describe the different bonding agents, and their applications
2.17	Describe the correct methods for storage and handling of bonding agents
2.18	Describe the methods of preparation for bonding different materials
2.19	Describe the mixing procedures and ratios for two-part pastes, and the associated working times
2.20	Describe the methods of application for different bonding and adhesive systems
2.21	Describe the different methods of retaining the bond during curing
2.22	Explain how to conduct any necessary checks to ensure the accuracy, position, security, completeness and (where appropriate) the function of the assembly
2.23	Explain how to detect assembly defects (such as ineffective joining techniques, foreign objects, component damage), and what to do to rectify them
2.24	Describe the methods and equipment used to transport, lift and handle composite components and assemblies
2.25	Explain how to check that the tools and equipment to be used are in a safe and serviceable condition
2.26	Describe the importance of ensuring that all tools are used correctly and within their permitted operating range
2.27	Describe the problems with the composite assembly operations, and the importance of informing the appropriate people when things go wrong
2.28	Explain when to act on their own initiative and when to seek help and advice from others
2.29	Describe the importance of leaving the work area in a safe and clean condition on completion of the composite assembly activities (such as returning hand tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 847 Producing components by rapid prototyping techniques

UAN:	**M/600/5949**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 47: Producing components by rapid prototyping techniques (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce components by rapid prototyping techniques. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the rapid prototyping activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. The learner will be expected to prepare the equipment in readiness for the required operations, to start a pre-prepared build and to have an understanding of imported STL files required for the build. In producing the components, the learner will need to set up the machine operating functions, parameters and safety devices, and to produce the components using safe and correct operating procedures. The learner's responsibilities will require

them to comply with health and safety requirements and organisational policy and procedures for using the rapid prototyping software and for operating the rapid prototyping equipment. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to operate rapid prototyping machines safely. The learner will understand the rapid prototyping equipment used, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the rapid prototyping equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce components by rapid prototyping techniques
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare the system and data for operation by carrying out all of the following: • check that all the equipment is in a safe and usable working condition (such as undamaged, safety devices in place and operational) • obtain sufficient quantities of all required materials • obtain all the necessary data, documentation and specifications for the components to be produced • download the correct build files to produce the components • check that data files are suitable for the application • apply safe working practices and procedures at all times 1.3 Select the type of rapid prototyping machine to be used

1.4 Identify material specification before they start
1.5 Check material availability
1.6 Load/input the program file to the machine controller, and check the program for errors using the approved procedures
1.7 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations
1.8 Set up the rapid prototyping equipment, to include carrying out all of the following:
- powering up the equipment and activating the appropriate software
- importing files from system
- loading materials
- checking/setting equipment operating parameters

1.9 Produce the required components, using appropriate manufacturing methods and techniques
1.10 Produce components using one of the following types of rapid prototyping equipment:
- Stereo Lithography Apparatus (SLA)
- Fused Deposition Modelling (FDM)
- Selective Laser Sintering (SLS)
- Direct Metal Laser Sintering (DMLS)
- Selective Laser Melting (SLM)
- 3D printing (thermojet)
- Laminated Object Manufacturing (LOM)
- Digital Light Process (DLP)

1.11 Produce components made from one of the following materials:
- photo-polymer resin
- plastics
- wax
- metal
- laminated paper
- polyurethane

1.12 Unload the components from the rapid prototyping equipment, to include carrying out all of the following:
- removing the part from remaining raw material
- removing the part from supports (where applicable)
- pre-cleaning
- infiltrate (when required)
- packing to avoid damage
- storing
- complete all relevant documentation (such as material batch number, CAD file name, date of manufacture, operator's name, quality report)

1.13 Produce components which comply with all the following quality and accuracy requirements:
- correctly formed
- free from manufacturing defects
- satisfactory visual appearance/finish

1.14	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.15	Shut down the equipment to a safe condition on completion of the rapid prototyping activities

Learning outcome
The learner will: 2. Know how to produce components by rapid prototyping techniques
Assessment criteria
The learner can: 2.1 Describe the safe working practices and procedures to be observed when setting and operating rapid prototyping equipment (such as care when working with laser beams; machine guards; ventilation and fume extraction; machine safety devices) 2.2 Explain how to start and stop the machine in normal and emergency situations, and how to close the machine down on completion of activities 2.3 Describe the hazards associated with operating rapid prototyping machines (such as dangers from laser beams; live electrical components; materials; fumes/gases), and how they can be minimised 2.4 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.5 Describe the importance of ensuring that the machine is isolated from the power supply before working with the equipment 2.6 Describe the basic principles of rapid prototyping relevant to the machine being used 2.7 Describe the benefits and limitations of the different types of rapid prototyping equipment 2.8 Describe the rapid prototyping techniques used, and how to differentiate between the different processes (including the advantages and disadvantages) 2.9 Describe the finishing techniques that are required, and how they are applied to the different rapid prototyping processes 2.10 Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.11 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.12 Explain how to import appropriate files (STL) from a data system into the rapid prototyping software 2.13 Explain how to set up the rapid prototyping equipment to achieve the component specification (such as electrical and optical conditions; focal distance; forming speed) 2.14 Explain how to place the machine in the correct operating mode, and how to access the program edit facility, in order to make minor adjustments for production 2.15 Describe the different materials used to produce components by the rapid prototyping process, and how the various materials used will affect the operating conditions that can be applied relevant to

	the machine being used
2.16	Describe the reasons why certain materials are suitable for producing components by the rapid prototyping process
2.17	Describe the importance of knowing when components can be unloaded from the machine in relation to the different rapid prototyping processes
2.18	Describe the importance of handling and storing materials correctly and linking to the correct documentation
2.19	Describe the problems and defects that can occur in components produced by rapid prototyping processes, how these can occur, and what preventative actions are needed to overcome them
2.20	Explain when to act on their own initiative and when to seek help and advice from others
2.21	Describe the importance of leaving the machine in a safe condition on completion of the rapid prototyping activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)

Unit 848 Producing and preparing sand moulds and cores for casting

UAN:	**M/600/5952**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 48: Producing and preparing sand moulds and cores for casting (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce and prepare sand moulds and cores for casting. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the production of the moulds and cores by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the type and size of the pattern, the moulding method employed, and the material to be cast. The learner will be expected to prepare the sand and produce the moulds using either greensand, chemically bonded gas activated sand, chemically bonded resin/catalyst activated sand or resin bonded heat activated sand. The patterns used will be loose or boarded, circular, square or irregular in shape, and will have projections and internal cavities. The moulds will be

produced either in boxes or boxless, as appropriate.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the production and preparation of the sand moulds and cores. The learner will need to take account of any potential difficulties or problems that may arise with the patterns, sand, additives or equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate manual sand moulding and core making techniques safely. The learner will understand the manual sand moulding and core making process, and its application, and will know about the equipment, materials, consumables and tests that are used to confirm that the sand is fit for purpose, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the sand moulding activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout. The learner will also understand their responsibilities for safety, and the importance of taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce and prepare sand moulds and cores for casting
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the sand moulding and core making activities: • adhere to procedures or systems in place for risk assessment,

COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations

- follow job instructions and moulding procedure specifications
- use the correct tools and equipment for the moulding activity
- follow the defined moulding techniques and procedures
- ensure that the moulds produced meet the required specification for quality and accuracy
- return all tools and equipment to the correct location on completion of the moulding and core making activities

1.3 Plan the sand moulding and core making activities before they start them

1.4 Prepare sand and produce moulds/cores from two of the following types of sand:

- greensand (naturally or synthetically bonded)
- chemically bonded gas activated
- other type of sand (specify)
- chemically bonded resin/catalyst
- resin bonded heat activated

1.5 Prepare the sand for the mould/core making activities, to include carrying out all of the following:

- measuring out the required amounts of sand for the operations being performed
- adding the correct additives in the correct ratios
- performing the mixing and milling operations safely and correctly
- testing that the finished sand meets requirements (such as moisture, permeability, viscosity and strength)

1.6 Obtain and prepare the appropriate tools, equipment and materials

1.7 Prepare the mould/coremaking equipment for use, to include carrying out both of the following:

- visually inspecting the pattern or core box for damage
- applying release agents to the pattern or core box (as applicable)

1.8 Ensure that the patterns are correctly prepared, sited and positioned ready for the moulding process

1.9 Ensure that the sand is correctly mixed and milled

1.10 Test the prepared sand to ensure that it meets the specification requirements

1.11 Carry out the sand moulding and core making activities, using the correct methods and techniques

1.12 Produce moulds and cores to the required specification

1.13 Produce full or half cores from both of the following types of core box:

- solid turnout boxes
- split boxes

1.14 Produce cores using two of the following techniques:

- hand tucking and ramming
- mechanical assistance with core consolidation
- curing and drying the cores
- inserting reinforcements (such as wire or bars)

- incorporating vents (such as pre-formed, manually applied)

1.15 Produce drag and cope mould parts from patterns which are either:
- loose flat back and split type

OR
- plated flat type and split type

1.16 Produce mould parts, using one of the following methods:
- use of moulding boxes
- boxless, using mould location devices

1.17 Assemble and finish the moulds (which must include at least one core), by carrying out all of the following:
- inserting the cores (such as horizontal or vertical location)
- securing the cores (using print locations, adhesives or mechanical devices)
- forming runner, riser and feeder systems on the mould (such as cut and formed manually, reformed with fixed formers, preformed with loose formers)
- carrying out any repairs to the moulds/cores (such as patching up greensand moulds or cores, repairing rigid sand moulds or cores using adhesives)
- applying mould coatings/dressings (such as by spray, flood, brush or dry)

1.18 Prepare and close the moulds ready for casting, to include carrying out all of the following:
- cleaning and removing foreign bodies and surplus sand from the mould cavity
- carrying out visual checks on moulds for completeness (including all cores and freedom from cracks)
- checking that runner/riser/feeder systems are clean, connected and complete
- applying mould sealant, where appropriate
- locating the moulds (using pins, rebates, diabolos or cores, as appropriate)
- closing moulds manually or by mechanical means
- securing the moulds using clamps/clips and/or weights

1.19 Produce sand moulds which meet all of the following quality and accuracy standards:
- complete and free from obvious defects (such as cracks, broken or damaged mould surfaces)
- meet the required specification (such as shape, dimensional accuracy)
- free from soft spots

1.20 Dispose of surplus material safely and correctly

1.21 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.22 Leave the work area in a safe condition on completion of the moulding and core making activities

Learning outcome
The learner will: 2. Know how to produce and prepare sand moulds and cores for casting
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when producing and preparing sand moulds for casting (such as wearing full protective clothing and protective equipment; ensuring adequate ventilation/fume extraction and the elimination of slipping or tripping hazards) 2.2 Describe the COSHH regulations that apply when dealing with chemically bonded sands, surface coatings, release agents and surface dressings 2.3 Describe the hazards associated with producing and preparing sand moulds and cores for casting, and how they can be minimised 2.4 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.5 Describe the types of sands used in the core and mould making activities (such as green sand, and chemically prepared sands such as gas activated, resin/catalyst and oil types) 2.6 Describe the various types of sand additives which are suitable for the sand and type of metal to be cast (such as oil, starches, chemicals, resins, catalyst, esters, breakdown agents, inhibitors, refractory materials) 2.7 Describe the methods used to prepare green sands and chemically or resin bonded sands, using manual and machine methods 2.8 Explain how to calculate the amount of sand required, and the ratios of sand additives that may be required 2.9 Describe the effects on the prepared materials if the base product is passed the 'use by' date, is added to the mix at the wrong time or at the wrong temperature, too little or too much is added to the mix, or the mixture is over mixed or over milled 2.10 Describe the procedures for testing the prepared sand for moisture content, strength, viscosity and freedom from foreign bodies 2.11 Describe the various types of core box that are used (such as solid turnout boxes, split boxes, multi-part, strickle and boxes containing loose pieces or prints) 2.12 Describe the different pattern types used in the moulding process (such as loose and plated), and the jointing methods that are required for the different pattern types 2.13 Describe the methods of positioning the patterns for correct orientation; centralising and supporting the pattern in the moulding box 2.14 Describe the application and use of pattern release agents and core coatings or dressings 2.15 Describe the methods of filling moulds and core boxes and compacting sands (such as manual filling and compacting and machine filling and compacting), and the precautions to be taken to ensure that the pattern doesn't become displaced during the filling and compacting activities 2.16 Describe the methods of reinforcement, venting and chilling of the moulds and cores (such as using vent wire and rods, pre-formed

shapes, pre-formed wax or nylon)

2.17 Describe the methods of mould stripping and pattern rapping; removing the pattern without damaging the mould cavity or pattern

2.18 Describe the methods of cutting and forming downsprues, ingates, riser and feeder systems

2.19 Describe the various methods of drying and curing cores (such as the use of ovens, CO2 gas and catalytic action)

2.20 Explain why it is necessary to check the moulds and cores prior to commencing core setting and mould closing operations

2.21 Describe the defects that can occur in the moulds and cores (such as cracked surfaces, exposed reinforcements, friable surfaces, broken or weak mould and core sections, incomplete mould or cores, damaged or broken core prints and core locations, mould location devices missing or distorted, uncoated moulds or cores)

2.22 Describe the methods of rectifying defects in moulds or cores, by patching and gluing

2.23 Explain how to prepare the moulds, and the methods of locating and setting cores in the moulds (using core prints, glues and sprigs)

2.24 Describe the methods of closing and securing the moulds (using weights or clamps), and the dangers/effects of using moulds which are incorrectly closed or clamped

2.25 Explain why it is important to keep the pattern and core box equipment clean and free from damage, to practice good housekeeping of moulding tools and equipment, and to maintain a clean working area

2.26 Explain when to act on their own initiative and when to seek help and advice from others

2.27 Describe the importance of leaving the work area in a safe and clean condition on completion of the sand moulding and core making activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 849 Producing and preparing molten materials for casting

UAN:	**A/600/5954**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 49: Producing and preparing molten materials for casting (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to prepare and process the materials used in the production of molten materials, to produce cast components using moulds and shells. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the melting activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. The learner will be required to prepare the appropriate equipment to use, based on the type and amount of molten material needed. This includes ferrous and non-ferrous alloys, plastic/polymers and liquid ceramics. The learner will prepare the base material for insertion into the melting furnace, and will light/start up the furnace, and charge the base material plus any other specified materials or additions into the melting vessel at the specified time. The learner will also adjust the furnace operating conditions to

suit the molten material requirements. The learner will be expected to discharge the molten material into the receiving vessel or to other holding furnaces, as appropriate.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the preparation and control of the melting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the base materials, additives or equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate preparation and control procedures safely for the production of molten materials for casting. The learner will understand the melting techniques used, and their application, and will know about the equipment, materials, consumables and tests that are used to confirm that the process is under control, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the melting operations, and when using the associated tools and equipment, especially those involved in handling and pouring the molten material. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce and prepare molten materials for casting
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare the furnace for operation, to include all of the following, as

appropriate to the equipment used:

- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- follow job instructions, melting specifications and procedures
- ensure that services/power supplies are connected, and operational and start-up procedures are initiated
- check that guards/screens are in position and operational
- check that emergency stop controls are operational
- check that visual display panels are operational
- ensure that supply and discharge outlets are clear and operational
- check that furnace linings and equipment are in a safe and usable condition
- shut down the furnace to a safe condition on completion of the melting activities
- return all tools and equipment to the correct location on completion of the melting activities

1.3 Plan the material melting activities before they start them

1.4 Set up the operating conditions of the melting furnace, making any necessary adjustments to maintain satisfactory operating conditions

1.5 Obtain the required charge materials, and check that they are in a suitable condition to use

1.6 Prepare the materials used in the casting process, and check that they are to the required specification, to include all of the following:

- selection and preparation of the base charge materials (such as scrap, ingots, returns)
- selection and preparation of any additives and additions (such as fluxes, inhibitors, de-oxidisers, colour)
- selection and preparation of any fuel charge materials

1.7 Produce molten materials, using one of the following types of furnace:

- cupola
- induction (high or low frequency)
- rotary
- bale out
- lift out crucible
- tilting crucible
- direct or indirect arc
- other melting furnaces (specify)

1.8 Start up the furnace, using approved procedures, and add the materials at the appropriate time

1.9 Produce molten material from one of the following:

- ferrous alloys
- non-ferrous alloys
- plastic/polymer
- liquid ceramics

1.10 Carry out appropriate tests of the molten material at suitable

intervals, in order to achieve the material specification 1.11 Monitor the melting process, to include all of the following: • measuring the melt temperature (such as visually, immersion pyrometer, Visual Display Units) • adjusting the operating conditions of the melting furnace (such as melting rate by changing the power or fuel input) • making necessary additions to the melt • where applicable, informing appropriate people of non-conformance of the molten material • confirming that the melt is ready for casting 1.12 Carry out treatment of the melting/molten material, to include two of the following: • adding deoxidising agents to charge material • adding oxidising agents to charge material • deoxidising molten material • modification of molten material • adding cover fluxes to charge material • degassing molten material • grain refining of molten metal • removal of slag/oxide skins/impurities 1.13 Take samples of the molten material, for one of the following types of test: • carbon equivalent measurement • chemical analysis • X-Ray Fluorescence spectrometry (XRF) • spark emission spectrometry • wedge tests 1.14 Discharge the molten material from the furnace into one of the following: • holding furnace • prepared pouring ladles • prepared treatment ladles • other holding/casting vessels/pigs 1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve 1.16 Dispose of waste and excess materials safely and correctly 1.17 Leave the work area in a safe and tidy condition on completion of the melting activities

Learning outcome
The learner will: 2. Know how to produce and prepare molten materials for casting
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when working with melting furnaces and molten materials (such as wearing full protective clothing and protective equipment; ensuring adequate

ventilation/fume extraction, and the elimination of slipping or tripping hazards)

2.2 Describe the COSHH regulations that apply when dealing with charge materials, furnace additions and additives

2.3 Describe the hazards associated with working with melting furnaces and molten materials (such as splashes and spills of molten materials; fumes; handling hot and heavy materials), and how they can be minimised

2.4 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy

2.5 Describe the emergency procedures to be followed in the event of a malfunction of any melting furnace, holding ladle or pouring vessels in use

2.6 Explain why it is important to keep the furnace and melting equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area

2.7 Describe the importance of following job instructions and defined casting procedures

2.8 Describe manual lifting techniques and EU requirements on acceptable weights to be handled

2.9 Describe the various types and applications of material melting furnace that are used (such as rotary and cupola types; crucible types such as lift out, push up, bale out, and tilting; electric furnaces such as induction arc and resistance)

2.10 Explain how to check that the furnace and its linings are in a safe and serviceable condition

2.11 Explain how to identify the various materials they are to use in producing the cast components

2.12 Describe the various forms of materials used in the melting process (such as ingots, granules, powders, bought-in scrap and scrap cast components for re-melting)

2.13 Explain why it is necessary to check the amounts of materials, prior to commencing melting operations

2.14 Describe the effects on the melting operation and the molten material if the base materials are out of date, different in content from the specification requirements, added to the furnace/melt at the wrong time or temperature, or when wet or damp, or if too little or too much is added to the melt

2.15 Describe the reasons why furnace start-up procedures are performed, and why these must always be adhered to

2.16 Describe the methods of charging the furnaces, and the precautions to be taken when adding materials to molten liquids

2.17 Describe the reasons for preheating some materials prior to furnace charging

2.18 Describe the additions that are made to the material/metals/alloys to aid the melt or produce and/or correct the material specification

2.19 Explain how to establish melting and pouring temperatures of the materials to be used, and how to set the furnace/crucible controls to give the required melt conditions

2.20 Describe the methods of checking when the molten material is at the required temperature (such as by visual means, by use of fixed and optical pyrometers, by spectrographic or chemical analysis of samples taken from the melt)

2.21 Describe the actions to take if the molten material is outside the

	specified temperature range
2.22	Describe the defects in castings which can be directly related to the use of molten material which is outside the specified temperature range, is untreated, is treated but the casting of the moulds, etc, is delayed, or to the use of un-skimmed metal/material
2.23	Explain when to act on their own initiative and when to seek help and advice from others
2.24	Describe the importance of leaving the work area in a safe and clean condition on completion of the melting activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 850 Producing cast components by manual means

UAN:	**J/600/5956**
Level:	Level 2
Credit value:	13
GLH:	65
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 50: Producing cast components by manual means (Suite 2.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to prepare and safely cast molten materials into prepared moulds, dies, or shells, manually. It will prepare the learner for entry into the engineering or manufacturing sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the casting activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required casting activities. The learner will be required to select the appropriate equipment to use, based on the type and amount of molten material to be cast. Both single and double pours, with ferrous or non-ferrous alloys, plastic polymers and liquid ceramics are included in this unit. The learner will check that the moulds/dies/shells to be cast are positioned correctly, and are bushed up and secure. The learner must ensure that the casting ladles and any supporting or carrying frames

are free from defects that could affect the safe operation of carrying and pouring the molten material. The learner will confirm that the molten material is at the required temperature and suitable for purpose. The learner will collect the molten material from the source vessel or furnace, and skim or apply coagulant to the molten material to remove/contain impurities from the surface. The learner will then cast the moulds or dies in a safe manner, at the correct speed, and in the correct order. On completion of the casting activity, any surplus molten material will be disposed of safely and correctly.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the casting activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the casting activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate molten material pouring and casting procedures safely. The learner will understand the casting techniques used, and their application, and will know about the equipment, materials, consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the manual casting activities, especially those for transporting and pouring molten materials. The learner will be required to demonstrate safe working practices throughout. The learner will also understand their responsibilities for safety, and the importance of taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce cast components by manual means
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the manual casting activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that the work area is clear of obvious hazards • follow job instructions, casting specifications and procedures • confirm that the required material handling equipment is available, and is in a safe and usable condition • check that any required ancillary equipment is operational (such as fume extraction equipment, inhibitor gas supply and molten material treatment equipment) • return all tools and equipment to the correct location on completion of the casting activities 1.3 Plan the casting activities before they start them 1.4 Ensure that the moulds are correctly prepared, sited and positioned ready for the casting process 1.5 Check that the moulds/dies are complete and ready for casting, to include carrying out all of the following checks: • appropriate clamps and/or weights are in position • downsprues are marked, and pouring bushes/basins are in position and free from obstructions • any necessary filters are in place • access to the moulds/dies/shells is clear • containers for surplus molten material are prepared and positioned conveniently in relation to the mould/dies/shells 1.6 Prepare the molten material ladles/handling equipment, to include carrying out all of the following: • checking that the ladle is the correct size for the amount of material to be poured • checking that the ladle/lining is in a safe condition and is complete and dry • ensuring that any necessary pre-heating has been carried out 1.7 Ensure that the molten material is at the required casting temperature 1.8 Collect the molten material and carry out all of the following melt checks/procedures, as appropriate to the melt: • making temperature checks • skimming of the melt to remove slag and other impurities • applying coagulant material • using inhibitor materials or gas 1.9 Collect and transport the molten material safely and correctly from

the furnace

1.10 Use the appropriate technique to pour the molten material into the moulds

1.11 Transfer and pour the molten material into moulds/dies, using one of the following:
- single operation
- double pour

1.12 Produce cast components to the required specification

1.13 Produce cast components from one of the following:
- ferrous alloys
- non-ferrous alloys
- plastics/polymers
- liquid ceramics

1.14 Produce cast components which contain all of the following features:
- faces that are flat, square or angled to each other
- have round, curved or contoured surfaces
- have slots or holes

1.15 Cast molten materials into one of the following:
- sand moulds
- metal moulds/dies
- shells (investment process)

1.16 Produce cast components which comply with all of the following:
- complete and free from obvious defects (such as blow holes, impurities, cracks, damaged or deformed surfaces)
- meet the required specification (such as shape, dimensional accuracy)
- meet company standards and procedures

1.17 Dispose of surplus material safely and correctly

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Leave the work area in a safe condition on completion of the casting activities

Learning outcome
The learner will: 2. Know how to produce cast components by manual means
Assessment criteria
The learner can: 2.1 Describe the specific health and safety precautions with regard to handling and transporting molten materials (such as wearing full protective clothing and protective equipment, and the elimination of slipping or tripping hazards) 2.2 Describe the hazards associated with pouring molten materials (such as splashes and spills of molten materials; fumes; handling hot and heavy materials), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition

2.4 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed
2.5 Describe the importance of following job instructions and defined casting procedures
2.6 Describe the emergency procedures to be followed in the event of a furnace failure or malfunction in any vessel used to transport and cast molten materials
2.7 Describe manual lifting techniques and EU requirements on acceptable weights to be handled
2.8 Describe the various methods of collecting molten material from the furnace or ladle, and the different types of vessels used to hold ferrous and non-ferrous metal alloys, plastic/polymer or liquid ceramic materials
2.9 Explain why it is sometimes necessary for the ladles to be preheated, and the effects of using wet or untreated/cold ladles
2.10 Explain why it is important to keep the ladles and molten material handling equipment clean and free from damage, to practice good housekeeping of tools and equipment, to maintain a clean and unobstructed working area, and to dispose of surplus molten material into prepared containers or areas
2.11 Describe the causes of surface impurities on molten materials
2.12 Describe the reasons why some impurities float on some materials and sink in others
2.13 Describe the methods of removing impurities from the surface of the molten materials
2.14 Describe the effects on the quality of the cast components if impurities are allowed to enter the mould/die cavity
2.15 Explain why the temperature of the molten material should be taken prior to the transfer from holding ladle to pouring vessel
2.16 Describe the actions they need to take if the molten material is outside the required temperature range
2.17 Describe the checks to be carried out on the moulds/dies/shells prior to casting (such as checking that clamps or weights are correctly positioned, downsprues are marked and pouring bushes/basins are in position, necessary filters are in place and access to moulds is clear)
2.18 Describe the importance of using the correct pouring techniques and of casting at the correct speed
2.19 Describe the methods of pouring molten material for single operations or double pour applications
2.20 Describe the defects in cast components which can be directly related to using the incorrect pouring technique, incorrect material temperature, or untreated molten material
2.21 Explain how to dispose of surplus molten material (such as returning material to furnace or receiver; pouring into prepared sand beds or ingot moulds)
2.22 Explain when to act on their own initiative and when to seek help and advice from others
2.23 Describe the importance of leaving the work area in a safe and clean condition on completion of the casting activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 851 Fettling, finishing and checking cast components

UAN:	**L/600/5960**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 51: Fettling, finishing and checking cast components (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to use hand and power tools to fettle and finish cast components produced from sand moulds, metal moulds/dies, ceramic moulds or investment shells. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the fettling and finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required fettling, finishing and checking activities. The learner will be required to select the appropriate equipment to use, based on the shape and size of the components and the material from which they are cast. The learner will be expected to carry out checks on the tools and equipment, to ensure that they are in a safe and usable condition and that the abrasive wheels /discs to be used during the fettling operation are suitable for the material and operations to be carried out.

The cast components could be circular, square or irregular in shape, and may have projections and internal cavities. The learner will remove the runners and risers/feeders, using manual or mechanical means. Other surplus material present, on both external and internal surfaces (such as joint line and core print flash) must also be removed. On completion of the fettling activities, the learner will be expected to check the castings for a range of visual and geometric defects.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fettling, finishing and checking activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate fettling, finishing and checking procedures safely to cast components. The learner will understand the fettling, finishing and checking techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the fettling and finishing activities, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout. The learner will also understand their responsibilities for safety, and the importance of taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Fettle, finish and check cast components
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following, in preparation for the fettling and finishing activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that the work area is clear of obvious hazards • obtain any necessary Personal Protective Equipment, and check that it is in good order • follow job instructions, fettling and finishing specifications and procedures • check that the tools and equipment they need are in a safe and usable condition (such as extension leads, hoses, pneumatic equipment, hand tools) • ensure that dust extraction and air filtering equipment is functioning correctly • ensure that all guards and screens are in place and in good order • return all tools and equipment to the correct location on completion of the fettling and finishing activities 1.3 Plan the fettling, finishing and checking activities before they start them 1.4 Remove the cast components from the moulds/dies, using appropriate tools and techniques 1.5 Remove cast components from moulds, and carry out all of the following, as appropriate to the castings produced: • knocking castings out of the moulds • removing castings from the moulding material • de-coring • removing runner/riser/feeder systems 1.6 Clean the cast components and, where appropriate, remove any cores 1.7 Fettle and finish the castings to remove excess material 1.8 Fettle and finish cast components which have been produced from one of the following materials: • ferrous alloys • non-ferrous alloys • plastics/polymers • liquid ceramics 1.9 Fettle and finish cast components, to include the use of three of the following: • hand tools (such as wire brushes, knives, scrapers, saws, files)

- pneumatic chipping hammers
- other methods (specify)
- slitting saw
- linishers
- thermal cutters
- laser cutters
- disc/angle grinder
- pedestal grinders
- band saw

1.10 Fettle and finish cast components that have four of the following shapes/profiles:
- circular
- square
- irregular
- projections
- curved or tapered profiles
- internal cavities

1.11 Check the casting for visual defects

1.12 Visually check cast components, and identify defects including six of the following:
- incomplete or deformed castings
- variable metal section thickness
- incorrect profiles
- swells
- cross joints
- blow holes
- impurity inclusions
- shrinkage
- cracks
- surface porosity
- misplaced cores
- mis-runs/cold shuts
- undercuts on runners/risers/feeders
- poor ingate or feeder cut-off
- excessive flash

1.13 Complete dimensional checks on cast components, to include checking five of the following features:
- flatness
- squareness
- concentricity
- straightness
- taper
- profiles
- angularity
- roundness

1.14 Dispose of waste material safely and correctly, in line with organisational procedures

1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.16 Leave the work area in a safe condition on completion of the fettling and finishing activities

Learning outcome

The learner will:

2. Know how to fettle, finish and check cast components

Assessment criteria

The learner can:

2.1 Describe the specific health and safety precautions which must be taken when fettling and finishing cast components (such as wearing full protective clothing and protective equipment, using screens and dust extraction equipment)

2.2 Describe the hazards associated with fettling and finishing cast components (such as handling hot castings, airborne sparks and metal particles, sharp edges on components, using power tools and abrasive disks, handling heavy materials), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye protection, overalls, full face masks, breathing equipment)

2.4 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

2.5 Describe the importance of following job instructions and defined fettling procedures

2.6 Describe manual lifting techniques and EU requirements on acceptable weights to be handled

2.7 Describe the emergency procedures to be followed in the event of a malfunction of any of the equipment that they use

2.8 Describe the factors which govern the cooling times of cast components in the moulds, prior to knocking out

2.9 Describe the different methods that can be used to knock out and de-core moulds and shells, and how to avoid damaging the moulds and cast components

2.10 Explain how to clean the castings and remove any cores, and the tools and equipment that can be used

2.11 Describe the casting defects which can be directly related to the use of incorrect methods for the removal of runners/risers/feeders from castings during the knocking out process

2.12 Explain how to remove runners and associated systems by braking off or cutting off

2.13 Explain how to fettle castings to remove joint line flash, runner and feeder stubs, and the amount of material that should be removed

2.14 Describe the various hand and power tools that are used to carry out the fettling activities (such as hammers and chisels, files, grinding machines/discs, linishing equipment, knives and scrapers, thermal or laser cutters)

2.15 Describe the checks to be made on the tools and equipment to ensure that they are in a safe and usable condition

2.16	Describe the various workholding methods and devices used to hold the cast components during the cleaning and fettling activities
2.17	Describe the effect on casting quality of incorrectly fettling of castings (such as under or over-dressing)
2.18	Describe the reasons why different types of tools and equipment are used to fettle ferrous, non-ferrous and non-metallic cast components
2.19	Explain why it is important to keep the equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean working area
2.20	Describe the different equipment that can be used to assist with the visual inspection of cast components (such as electronic scanning units, shadowgraph units, magnifying glasses or dye-penetrant equipment)
2.21	Describe the different types of defects which can be detected through visual inspection (such as incomplete or deformed castings, blow holes, impurity inclusions, mis-runs/cold shuts, shrinkage, surface/sub-surface porosity, cracks, undercuts on runners/risers/feeders, poor ingate or feeder cut-off, swells, cross joints, scabs, misplaced cores, variable metal section thickness and excessive flash)
2.22	Explain when to act on their own initiative and when to seek help and advice from others
2.23	Describe the importance of leaving the work area in a safe and clean condition on completion of the fettling activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 852 Finishing surfaces by applying coatings or coverings

UAN:	**R/600/5961**
Level:	Level 2
Credit value:	9
GLH:	41
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 52: Finishing surfaces by applying coatings or coverings (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to apply specified surface finishes by the application of coatings or coverings. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required finishing activities. The learner will be required to select the appropriate equipment to use, based on the finishing materials to be applied and the surface area to be covered. The learner will be expected to use the specified or appropriate techniques to prepare the surfaces in readiness for the application of the coatings or coverings. The finishing activities will include the application of sealers and primers, paints, varnish, stain, wax or polish, sheet roll, block or tile materials, using hand tools, brushes, rollers, pads, cloths, or spray equipment, as applicable to the task.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the preparation and finishing activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate preparation and hand finishing techniques and procedures safely. The learner will understand the preparation and finishing techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the finishing operations, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Finish surfaces by applying coatings or coverings
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the surface finishing activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions and finishing specifications and procedures • check that the tools and finishing equipment that they need (such as brushes, rollers spray equipment, hoses, hand tools) are in a safe and usable condition

- where appropriate, ensure that dust extraction and air filtering equipment is functioning correctly
- provide a suitable means for curing the coating (such as heating, or air supply to assist curing)

1.3 Plan the surface finishing activities before they start them

1.4 Prepare the work surfaces in readiness to receive the appropriate coating or covering

1.5 Prepare the surface to be finished, to include carrying out six of the following:

- stripping old finishes
- cleaning/degreasing
- mechanical surface preparation
- flattening down
- masking up
- filling
- sealing
- pre-surface treatments
- re-activating treatments

1.6 Prepare the required coating or covering materials for use

1.7 Prepare the coating or covering materials for application, to include carrying out all of the following:

- obtaining the correct types and quantities of materials
- ensuring that the correct mixing ratios are adhered to
- checking that the prepared coating material is of the correct viscosity/consistency
- ensuring that the prepared material has been left for the required induction period (if applicable)
- ensuring that the prepared material is at the temperature recommended for application

Plus one of the following:

- mixing base materials (such as primers, sealers)
- mixing finishing materials (such as final colour, stain, polish)
- preparing adhesives
- preparing cleaning materials (such as degreasing)

1.8 Apply the coatings or coverings to the surfaces, using appropriate techniques and procedures

1.9 Apply coatings or coverings to two of the following materials:

- wood based
- ferrous material
- non-ferrous material
- composite (such as glass fibre, Kevlar)
- pre-painted surfaces
- ceramic
- plaster/brick/concrete

1.10 Apply liquid coatings such as primer/undercoat and finishing coats, using four of the following finishing materials:

- sanding sealer
- water based paints

- oil/alkyd based paints
- synthetic paints
- two component polyurethane paint
- petroleum based
- polyurethane varnish
- lacquer
- stain
- wax
- French polish
- temporary protective coatings
- mastics
- bituminous or rubber paints
- other special finishes (specify)

OR apply coverings which are decorative, insulative or protective, to include three of the following:

- paper based
- polymer based
- composite
- metallic
- wood
- ceramic

1.11 Apply finishes to a range of surfaces, to include four of the following:

- flat
- horizontal
- vertical
- overhead
- curved or cylindrical
- corners (such as outside corners, edges, 'obscured' corners)

1.12 Check that the finished surface achieves the required characteristics and meets the finishing specification

1.13 Check that the completed surface finishes or coverings comply with all of the following:

- the final finish or covering is in line with the specification or job requirements
- the final finish achieves acceptable colour match and, where applicable, gloss levels
- the finished surface is free from defects (such as runs, drips, bubbles, unevenness)
- the finished surface meets customer/company requirements

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Tidy up the work area on completion of the coating or covering activities, to include carrying out all of the following:

- disposing of excess or unused materials, in accordance with approved procedures
- cleaning containers to be reused

• disposing of non-reusable containers, in accordance with approved procedures • cleaning and returning all tools and excess materials to their designated location • disposing of waste materials and used solvents, in accordance with approved procedures 1.16 Dispose of waste material safely and correctly, in line with organisational procedures 1.17 Leave the work area in a safe condition on completion of the finishing activities

Learning outcome
The learner will: 2. Know how to finish surfaces by applying coatings or coverings
Assessment criteria
The learner can: 2.1 Describe the specific health and safety precautions which must be taken when preparing surfaces and applying surface coatings and coverings (such as wearing protective clothing and protective equipment, using fume and dust extraction equipment) 2.2 Describe the hazards associated with preparing surfaces and applying surface coatings and coverings (such as using chemicals for cleaning activities, dust and fume inhalation, use of power tools and abrasive disks; including the hazard information to be found in manufacturers' data sheets), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye protection, overalls, face masks, breathing equipment) 2.4 Describe the requirements for working in confined spaces, and safe systems of work (including Required Air Quantities (RAQs) and Local Exhaust Ventilation (LEV) to maintain safe conditions; the provision of adequate and safe lighting and avoidance of sources of ignition 2.5 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed 2.6 Describe the importance of following job instructions and defined surface finishing procedures 2.7 Describe the surface preparation methods and techniques to be undertaken, prior to applying the coatings or coverings (such as carrying out repairs to the surface or making good any damaged or defective surfaces; stripping off old materials; using solvents to remove dirt and grease; masking surfaces to prevent overspill/spray) 2.8 Describe the specific coatings or coverings to be used, and the types of surfaces for which they are best suited (such as liquid coatings, coverings in sheet, roll or tile form) 2.9 Explain how to determine quantities of finishing materials required and, where applicable, mixing materials to achieve the required colour, viscosity or adhesive strength 2.10 Describe the preparation methods and techniques for mixing paints, varnishes, lacquers, stains and polishes 2.11 Describe the various methods of applying the required finishes (such as using brushes, rollers, paint pads, cloths, adhesive

	spreaders and spray equipment)
2.12	Describe the safe operation of spray equipment, and the effects of air pressure variance on the spray quality
2.13	Describe the time intervals that are required between coats, and why these must be adhered to
2.14	Describe the use of lamps and heaters to aid the drying of the coatings or coverings
2.15	Describe the cleaning and maintenance procedures for the tools and equipment that are used (such as brushes, rollers, adhesive spreading tools and spray equipment)
2.16	Describe the procedures for dealing with used consumables and surplus coatings or coverings safely and correctly
2.17	Explain how to check and assess the finished work (such as for appearance, colour, coating thickness, coverage and adhesion)
2.18	Explain how to recognise defects (such as bubbles, contamination, runs and other surface defects)
2.19	Describe the problems that can occur with the finishing operations, and how these can be overcome
2.20	Explain when to act on their own initiative and when to seek help and advice from others
2.21	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the finishing activities (such as returning tools and equipment to the designated location, cleaning the work, area and removing and disposing of waste)

Unit 853 Finishing surfaces by applying treatments

UAN:	**H/600/5964**
Level:	Level 2
Credit value:	9
GLH:	41
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 53: Finishing surfaces by applying treatments (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to apply specified surface treatments on components. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required finishing activities. The learner will be required to prepare the appropriate equipment to use, based on the surface treatment process and materials to be applied, and the surface area to be covered. The learner will be expected to use the specified or appropriate techniques to prepare the surfaces in readiness for the application of the treatments. The surface treatment activities will include the application of plating, anodising, powder coating, hot dip treatments and chemical treatments, as applicable to the task. The learner's responsibilities will require

them to comply with health and safety requirements and organisational policy and procedures for the preparation and surface treatment activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the surface treatment activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate preparation and surface treatment techniques and procedures safely. The learner will understand the preparation and treatment techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the surface treatment operations, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Finish surfaces by applying treatments
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the surface treatment activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions and surface treatment specifications and procedures • ensure that the equipment is correctly prepared for the treatment operations being performed • carry out handling/jigging of the component (where

appropriate)
- clean all tools and equipment on completion of the surface treatment activities
- dispose of waste and excess materials, in line with agreed organisational procedures

1.3 Apply surface treatments to components by carrying out one of the following processes:
- powder coating
- hot dip treatments
- electroplating
- anodising
- chemical treatments
- phosphating

1.4 Apply surface treatments to two different substrates from the following:
- mild steel
- stainless steel
- brass
- copper
- zinc based diecastings
- aluminium
- previously plated substrates
- plastics/composite material
- glass
- other materials (specify)

1.5 Apply surface treatments to two different types of component from the following:
- irregular components with multiple surfaces
- welded/joined components
- hollow/tubular components
- flat components

1.6 Plan the surface treatment activities before they start them

1.7 Prepare the work surfaces in readiness to receive the appropriate treatment

1.8 Prepare the components for the surface treatment activities, by carrying out three of the following:
- degreasing
- cleaning
- rinsing
- masking
- pre-heating
- pickling

1.9 Check that the surface treatment equipment and solutions are set up and maintained at satisfactory operating conditions and levels

1.10 Use one of the following methods for locating the work during the surface treatment process:
- wiring
- specialised jigs

- jigging components, which are masked prior to processing
- jigs with integral masking

1.11 Carry out the surface treatment process, using appropriate techniques and procedures

1.12 Carry out the surface treatment activities, to include carrying out all of the following:

- start up the surface treatment equipment, using approved procedures
- confirm with the authorised person that the plant is ready for carrying out the surface treatment operations
- ensure that the equipment settings and process solutions are set and adjusted to maintain the correct specification (such as time, levels, temperature, current)
- check that the components are correctly prepared for the required treatment activities (such as dry, at the correct temperature, correctly masked)
- load components safely into the treatment plant/solutions
- ensure that components are left for the required induction period (if applicable)
- remove the components from the plant/solution safely and correctly
- apply appropriate post treatment activities (such as curing, cooling, quenching)

1.13 Check that the finished surface achieves the required characteristics and meets the surface treatment specification

1.14 Carry out checks on the treated surfaces, to include four of the following:

- freedom from damage
- freedom from contamination
- overall coverage/completeness of the coating operations
- thickness of deposit/coating
- appearance of deposits (such as colour, brightness)
- bend test (such as manual or mechanical)
- surface roughness checks
- adhesion of deposit to substrate
- porosity of coating
- deposit hardness
- brittleness of deposit
- abrasion resistance
- corrosion testing

1.15 Carry out surface treatment processes which comply with all of the following:

- the final surface finish is in line with the specification or job requirements
- the finished surface is free from defects
- the finished surface meets customer/company requirements

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Shut down the surface treatment equipment to a safe condition on

completion of the activities 1.18 Leave the work area in a safe condition on completion of the surface treatment activities

Learning outcome
The learner will: 2. Know how to finish surfaces by applying treatments
Assessment criteria
The learner can: 2.1 Describe the specific health and safety precautions which must be taken when preparing surfaces and applying surface treatment processes (such as wearing protective clothing and protective equipment, using fume extraction equipment) 2.2 Describe the hazards associated with preparing surfaces and applying surface treatments (such as using chemicals for cleaning and coating activities, fume inhalation, splashes from hot or corrosive treatment processes), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye protection, overalls, face masks, breathing equipment) 2.4 Describe the requirements for working in confined spaces and safe systems of work (including Required Air Quantities (RAQs) and Local Exhaust Ventilation (LEV)) to maintain safe conditions 2.5 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed 2.6 Describe the importance of following job instructions and defined surface treatment procedures 2.7 Describe the surface preparation methods and techniques to be undertaken prior to applying the treatments (such as stripping off old materials; using solvents to remove dirt and grease; masking surfaces to contain the deposits) 2.8 Describe the specific surface treatment process to be carried out, and the types of application for which they are best suited (such as powder coating, hot dip treatments, chemical treatments, phosphating, electroplating and anodising) 2.9 Describe the basic principles of operation of the specific surface treatment process being carried out 2.10 Describe the pre-treatments to be carried out on the components prior to the surface treatment activities (such as cleaning/degreasing, pickling, pre-heating) 2.11 Describe the visual checks to be made on the components prior to carrying out the surface treatment activities (such as checking they are dry, have been pre-heated or are correctly masked up) 2.12 Describe the need to make certain that all substrates and jigs are completely free of water or other solvents prior to immersing in a hot solution, and the potential consequences of failing to check this 2.13 Describe the methods used to hold/secure components during the surface treatment process (such as wires, hooks, jigs) 2.14 Describe the setting up of the surface treatment plant and equipment, and the operation and locations of emergency shutdown stops 2.15 Describe the importance of monitoring the equipment settings and

	process solutions during the treatment process
2.16	Describe the time intervals that the components need to be immersed, or time required between coats, and why these must be adhered to
2.17	Explain how to identify surface treatment processing faults (including blistering, missed deposits, dull deposits, contamination and poor adhesion)
2.18	Explain how to check and assess the finished work (such as for appearance, colour, coating thickness, coverage and adhesion)
2.19	Describe the problems that can occur with the surface treatment operations, and how these can be overcome
2.20	Explain when to act on their own initiative and when to seek help and advice from others
2.21	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the surface treatment activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 854 Carrying out heat treatment of engineering materials

UAN:	**T/600/5967**
Level:	Level 2
Credit value:	9
GLH:	41
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 54: Carrying out heat treatment of engineering materials (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to apply specified heat treatment processes to engineering materials/components. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the heat treatment activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required heat treatment activities. The learner will be required to prepare the appropriate equipment to use, based on the heat treatment process and materials to be treated. The learner will be expected to use the specified or appropriate techniques to prepare the materials and equipment in readiness for the application of the treatments. The heat treatment activities will include the application of treatments such as flame hardening, case hardening, carburising, tempering, annealing and normalising, as applicable to the task.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the heat treatment activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate heat treatment techniques and procedures safely. The learner will understand the heat treatment techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the heat treatment operations, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out heat treatment of engineering materials
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the heat treatment activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions and heat treatment process specifications and procedures • ensure that the equipment is correctly prepared for the heat treatment operations being performed • store all tools and equipment on completion of the heat treatment activities

- dispose of waste and excess materials, in line with agreed organisational procedures

1.3 Carry out three of the following heat treatment processes:
- flame hardening
- case hardening
- carburising
- tempering
- annealing
- normalising

1.4 Apply heat treatments to two different types of material from the following:
- low carbon steel
- high carbon steel
- silver/tool steel
- chilled cast iron
- welded fabrications
- copper
- other materials (specify)

1.5 Plan the heat treatment activities before they start them

1.6 Prepare the materials in readiness to receive the appropriate heat treatment

1.7 Prepare the components for the heat treatment activities, by carrying out two of the following:
- removing scale
- degreasing/cleaning
- masking
- polishing area to be tempered
- pre-heating

1.8 Use two of the following methods of heating the components:
- furnace
- blacksmith's hearth
- gas torches
- salt/chemical baths

1.9 Check that the heat treatment equipment is set up and maintained at satisfactory operating conditions

1.10 Carry out the heat treatment process, using appropriate techniques and procedures

1.11 Carry out the heat treatment activities to include all of the following:
- lighting up the furnace/hearth or torch, using approved procedures
- setting the equipment to maintain the correct conditions (such as soak time, temperature)
- checking that the components are correctly prepared for the required heat treatment activities (such as dry, at the correct temperature, correctly polished or masked, packed with carbon enriched material)
- checking that there is sufficient cooling medium (so that it will not overheat or reach flash point)

- loading the components safely into the heat source/solution
- ensuring that components are left for the required induction period
- removing the components from the heat source/solution safely and correctly
- quenching/cooling the components, using the appropriate medium and technique

1.12 Use two of the following methods of quenching/cooling the material:
- fresh water
- salt water
- oil
- air
- sand
- leave in the furnace to cool

1.13 Check that the finished material achieves the required characteristics and meets the heat treatment specification

1.14 Carry out simple checks on the heat treated components, to include two of the following:
- visual checks for cracks or distortion
- NDT tests (such as dye penetrant, magnetic particle, ultrasonic)
- simple physical checks to confirm that hardening or annealing has been achieved (such as grinding wheel spark tests, file test)
- specific hardness tests (such as Vickers, Brinell)

1.15 Carry out heat treatment processes which comply with all of the following:
- the final heat treated material is in line with the specification or job requirements
- the heat treated material is free from defects
- the heat treatment process meets customer/company requirements

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Shut down the heat treatment equipment to a safe condition on completion of the activities

1.18 Leave the work area in a safe condition on completion of the heat treatment activities

Learning outcome
The learner will: 2. Know how to carry out heat treatment of engineering materials
Assessment criteria
The learner can: 2.1 Describe the specific health and safety precautions which must be taken when carrying out heat treatment processes (such as wearing protective clothing and protective equipment, using fume extraction equipment)

2.2 Describe the hazards associated with carrying out heat treatment processes (such as handling hot materials, using heat treatment solutions, fume inhalation, splashes from hot oil or liquids, fire and explosive mixtures), and how they can be minimised

2.3 Describe the Personal Protective Equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as leather aprons, eye protection, overalls, face masks, breathing equipment)

2.4 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

2.5 Describe the importance of following job instructions and defined heat treatment procedures

2.6 Explain how to obtain the required information on heat treatment temperatures, tempering colours, soak times and quenching/cooling methods to be used

2.7 Describe the various types of material that can be flame hardened, case hardened, tempered, normalised and annealed

2.8 Describe the material preparation methods and techniques to be undertaken prior to applying the heat treatments (such as removing scale, oil and dirt; masking surfaces to contain the case hardening or carburising deposits; polishing surfaces to be tempered; packing or coating the components with a carbon enriched material; pre-heating before immersion into a salt bath)

2.9 Describe the specific heat treatment process to be carried out, and the types of application for which they are best suited (such as flame hardening, case hardening, carburising, annealing, tempering and normalising)

2.10 Describe the basic principles of operation of the specific heat treatment process being carried out

2.11 Explain how to prepare the equipment for the heat treatment activities (such as setting furnace or salt bath controls to give correct temperature; the procedure for lighting and extinguishing the blacksmith's hearth; setting up gas torches; ensuring that suitable tongs/handling devices are available)

2.12 Describe the visual checks to be made on the components prior to carrying out the surface treatment activities (such as checking that they are dry, have been pre-heated or are correctly masked up)

2.13 Describe the need to make certain that all components and jigs are completely free of water or other solvents prior to immersing them in a hot solution, and the potential consequences of failing to check this

2.14 Describe the methods used to hold/secure components in a heat treatment solution (such as wires, hooks, jigs)

2.15 Describe the importance of monitoring the equipment settings and process solutions during the heat treatment process

2.16 Explain how to heat the components to the correct temperature for the process being carried out (such as hardening temperatures for various carbon contents; soak times at set temperatures for carburising, annealing or normalising; temperatures and colours for various tempering applications), and why these must be adhered too

2.17 Describe the quenching and cooling methods to be used (such as fresh water, salt water, oil, sand, air and leaving the components in the furnace to cool naturally)

2.18	Describe the need to maintain quenching oil at a temperature below its flash point
2.19	Explain how to check the finished work after heat treatment (such as visual checks for cracks or distortion; using simple file or spark tests to check that hardening or annealing has been achieved; the use of dye penetrant and magnetic particle tests; the use of specialised hardness tests)
2.20	Describe the problems that can occur with the heat treatment operations, and how these can be overcome
2.21	Explain when to act on their own initiative and when to seek help and advice from others
2.22	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the heat treatment activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 855 Carrying out hand forging of engineering materials

UAN:	**A/600/5968**
Level:	Level 2
Credit value:	9
GLH:	41
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 55: Carrying out hand forging of engineering materials (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to carry out hand forging activities on engineering materials/components. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the hand forging activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required hand forging activities. The learner will be required to prepare the appropriate equipment to use, based on the hand forging operations required and the materials to be used. The learner will be expected to use the specified or appropriate techniques to prepare the materials and equipment in readiness for the hand forging activities. The forging activities will include operations such as bending, twisting, drawing down, upsetting, swaging, punching, cutting off and flame welding, as applicable to the task.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the hand forging activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, in order to safely apply appropriate hand forging techniques and procedures. The learner will understand the hand forging techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the hand forging operations, and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out hand forging of engineering materials
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the hand forging activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • follow job instructions and hand forging specifications and procedures • ensure that the material handling equipment and hand tools are in a safe and usable condition • return all tools and equipment to their correct designation on completion of the hand forging activities

- dispose of waste and excess materials, in line with organisational procedures

1.3 Use one of the following methods of heating the components:
- furnace
- blacksmith's hearth
- gas torch

1.4 Plan the hand forging activities before they start them

1.5 Prepare the materials in readiness for the forging operations

1.6 Carry out hand forging operations on two different materials from the following:
- wrought iron
- low carbon steel
- high carbon steel
- alloy steel
- brass
- copper
- other materials (specify)

1.7 Prepare the forging equipment in readiness for the forging operations

1.8 Carry out the hand forging operations, using appropriate techniques and procedures

1.9 Carry out six of the following hand forging operations:
- bending
- twisting
- drawing down
- upsetting
- swaging
- punching
- cutting off
- flame welding

1.10 Use five of the following during the forging process:
- hand hammers
- pneumatic hammers
- blacksmith's anvil
- formers
- swages
- stakes
- punches
- drifts
- other tools (specify)

1.11 Carry out the hand forging activities, to include all of the following:
- lighting up the furnace/hearth or torch, using approved procedures
- setting the equipment to maintain the correct conditions (such as temperature), where applicable
- checking that the components are correctly prepared for the required hand forging activities (such as free from scale or excessive rust, heated to the correct colour/temperature)

- using appropriate tools and techniques to forge the required shapes/profiles
- re-heating the forged components at suitable periods during the forging process
- using appropriate tools/gauges to determine when the required shape is achieved

1.12 Check that the finished components conform to specification

1.13 Produce hand forged components which comply with all of the following:

- all dimensions are within +/- 3.0mm or +/- 0.125”
- finished components meet the required shape/geometry (such as flat, straight, angles, twists)
- completed components are free from excessive tooling/hammer marks, deformation or cracks

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Shut down the forging equipment to a safe condition on completion of the activities

1.16 Leave the work area in a safe condition on completion of the hand forging activities

Learning outcome
The learner will: 2. Know how to carry out hand forging of engineering materials
Assessment criteria
The learner can: 2.1 Describe the specific health and safety precautions which must be taken when carrying out hand forging processes (such as wearing protective clothing and protective equipment, using fume extraction equipment) 2.2 Describe the hazards associated with carrying out hand forging processes (such as handling hot materials, fume inhalation, fire), and how they can be minimised 2.3 Describe the Personal Protective Equipment (PPE) to be used (such as leather aprons, eye protection, overalls, face masks, breathing equipment); how to obtain it and check that it is in a safe and usable condition 2.4 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed 2.5 Describe the importance of following job instructions and defined hand forging techniques and procedures 2.6 Explain how to obtain the required information on forging colours/temperatures to be used 2.7 Describe the various types of material that can be hand forged 2.8 Describe the characteristics of the materials, and how they effect and are affected by the forging process 2.9 Describe the meaning of forging terminology (such as drawing down, upsetting, swaging, twisting, punching and flame welding) 2.10 Explain how to prepare the equipment for the hand forging activities (such as setting furnace controls to give correct

temperature; the procedure for lighting and extinguishing the blacksmith's hearth; setting up gas torches; ensuring that suitable tongs/handling devices are available)

2.11 Describe the material preparation methods and techniques to be undertaken prior to carrying out the hand forging operations (such as removing scale, oil and dirt; heating the material to the correct forging temperature)

2.12 Explain how to determine when the material is ready for the forging operations (by checking the colour of the hot material)

2.13 Describe the various hand forging methods used, and the range of tools required (including types of hammers, formers, swages, stakes, punches and drifts)

2.14 Describe the use of the various parts of the blacksmith's anvil for the forging operations

2.15 Describe the use of various cooling or quenching mediums (such as water, oil, air or sand)

2.16 Describe the effect on the materials of plunging them into cooling mediums whilst they are still hot

2.17 Explain how to check that the forged components meet the specification requirements (such as visual checks for cracks, scale inclusions or distortion; use of measuring equipment, gauges or templates to check dimensional and geometric features)

2.18 Describe the problems that can occur with the hand forging operations, and how these can be overcome

2.19 Explain when to act on their own initiative and when to seek help and advice from others

2.20 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the forging activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 856 Stripping and rebuilding motorsport vehicles (pre-competition)

UAN:	**T/600/5970**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 56: Stripping and rebuilding motorsport vehicles (pre-competition) (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to prepare a motorsport vehicle, in a recognised sequence and to a high standard, prior to a competition. It will prepare the learner for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competencies in the working environment. The activities will involve the dismantling and removal of components, inspection and checking for faults and excessive wear and potential problems, replacement of components, and rebuilding the vehicles using hand tools, specialist tools and test equipment, in accordance with approved procedures. It covers motorsport vehicles such as single seat, rally cars, sports cars, karts, historic vehicles, motor cycles and other specific approved competition vehicles, and covers a range of equipment such as chassis and suspension, engine and transmission, steering and wheel braking systems, fuel and lubrication, electrical and other specific equipment. The preparation activities will include carrying out all necessary safety activities to

lift and support the vehicle and its components, lifting and removing engine and transmission systems, breaking into hydraulic and fuel system circuits, removing springs under compression, removing and replacing faulty equipment at component or unit level, replenishing fluids, and setting and adjusting the completed system in readiness for testing. The learner will also be expected to use recognised methods for crack testing ferrous and non-ferrous materials/components, and to be able to inspect a motorsport vehicle within the team's guidelines.

The learner's responsibilities will require them to comply with recognised procedures for the stripping and rebuilding activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, the learner must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated.

On completion of the activities, the learner must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. The learner must show that they can use and maintain the tools and equipment needed for the dismantling and inspection activities, and return them to their recognised storage area ready for further use.

The learner's knowledge will provide an understanding of their work, and will enable them to apply the appropriate dismantling, inspection and rebuilding procedures safely. The learner will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the removal and replacement activities, correct faults and ensure that the equipment is replaced to the required standard. The learner will also have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications.

The learner will understand the safety precautions required when carrying out the stripping and rebuilding activities, especially those for lifting and supporting the equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Strip and rebuild motorsport vehicles (pre-competition)
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following activities prior to stripping and rebuilding of the motorsport vehicle: • positioning and securing the vehicle, using the correct equipment • carrying out all preparatory work (such as removal of wheels, bodywork or fairings, removing dirt, oil and track debris) • checking for leaks in the braking system, clutch, cooling, steering, lubrication and fuel systems • checking for play in spherical bearings, bushes, couplings and joints • checking for excessive wear to bodywork fasteners, brake linings, clutch linings, skid plates, dog rings and gear ratios • making initial judgements as to the cause of damage and/or wear 1.3 Obtain all the information they need for the motorsport vehicle preparation activities to be carried out 1.4 Use three of the following to aid the vehicle preparation: • system diagrams • equipment manuals • vehicle telemetry data • engineer's records • set-up sheets • inspection check sheets 1.5 Establish and, where appropriate, mark component orientation for re-assembly 1.6 Ensure that any stored energy or substances are released safely and correctly 1.7 Carry out the removal and replacement activities, within the limits of their personal authority to include all of the following:

- disconnecting electrical connections
- disconnecting and removing hoses and pipes
- draining and removing fluids
- proof marking/labelling of components to aid reassembly
- separation of components by means of removing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
- inspecting components for damage and wear, and identifying all components and fasteners that require replacement.
- arranging and storing components in a manner that makes re-assembly as straightforward as possible
- labelling (and storing in the correct location) components that require repair or overhaul
- reassembly of components using mechanical fastening devices (such as nuts, bolts, quick-release fasteners, circlips, rivets)
- replacement of sealing devices (such as 'O' rings, seals, gaskets, sealing compounds)
- positioning, aligning, setting and adjusting replaced components (such as travel, working clearance)
- tightening fastenings to the required torque, and applying bolt locking methods (such as split pins, wire locking, lock nuts)
- making electrical connections and earth bonding
- replacing fluids and bleeding the system

1.8 Remove and replace the required components, using approved tools and techniques

1.9 Remove and replace components on one of the following types of motorsport vehicle:

- single seater
- rallying
- sports cars
- karts
- historic
- motorcycles (such as circuit and off-road)
- other specific approved competition vehicle

1.10 Remove and replace motorsport vehicle components from all of the following categories:

- 'lifed' components (such as filters, gaskets, seals, bearings, securing devices, fuel cells)
- pipes and pipe connecting devices (such as rigid pipe, hoses, unions/couplings,)
- chassis (such as uprights, suspension systems, steering and brake callipers/discs)
- mechanical controls (such as throttle, brakes, clutch, gear)
- safety equipment (such as seats, belts, fire extinguishers)

Plus assist in the removal and replacement of motorsport vehicle components from three of the following categories:

- engine and ancillary components (such as exhaust primaries and silencers, airboxes, engine mounts, filters)

- transmission (such as gear ratios, gear selectors, dog rings, final drives, clutches, oil coolers, drive and prop shafts)
- fuel systems (such as fuel pumps, fuel tanks, fuel collectors)
- cooling systems (such as radiators, heat exchangers, header tanks)
- electrical (such as voltage generation, ignition system components, engine management, data control boxes, ECUs, wiring looms, lighting)
- system components (such as sensors, regulators, safety devices, gauges)

1.11 Carry out all of the following inspection and testing techniques:
- functional testing
- mechanical measurement
- sensory testing (such as sight, sound smell touch)

Plus two more of the following test procedures:
- ferrous metal crack detection
- non-ferrous metal crack detection
- static or dynamic balancing
- brake balance and pressure testing
- cylinder pressure/balance tests
- electrical tests
- damper dynamometer testing
- other specific tests

1.12 Remove and replace motorsport vehicle equipment and components, in compliance with one or more of the following standards:
- Race Association's (such as FIA, MSA)
- BS or ISO standards and procedures
- vehicle manufacturer's specification
- customer standards and requirements
- team/company standards and procedures
- specific system requirements

1.13 Take suitable precautions to prevent damage to components and the surrounding structure

1.14 Report any instances where the removal and replacement activities cannot be fully met, or where there are identified defects outside the planned activities

1.15 Complete the relevant documentation, in accordance with organisational requirements

1.16 Complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:
- job sheets
- computer records
- vehicle preparation sheet
- formal risk assessment

1.17 Label and store, in an appropriate location, components that require repair or overhaul

1.18 Dispose of waste materials and scrap components, in accordance with safe working practices and approved procedures

Learning outcome
The learner will: 2. Know how to strip and rebuild motorsport vehicles (pre-competition)
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when stripping and rebuilding motorsport vehicles and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to dismantling motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines) 2.2 Describe the hazards associated with removing and replacing motorsport vehicle components, and with the tools and equipment used (such as the safe support of the vehicle at the correct working height and position, the safe release of fuel and other liquids, handling hydraulic fluids, misuse of tools), and how they can be minimised 2.3 Describe the protective equipment that they need to use for both personal protection and protection of the vehicle 2.4 Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation 2.5 Describe the preparations to be carried out on the vehicle (such as removing bodywork or fairings, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage or excessive wear - such as bearings, bushes, bodywork, floors, fairings, leaking coolant or oil, chafing, cracks, excessive clearances); ensuring that suitable storage space is readied once the systems have been removed from the vehicle, and providing suitable containers for the storage of fasteners and other small components 2.6 Explain how to use and extract information from motorsport vehicle documentation (such as vehicle manuals, system diagrams, telemetry data, engineer's records, set-up sheets, inspection reports) 2.7 Describe the importance of ensuring that they use the correct and up-to-date documentation 2.8 Describe the techniques used to remove components from vehicle systems without damage to the components or surrounding structure (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components and the need to protect the circuit integrity by fitting blanking plugs to exposed pipes) 2.9 Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, punches, drifts) to remove a range of components (such as studs, pins, circlips, rivets, seals and gaskets, bearings, gears, final drives, wings, floors, skid plates, fairings, seats); and using release agents to help free joined parts where seizure or crash damage may have occurred

2.10 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners, special securing devices)
2.11 Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking-in of the connections
2.12 Describe the methods of lifting, and supporting the components/equipment during the removal and replacement activities
2.13 Describe the methods of checking the components for damage or wear (using visual methods, measurements, and crack detection techniques)
2.14 Describe the need to use new components where checks during dismantling revealed such needs; fitting together new or prototype components, where a degree of initial fitting may be needed (such as filing, fettling, reaming, tapping, shimming, polishing and adjusting to achieve the required assembly specification); sealing and securing components (such as using nuts, bolts and associated fasteners, rivets, circlips, sealants and locking compounds); checking for correctness of fit and accuracy at critical stages during the rebuild and on completion of the assembly
2.15 Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)
2.16 Explain why securing devices must be tightened to the correct torque and locked, and the different methods that are used
2.17 Describe the tools and equipment used in the removal and replacement activities, their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the removal and replacement activity
2.18 Explain how to deal with problems (such as what to do when components are damaged or worn in some way, the correct equipment or parts not available, components do not come apart as readily as expected, when to act on their own initiative and when to seek help from others)
2.19 Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation
2.20 Describe the procedure for the safe disposal of waste materials, scrap components, hydraulic fluids, contaminated fuel
2.21 Explain when to act on their own initiative and when to seek help and advice from others
2.22 Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the stripping and rebuilding activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 857 Inspecting a motorsport vehicle during a competition

UAN:	**F/600/5972**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 57: Inspecting a motorsport vehicle during a competition (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to inspect a motorsport vehicle, in a recognised sequence, and to a high standard, during a race meeting or competition. It will prepare the learner for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will involve inspecting a motorsport vehicle immediately before it enters the competition, and checking the vehicle for such things as system leaks, low fluid levels, loose fastenings and fixings, arming of the fire extinguisher system, checking driver/rider safety equipment, and checking correct fuel levels, correct cold tyre and damper pressures and other potential problem areas. It covers motorsport vehicles such as single seat, rally cars, sports cars, karts, historic vehicles, motor cycles and other specific approved competition vehicles. In carrying out the activities, the learner will be required to use a range of inspection techniques, tools and equipment. The learner must be able to use recognised methods of checking components for wear,

chafing, damage and ‘play’, within the team’s guidelines. The learner will be expected to follow the team’s procedures for inspecting the motorsport vehicle during a competition. The learner must also understand and use the correct coolants, oils, fluids and agents for the system being inspected.

The learner’s responsibilities will require them to comply with recognised procedures for the inspection activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, the learner must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated.

On completion of the inspection activities, the learner must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. The learner must show that they can use and maintain the tools and equipment needed for the inspection activities, and return them to their recognised storage area ready for further use.

The learner’s knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate inspection procedures during a motorsport event or competition. The learner will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the inspection activities, identify and correct faults and ensure that the vehicle is to the required standard.

The learner will understand the safety precautions required when carrying out motorsport inspection activities, especially those for lifting and supporting vehicles. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Inspect a motorsport vehicle during a competition
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following in preparation for the inspection of the motorsport vehicle: • ensure that there is enough time available to complete the inspection • obtain all the required tools and equipment, and check that they are in a safe and usable condition • ensure that the motorsport vehicle is safely supported on the appropriate stands • ensure that all bodywork, fairings, covers and hatches have been removed (where appropriate) • obtain and wear the correct Personal Protective Equipment for the tasks being undertaken • obtain the appropriate fluids and lubricants • obtain the correct auxiliary engine starting devices (where appropriate) • obtain the relevant inspection documentation 1.3 Inspect one of the following types of motorsport vehicle during a motorsport event or competition: • single seater • rallying • sports cars • karts • historic • motorcycles (such as circuit and off-road) • other specific approved competition vehicle 1.4 Obtain all the information they need for the motorsport vehicle inspection activities to be carried out 1.5 Plan the inspection activities before they start them 1.6 Obtain and prepare tools and ancillary equipment necessary for the inspection work to be carried out 1.7 Carry out the inspection activities, using approved tools and techniques, and within the limits of their personal authority 1.8 Take suitable precautions to prevent damage to components and surrounding systems 1.9 Carry out inspections and checks, to include ten of the following, as appropriate to the motorsport vehicle being inspected: • using a torque wrench to spanner-check wheel nuts, bolts and other critical fastenings

- ensuring that fuel tanks are filled to their correct capacity
- checking that suitable tyres are fitted, that they are free from damage and are at the correct cold pressures
- checking for correct oil pressure prior to engine warm-up
- checking engine temperatures and pressures during warm-up
- pressurising the cooling system after initial start-up
- testing that the throttle operation reaches 100% opening
- checking that power steering fluid levels are correct and free from leaks
- checking that hydraulic brake and clutch fluids are at the correct levels, and that the brake balance is set
- inflating damper bump canisters, using the appropriate gases
- checking that clutch operating clearance is correct, and that gear selection is satisfactory through all gears
- testing that electrical systems are operating correctly
- checking spherical bearings and wheel bearings for play

1.10 Carry out three of the following before the vehicle leaves the 'pit' area:

- checking that all bodywork, fairings, wings, covers and hatches are correctly secured
- checking that the driver is fitted correctly into the seat, and that seat belts are securely fastened
- ensuring that the fire extinguisher bottle is full and the system is armed
- ensuring that wheels are correctly torqued, and locking mechanisms are in place
- ensuring that the driver has the appropriate vehicle information prior to entering the vehicle or competition (such as amount of fuel, type of tyres and pressures, track conditions, vehicle geometry changes, brake balance, brake condition)
- cleaning the bodywork, fairings, windscreen and other relevant areas of the vehicle
- checking that the work area/vehicle track access lane is free from tools, equipment and foreign objects

1.11 Report any instances where the inspection activities cannot be fully met, or where there are identified issues outside the planned activities

1.12 Record the results of the inspection activities

1.13 Complete the relevant paperwork and pass it to the appropriate person, to include one from:

- driver/rider
- team manager
- chief mechanic
- No.1 mechanic
- other appropriate person

1.14 Use the evidence they have gained to during the inspection activities to improve future reliability and performance of the motorsport vehicle

1.15 Tidy up on completion of the inspection activities

Learning outcome
The learner will: 2. Know how to inspect a motorsport vehicle during a competition
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when inspecting motorsport vehicles and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to inspecting motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines) 2.2 Describe the hazards associated with inspecting motorsport vehicles, and with the tools and equipment used, (such as the safe support of the vehicle at the correct working height and position, the safe release of fuel and other liquids, handling hot or damaged components, misuse of tools), and how they can be minimised 2.3 Describe the protective equipment that they need to use for both personal protection and protection of the vehicle 2.4 Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation 2.5 Describe the need to ensure that suitable storage space is readied for all bodywork, panels, fairings and covers once the vehicle has been stopped after its initial running period and before any checks are made 2.6 Describe the preparations to be carried out on the vehicle (such as removing bodywork or fairings, covers and panels, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage, insecurity and leaks) 2.7 Describe the importance of communicating with others and using inspection check sheets or other relevant documentation to ensure that the inspection is carried out in a systematic way, within the times restraints, and determining what consumables and or components may be needed 2.8 Explain how the information is recorded and returned to the relevant person, once all inspection work has been completed 2.9 Describe the techniques used to check components and systems without damaging the motorsport vehicle or disabling it from immediate use 2.10 Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, torque wrenches, pressure gauges) to check the security of a range of vehicle systems and sub-assemblies (such as engine, transmission, suspension, steering, cooling, lubrication, electrical) 2.11 Explain how to pressurise tyres, dampers, cooling systems and fuel systems; how to check for leaks and understand the specifications of fluids, fuels and lubricants to top up the vehicle systems following a leak or other problems 2.12 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as

	threaded fasteners, special securing devices)
2.13	Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)
2.14	Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used
2.15	Describe the tools and equipment used in the inspection activities, and their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the inspection activities at an event or competition
2.16	Explain how to deal with problems (such as what to do when components are damaged or insecure, the correct equipment, fluids or lubricants not available, when to act on their own initiative and when to seek help from others)
2.17	Explain how to report any alterations that they have made, or losses of fluids, lubricants, pressures, or abnormally excessive wear of components - to the relevant person
2.18	Explain how to complete the relevant documentation, stating the tasks completed and any adjustments made (such as setting of pressures, levels, geometry changes)
2.19	Describe the procedure for the safe disposal of waste materials, scrap components, hydraulic fluids, contaminated fuel
2.20	Explain when to act on their own initiative and when to seek help and advice from others
2.21	Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the inspection activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 858 Diagnosing and rectifying faults on motorsport vehicle systems (during competition)

UAN:	**H/600/5978**
Level:	Level 2
Credit value:	15
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 58: Diagnosing and rectifying faults on motorsport vehicle systems (during competition) (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to diagnose and rectify motorsport vehicle system faults, in a fast and efficient manner, during a race meeting or competition. It will prepare the learner for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will involve the application of a range of fault diagnostic techniques, tools and equipment, and the diagnosis and location of the faults to their unit and/or component parts, on a range of systems such as engine, transmission, chassis, wheel braking, suspension, steering, fuel, lubrication, cooling and electrical. The learner will be expected to remove the relevant components, to inspect the parts for wear or damage, to determine which (if any) parts need replacing and then to reassemble them for further use. The removal and replacement activities will include carrying out all necessary safety activities, to lift and support the vehicle and its components, lifting and removing engine

and transmission systems, breaking into hydraulic and fuel system circuits, removing and replacing faulty equipment at component or unit level, replenishing fluids, and setting and adjusting the completed system. The learner will also be expected to carry out routine testing and functional checks of the rebuilt components to determine that the equipment performs to the specified requirements.

The learner's responsibilities will require them to comply with recognised procedures for the fault diagnosis and removal and replacement activities undertaken, to take account of any potential difficulties or problems that may arise, and seek appropriate help and advice in determining and implementing a suitable solution. The learner will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, the learner must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated.

The learner must ensure that they remove all tools and equipment from the vehicle and work area on completion of the activities, complete all necessary job/task documentation accurately and legibly, and maintain the work area to a standard that will reflect the professional image of the team.

The learner's knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate fault diagnosis and rectification techniques and procedures. The learner will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the fault diagnostic activities, correct faults and ensure that the equipment is replaced and functions to the required standard.

The learner will understand the safety precautions required when carrying out the fault diagnosis, adjustments and the component removal and replacement activities, especially those for lifting and supporting the equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Diagnose and rectify faults on motorsport vehicle systems (during competition)
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the fault diagnostic activities: • carry out all preparatory work (such as removal of bodywork, fairings and covers, removing excessive dust, grease and dirt) • check for obvious signs of damage (such as impact damage, broken parts) • check for excessive wear or play (such as on shafts, bearings, spherical joints and drive shafts) • check for leaks on seals, gaskets, bushes, controls and pipe fittings • check the condition and security of suspension and drive components • check the condition of tyres (such as damage, wear, pressures, security) • check for metallic particles in lubricants 1.3 Assist in diagnosing faults on one of the following types of motor sport vehicle: • single seater • rallying • sports cars • karts • historic • motorcycles (such as circuit and off road) • other specific approved competition vehicle 1.4 Obtain and use all the relevant information on the symptoms and problems associated with the vehicle 1.5 Assist in locating faults that have resulted in two of the following breakdown categories: • intermittent problem • partial failure (where the vehicle is able to return to the 'pit' area under power) • complete breakdown (where the vehicle is unable to return to the 'pit' area under power) 1.6 Assist in the investigation and help establish the most likely causes of the faults 1.7 Assist in the selection and use of appropriate diagnostic techniques, tools and aids to locate the fault

1.8 Assist in the collection of evidence regarding the fault, from three of the following sources:
- system diagrams
- vehicle/equipment manuals
- data logging
- test instruments
- equipment self-diagnostics
- maintenance/history records
- discussion with user/team member
- monitoring equipment (such as gauges recording devices)
- fault analysis charts (such as flow charts)
- troubleshooting guides

1.9 Assist in carrying out three of the following fault diagnostic techniques:
- function testing
- unit substitution
- input/output
- taking measurements and readings
- half-split
- six point technique
- sensory input (such as sight, sound, smell, touch)

1.10 Assist in determining which components or units need adjusting or replacing

1.11 Where appropriate, ensure that any stored energy or substances are released safely and correctly

1.12 Rectify faults in four of the following motorsport vehicle major assemblies or systems:
- engine
- transmission
- chassis
- wheel braking
- suspension
- steering
- fuel
- lubrication
- cooling
- electrical

1.13 Remove, replace or refit the required components, using approved tools and techniques, within the limits of their personal authority and without causing damage to components or surrounding areas

1.14 Use a variety of fault rectification activities, to include six of the following:
- removing and replacing electrical connections (such as plugs, sockets, earth straps)
- removing and replacing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
- removing and replacing hoses and pipes
- replacing faulty and or worn components with new or

reconditioned components
- adjusting components (such as travel, working clearance, torque, electrical values)
- realignment of components
- repairing components (such as brackets, mountings, panels)
- refitting loose/dislodged components
- making temporary repairs to an acceptable standard

1.15 Assist in carrying out four of the following monitoring or testing procedures, to help diagnose and check that the fault has been rectified:
- pressure testing (such as cylinder pressure, hydraulic or pneumatic pressures)
- electrical checks (such as voltage, current, continuity checks)
- noise intensity
- exhaust analysis
- thermal checks (such as bearings, friction surfaces)
- movement checks (such as travel, clearance, operation of levers and links, torque)
- vibration analysis
- functional testing
- visual examination to the required standard

1.16 Deal with any difficulties during the fault location, rectification and testing activities

1.17 Report any instances where the removal and replacement activities cannot be fully met, or where there are identified defects outside the planned activities

1.18 Complete the relevant documentation, in accordance with organisational requirements

1.19 Complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:
- body sheets
- computer records
- vehicle log/report
- corrective action report

1.20 Clean the work area and dispose of waste materials and defective components, in accordance with safe working practices and approved procedures

Learning outcome
The learner will: 2. Know how to diagnose and rectify faults on motorsport vehicle systems (during competition)
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements of the area in which they are carrying out the fault diagnostic activities, and the responsibility these requirements place on them 2.2 Describe the specific safety precautions to be taken when carrying out fault diagnosis on motorsport vehicles

2.3 Describe the importance of wearing protective clothing and other appropriate safety equipment during the fault diagnosis and rectification activities, and of good personal presentation to ensure quality representation of the team or organisation
2.4 Describe the hazards associated with diagnosing and rectifying motorsport vehicle faults, and with the tools and equipment used (such as moving vehicles in a race environment; the safe support of the vehicle at the correct working height and position; hot vehicle components; the safe release of fuel and other liquids; stored pressure/force; handling and using release agents, sealants and adhesives; misuse of tools), and how they can be minimised
2.5 Explain how to extract and use information from the relevant areas to assist in the diagnosis and rectification of the fault on the motorsport vehicles (such as from the driver, rider or team member, telemetry data, engineer's records, set-up sheets and inspection reports)
2.6 Describe the techniques used to diagnose the faults (such as sensory information (sight, sound, smell, touch); half-split, six point technique, checking inputs and outputs, component substitution, aural, visual, functional, taking measurements and use of equipment self-diagnostics)
2.7 Explain how to use a range of fault diagnostic equipment to investigate the problem (such as multimeters, pressure gauges, thermal measuring equipment, Verniers, micrometers and other specialised tools)
2.8 Explain how to evaluate the likely risk of running the vehicle with the known fault, and the effects that the fault could have on health and safety, and on the overall vehicle performance
2.9 Explain how to remove components from vehicle systems without damage to the components or surrounding structure (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components, and the need to protect the circuit integrity by fitting blanking plugs to exposed pipes)
2.10 Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, pliers, cutters, punches) to remove a range of components, and how to use release agents to help free joined parts where seizure or crash damage may have occurred
2.11 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners and special securing devices)
2.12 Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used
2.13 Explain why they need to be methodical and lay the removed components out in a logical sequence to aid re-assembly, and methods that can be used to keep component parts together in the order they were removed
2.14 Describe the methods of inspecting removed components, and the awareness of what to look for with regard to damage and wear
2.15 Describe the equipment used in the rectification operations (such as alignment tools, torque wrenches, presses)
2.16 Explain how to rectify the fault using methods such as component replacement, adjustments, repair and refitting techniques
2.17 Explain how to select and carry out visual, aural, functional and measurement tests to ensure the correct operation of the component or system

2.18	Describe the expected outcomes of the tests being conducted
2.19	Describe the importance of working to the critical timescales relevant to the motorsport industry
2.20	Explain how to deal with problems (such as what to do when components do not come apart as readily as expected, when to act on their own initiative)
2.21	Explain when to act on their own initiative and when to seek help and advice from others
2.22	Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 859 Carrying out maintenance activities on motorsport vehicle electrical equipment

UAN:	**H/600/5981**
Level:	Level 2
Credit value:	18
GLH:	68
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 59: Carrying out maintenance activities on motorsport vehicle electrical equipment (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to carry out maintenance activities on motorsport vehicle electrical systems, in accordance with approved procedures. It will prepare the learner for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will involve dismantling, removing and replacing or repairing faulty components, in line with company procedures, on electrical equipment that uses battery, alternating current generators, or direct current power supplies. This includes equipment such as control systems, switches and solenoids, starter motors, wiring harnesses and instrumentation panel, wiring enclosures and warning lights, vehicle lighting systems, data acquisition systems and other specific electrical equipment. The learner will be expected to apply a range of maintenance techniques and procedures, such as selection of raw materials, attaching connectors, shielding, testing, isolating, disconnecting, removing and reconnecting electrical components and looms, attaching

cable identification markers, replacing damaged or defective electrical components and looms, setting and adjusting components, and making continuity checks before testing and starting up the equipment.

The learner's responsibilities will require them to comply with organisational policy and procedures for the maintenance activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, the learner must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated.

On completion of the activities, the learner must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. The learner must show that they can use and maintain the tools and equipment needed for the maintenance activities, and return them to their recognised storage area ready for further use.

The learner's knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate electrical maintenance procedures. The learner will know how the motorsport electrical equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the maintenance, repair or adjustment activities, and to ensure that the equipment functions to the required specification. In addition, the learner will have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications.

The learner will understand the safety precautions required when carrying out the maintenance activities, especially those for isolating the equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out maintenance activities on motorsport vehicle electrical equipment
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the electrical maintenance activities: • plan the maintenance activities, in conjunction with others involved, so as to minimise disruption to motorsport vehicle preparation • use the correct issue of drawings, job instructions and procedures • adhere to risk assessment, COSHH and other relevant safety standards • ensure the safe isolation of equipment (such as mechanical, electricity, fuel, air or fluids) • ensure that safe working arrangements have been provided for the maintenance area (such as pit lane/service point) • re-connect and return the equipment to service on completion of activities • dispose of waste items in a safe and environmentally acceptable manner, and leave the work area in a safe condition 1.3 Carry out maintenance of electrical equipment on one of the following types of motorsport vehicle: • single seater • rallying • sports cars • karts • historic • motorcycles (such as circuit and off-road) • other specific approved competition vehicle 1.4 Carry out maintenance activities on five of the following types of motorsport vehicle sub-systems: • charging systems • data acquisition system • direct current power supply system • auxiliary motorsport vehicle power supply system • lighting systems

- instrumentation, indication and warning systems
- electrical control system
- safety and emergency systems

1.5 Obtain all the information they need for the motorsport vehicle electrical maintenance activities to be carried out

1.6 Follow the relevant maintenance procedures to carry out the required work

1.7 Maintain motorsport vehicle electrical equipment, in compliance with one or more of the following standards:
- Race Association's (such as FIA, MSA)
- BS or ISO standards and procedures
- vehicle manufacturer's specification
- customer standards and requirements
- team/company standards and procedures
- specific system requirements

1.8 Carry out the maintenance activities, within the limits of their personal authority

1.9 Carry out the maintenance activities in the specified sequence, and in an agreed timescale

1.10 Carry out all of the following maintenance activities:
- isolating the equipment
- disconnecting and reconnecting wires and looms
- attaching suitable cable identification markers
- removing electrical units/components
- checking components for serviceability
- replacing damaged/defective components
- removing and replacing damaged wires and looms
- setting and adjusting replaced components
- making 'continuity' checks before powering up
- functionally testing the maintained equipment
- examining wiring looms for chafing, dislodging, correct routeing, protection in hazardous areas

1.11 Replace and/or repair a range of motorsport vehicle electrical components, to include ten of the following:
- looms and connectors
- locking and retaining devices
- overload protection devices
- pickup sensor
- relay components
- potentiometers
- capacitors
- circuit boards
- lighting components
- electrical switches or sensors
- manual switches
- transmitter beacons
- batteries

- solenoids
- thermistors or thermocouples
- starter motors
- other specific motorsport related components

1.12 Report any instances where the maintenance activities cannot be fully met, or where there are identified defects outside the planned schedule

1.13 Use the evidence they have gained to during maintenance activities to improve future reliability and performance of the motorsport vehicle

1.14 Complete the relevant maintenance records accurately, to include one of the following, and pass them on to the appropriate person:
- job cards
- computer records
- company specific documentation
- formal risk assessment
- vehicle maintenance logs or reports

1.15 Dispose of waste materials, in accordance with safe working practices and approved procedures

1.16 Tidy up on completion of the electrical maintenance activities

Learning outcome

The learner will:

2. Know how to carry out maintenance activities on motorsport vehicle electrical equipment

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when carrying out electrical maintenance activities on motorsport vehicles (including lifting and handling techniques; safe working practices with regard to removing components from motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines)

2.2 Describe the hazards associated with removing and replacing motorsport vehicle electrical components, and with the tools and equipment used (such as ensuring the safe support of the vehicle at the correct working height and position, ensuring the safe isolation of the circuits/equipment, removal of fuses, misuse of tools), and how they can be minimised

2.3 Describe the protective equipment that they need to use for both personal protection and protection of the vehicle

2.4 Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation

2.5 Explain how to use and extract information from motorsport vehicle documentation (such as vehicle manuals, system diagrams, telemetry data, engineer’s records, set-up sheets, inspection reports)

2.6 Describe the importance of ensuring that they use the correct and up-to-date documentation
2.7 Describe the basic principles of how the motorsport vehicle electrical equipment functions, its operating sequence, the working purpose of individual units/components and how they interact
2.8 Describe the different types of cabling and their application (such as multicore cables, single core cables, screened cables) as used on motorsport vehicles
2.9 Describe the care, handling and application of electrical measuring instruments
2.10 Describe the techniques used to dismantle/assemble electrical equipment (such as unplugging, de-soldering, removal of screwed, clamped and crimped connections)
2.11 Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking in of the connections
2.12 Describe the methods of removing and replacing cables, wires and looms without causing damage to existing cabling or other vehicle components
2.13 Describe the use of BS/ISO wiring and other regulations when selecting wires and cables, and when carrying out tests on systems
2.14 Describe the methods of attaching identification markers/labels to removed components or cables to assist with re-assembly
2.15 Describe the tools and equipment used in the maintenance activities (such as cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
2.16 Describe the methods of checking that components are fit for purpose, and the need to replace 'lifed' items (such as seals and gaskets, overload protection devices)
2.17 Explain how to make adjustments to components/assemblies to ensure that they function correctly
2.18 Explain how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are set up correctly for the intended purpose
2.19 Describe the importance of making 'off-load' checks before proving the equipment with the electrical supply on
2.20 Describe the equipment operating and control procedures to be applied during the maintenance activity
2.21 Explain how to use appropriate lifting and handling equipment techniques in the maintenance activity
2.22 Describe the problems that can occur during the maintenance activity, and how they can be overcome
2.23 Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation
2.24 Explain when to act on their own initiative and when to seek help and advice from others
2.25 Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the maintenance activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 860 Stripping and rebuilding motorsport engines (pre-competition)

UAN:	**L/600/5988**
Level:	Level 2
Credit value:	14
GLH:	64
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 60: Stripping and rebuilding motorsport engines (pre-competition) (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to re-build a motorsport engine in a recognised sequence and to a high standard, prior to a competition. It will prepare the learner for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The activities will involve the dismantling and removal of components, inspection and checking for faults, excessive wear and potential problems, replacement of components, and rebuilding the engine using hand tools, specialist tools and test equipment, in accordance with approved procedures. It covers motorsport engines fitted into motorsport vehicles such as single seater, rally cars, sports cars, karts, historic vehicles, motorcycles and other specific approved competition vehicles. The stripping and re-building activities will include carrying out all necessary safety activities, to lift and support the engine and its ancillary components. The learner will need to lift and remove the engine from any transportation containers and place it onto

an approved holding device, ready for removing all ancillary components and the stripping and rebuilding of the engine. The learner will need to ensure that all removed components are stored safely, prior to inspection and re-building. The learner will also be expected to use recognised methods for crack testing ferrous and non-ferrous materials/components, and to be able to inspect a motorsport engine within the team's or organisation's guidelines.

The learner's responsibilities will require them to comply with recognised procedures for the stripping and rebuilding activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, the learner must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated.

On completion of the activities, the learner must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. The learner must show that they can use and maintain the tools and equipment needed for the stripping and rebuilding activities, and return them to their recognised storage area ready for further use.

The learner's knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate stripping, inspection and rebuilding procedures. The learner will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the stripping and rebuilding activities, correct faults and to ensure that the equipment is replaced to the required standard. The learner will also have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications.

The learner will understand the safety precautions required when carrying out the stripping and rebuilding activities, especially those for lifting and supporting the equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Strip and rebuild motorsport engines (pre-competition)
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following in preparation for the stripping and rebuilding of the motorsport engine: • remove engine from its transportation container, and remove dirt, oil and track debris from engine externals • visual check for damage and wear to engine externals • mount the engine on the correct mounting stand • drain all coolants and lubricants from the engine • obtain all stripping and re-building documentation, prior to disassembly • obtain suitable storage bins for the removed components 1.3 Rebuild engines for one of the following types of motorsport vehicle: • single seater • rallying • sports cars • karts • historic • motorcycles (such as circuit and off-road) • other specific approved competition vehicle 1.4 Obtain all the information they need for the motorsport engine stripping and re-building activities to be carried out 1.5 Use three of the following to aid the stripping and rebuilding of the motorsport engine: • system diagrams • lifting records • engine strip check sheets • engineer's records • engineering drawings • engine re-build sheets 1.6 Establish and, where appropriate, mark component orientation for re-assembly

1.7 Ensure that the motorsport engine is correctly mounted in the correct work area
1.8 Carry out the engine stripping and re-building activities, within the limits of their personal authority
1.9 Remove and replace the required components, using approved tools and techniques
1.10 Remove and refit motorsport engine components from three of the following areas:
- engine ancillary components (such as exhaust primaries and silencers, airboxes, engine mounts, filters)
- clutch (such as clutch covers, driven plates, thrust bearings)
- cam timing (such as pulleys, belts, gears, adjusters)
- electrical (such as generation, ignition, engine management, data control boxes, ECUs, wiring looms)
- system components (such as sensors, regulators, safety devices, gauges)

1.11 Plus assist in the stripping and re-building of motorsport engine components from three of the following areas:
- cylinder head (such as valves, valve springs, valve spring heights, rockers, valve stem seals, spark plugs)
- engine block (such as crankshafts, connecting rods, pistons, rings, main bearings, big end bearings)
- lubrication system (such as oil pumps, oil filters, scavenge pumps, oil tanks, pressure relief valves)
- fuel system (such as carburettors, fuel pumps, fuel filters, metering units, fuel rails, pressure relief valves)

1.12 Carry out eleven of the following stripping and rebuilding activities:
- removing covers and cowlings
- disconnecting electrical connections
- disconnecting and removing hoses and pipes
- proof marking/labelling of components to aid reassembly
- separation of components by means of removing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
- inspecting components for damage and wear, and identifying all components and fasteners that require replacement.
- arranging and storing components in a manner that makes re-assembly as straightforward as possible
- labelling (and storing in the correct location) components that require repair or overhaul
- replacing damaged/defective and ‘lifed’ components
- reassembly of components, using mechanical fastening devices (such as nuts, bolts, quick-release fasteners, circlips, rivets)
- checking of bearing clearances (such as using engineer’s blue or compressible strip)
- lapping in valves and valve seats
- torque setting cylinder-head bolts, in the correct sequence
- replacement of sealing devices (such as ‘O’ rings, seals, gaskets, sealing compounds)

- positioning, aligning, setting, and adjusting replaced components (such as valve spring heights, cam timing, ring gaps, torque angles)
- tightening fastenings to the required torque, and applying bolt locking methods (such as split pins, wire locking, lock nuts, engineering adhesives)

1.13 Carry out three of the following inspection and testing techniques:

- ferrous metal crack detection
- non-ferrous crack detection
- mechanical measurements
- sensory testing (such as sight, sound, smell or touch)
- connecting and setting engine to dynamometer installation

Plus two more of the following test procedures:

- compression testing
- leak down cylinder leakage testing
- carburettor vacuum testing
- ignition timing
- electrical charging tests
- other specific tests

1.14 Strip and re-build motorsport engine equipment and components, in compliance with one or more of the following standards:

- BS or ISO standards and procedures
- vehicle manufacturer's specification
- customer standards and requirements
- team/company standards and procedures
- specific engine system requirements

1.15 Take suitable precautions to prevent damage to components and surrounding systems

1.16 Report any instances where the engine stripping and re-building activities cannot be fully met, or where there are identified defects outside the planned activities

1.17 Complete the relevant documentation, in accordance with organisational requirements

1.18 Complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:

- post-competition stripdown sheets
- engineer's/team's records
- engine re-build sheet
- formal risk assessment

1.19 Label and store (in an appropriate location) components that require repair or overhaul

1.20 Dispose of waste materials and scrap components, in accordance with safe working practices and approved procedures

Learning outcome
The learner will: 2. Know how to strip and rebuild motorsport engines (pre-competition)
Assessment criteria
The learner can: 2.1 Describe the specific safety practices and procedures that they need to observe when stripping and rebuilding motorsport engines and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to dismantling motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines) 2.2 Describe the hazards associated with stripping and re-building motorsport engine components, and with the tools and equipment used (such as the safe support of the engine at the correct working height and position, the safe release of fuel and other liquids, misuse of tools), and how they can be minimised 2.3 Describe the protective equipment that they need to use for both personal protection and protection of the engine 2.4 Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation 2.5 Describe the preparations to be carried out on the engine (such as removing transportation containers, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage or excessive wear - such as leaking coolant or oil, chafing, cracks, excessive clearances; ensuring suitable storage space is readied once the systems have been removed from the engine and providing suitable containers for the storage of fasteners and other small components) 2.6 Explain how to use and extract information from motorsport engine building documentation (such as engine manuals, system diagrams, engineering drawings, engineer's records) 2.7 Describe the importance of ensuring that they use the correct and up-to-date documentation 2.8 Describe the techniques used to remove components from motorsport engines without damage to the components or surrounding systems (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components and the need to protect the system integrity by fitting blanking plugs to exposed pipes) 2.9 Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, punches, drifts) to remove a range of components (such as studs, pins, circlips, seals and gaskets, bearings, gears), and how to use release agents to help free joined parts where seizure or damage may have occurred 2.10 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners, special securing devices) 2.11 Describe the various types of electrical connectors that are used,

methods of unlocking, orientation indicators and locating and locking-in of connections

2.12 Describe the methods of lifting, handling and supporting the components/equipment during the stripping and re-building activities

2.13 Describe the methods of checking the components for damage or wear (using visual methods, measurements, and crack detection techniques)

2.14 Describe the need to use new components where checks during stripping revealed such needs; fitting together new or prototype components where a degree of initial fitting may be needed (such as filing, fettling, reaming, tapping, shimming, polishing and adjusting to achieve the required assembly specification); sealing and securing components (such as using nuts, bolts and associated fasteners, rivets, circlips, sealants and locking compounds); checking for correctness of fit and accuracy at critical stages during the rebuild and on completion of the assembly

2.15 Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)

2.16 Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used

2.17 Describe the tools and equipment used in the engine stripping and re-building activities, and their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the stripping and re-building activities

2.18 Explain how to deal with problems (such as what to do when components are damaged or worn in some way, the correct equipment or parts not available, components do not come apart as readily as expected)

2.19 Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation

2.20 Describe the procedure for the safe disposal of waste materials, scrap components, contaminated oil and fuel

2.21 Explain when to act on their own initiative and when to seek help and advice from others

Unit 861 Producing CAD models (drawings) using a CAD system

UAN:	**Y/600/5993**
Level:	Level 2
Credit value:	11
GLH:	61
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 61: Producing CAD models (drawings) using a CAD system (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to set up and operate a computer aided modelling system to produce detailed three-dimensional models for engineering activities. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be given a specific 'model' brief or a request for a change/modification to a model, and they will be required to access these requirements and to extract all necessary information in order to carry out the modelling operations. The learner will need to select the appropriate equipment and modelling software to use, based on the type and complexity of the drawing functions to be carried out. The learner will be expected to produce models in a 3D modelling environment, and to print 2D and 3D prints or plots. On completion of the modelling activities, the learner will be expected to return all documentation, reference manuals or specifications to the designated location, to

shut down the CAD system correctly, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for working with the CAD equipment. The learner will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or drawing procedures, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate computer aided drawing procedures and techniques for 3D modelling and conventional mechanical and production engineering drawings. The learner will understand the modelling CAD system and software used, and its application, and will know about the various tools and techniques used to produce the models and drawings, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the computer modelling/drawing system. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce CAD models (drawings) using a CAD system
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Prepare the CAD system for operation, by carrying out all of the following: • check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed)

- power up the equipment and activate the appropriate modelling software
- set up the modelling environment and select a suitable template/folder
- set up and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter)
- set the drawing datum at a convenient point (where applicable)
- create a modelling template to the required standards, which includes all necessary detail (such as title, file/drawing number, material, date)

1.3 Plan the modelling activities before they start them

1.4 Use appropriate sources to obtain the required information for the model to be created

1.5 Use three of the following to obtain the necessary data to produce the required model:

- model brief/request
- change order/modification request
- manuals
- calculations
- sketches
- specifications
- regulations
- sample component
- previous models/designs
- other available data
- standards reference documents (such as limits and fits, tapping drill charts)
- notes from meetings/discussions

1.6 Take into account three of the following, as appropriate to the model being produced:

- function
- quality
- manufacturing method
- ergonomics
- materials
- cost
- lifetime of the product
- tolerances
- clearance
- aesthetics
- physical space
- operating environment
- interfaces
- safety

1.7 Carry out all of the following before producing the engineering model:

- ensure that the data and information they have is complete and accurate
- review the data and information to identify the model requirements
- recognise and deal with problems (such as lack of, or incorrect, information and technical issues)

1.8 Access and use the correct modelling software

1.9 Use appropriate techniques to create models that are sufficiently and clearly detailed

1.10 Use one of the following modelling tools:

- surface modelling
- solid modelling
- wire frame modelling

1.11 Use all of the following CAD operations to highlight design areas in the modelling environment:

- pan
- isometric
- zoom

1.12 Produce models which include the use of the following from the part feature menu:

- constrained parts

Plus eight more from the following:

- extrude
- revolve
- hide
- fillet
- shell
- solid model
- wire frame
- rib
- cut/remove
- mirror
- radius
- rectangular pattern
- circular pattern

1.13 Modify parts in the assembly environment using the following feature:

- constrained parts and assemblies

Plus eight more from the following:

- straight lines
- dimensions
- angular surfaces
- text
- surface texture
- insertion of standard components
- symbols and abbreviations
- curved surfaces

- circles or ellipses
- material colour
- hidden detail
- hatching and shading
- parts lists
- other specific detail

1.14 Produce the following to provide sufficient detail for manufacture:
- 3D isometric or model view to provide a pictorial view

Plus one more from the following:
- first angle 2D drawings (2 or 3 views) with dimensions
- third angle 2D drawings (2 or 3 views) with dimensions
- the most informative model that could be dimensioned

1.15 Use codes and other references that follow the required conventions

1.16 Produce models which comply with one or more of the following:
- organisational guidelines
- statutory regulations and codes of practice
- CAD software standards
- BS and ISO standards
- other international standard

1.17 Make sure that models are checked and approved by the appropriate person

1.18 Save the models in the appropriate file type and location

1.19 Save and store models in appropriate locations, to include carrying out all of the following:
- ensure that their model has been checked and that it complies to their company QA procedure
- check that the model is correctly titled, referenced and annotated
- save the model to an appropriate storage medium (such as hard drive, disc, CD, external storage device)
- create a separate backup copy, and place it in safe storage
- register and store the models in the appropriate company information system (where appropriate)
- record and store any changes to the models in the appropriate company information system (where appropriate)

1.20 Produce hard copies of the finished models, with sufficient detail to allow production

1.21 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.22 Shut down the CAD system to a safe condition on completion of the modelling activities

Learning outcome
The learner will: 2. Know how to produce CAD models (drawings) using a CAD system
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when working with computer systems (to include such things as safety guidance relating to the use of Visual Display Unit (VDU) equipment and work station environment such as lighting, seating, positioning of equipment; Repetitive Strain Injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections) 2.2 Describe the importance of good housekeeping arrangements (such as cleaning down work surfaces; putting disks, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition) 2.3 Describe the relevant sources and methods for obtaining any required technical information relevant to the model being produced (such as drawing briefs, specification sheets, request for changes or modifications to models; technical information such as limits and fits, contraction allowances, bearing selection, surface finish) 2.4 Describe the identification of the correct 3D drawing software package from the menu or windows environment; the various techniques that are available to access and use the CAD software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners) 2.5 Describe the correct start-up and shutdown procedures to be used for the computer systems 2.6 Explain how to access the specific computer modelling software to be used, and the use of the help file to aid efficient operation of the relevant drawing system 2.7 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads) 2.8 Describe the documentation required for particular applications (such as design briefs, specification sheets, request for change orders) 2.9 Describe the types of drawings that may be produced by the modelling software 2.10 Explain how to set up the viewing screen to show multiple views of the component to help with drawing creation (to include isometric front and side elevations) 2.11 Describe the national, international and organisational standards and conventions that are used for the models/drawings 2.12 Describe the application and use of modelling tools (such as for straight lines, curves and circles; how to add dimensions and text to drawings) 2.13 Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment 2.14 Describe the applications of different 3D modelling programmes (such as surface, solid and wire frame) 2.15 Describe the need for document control (such as ensuring that

completed models are approved, labelled and stored on a suitable storage medium)

2.16 Explain why it is necessary to be able to recall previous issues of modified models

2.17 Describe the need to create backup copies, and to file them in a separate and safe location away from electromagnetic sources, filing and storing hard copies for use in production

2.18 Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

2.19 Explain when to act on their own initiative and when to seek help and advice from others

2.20 Describe the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 862 Producing engineering project plans

UAN:	**H/600/5995**
Level:	Level 2
Credit value:	8
GLH:	37
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 62: Producing engineering project plans (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to produce detailed plans for an engineering project. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the project planning activity by obtaining all necessary information, drawings, specifications and documentation. In producing the project plan, the learner will need to clearly identify what has to be done, the processes required to achieve this, the materials, component or consumables required, detailed instructions/operation sequence required, the estimated timescales and costs involved, the quality control requirements, and how they will evaluate and prove that the finished project has met its aims. The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the project planning activities undertaken. The learner will need to take

account of any potential difficulties or problems that may arise with the project planning activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate engineering project planning principles. The learner will understand the project planning techniques and procedures used, and their application, and will know about the engineering equipment, materials and consumables that will be required, to the required depth to provide a sound basis for carrying out the activities and producing project plans that will lead to a successful project outcome.

The learner will understand the safety precautions required when carrying out the project planning operations. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Produce engineering project plans
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Produce detailed engineering project plans for one of the following: • manufacturing operations • research and development • cleaning of equipment • maintenance of equipment • testing and trialling • process procedures • installation of equipment • modification or repair 1.3 Determine the scope of the project and the processes required to achieve it 1.4 Collect all the information needed to prepare the project plan 1.5 Prepare for the project planning activity by carrying out all of the

following:

- determine and set the aims and objectives of the project
- obtain all essential information and data needed to produce the project plans
- collect relevant information on the engineering requirements, operations, methods and resources
- determine the availability of the resources required
- ensure that health and safety regulations and safe working practices are taken into account
- present the engineering plans in the appropriate formats

1.6 Determine the resources required to include five of the following:

- people required who have the necessary skills and knowledge
- the raw materials required (such as types of material, forms of material, amounts of material)
- mechanical fasteners required (such as nuts, bolts, rivets, cable clips)
- bought-in standard components required (such as bearings, electrical or electronic components, fluid power components)
- equipment required (such as hand tools, power tools, machinery, lifting and handling equipment)
- measuring or test equipment required (such as mechanical measuring, electrical measuring)
- lifting and moving equipment required
- consumable materials required (such as welding accessories, masking mediums, oil)
- any outside support services required (such as material treatments like hardening or plating)
- special/specific safety equipment required (such as fume extraction)

1.7 Identify the specific operations to be carried out, and determine their sequence

1.8 Produce detailed work instructions of the specific processes required, to include all of the following:

- details of the drawing/specification to be used (such as drawing number, maintenance manual)
- specific materials required for this part of the process/operation
- the specific tools and equipment required for each operation being carried out
- the specific operations to be carried out
- the specific sequence in which the operations must be carried out
- the specific time to produce/complete the operations
- quality control checks that need to be implemented

1.9 Identify health and safety issues, and safe working practices and procedures that must be followed

1.10 Estimate timescales required and costs to complete the project

1.11 Prepare a detailed project plan which accurately reflects the project aims and objectives

1.12 Produce engineering project plans that include both of the

following:

a) The use of a Gantt Chart showing estimates of the timeframe for the project, to include all of the following:

- start time of the project
- outcomes to be achieved at milestones
- completion date of the project

b) An estimate of the likely costs of the project, to include all of the following:

- material costs (to include raw, consumable, bought-in)
- labour costs (based on the estimated working time and a fixed manufacturing cost figure)
- overhead costs

1.13 Prepare engineering project plans that include all of the following:

- the aims and objectives of the engineering project being undertaken
- description of the activities to be carried out
- the sequence in which the activities will take place
- the documentation to be used (such as drawings, specifications, quality assurance)
- tooling requirements (such as jigs, fixtures, cutting tools, moulds)
- resources required
- the timescales to be met
- any special requirements that must be met (such as details of health and safety issues)
- outcomes in terms of quality, cost and delivery (when needed)
- people involved, and their responsibilities (such as decision maker, individuals that must be consulted/informed, people who can give advice)
- how the project will be proved and evaluated

1.14 Ensure that project plans include any relevant regulations, standards and guidelines, including all of the following:

- health and safety requirements
- BS and ISO standards and procedures
- company policy and procedures

1.15 Record and present the plans to the appropriate people, using the following methods:

- verbal report

Plus one more method from the following:

- written or typed report
- specific company documentation
- computer based presentation

1.16 Obtain approval for the project plan from the appropriate people

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

Learning outcome
The learner will: 2. Know how to produce engineering project plans
Assessment criteria
The learner can: 2.1 Explain how to access information on health and safety regulations and guidelines relating to the engineering activities to be used and project plans being produced 2.2 Describe the implications of not taking account of legislation, regulations, standards and guidelines when producing the engineering project plans 2.3 Explain how to obtain information on the engineering requirements, and the type of information that is available (such as customer specifications and instructions, quality control requirements, product drawings/specification, manufacturing methods) 2.4 Explain how to access and use the appropriate information and documentation systems 2.5 Describe the types of data that should be included in the engineering project plans (such as aims and objectives of the project, activities to be carried out, sequence in which they must be carried out, timescales, resource requirements, health and safety issues) 2.6 Explain how to extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work being planned 2.7 Describe the materials, formats, codes and conventions that are used in preparing the engineering project plans 2.8 Describe the main project planning methods and techniques in use, and what problems could occur with them 2.9 Describe the factors to be taken into account when preparing the project plans, especially those covering working conditions and safety 2.10 Describe the main types of resource involved with the various types of engineering activity (such as raw materials, bought-in components, plant and equipment, lifting and handling equipment, tooling and measuring and test equipment) 2.11 Describe the obvious (and hidden) costs of resources/activities 2.12 Describe the normal timescales for carrying out specific engineering activities, and how and why they vary 2.13 Explain how to arrive at an estimate of timescales for the project, and the need to set milestones for achievement 2.14 Explain how to estimate the likely costs of the project (including the cost of raw materials, people and overheads) 2.15 Describe the products (or assets) involved in the activity being planned, and how to determine their availability 2.16 Describe the development of the engineering project plans (to include both master documents and working instructions, along with their purpose, content and status) 2.17 Explain how to write project plans that specify quality, cost and delivery requirements (including allocation of responsibilities and milestone targets) 2.18 Explain how to prepare the plans (to include the structure, style, clarity and compliance with relevant standards)

2.19	Describe the process used in the organisation to validate the engineering plans produced
2.20	Describe the procedures for changing the plans, and why control procedures are used
2.21	Describe the procedures and process for project plan approval, and why these procedures and processes are used
2.22	Describe the importance of maintaining records, what needs to be recorded and where records are kept
2.23	Explain why contingency plans need to be drawn up
2.24	Describe the different ways of presenting information to different people
2.25	Describe the importance of providing the right information at the right time
2.26	Describe the typical of problems that can occur during the implementation of the plan, and how these problems can be rectified
2.27	Explain when to act on their own initiative and when to seek help and advice from others

Unit 863 Using computer software packages to assist with engineering activities

UAN:	**K/600/5996**
Level:	Level 2
Credit value:	8
GLH:	37
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 63: Using computer software packages to assist with engineering activities (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to operate a computer and use a variety of software packages to assist with engineering activities, such as report writing, stock/stores control, costing activities and electronic mail. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The types of software package used will include the Windows™ operating system, word processing, databases, spreadsheets, graphics packages and electronic mail. The learner will be expected to check that all power leads and peripheral connecting leads from their workstation are correctly and securely connected to the appropriate terminations, and that they are safely routed so as not to cause a trip hazard. The learner will use the correct procedure to power up and operate the computer and peripheral hardware, to access the appropriate software packages and to create and maintain suitable work folders and files. On completion of the activities, the learner will

be expected to shut down the software and computer system, using the correct procedures, to return all documentation, reference manuals or specifications to the designated location, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for working with the computer equipment. The learner will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or activities undertaken, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate computer operating procedures and techniques safely. The learner will understand the computer system and software packages used, and their application, and will know about the various tools and techniques used to carry out the various activities, to the required depth to provide a sound basis for carrying out the activities correctly.

The learner will understand the safety precautions required when working with the computer system. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Use computer software packages to assist with engineering activities
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Check that all connections to the computer and peripherals are correctly connected and in a safe working condition 1.3 Prepare the computer system for operation, by carrying out all of the following:

- check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed)
- power up the equipment and, where appropriate, log in as a user
- check that all peripheral devices are operating correctly (such as keyboard, mouse, light pen, web camera, digitiser/tablet, scanner, printer/plotter)
- create and maintain folders and files, in accordance with organisational procedures

1.4 Power up the equipment, using the correct operating procedures

1.5 Use appropriate sources to obtain the required information for the activities to be undertaken

1.6 Access the correct application software for the activities undertaken

1.7 Use appropriate techniques to create files and documents, in the required formats, that are sufficiently and clearly detailed

1.8 Use all of the following software packages:

Word-processing: produce three of the following types of documentation:

- standard letter
- memorandum
- facsimile
- Curriculum Vitae (CV)
- project report
- work timetable
- layouts/templates
- macros
- other specific application

Database: create and use a database for two of the following applications:

- personnel details list
- address list (such as for mail merging)
- customer/sales details
- stock control (such as tools or stationery)
- plant maintenance information
- fault diagnosis information
- other specific application

Spreadsheet: create and use spreadsheets for two of the following applications:

- budgeting
- cost analysis (such as transport, photocopying, materials)
- wages
- project costing
- other specific application

Graphics: use graphics software to produce two of the following types of documentation:

- preparing visual aids for a presentation
- producing advertising material
- producing technical information

- producing logbook entries
- other specific application

Electronic communication: use two of the following methods :

- company e-mail system
- internet e-mail
- mobile text messaging
- web camera chat/conferencing

1.9 Carry out all of the following whilst using the software packages:

- ensure that they have all the required information/data for the activities to be carried out
- open or create a suitable word processing file/format document which will display the information effectively
- create a suitable spreadsheet/worksheet which contains a suitable number of cells and rows of the required width
- where appropriate, enter formulae at the relevant point within the worksheet
- use graphs which are representative of the information to be shown
- create a suitable database with appropriate alpha/numeric fields and search facilities
- use a font style and size of text in keeping with organisational codes and specific job requirements
- enter alpha and numeric data/text accurately into the correct location
- select and use appropriate text features (such as bold, italics, colour, underline)
- import and export information to and from other files or software packages
- correct routine errors or mistakes in operation
- edit documents, using appropriate techniques for the package being used (such as using sort, search and replace, spelling and grammar checks)

1.10 Save and store files in appropriate locations, to include carrying out all of the following:

- create a group of folders or directories in which related files can be stored
- check that the file/document is correctly titled and referenced
- determine the size of the file/document, and check for sufficient space on the storage device for saving it
- save the file/document to an appropriate storage medium (such as hard drive, disc, CD, external storage device)
- where appropriate, create a separate backup copy and place it in safe storage
- produce a hard copy printout of the file/document

1.11 Use computer software packages in compliance with one or more of the following:

- organisational guidelines
- statutory regulations and codes of practice
- computer software standards

- BS and ISO standards

1.12 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.13 Shut down the computer system to a safe condition on completion of the activities

Learning outcome
The learner will: 2. Know how to use computer software packages to assist with engineering activities
Assessment criteria
The learner can: 2.1 Describe the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of Visual Display Unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), Repetitive Strain Injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections) 2.2 Describe the importance of good housekeeping arrangements (such as cleaning down work surfaces; putting disks, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition) 2.3 Describe the correct start-up and shutdown procedures to be used for the computer systems 2.4 Describe the identification of the correct software package from the menu or operating systems environment; the various techniques that are available to access and use the software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners) 2.5 Describe the use of software manuals or help facilities and related documents to aid efficient operation of the relevant software system 2.6 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads) 2.7 Describe the various software packages that are used within an engineering environment (such as word processing, databases, spreadsheets, graphic design and drawing packages, and electronic communication) 2.8 Describe the use of personal access codes, and logging on/off procedures that are required 2.9 Describe the various standard document formats that are used (such as letters, memoranda, facsimile, technical reports) 2.10 Explain how to create and set up a spreadsheet/worksheet, and how to determine and set out the required number of cells, rows, cell width 2.11 Explain how to create a database record, and how to determine and set out the required alpha/numeric fields of the correct size and type 2.12 Explain how to enter alpha/numeric and formulaic data, using keyboards, mouse and menu/tool bar facilities

2.13	Explain how to use highlighting/enhancement features and techniques
2.14	Explain how to edit documents using sort, search and edit facilities, spelling and grammar checks
2.15	Explain how to create tables, charts and graphs
2.16	Explain how to import and export files to and from other locations and other software packages
2.17	Explain how to save and store files/documents (such as determining document size; how to check that there is sufficient space to save the file in their chosen destination; saving and naming the file/document)
2.18	Describe the need to create backup copies, and to file them in a separate and safe location away from electromagnetic sources
2.19	Explain how to produce hard copies of the documents that they have been working on
2.20	Explain when to act on their own initiative and when to seek help and advice from others
2.21	Describe the importance of leaving the work area and equipment in a safe condition on completion of the activities (such as correctly isolated, removing and disposing of waste)

Unit 864 Conducting business improvement activities

UAN:	**M/600/5997**
Level:	Level 2
Credit value:	8
GLH:	41
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 64: Conducting business improvement activities (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to conduct a business improvement activity using a systematic plan, do, check, act approach for an engineering operation or process. It will prepare the learner for entry into the engineering industry or engineering manufacturing sector, creating a progression between education and employment and acting as a basis for the development of additional skills and occupational competencies in the working environment. The learner will be expected to adopt a systematic approach to conducting business improvement activities on an engineering/manufacturing operation or process to identify opportunities for the elimination of waste. The learner will be required to conduct a 5S/5C audit and identify wasteful or non-added value activities in the operation or process. The learner will need to produce a new Standard Operating Procedure (SOP) or contribute to improving an existing SOP. These activities will include creating the appropriate visual management systems required, calculating key performance indicators required and the quality control requirements and presenting records of the business improvement activities and how they will meet their aims.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the business improvement activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the business improvement activities and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision whilst taking responsibility for their own actions and the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, in order to safely apply appropriate engineering principles to business improvement activities. The learner will understand the tools and techniques used in business improvement activities and procedures used, and their application, and will know about the engineering equipment, materials and consumables that will be required, to the required depth to provide a sound basis for carrying out the activities and producing project plans that will lead to a successful project outcome.

The learner will understand the safety precautions required when carrying out the business improvement activities for engineering operations and processes. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Learning outcome
The learner will: 1. Conduct business improvement activities
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 Apply and document a systematic Plan, Do, Check, Act (PDCA) approach to problems/improvement activities 1.3 Identify improvements within the operation or process for three of the following: • reduced product cost • improved safety

- improvement in delivery performance
- reduction in lead times
- improved quality
- improvements to working practices
- reduction in waste
- improvement in customer satisfaction

1.4 Apply the principles of workplace organisation to an operation or process using a 5S/5C audit and a 'red tag' exercise

1.5 Identify where information, tools and/or equipment are missing and where improvement can be made to increase the 5S/5C score

1.6 Apply the principle and processes of visual management to a operation or process using a variety of visual management techniques

1.7 Identify appropriate parts of the operation or process that will have visual controls

1.8 Identify key performance indicators that will be displayed in the work area

1.9 Determine and calculate both of the following:

- not right first time
- delivery schedule achievement

Plus one more of the following:

- Parts Per Operator Hour (PPOH)
- Value Added Per Person (VAPP)
- cost breakdown in term of labour, material and overhead
- Overall Equipment Effectiveness (OEE)
- stock turns
- Floor Space Utilization (FSU)

1.10 Produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process

1.11 Produce/contribute to improvements in existing standard operating procedures for three of the following:

- customer service
- cleaning of equipment
- maintenance of equipment
- health and safety practices
- process procedures
- manufacturing operations
- product quality

1.12 Create and/or update visual controls that promote the following:

- producing shadow boards to standardise the storage and location of area equipment
- colour coding of equipment

Plus four more of the following:

- safety
- zero defects
- performance measures
- process control boards
- parts control system

- skills matrices
- process concerns or corrective actions
- work in progress locations and quantities (WIP)
- standard operating procedures
- workplace organisation
- problem resolution (such as Kaizen boards)
- autonomous maintenance worksheets

1.13 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

1.14 Record and present the records from business improvement activities to the appropriate people using:

- verbal report using visual aids such as flipcharts and white boards

Plus one more method from the following:

- written or typed report
- specific company documentation
- computer based presentation

Learning outcome
The learner will: 2. Know how to conduct business improvement activities
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements of the area in which they are carrying out the business improvement activities 2.2 Explain how to conduct a systematic Plan, Do, Check, Act (PDCA) approach to problem-solving and business improvement 2.3 Describe the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities 2.4 Explain what is meant by business improvement, and how continuous improvement activities can benefit a company 2.5 Describe the application of the DTI's seven key measures of competitiveness (delivered right first time, delivery schedule achievement, people productivity, stock turns, overall equipment effectiveness, value added per person, floor space utilisation) 2.6 Explain how to obtain and interpret information on the engineering/manufacturing operation or process requirements (such as customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used) 2.7 Describe the eight wastes (over-production, inventory, transport, over-processing, waiting time, operator motion, bad quality, failure to exploit human potential) and how to eliminate these forms of waste in a process or operation 2.8 Describe the steps in a 5S/5C audit and a 'red tag' exercise and how to carry them out 2.9 Explain how to score and audit the 5S/5C exercise 2.10 Explain how to arrange and label the necessary equipment for rapid

	identification and access
2.11	Explain how to use “root cause” problem solving analysis using the 5 Whys/How technique
2.12	Explain how to evaluate improvement ideas in order to select those that are to be pursued
2.13	Explain how improvements to the process are achieved by engaging the knowledge and experience of the people working on the process
2.14	Explain how to create standard operating procedures (SOP’s) and correlate work activities into them.
2.15	Describe the techniques required to communicate information using visual control systems (such as, Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)
2.16	Explain how information and equipment can be displayed for various work applications (IT systems)
2.17	Describe the extent of their own authority and whom they should report to, in the event of problems that they cannot resolve

Unit 865 General machining, fitting and assembly applications

UAN:	**M/600/6003**
Level:	Level 2
Credit value:	12
GLH:	55
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 65: General machining, fitting and assembly applications (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic machining, fitting and assembly activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to carry out practical exercises in order to gain an understanding of how these machining, fitting and assembly activities are undertaken, the types of equipment used, the manufacturing techniques, and the operating and safety procedures that are required. In carrying out the activities, the learner will use appropriate tools and equipment to mark out the material for the features to be produced, and then to use hand tools, portable power tools, machine tools and shaping, fitting and assembly techniques appropriate to the operations being performed. These activities will include such things as hand sawing, filing, drilling, turning, milling and assembly.

During, and on completion of, the operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise when the activities are not meeting the required specification, and to discuss/determine what action needs to be taken to remedy any faults that occur, in order to ensure that the finished workpiece is within the specification requirements. On completion of the activities, the learner will be expected to return all tools and equipment that they have used to the correct location, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate machining, fitting and assembly techniques and procedures safely. The learner will understand the machining, fitting and assembly processes, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the various machining, fitting and assembly techniques, and when using hand tools and machinery. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out general machining, fitting and assembly applications
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the machining, fitting and assembly activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that all hand tools and equipment used are in a safe and serviceable condition (such as cables to hand tools and extension leads, file handles, hammer striking faces) • ensure that all machine tools are correctly guarded at all times • check that all measuring equipment is within calibration date • return all tools and equipment to the correct location on completion of the fitting activities 1.3 Determine what has to be done and how they are going to do it 1.4 Obtain the appropriate tools and equipment for the manufacturing operations 1.5 Mark out the components for the required operations, using appropriate tools and techniques to include all of the following: • preparing/determining suitable datums from which to mark out (such as choosing a machine face or filing a flat face as a datum) • applying a marking medium to enhance clarity of the marking out • using an appropriate method of marking out (such as direct marking using instruments, use of templates or tracing/transfer methods) • using a range of marking out equipment (such as rules, squares, scribers, Vernier instruments) • marking out a range of features (such as datum/centre lines, square/rectangular profiles, circles/radial profiles, hole positions) 1.6 Cut and shape the materials to the required specification, using appropriate tools and techniques 1.7 Cut and shape two different types of material from the following: • low carbon/mild steel • high carbon steel • cast iron • stainless steel • aluminium/aluminium alloys • brass/brass alloys • plastic/nylon/synthetic • composite

- other specific material

1.8 Use appropriate methods and techniques to assemble and secure the components in their correct positions

1.9 Use three of the following workholding devices:

- bench vice
- machine vice
- clamps (such as toolmaker's)
- three-jaw chuck
- four-jaw chuck
- collet chuck
- drive plate and centres

1.10 Use a range of hand fitting methods, to include all of the following:

- cutting out the rough profile using saws (such as hacksaw, band saw)
- cutting a screw thread (such as by tapping or dieing)
- filing flat and square
- filing a curved profile
- drilling holes

1.11 Produce mechanical assemblies, using six of the following methods and techniques:

- assembling components having interference fits (such as by pressure, expansion or contraction)
- securing components using threaded fasteners (such as nuts, bolts, machine screws, cap screws)
- securing components using spring clips (such as external circlips, internal circlips, special clips)
- using locking and retaining devices (such as tab washers, locking nuts, wire locks, special purpose types)
- securing components using rivets (such as countersunk, roundhead, blind, special purpose types)
- applying sealing compounds or adhesives
- electrical bonding of components
- setting and adjusting components to give correct working parameters (such as shimming and packing)
- torque setting of nuts and bolts

1.12 Carry out turning operations to include all of the following:

- mounting the workpiece in an appropriate workholding device
- mounting cutting tools in tool holders to give the correct centre height
- selecting and setting appropriate feeds and speeds
- facing off
- producing parallel diameters
- producing stepped diameters
- producing tapered diameters
- centre drilling and drilling a hole
- reaming or boring a hole

1.13 Carry out milling operations, to include all of the following:

- mounting the workpiece in an appropriate workholding device

- mounting cutting tools on appropriate arbors or direct to the machine spindle
- selecting and setting appropriate feeds and speeds
- producing flat and square faces
- producing parallel faces
- producing angular faces
- producing an enclosed slot
- producing an open ended slot

1.14 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.15 Carry out the necessary checks for accuracy, to include all of the following:
- linear dimensions (such as lengths, depths)
- diameters (such as external, internal)
- flatness
- squareness
- angles
- profiles
- hole size and position
- thread size and fit
- surface finish

1.16 Use the following measuring equipment during the checking activities:
- external micrometers
- Vernier/digital/dial calliper
- surface finish equipment (such as comparison plates, machines)

Plus four more of the following:
- rules
- squares
- protractors
- depth micrometers
- depth Verniers
- feeler gauges
- bore/hole gauges
- slip gauges
- radius/profile gauges
- thread gauges
- Dial Test Indicators (DTI)

1.17 Produce components within all of the following standards, as applicable to the process:
- components to be free from false tool cuts, burrs and sharp edges
- dimensional tolerance +/- 0.25mm or +/- 0.010”
- flatness and squareness within 0.125mm per 25mm or 0.005” per inch
- angles within +/- 1 degree

- screw threads to BS Medium fit
- reamed holes within H8
- surface finish 63µin or 1.6µm

1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Leave the work area in a safe and tidy condition on completion of the manufacturing activities

Learning outcome
The learner will: 2. Know how to carry out general machining, fitting and assembly applications
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the machining, fitting and assembly activities undertaken (such as wearing appropriate protective clothing and equipment, using machine guards, and of keeping the work area safe and tidy 2.2 Describe the hazards associated with the activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles, using machine tools), and how they can be minimised 2.3 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.4 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.5 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking-out medium) 2.6 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum 2.7 Describe the use of marking-out conventions when marking out the workpiece (such as datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles) 2.8 Describe the various fitting activities to be carried out (such as how to file flat, square and curved surfaces and achieve a smooth surface finish; how to select saw blades for different materials, and how to set the saw blades for different operations; how to produce screw threads on workpieces using hand dies; how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence) 2.9 Explain how to prepare drilling machines for operations (such as adjustment of table height and position; mounting and securing drills, in chucks or Morse taper sockets; setting and adjusting spindle speeds; setting and adjusting guards/safety devices)

2.10	Describe the methods of holding the workpiece for the hand fitting, turning and milling activities (such as in a bench vice, machine vice, chuck, collets or clamped directly to the machine table)
2.11	Describe the assembly methods, techniques and procedures to be used; how the components are to be aligned, adjusted and positioned prior to securing them, and the tools and equipment that is used
2.12	Describe the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)
2.13	Describe the various turning operations that can be performed (such as parallel, stepped and tapered external diameters, drilled, bored and reamed holes, internal and external screw threads, special profiles)
2.14	Describe the various milling operations that can be performed (such as flat, parallel, square and angled surfaces; open ended and enclosed slots, special forms, drilled and bored holes)
2.15	Explain how to mount and secure the cutting tools in the tool holding devices (such as front or rear tools posts; mounting cutters on long or stub arbors; mounting drills in chucks or by the use of Morse taper sockets; the need to ensure that the tool is sharp and secure)
2.16	Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
2.17	Describe the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
2.18	Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
2.19	Explain how to check the workpiece and the measuring equipment that is used (such as rules, micrometers, Verniers, gauges and surface finish comparison equipment)
2.20	Describe the need to check that the measuring equipment is within current calibration dates, and that the instruments are correctly zeroed; measuring internal and external dimensions (such as lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)
2.21	Explain when to act on their own initiative and when to seek help and advice from others
2.22	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the machining and fitting activities (such as isolating machines, removing and returning cutting tools, cleaning the equipment, and removing and disposing of waste)

Unit 866 General fabrication and welding applications

UAN:	**T/600/6004**
Level:	Level 2
Credit value:	12
GLH:	55
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 66: General fabrication and welding applications (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic fabrication, assembly and welding activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to carry out practical exercises in order to gain an understanding of how these fabrication, assembly and welding activities are undertaken, the type of equipment used and the manufacturing techniques and operating and safety procedures that are required. In carrying out the activities, the learner will use appropriate tools and equipment, based on the type and thickness of material and the operations to be carried out. The learner will need to mark out the material for the features to be produced, and then to use hand tools, portable power tools and machines to produce a variety of shapes, profiles and forms. The learner will also be expected to produce fabrication assemblies using mechanical fastening devices; self secured joints, and thermal joining methods.

During, and on completion of, the operations, the learner will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. The learner will need to be able to recognise when the activities are not meeting the required specification, and to discuss/determine what action needs to be taken to remedy any faults that occur, in order to ensure that the finished workpiece is within the specification requirements. On completion of the activities, the learner will be expected to return all tools and equipment that they have used to the correct location, and to leave the work area in a safe and tidy condition.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fabrication, assembly and welding activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate fabrication, assembly and welding techniques and procedures safely. The learner will understand the cutting, forming, assembly and welding processes, and their application, and will know about the tools and equipment used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the fabrication activities, and when using the various tools and equipment, especially those involved in using guillotines and bending/forming equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out general fabrication and welding applications
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the fabrication and welding activities: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure that all hand tools and equipment used are in a safe and serviceable condition (such as extension leads, powered hand tools and welding equipment cables, welding plant hoses, the striking faces of chisels and hammers, guillotines, shears and forming machines) • check that all measuring equipment to be used is within calibration date • return all tools and equipment to the correct location on completion of the fabrication activities 1.3 Determine what has to be done and how they are going to do it 1.4 Obtain the appropriate tools and equipment for the fabrication operations 1.5 Mark out the components for the required operations, using appropriate tools and techniques to include all of the following: • preparing/determining suitable datums from which to mark out • applying a marking medium to enhance clarity of the marking out (such as chalk, bluing or paint) • using an appropriate method of marking out (such as direct marking using instruments, use of templates or tracing/transfer methods) • using a range of marking-out equipment (such as rules/tapes, straight edge, squares, scribers, dividers or trammels, protractors, punch) • marking out a range of features (such as datum/centre lines, square/rectangular profiles, circles/radial profiles, hole positions, cutting and bending detail) 1.6 Cut and shape the materials to the required specification, using appropriate tools and techniques 1.7 Use two appropriate materials from the following: • hot rolled mild steel • cold rolled mild steel • coated mild steel (such as tinned, galvanised) • stainless steel • aluminium • brass • copper

- lead
- titanium

1.8 Cut and form material to the marked-out shape, using six of the following hand tools:

- tin snips
- bench shears
- saws (such as hand, mechanical, band)
- hand power tools (such as drill, nibbling, saw)
- hammers/panel beating equipment
- stakes and formers
- trepanning
- files
- pneumatic tools
- free hand thermal cutting (such as gas or plasma)

1.9 Cut and form material to the marked-out shape, using all of the following machine tools:

- guillotine
- pillar or bench drill
- bending machine (hand or powered)

Plus two more from the following:

- press
- punch/cropping machine
- nibbling machine
- rolling machine (hand or powered)
- trepanning machine
- wheeling machine
- jenny/wiring machine
- swaging machine

1.10 Perform cutting and forming operations to produce four of the following shapes:

- straight cuts
- cut-ins (straight and curved)
- notches
- external curved contours
- internal curved contours
- round holes
- square holes

Plus four of the following:

- bends/upstands
- folds/safe edges
- tray/box sections
- wired edges
- swages
- curved panels
- cylindrical sections
- square-to-round trunking

- ribbed components

1.11 Use the appropriate methods and techniques to assemble and secure the components in their correct positions

1.12 Assemble fabricated components, using four of the following methods:
- temporary tack welding
- soldering or brazing
- resistance spot welding
- riveting (such as hollow or solid)
- adhesive bonding
- mechanically fastened (such as bolts, screws)
- self securing joints (such as knocked up, paned down, swaged, joggled)

1.13 Use manual welding and related equipment, to include one of the following welding processes:
- manual metal-arc
- MIG/MAG
- TIG
- manual gas welding

1.14 Produce two of the following welded joints of at least 150mm long, with at least one stop and start included:
- fillet lap joints
- corner joints
- Tee fillet joints
- butt joints

1.15 Produce fabricated components and assemblies which meet all of the following:
- all dimensions are within +/- 3.0mm or +/- 0.125"
- finished components meet the required shape/geometry (such as squareness, straightness, angularity and being free from twists)
- completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
- all components are correctly assembled, and have secure and firm joints
- welds are adequately fused and have a uniform profile, free from excessive undulations, with regular and even ripple formation
- the weld surface is free from cracks and substantially free from porosity, shrinkage cavities and trapped slag

1.16 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.17 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.18 Leave the work area in a safe and tidy condition on completion of the manufacturing activities

Learning outcome
The learner will: 2. Know how to carry out general fabrication and welding applications
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the fabrication and welding activities undertaken 2.2 Describe the personal protective clothing and equipment to be worn when carrying out the fabrication and welding activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy 2.3 Describe the hazards associated with carrying out fabrication and welding activities (such as handling sheet materials; using dangerous or badly maintained tools and equipment; operating guillotines and bending machines; using hand and bench shears; the electric arc; fumes and gases; spatter; hot slag and metal), and how they can be minimised 2.4 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken 2.5 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.6 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking-out medium) 2.7 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum 2.8 Describe the use of marking-out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles) 2.9 Describe the tools and techniques available for cutting and shaping sheet materials (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws) 2.10 Describe the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose - such as sharp, undamaged, plugs and cables secure and free from damage, machine guards or safety devices operating correctly) 2.11 Describe the hand tools used in fabrication forming activities, and typical operations that they are used for (such as hammers, stakes, formers, sand bags) 2.12 Describe the various machine tool forming equipment that can be used to produce a range of shapes (such as bends, box sections, cylinders and curved sections, wired edges and swages) 2.13 Explain how to set up the various machines to produce the required forms (such as setting up of rolls; setting fingers on bending machines; setting forming tools for swaging) 2.14 Describe the characteristics of the various materials used, with

	regard to the bending and forming process
2.15	Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming
2.16	Describe the various methods of securing the assembled components (the range of mechanical fastening devices that are used (such as nuts and bolts, screws, special fasteners, resistance and tack welding methods and techniques, adhesive bonding of components and self-secured joints - such as knocked up, paned down, swaged and joggled)
2.17	Describe the preparations to be carried out on the components prior to assembling them
2.18	Explain how to set up and align the various components, and the tools and equipment to be used
2.19	Describe the methods of temporarily holding the joints together to aid the assembly activities (clamps, rivet clamps)
2.20	Describe the basic principles of fusion welding and the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)
2.21	Describe the various welding techniques that can be used, and their typical applications (such as manual metal arc, MIG/MAG, TIG and manual gas welding)
2.22	Describe the Types, selection and application of filler wires and welding electrodes
2.23	Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits
2.24	Describe the problems that can occur with the fabrication and welding activities (such as defects caused by incorrectly set or blunt shearing blades), and how these can be overcome
2.25	Explain when to act on their own initiative and when to seek help and advice from others
2.26	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the fabrication and welding activities (such as isolating machines, cleaning the equipment, and removing and disposing of waste)

Unit 867 General electrical and electronic engineering applications

UAN:	**F/600/6006**
Level:	Level 2
Credit value:	12
GLH:	55
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 67: General electrical and electronic engineering applications (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic electrical and electronic engineering activities. It will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. The electrical and electronic engineering activities will include the wiring and termination of a range of wire/cables, electrical components, circuit boards and electronic components. This will involve using a range of tools and equipment, along with soldering techniques and anti-static protection techniques. The learner will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components/circuits to be connected. The learner will be expected to use appropriate tools and techniques for the assembly and wiring of the various electrical and electronic components and connectors that make up the circuit. The wiring and testing activities will include

making all necessary checks and adjustments to the circuit (such as continuity, polarity, insulation resistance, current, voltage and waveform values), and ensuring that the circuit functions to the specification.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical and electronic wiring and testing activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the wiring and testing activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical and electronic wiring and testing procedures and techniques safely. The learner will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out general electrical and electronic engineering applications
Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

1.2 Carry out all of the following during the wiring and testing activities:

- adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations
- ensure the safe isolation of services during the wiring and testing activities
- follow job instructions, circuit and assembly drawings and test procedures at all times
- check that tools and test instruments to be used are within calibration date and are in a safe and usable condition
- ensure that the components used are free from damage, dirt or other contamination
- prepare the electrical and electronic components for the assembly and wiring operations (such as pre-forming pins)
- where appropriate, apply procedures and precautions to eliminate Electrostatic Discharge (ESD) hazards (such as the use of grounded wrist straps)
- return all tools and equipment to the correct location on completion of the wiring and testing activities

1.3 Plan the electrical and electronic wiring and testing activities before they start them

1.4 Use appropriate sources to obtain the required specifications, circuit diagrams and test information

1.5 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition

1.6 Use two of the following test instruments during the wiring and testing activities:

- low reading ohmmeter
- insulation resistance tester
- clamp meter
- voltage indicator

Plus three more of the following:

- multimeter
- oscilloscope
- logic probe/clip
- logic analyser
- pulse sequencing analyser
- counter-timers
- signature analysers
- protocol analyser
- signal generator
- signal tracer
- stabilised power supplies
- measuring bridges
- software diagnostic programs
- data communications test set
- bus exerciser

1.7 Mount and secure the electrical and electronic components safely and correctly, to meet specification requirements

1.8 Use three of the following types of cable when producing the electrical and electronic circuits:

- single core
- multi core
- PVC twin and earth
- armoured
- coaxial
- ribbon cables
- fibre optics
- screened
- wiring loom/harness
- data/communication
- flexible (such as cotton or rubber covered)
- Mineral Insulated (such as FP 200)

1.9 Install and terminate the cables to the appropriate connections on the components

1.10 Wire up three of the following electrical circuits/systems:

- domestic lighting circuits
- domestic power circuits
- motor control circuits
- instrumentation and control circuits
- vehicle heating or ventilating
- vehicle lighting
- vehicle starting and ignition
- emergency lighting systems
- air conditioning control circuits
- refrigeration control circuits
- heating/boiler control circuits
- aircraft lighting circuits
- alarm systems (such as fire, intruder, process control)
- electro-pneumatic or electro-hydraulic control circuits
- other control circuits (such as pumps, fans, blowers, extractors)
- power generation and control circuits
- avionic circuits and systems
- communication systems
- computer systems
- other specific electrical circuits

1.11 Apply wiring methods and techniques, to include all of the following:

- positioning and securing of equipment and components
- determining size and lengths of cables required
- stripping outer coating without damage to conductor insulation
- stripping cable conductor insulation/protection
- adding cable end fittings (such plugs, sockets multi-way connectors)

- making mechanical/screwed/clamped connections
- crimping (such as spade end, loops, tags and pins)
- soldering and de-soldering
- attaching suitable cable identification
- leaving sufficient slack for termination and movement
- secure wires and cables (such as clips, plastic strapping, lacing, harnessing)

1.12 Assemble electronic components to produce four of the following types of circuit:

- audio amplifiers
- signal converters
- signal generators
- counter-timers
- oscillators
- filters
- microprocessor-based applications
- comparators
- power amplifiers
- motor control
- regulated power supplies
- logic function controls
- display circuits
- other specific circuit
- sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
- digital circuit (such as process control, microprocessor, logic devices, display devices)
- signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
- alarms and protection circuits
- ADC and DAC hybrid circuits

1.13 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification

1.14 Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include three of the following:

- making visual checks (such as signs of damage, incorrect termination, solder bridges, dry joints, incorrect value components)
- movement checks (such as loose wires, fittings and connections, incorrectly seated devices/packages)
- testing that the equipment operates to the circuit specification
- carrying out fault finding techniques (such as half-split, input/output, unit substitution)

Plus six more from the following:

- protective conductor resistance values
- insulation resistance
- continuity
- polarity

- power rating
- resistance
- capacitance
- dc voltage/current levels
- ac voltage/current levels
- logic states
- clock/timer switching
- oscillations
- attenuation
- pulse width/rise time
- open/short circuit
- waveform analysis
- frequency values
- inductance
- RCD disconnection time
- modulation/demodulation
- amplification
- signal noise/interference levels

1.15 Produce electrical and electronic circuits which comply with one or more of the following standards:
- BS 7671/IEE wiring regulations
- other BS and/or ISO standards
- company standards and procedures

1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.17 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Learning outcome

The learner will:

2. Know how to carry out general electrical and electronic engineering applications

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when wiring and testing electrical and electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)

2.2 Describe the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (such as using sharp instruments for stripping cable insulation), and how they can be minimised

2.3 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy

2.4 Describe the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology)

2.5 Describe the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used

2.6 Describe the different types of cabling and their application (such as multicore cables, single core cables, solid and multi-stranded cables, Steel Wire Armoured (SWA), Mineral Insulated (MI), screened cables, data/communications cables, fibre-optics)

2.7 Describe the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)

2.8 Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, Residual Current Device (RCD))

2.9 Describe the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)

2.10 Explain how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, resistors, inductors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)

2.11 Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)

2.12 Describe the methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)

2.13 Describe the methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited

2.14 Describe the techniques used to terminate electrical and electronic components and equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)

2.15 Describe the use of BS7671/IEE wiring regulations when selecting wires and cables, and when carrying out tests on circuits

2.16 Describe the methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)

2.17 Describe the tools and equipment used in the wiring activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)

2.18 Explain how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition

2.19 Describe the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)

2.20 Describe the care, handling and application of electrical and electronic test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)

2.21 Explain how to apply approved test procedures; the safe working

	practices and procedures required when carrying out the various tests, and the need to use suitably fused test probes and clips
2.22	Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit so as to ensure the correct polarity and without damaging the circuit components
2.23	Explain how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters
2.24	Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
2.25	Describe the fault-finding techniques to be used if the equipment fails to operate correctly
2.26	Explain when to act on their own initiative and when to seek help and advice from others
2.27	Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 868 General maintenance engineering applications

UAN:	**J/600/6007**
Level:	Level 2
Credit value:	12
GLH:	55
Relationship to NOS:	This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 68: General maintenance engineering applications (Suite 2).
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic maintenance activities required for the maintenance of engineering equipment and systems. This will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment. The learner will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of equipment being maintained. The maintenance activities will involve the application of fault finding techniques to identify and locate faults on mechanical, electrical/electronic, fluid power and process controller equipment. The learner will be expected to use a variety of fault location methods and procedures, such as gathering information from the person who reported

the fault, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

The learner will then be expected to dismantle, remove and replace or repair the faulty units or components, on a variety of engineering systems or equipment. The learner will be expected to cover a range of maintenance activities, such as draining and removing fluids, isolating equipment, releasing stored energy, labelling/proof marking to aid reassembly, dismantling components to the required level, checking components for serviceability, replacing faulty components and 'lifed' items, setting and adjusting components, tightening fasteners to the required torque, and making 'off-load' checks of the maintained equipment.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate maintenance techniques and procedures safely. The learner will understand the maintenance process, and its application, and will know about the equipment being maintained, the equipment components, tools and consumables used, to the appropriate depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcome
The learner will: 1. Carry out general maintenance engineering applications

Assessment criteria
The learner can: 1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines 1.2 Carry out all of the following during the maintenance activity: • adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment (PPE) and other relevant safety regulations • ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids), where appropriate • follow job instructions, maintenance drawings and procedures • check that the tools and test instruments are within calibration date, and are in a safe and usable condition • ensure that the system is kept free from foreign objects, dirt or other contamination • return all tools and equipment to the correct location on completion of the maintenance activities 1.3 Plan the maintenance activities before they start them 1.4 Obtain all the information they need for the safe removal and replacement of the equipment components 1.5 Obtain and prepare the appropriate tools and equipment 1.6 Apply appropriate fault finding techniques, tools and aids to locate the faults 1.7 Use appropriate dismantling and re-assembly techniques to deal with three of the following technologies: Mechanical equipment: Carry out all of the following: • draining and replenishing fluids • removing and refitting locking and retaining devices • proof marking components to aid reassembly • removing minor mechanical units/sub-assemblies (such as guards, cover plates, pulleys and belts) • removing major mechanical components (such as shafts, gear mechanisms, bearings, clutches) • replacing lifed items (such as filters, oils/lubricants) • setting, aligning and adjusting replaced units Electrical equipment: Carry out all of the following: • isolating the power supply • disconnecting and reconnecting wires/cables • removing and replacing minor electrical components (such as relays, sensing devices, limit switches) • removing and replacing major electrical components (such as motors, switch/control gear) • attaching cable end fittings (such as crimped and soldered) • making de-energised checks before powering up Fluid power equipment: Carry out all of the following:

- chocking/supporting cylinders/rams/components
- releasing stored pressure
- removing and replacing hoses/pipes
- removing and replacing minor or lifted components (such as filters, gaskets, dust seals)
- removing and replacing major components (such as pumps, cylinders, valves, actuators)
- setting and adjusting replaced components
- making de-energised checks before re-pressurising the system

1.8 Programmable controller based equipment: Carry out all of the following:

- de-activating and resetting program controller
- disconnecting and reconnecting wires/cables
- removing and replacing input/output interfacing
- removing and replacing program logic peripherals
- checking and reviewing program format and content
- editing programs using the correct procedure (where appropriate)

1.9 Process instrumentation: Carry out all of the following:

- isolating instruments/sensing devices
- disconnecting supply/signal connections
- removing and replacing instruments in the system
- replacing all 'lifed' items (such as seals, gaskets, dust covers)
- re-connecting instrumentation pipework and power supply
- checking that signal transmission is satisfactory

Electronic equipment: Carry out all of the following:

- isolating equipment from the power supply
- dismantling/disconnecting equipment to the required level
- disconnecting and reconnecting wires and cables
- removing and replacing electronic units/circuit boards
- removing and replacing electronic components
- soldering and de-soldering
- making de-energised checks before powering up

1.10 Use the appropriate methods and techniques to remove and replace the required components

1.11 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

1.12 Carry out checks and tests to help diagnose problems, and confirm that the maintained equipment performs to specification, to include two of the following:

- making visual checks (such as signs of leakage, damage, missing parts, overheating, wear/deterioration)
- the use of fault finding techniques (such as six point, half-split, input/output, unit substitution)
- the use of diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

Plus two more from the following:

- mechanical checks (such as correct operation of moving

parts, correct working clearance of parts, belt/chain tension, bearing loading, torque loading of fasteners)
- electrical checks (such as continuity, polarity, protective conductor resistance values, voltage levels, load current, inductance)
- electronic checks (such as resistance, capacitance, waveform, frequency values, amplification, signal noise/interference levels, logic states)
- process control checks (such as pressure, flow, level, temperature, weight, sequence/timing)
- controller checks (such as forcing contacts on and off, logic states, checking that fail safe devices and system emergency stops are operating correctly)

1.13 Maintain engineering equipment and systems, in compliance with one or more of the following:
- organisational guidelines and codes of practice
- equipment manufacturer's operation range
- BS and/or ISO standards

1.14 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.15 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Learning outcome
The learner will: 2. Know how to carry out general maintenance engineering applications
Assessment criteria
The learner can: 2.1 Describe the health and safety requirements, and safe working practices and procedures required for the maintenance activities undertaken 2.2 Describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy 2.3 Describe the hazards associated with carrying out maintenance activities on engineering equipment and systems (such as handling oils, greases, stored energy/force, live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them 2.4 Describe the system isolation procedures or permit-to-work procedure that applies 2.5 Explain how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process 2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities 2.7 Describe the basic principles of how the equipment functions, operation sequence, the working purpose of individual units/components and how they interact 2.8 Explain how to use the various diagnostic aids to help identify the

location of the fault

2.9 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

2.10 Explain how to evaluate sensory information (sight, sound, smell, touch)

2.11 Explain how to use a range of fault diagnostic equipment to investigate the problem

2.12 Describe the methods and techniques used to dismantle and reassemble mechanical equipment (such as release of pressures/force; proof marking to aid reassembly; removing/replacing mechanical fasteners - nuts, bolts, clips and pins); removing components by extraction or pressing)

2.13 Describe the methods and techniques used to dismantle and reassemble electrical/electronic equipment (such as unplugging, soldering and de-soldering, removal and replacement of screwed, clamped and crimped connections)

2.14 Describe the methods and techniques used to dismantle and reassemble fluid power and process control instrumentation equipment (such as isolation of equipment; release of pressures/force; disconnecting and reconnecting pipes and hoses)

2.15 Describe the methods and procedures used to check programmable controllers (such as checking the program for errors against the required performance with regard to the sequence of operations and programmed instructions; using monitoring devices and test measurements to check inputs and outputs; using techniques such as 'force on - force off' to simulate process conditions; checking that fail safe devices and system emergency stops are operating correctly)

2.16 Describe the methods of checking that components are fit for purpose; how to identify defects and wear characteristics; and the need to replace 'lifed' items

2.17 Describe the use of BS 7671/IEE wiring and other regulations when selecting wires and cables, and when carrying out tests on systems

2.18 Explain how to check that tools and equipment are free from damage or defect, are in a safe and usable condition; are within calibration, and are configured correctly for the intended purpose

2.19 Describe the importance of making 'off-load' checks before running the equipment under power

2.20 Describe the importance of completing maintenance documentation and/or reports following the maintenance activity

2.21 Describe the problems that can occur during the maintenance activity, and how they can be overcome

2.22 Explain when to act on their own initiative and when to seek help and advice from others

2.23 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Appendix 1 Relationships to other qualifications

Links to other qualifications

Mapping is provided as guidance and suggests areas of commonality between the qualifications. It does not imply that candidates completing units in one qualification have automatically covered all of the content of another.

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

This qualification has connections to the:
- Level 2 NVQ in Performing Engineeirng Operations (7582)
- Level 2 NVQ Diploma in Mechcnial Manufacturing Engineering (1712)
- Level 3 NVQ Diploma in Mechanical Manufacturing Engineering (1712)
- Level 3 NVQ Extended Diploma in Fabrication and Welding Engineering (1781)
- Level 3 NVQ Extended Diploma in Engineering Technical Support (1786)
- Level 3 NVQ Extended Diploma in Engineering Maintenance (1788)
- Level 3 NVQ Extended Diploma in Aeronautical Engineering (1789)

Literacy, language, numeracy and ICT skills development

This qualification can develop skills that can be used in the following qualifications:
- Functional Skills (England) – see **www.cityandguilds.com/functionalskills**
- Essential Skills (Northern Ireland) – see **www.cityandguilds.com/essentialskillsni**
- Essential Skills Wales – see **www.cityandguilds.com/esw**

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- Regulatory Arrangements for the Qualifications and Credit Framework (2008)
- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

Access to Assessment & Qualifications provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information such on such things as:

- **Walled Garden**: how to register and certificate candidates on line
- **Qualifications and Credit Framework (QCF)**: general guidance about the QCF and how qualifications will change, as well as information on the IT systems needed and FAQs
- **Events**: dates and information on the latest Centre events
- **Online assessment**: how to register for e-assessments.

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Useful contacts

UK learners **General qualification information**	**T: +44 (0)844 543 0033** **E: learnersupport@cityandguilds.com**
International learners General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: **intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **centresupport@cityandguilds.com**
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) E: **singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: **business@cityandguilds.com**
Publications Logbooks, Centre documents, Forms, Free literature	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

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The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Land Based Services (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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