

# Level 3 NVQ Diploma in Mechanical Manufacturing Engineering (Photonics Engineering) (1712-38)

September 2011 Version 1.0



## Qualification at a glance

<b>Subject area</b>	Mechanical Manufacturing Engineering
<b>City &amp; Guilds number</b>	1712
<b>Age group approved</b>	16+
<b>Entry requirements</b>	None
<b>Assessment</b>	Portfolio of evidence
<b>Automatic approval</b>	Available
<b>Support materials</b>	Centre handbook
<b>Registration and certification</b>	Consult the Walled Garden/Online Catalogue for last dates

<b>Title and level</b>	<b>City &amp; Guilds number</b>	<b>Accreditation number</b>
Level 3 NVQ Diploma in Mechanical Manufacturing Engineering – Photonics Engineering	1712-38	501/1803/1



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# 1 Introduction

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

Area	Description
Who is the qualification for?	It is for candidates who work or want to work as mechanical manufacturing engineers – photonics engineering in the mechanical manufacturing engineering sector.
What does the qualification cover?	It allows candidates to learn, develop and practise the skills required for employment and/or career progression in the mechanical manufacturing engineering sector.
Is the qualification part of a framework or initiative?	It serves as a competence qualification, in the Engineering Apprenticeship framework.
What opportunities for progression are there?	It allows candidates to progress into employment or to the following City & Guilds qualifications: <ul style="list-style-type: none"> <li>Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering</li> </ul>

## Structure

To achieve the **Level 3 NVQ in Mechanical Engineering (Photonics Engineering)**, learners must achieve **15** credits from the mandatory units 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
<b>Mandatory</b>			
A/601/5013	Unit 201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	Unit 202	Using and interpreting engineering data and documentation	5
K/601/5055	Unit 303	Working efficiently and effectively in engineering	5

**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

Centres currently offering the City & Guilds Level 3 NVQ in Mechanical Manufacturing Engineering (1682) will be automatically approved to run this new qualification.

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 qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification, 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. Further details are available at: [www.cityandguilds.com/eportfolios](http://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

The following units can also be obtained from The Register of Regulated Qualifications: <http://registerofqual.gov.uk/Unit>

### 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

<b>UAN:</b>	A/601/5013
<b>Level:</b>	2
<b>Credit value:</b>	5
<b>GLH:</b>	35
<b>Relationship to NOS:</b>	This unit has been derived from Semta national occupational standard: Complying with statutory regulations and organisational safety requirements (Suite 2).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	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

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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.

<b>Learning outcome</b>
The learner will: 1. comply with statutory regulations and organisational safety requirements
<b>Assessment criteria</b>
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: <ul style="list-style-type: none"><li>• applying in principle their duties and responsibilities as an individual under the Health and Safety at Work Act</li><li>• identifying, within their organisation, appropriate sources of information and guidance on health and safety issues, such as:<ul style="list-style-type: none"><li>- eye protection and Personal Protective Equipment (PPE)</li><li>- COSHH regulations</li><li>- risk assessments</li></ul></li><li>• identifying the warning signs and labels of the main groups of hazardous or dangerous substances</li><li>• complying with the appropriate statutory regulations at all times</li></ul> 1.3 present themselves in the workplace suitably prepared for the activities to be undertaken

1.4	follow organisational accident and emergency procedures
1.5	comply with emergency requirements, to include: <ul style="list-style-type: none"> <li>• identifying the appropriate qualified first aiders and the location of first aid facilities</li> <li>• identifying the procedures to be followed in the event of injury to themselves or others</li> <li>• following organisational procedures in the event of fire and the evacuation of premises</li> <li>• identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment</li> </ul>
1.6	recognise and control hazards in the workplace
1.7	identify the hazards and risks that are associated with the following: <ul style="list-style-type: none"> <li>• their working environment</li> <li>• the equipment that they use</li> <li>• materials and substances (where appropriate) that they use</li> <li>• working practices that do not follow laid-down procedures</li> </ul>
1.8	use correct manual lifting and carrying techniques
1.9	demonstrate one of the following methods of manual lifting and carrying: <ul style="list-style-type: none"> <li>• lifting alone</li> <li>• with assistance of others</li> <li>• with mechanical assistance</li> </ul>
1.10	apply safe working practices and procedures to include: <ul style="list-style-type: none"> <li>• maintaining a tidy workplace, with exits and gangways free from obstruction</li> <li>• using equipment safely and only for the purpose intended</li> <li>• observing organisational safety rules, signs and hazard warnings</li> <li>• taking measures to protect others from any harm resulting from the work that they are carrying out.</li> </ul>

<b>Learning outcome</b>	
The learner will:	
2.	know how to comply with statutory regulations and organisational safety requirements
<b>Assessment criteria</b>	
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

<b>UAN:</b>	Y/601/5102
<b>Level:</b>	2
<b>Credit value:</b>	5
<b>GLH:</b>	25
<b>Relationship to NOS:</b>	This unit has been derived from Semta national occupational standard: Using and interpreting engineering data and documentation (Suite 2).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>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.</p>

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

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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.

<b>Learning outcome</b>
The learner will: 1. use and interpret engineering data and documentation
<b>Assessment criteria</b>
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: <ul style="list-style-type: none"><li>• check the currency and validity of the data and documentation used</li><li>• exercise care and control over the documents at all times</li><li>• correctly extract all necessary data in order to carry out the required tasks</li><li>• seek out additional information where there are gaps or deficiencies in the information obtained</li><li>• deal with or report any problems found with the data and documentation</li><li>• make valid decisions based on the evaluation of the engineering information extracted from the documents</li><li>• return all documents to the approved location on completion of the work</li><li>• complete all necessary work related documentation such as production documentation, installation documentation, maintenance documentation, planning documentation</li></ul> 1.3 correctly identify, interpret and extract the required information 1.4 extract information that includes three of the following: <ul style="list-style-type: none"><li>• materials or components required</li><li>• dimensions</li><li>• tolerances</li><li>• build quality</li><li>• installation requirements</li><li>• customer requirements</li><li>• time scales</li><li>• financial information</li><li>• operating parameters</li><li>• surface texture requirements</li></ul>

- 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)

	<ul style="list-style-type: none"> <li>• specifications (such as material, finish, process, contractual, calibration)</li> <li>• reference materials (such as manuals, tables, charts, guides, notes)</li> <li>• schedules</li> <li>• operation sheets</li> <li>• service/test information</li> <li>• planning documentation</li> <li>• quality control documents</li> <li>• company specific technical instructions</li> <li>• national, international and organisational standards</li> <li>• health and safety standards relating to the activity (such as COSHH)</li> <li>• other specific related documentation</li> </ul>
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.

<b>Learning outcome</b>	
The learner will:	
2. know how to use and interpret engineering data and documentation	
<b>Assessment criteria</b>	
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

<b>UAN:</b>	K/601/5055
<b>Level:</b>	3
<b>Credit value:</b>	5
<b>GLH:</b>	25
<b>Relationship to NOS:</b>	This unit has been derived from Semta national occupational standard: Working efficiently and effectively in engineering (Suite 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>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.</p> <p>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.</p> <p>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</p>

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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.

<b>Learning outcome</b>
The learner will: 1. work efficiently and effectively in engineering
<b>Assessment criteria</b>
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: <ul style="list-style-type: none"><li>• the work area is free from hazards and is suitably prepared for the activities to be undertaken</li><li>• any required safety procedures are implemented</li><li>• any necessary personal protection equipment is obtained and is in a usable condition</li><li>• tools and equipment required are obtained and checked that</li></ul>

- 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 436

## Machining infra-red/special material lenses

<b>UAN:</b>	J/600/5746
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 150: Machining Infra-Red/Special Material Lenses (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical infra-red and special materials, using optical infra-red process machines, in accordance with approved procedures. The learner will be required to set up and operate a range of machines in order to produce the components, combining a mixture of processes identified for infra-red and special materials, and using a selection of specified optical lens and flat materials. The learner will be expected to produce a range of components that combine a number of different features, such as centre thickness, diameters, generated blanks, optical lens form and power.</p> <p>The learner will be required to set up and operate the machine in line with safe working practices and approved procedures, and to continuously monitor the machining operations, making any necessary adjustments to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining</p>

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activities undertaken, and to report any problems with the optical machining activities, materials or equipment that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying optical machining procedures. The learner will understand the optical lens, and flat infra-red and special material processes used, and their application, and will know about the setting-up procedures, equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. machine infra-red/special material lenses
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the lens machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being machined (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held securely, without damage or distortion</li><li>• ensure that tooling is appropriate for the operations and is</li></ul>

- maintained in a suitable condition
  - set the tooling and machine operating parameters to achieve the component specification
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - use safe working practices and machine operating procedures at all times
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the machine is set up and ready for the machining activities to be carried out
- 1.4 operate three types of optical lens process machine from the following:
- conventional pitch
  - lens silk polishing
  - flat silk polishing
  - special materials
  - automated
  - generating
  - lens edging
- 1.5 manipulate the machine tool controls safely and correctly in line with operational procedures
- 1.6 produce components to the required quality and within the specified dimensional accuracy
- 1.7 produce machined optical components that combine different operations, and cover six of the following:
- centre thickness
  - lens diameter
  - lens concentricity
  - flat parallelism
  - lens form analysis
  - lens power analysis
  - lens surface generation
  - lens cosmetic defects
  - lens truncation and cap height
- 1.8 machine four different types of material from the following:
- zinc selenide
  - zinc sulphide
  - optical silicon
  - optical infra-red glass 4
  - optical infra-red glass 5
  - optical infra-red glass 6
  - optical grade germanium
  - optical thallium ideobromide
  - other appropriate optical material
- 1.9 carry out quality sampling checks at suitable intervals
- 1.10 during production, carry out the necessary checks for accuracy, to include five of the following:

<ul style="list-style-type: none"> <li>• lens surface finish</li> <li>• component profiles</li> <li>• optical bevels</li> <li>• lens cap height</li> <li>• lens centre thickness</li> <li>• component cosmetic defects</li> <li>• optical parallelism</li> <li>• lens surface form error</li> <li>• angles</li> <li>• lens diameters</li> <li>• optical truncations</li> <li>• lens surface power error</li> </ul>
<p>1.11 produce components with dimensional accuracy, form and surface quality, in compliance with one of the following:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul>
<p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul>
<p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved</p>
<p>1.14 shut down the equipment to a safe condition on conclusion of the machining activities.</p>

<p><b>Learning outcome</b></p>
<p>The learner will:</p> <p>2. know how to machine infra-red/special material lenses</p>
<p><b>Assessment criteria</b></p>
<p>The learner can:</p> <p>2.1 describe the safe working practices and procedures to be followed while operating optical lens generating, smoothing and polishing equipment</p> <p>2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly</p> <p>2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency</p> <p>2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained</p> <p>2.5 describe the hazards associated with optical lens process operations, and how to minimise them and reduce any risks</p> <p>2.6 describe the importance of keeping the work area clean and tidy</p> <p>2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation</p>

- 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 various optical lens operations that can be performed, and the shapes and types of tooling that can be used (fly cutters, diamond abrasive wheels, polyurethane polishers, pitch polishers and silk polishers)
  - 2.10 describe the methods that can be used to set up the workpiece, prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool
  - 2.11 describe the effect of backlash in machine slides, dials and screws, and how this can be overcome
  - 2.12 explain how to handle and store all cutting tools and kit required, safely and correctly
  - 2.13 describe the factors which affect the selection of cutting feeds, pressures and speeds required, and the depth of cut that can be taken (workpiece rigidity, machine condition, types of tooling, material, finish and tolerance required)
  - 2.14 explain how tool wear affects surface finish and dimensional accuracy
  - 2.15 explain how the various types of material will affect the way the operation is performed
  - 2.16 describe the application of cutting fluids with regard to the range of materials being machined
  - 2.17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
  - 2.18 explain how to recognise machine faults and how to identify when tooling needs refurbishment
  - 2.19 describe the problems that can occur with optical lens infra-red and special material machining activities, and how they can be overcome
  - 2.20 explain how quality control procedures used, inspection checks to be carried out, and the equipment to be used for this
  - 2.21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

<b>UAN:</b>	R/600/5751
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 151: Machining Optical Glass Lenses (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical lens glass material, using optical lens glass process machines, in accordance with approved procedures. The learner will be required to set up and operate a range of machines, in order to produce components, combining a mixture of processes identified for optical lens glass machining and using a selection of specified optical lens glass materials. The learner will be expected to produce a range of components that combine a number of different features, such as centre thickness, diameters, generated blanks, optical lens form and power.</p> <p>The learner will be required to set up and operate the machines in line with safe working practices and approved procedures, and to continuously monitor the machining operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining activities undertaken, and to report any problems with the optical machining</p>

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activities, materials or equipment that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying optical machining procedures. The learner will understand the optical lens glass processes used, and their application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound basis for setting up the machines, carrying out the activities, correcting faults, and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. machine optical glass lenses
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the lens machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being machined (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held securely, without damage or distortion</li><li>• ensure that tooling is appropriate for the operations and is maintained in a suitable condition</li><li>• set the tooling and machine operating parameters to achieve</li></ul>

- the component specification
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - use safe working practices and machine operating procedures at all times
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the machine is set up and ready for the machining activities to be carried out
- 1.4 set up and operate three types of optical lens process machine from the following:
  - lens edging
  - automated small lens
  - conventional large lens pitch
  - generating
  - automated large lens
  - conventional small lens pitch
- 1.5 manipulate the machine tool controls safely and correctly in line with operational procedures
- 1.6 produce components to the required quality and within the specified dimensional accuracy
- 1.7 produce optical machined components which combine different operations, and cover six of the following:
  - centre thickness
  - lens diameter
  - lens concentricity
  - lens wedge
  - lens form analysis
  - lens power analysis
  - lens surface generation
  - lens cosmetic defects
  - lens truncation and cap height
- 1.8 machine four different types of material from the following:
  - barium crowns
  - borosilicate crowns
  - flints/light flints
  - optical orange filter glass
  - optical blue filter glass
  - optical neutral density glass
  - anomalous dispersion flint crowns
  - other optical grades
  - dense flints
  - barium dense flints
  - lanthanum crowns
- 1.9 carry out quality sampling checks at suitable intervals
- 1.10 during production, carry out the necessary checks for accuracy, to include five of the following:
  - optical bevels

<ul style="list-style-type: none"> <li>• optical lens wedge</li> <li>• optical parallelism</li> <li>• lens centre thickness</li> <li>• optical truncations</li> <li>• lens cap height</li> <li>• lens chamfers</li> <li>• lens surface form error</li> <li>• lens diameters</li> <li>• lens surface finish</li> <li>• lens surface power error</li> </ul> <p>1.11 produce components with dimensional accuracy, form and surface quality, in compliance with one of the following:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul> <p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved</p> <p>1.14 shut down the equipment to a safe condition on conclusion of the machining activities.</p>
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<b>Learning outcome</b>
The learner will:
2. know how to machine optical glass lenses
<b>Assessment criteria</b>
The learner can:
2.1 describe the safe working practices and procedures to be followed while operating optical lens, generating, smoothing and polishing equipment
2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained
2.5 describe the hazards associated with optical lens process operations, and how to minimise them and reduce any risks
2.6 describe the importance of keeping the work area clean and tidy
2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 various optical lens operations that can be performed, and the shapes and types of tooling that can be used (diamond abrasive wheels, diamond pellet smoothers, polyurethane polishers and pitch polishers)
  - 2.10 describe the methods that can be used to set up the workpiece, prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool
  - 2.11 describe the effect of backlash in machines slides, dials and screws, and how this can be overcome
  - 2.12 explain how to handle and store all cutting tools and kit required, safely and correctly
  - 2.13 describe the factors which affect the selection of cutting feeds, pressures and speeds required, and the depth of cut that can be taken (workpiece rigidity, machine condition, types of tooling, material, finish and tolerance required)
  - 2.14 explain how tool wear affects surface finish and dimensional accuracy
  - 2.15 explain how the various types of material will affect the way the operation is performed
  - 2.16 describe the application of cutting fluids/rouges, with regard to the range of materials being machined
  - 2.17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
  - 2.18 explain how to recognise machine faults and how to identify when tooling needs refurbishment
  - 2.19 describe the problems that can occur with optical lens glass machining activities, and how they can be overcome
  - 2.20 describe the quality controls procedures used, inspection checks to be carried out, and the equipment to be used for this
  - 2.21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 438

## Machining optical prism and flat components

<b>UAN:</b>	H/600/5754
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 152: Machining Optical Prism and Flat Components (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical prisms and flat components, using a range of optical prism and flat process machines, in accordance with approved procedures. The learner will be required to set up the machine for the operations to be performed, and to check that all the required components or materials and consumables are available. In operating the machine, the learner will be expected to produce a range of components that combine a number of different features, such as angles, flats, parallelism, wedge shapes, chamfers and bevels, using a selection of specified optical prism and flat materials. The learner will also be required to check finished components that have been machined by the combination of various processes, for accuracy and quality.</p> <p>The learner will be required to set up and operate the machine in line with safe working practices and approved procedures and to continuously monitor the machining operations, making any necessary adjustments to settings in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p>

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The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining activities undertaken, and to report any problems with the optical machining activities, materials, tooling or consumables that they cannot personally resolve, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying optical machining procedures. The learner will understand the optical prism and flat machining processes, and their application, and will know about the equipment, materials and consumables, in adequate 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 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.

<b>Learning outcome</b>
The learner will: 1. machine optical prism and flat components
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the optical prism machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being machined (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held</li></ul>

- securely, without damage or distortion
  - ensure that tooling is appropriate for the operations and is maintained in a suitable condition
  - set the tooling and machine operating parameters to achieve the component specification
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - use safe working practices and machine operating procedures at all times
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the machine is set up and ready for the machining activities to be carried out
- 1.4 operate four of the following types of optical prism and flat process machines:
- preparation and smoothing
  - twin lap flat polishing
  - lap-master flat and prism
  - hard lap flat and prism polishing
  - roof prism process (accurate angles)
- 1.5 manipulate the machine tool controls safely and correctly in line with operational procedures
- 1.6 produce components to the required quality and within the specified dimensional accuracy
- 1.7 produce machined optical components which combine different operations, and cover six of the following:
- flat centre thickness
  - angular tolerances
  - flatness tolerances
  - parallelism tolerances
  - cosmetic tolerances
  - transmission tolerances
  - finished size tolerances
  - prism chamfers/bevels tolerances
- 1.8 machine four different types of material from the following:
- optical grade germanium
  - zinc selenide prisms and flats
  - zinc sulphide prisms and flats
  - borosilicate crowns
  - barium crowns
  - dense flints
  - optical orange filter glass
  - optical blue filter glass
  - optical neutral density glass
  - flint/light flints
  - barium dense flints
  - lanthanum crowns
  - anomalous dispersion flour crowns

<ul style="list-style-type: none"> <li>• other appropriate optical material</li> </ul> <p>1.9 carry out quality sampling checks at suitable intervals</p> <p>1.10 during production, carry out the necessary checks for optical accuracy, to include five of the following:</p> <ul style="list-style-type: none"> <li>• flatness</li> <li>• prism chamfers and bevels</li> <li>• transmission deviation measurement</li> <li>• flat centre thickness</li> <li>• prism surface cosmetics</li> <li>• prism flatness measurement</li> <li>• flat surface cosmetics</li> <li>• flat chamfers and bevels</li> <li>• prism angular measurement</li> <li>• flat parallelism</li> <li>• prism balk height measurement</li> <li>• flatness transmission</li> </ul> <p>1.11 produce components with dimensional accuracy, form and surface quality, in compliance with one of the following:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul> <p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved</p> <p>1.14 shut down the equipment to a safe condition on conclusion of the machining activities.</p>
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<b>Learning outcome</b>
The learner will: 2. know how to machine optical prism and flat components
<b>Assessment criteria</b>
The learner can: 2.1 describe the safe working practices and procedures to be followed while operating optical prism preparation, smoothing and polishing equipment 2.2 describe the safety mechanisms on the machines, and the procedure for checking that they function correctly 2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency 2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained 2.5 describe the hazards associated with optical prism process

- operations, and how to minimise them and reduce any risks
- 2.6 describe the importance of keeping the work area clean and tidy
  - 2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 various optical prism operations that can be performed, and the shapes and types of tooling that can be used (polyurethane polishers, pitch lap polisher)
  - 2.10 describe the methods that can be used to set up the workpiece, prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool (alloy jigs, plaster blocks, pitch pads)
  - 2.11 explain how to handle and store all tools and kit required, safely and correctly
  - 2.12 describe the factors which affect the selection of cutting feeds, pressures and speeds required (types of tooling used, material used, finish and tolerance required)
  - 2.13 explain how tool wear affects surface finish and dimensional accuracy
  - 2.14 explain how the various types of material will affect the way the operation is performed
  - 2.15 describe the application of cutting fluids with regard to the range of materials being machined
  - 2.16 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
  - 2.17 describe the problems that can occur with optical prism machining activities, and how they can be overcome
  - 2.18 describe the quality controls procedures used, inspection checks to be carried out, and the equipment used to achieve the required components
  - 2.19 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 439

# Setting CNC aspheric glass and diamond turning machines

<b>UAN:</b>	A/600/5758
<b>Level:</b>	3
<b>Credit value:</b>	78
<b>GLH:</b>	175
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 153: Setting CNC Aspheric Glass and Diamond Turning Machines (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to set up computer numerical controlled (CNC) machines or CNC machining centres for the machining of aspheric glass and diamond turned components, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine spindle. 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.</p>

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 are entered into the operating program and machine. The learner will also be required to produce tool path information for each set-up, and to edit where required. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. The learner must produce trial components and prove that the machine is working satisfactorily before declaring the machine ready for

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production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine-setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 the setting-up procedures used. The learner will understand the CNC turning machine used, and its application, and will know about the workholding devices, tooling, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and for ensuring that the work output is produced to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. set CNC aspheric glass and diamond turning machines
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li></ul>

- confirm that the correct operating program has been loaded
  - obtain the correct tooling and check that it is in a safe and usable condition and appropriate to the operations to be performed
  - ensure that components are correctly positioned and held securely, without damage or distortion
  - update program tool data, as applicable
  - position and adjust machine guards
  - apply safe working practices at all times
  - leave the work area in a clean and safe condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 determine what has to be done and how the machine will be set to achieve this
- 1.5 prepare two of the following types of optical CNC machines in readiness for production:
- aspheric generating
  - aspheric polishing
  - diamond turning aspheric process
  - diamond turning diffractive/hybrid process
- 1.6 prepare the tooling for operation by carrying out all of the following activities, as applicable to the machine type:
- mounting the tools in/on the correct tool holding device
  - positioning tools in the correct position in the tool posts, turrets, magazine or carousel (where applicable)
  - ensuring that the tools have a specific tool number in relation to the operating program
  - entering all relevant tool data into the operating program (tool lengths, offsets, radius compensation)
  - presetting tooling using setting jigs/fixtures (where appropriate)
  - setting tool datums
  - saving changes to the operating program
- 1.7 mount and set the required workholding devices, workpiece and cutting tools
- 1.8 position and secure workpieces, using two of the following workholding methods and devices:
- chucks
  - faceplates
  - other workholding devices
- 1.9 select and mount, in the appropriate tool holding device, three of the following types of cutting tool:
- form tools
  - roughing tools
  - finishing tools
  - half radius tools
  - edging/step tools
- 1.10 set the machine tool operating parameters to achieve the component specification

<p>1.11 make trial components to prove that the machine is operating to the required specification, and in compliance with one of the following standards:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>
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<p><b>Learning outcome</b></p> <p>The learner will:</p> <p>2. know how to set CNC aspheric glass and diamond turning machines</p>
<p><b>Assessment criteria</b></p> <p>The learner can:</p> <p>2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC machines</p> <p>2.2 explain how to start and stop the machine in normal and emergency situations</p> <p>2.3 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy</p> <p>2.4 describe the hazards associated with working on CNC machines (such as use of power operated chucks, moving machinery, automatic machine operation, lifting and handling workholding devices, and airborne particles), and how to minimise them and reduce any risks</p> <p>2.5 explain how to handle and store cutting tools, and how to verify that programs are safe and correct</p> <p>2.6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken</p> <p>2.7 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing</p> <p>2.8 describe the relationship between design and manufacture of aspheric components</p> <p>2.9 describe the range of workholding methods and devices that are used on CNC machines</p> <p>2.10 explain why it is important to set the workholding device in relation to the machine datums and reference points</p> <p>2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used for this</p> <p>2.12 describe the range of cutting tools that are used on CNC machines for aspheric glass and diamond turning operations, and their typical applications</p> <p>2.13 explain how to check that the cutting tools are in a safe and serviceable condition</p> <p>2.14 describe the various tool holding devices that are used, and the</p>

methods of correctly mounting and securing the cutting tools to the tool holders

- 2.15 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)
- 2.16 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
- 2.17 describe the settings that they need to check before allowing the machine to operate in full program run mode
- 2.18 explain how the various types of material will affect the feeds and speeds that can be used
- 2.19 describe the application of cutting fluids
- 2.20 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 440

# Machining components using CNC aspheric glass and diamond turning machines

<b>UAN:</b>	F/600/5762
<b>Level:</b>	3
<b>Credit value:</b>	46
<b>GLH:</b>	150
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 154: Machining Components using CNC Aspheric Glass and Diamond Turning Machines (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out the machining of aspheric glass and diamond turned components, using computer numerical controlled (CNC) machines or CNC machining centres, in accordance with approved procedures. The learner will be required to produce a range of aspheric components of various infra-red and visible materials, which combine a range of different features, such as aspheric form, power, surface roughness, cap height, etc. The learner will also be required to check and verify finished components, using a variety of metrology equipment, to ensure that they meet the required specifications.</p> <p>The learner will be required to operate the machine in line with safe working practices and approved procedures, and to continuously monitor the machining operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require</p>

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them to comply with organisational policy and procedures for the optical machining activities undertaken, and to report any problems with the activities, materials or equipment used that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying optical machining procedures. The learner will understand the aspheric glass and diamond turning processes used, and their application, and will know about the equipment, materials and consumables, in adequate 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 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.

<b>Learning outcome</b>
The learner will: 1. machine components using CNC aspheric glass and diamond turning machines
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being machined (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held securely, without damage or distortion</li></ul>

- maintain cutting tools in a safe and suitable condition
  - check that the operating program is at the correct start point
  - check that the workpiece is clear of the machine spindle
  - use safe working practices and machine start-up and operating procedures at all times
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate three of the following aspheric lens processes:
- glass aspheric generating process
  - glass aspheric polishing process
  - diamond turning aspheric process
  - diamond turning diffractive/hybrid process
- 1.5 follow the defined procedure for starting and running the operating system
- 1.6 deal promptly and effectively with error messages or equipment faults that are within your control, and report those that cannot be solved
- 1.7 produce machined optical components that combine different operations, and cover six of the following:
- centre thickness
  - lens cosmetic defects
  - lens concentricity
  - lens cap height
  - lens diameter/step feature, angle
  - lens aspheric form analysis
  - lens surface roughness
  - lens power analysis/radius
  - lens diffractive step height
- 1.8 machine five different types of materials from the following:
- zinc selenide
  - zinc sulphide
  - optical silicon
  - optical glass
  - optical infra-red glass 4
  - optical infra-red glass 5
  - optical infra-red glass 6
  - gallium arsenide
  - acrylic
  - optical grade germanium
  - optical thallium iodobromide
  - other appropriate optical material
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 during production, carry out the necessary checks for accuracy, to include five of the following:

<ul style="list-style-type: none"> <li>• lens diameter</li> <li>• centre thickness</li> <li>• component profiles</li> <li>• surface/lens power error</li> <li>• component surface finish</li> <li>• lens bevels/chamfers</li> <li>• surface form error</li> <li>• component cosmetic defects</li> <li>• cap height</li> <li>• angles</li> </ul> <p>1.11 produce components with dimensional accuracy, form and surface quality to one of the following standards, as applicable to the operations:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul> <p>1.13 shut down the equipment to a safe condition on conclusion of the machining activities.</p>
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<b>Learning outcome</b>
The learner will:
2. know how to machine components using CNC aspheric glass and diamond turning machines
<b>Assessment criteria</b>
The learner can:
2.1 describe the safe working practices and procedures to be followed while operating CNC aspheric lens generating and polishing equipment and diamond turning equipment
2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained
2.5 describe the hazards associated with working on CNC machines (such as use of power operated chucks, moving machinery, automatic machine operation, handling cutting tools, lifting and handling workholding devices, hot and airborne particles), and how to minimise them and reduce any risks
2.6 describe the hazards associated with carrying out aspheric lens process operations, and how they can be minimised
2.7 describe the importance of wearing the appropriate protective

- clothing and equipment, and of keeping the work area clean and tidy
- 2.8 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
  - 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
  - 2.10 explain how to read the visual display and understand the various messages displayed
  - 2.11 describe the function of error messages, and what to do when an error message is displayed
  - 2.12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
  - 2.13 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
  - 2.14 explain how to operate the machine using single block run, full program run and feed/speed override controls
  - 2.15 explain how to make adjustments to the program operating parameters to take account of tool wear
  - 2.16 describe the various types of cutting tool used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel (including diamond tip tools, diamond abrasive wheels and polishing tools)
  - 2.17 explain how to check that the indexable tooling is in a serviceable condition; and the effects that worn tooling will have on the workpiece surface finish and dimensional accuracy
  - 2.18 describe the lens mounting methods used to set up the workpiece prior to operation, to minimise wedge error, concentricity and astigmatism
  - 2.19 describe the effect of backlash in machines slides, dials and screws, and how this can be overcome
  - 2.20 explain how to handle and store all cutting tools and kit required, safely and correctly
  - 2.21 describe the factors which affect the selection of cutting feeds, pressures and speeds required, and the depth of cut that can be taken (such as workpiece rigidity, machine condition, types of tooling, material, finish and tolerance required)
  - 2.22 describe the application of cutting fluids with regard to the range of material being machined
  - 2.23 explain how to recognise machine faults, and how to identify when tooling needs refurbishment
  - 2.24 describe the quality control procedures used, inspection checks to be carried out, and the equipment used for this
  - 2.25 describe the problems that can occur with the aspheric lens generating, polishing and diamond turning activities, and how they can be overcome
  - 2.26 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 441

# Setting CNC optical grinding and polishing machines for production

<b>UAN:</b>	Y/600/5766
<b>Level:</b>	3
<b>Credit value:</b>	78
<b>GLH:</b>	175
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 155: Setting CNC Optical Grinding and Polishing Machines for Production (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up optical grinding and polishing computer numerical controlled (CNC) machines, or CNC machining centres, in accordance with approved procedures. 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 grinding and polishing wheels and equipment, to mount and secure them to the appropriate holder, and to place the grinding/polishing wheels in the relevant positions within the slides or tool change magazine/carousel.</p> <p>The learner will need to ensure that all the grinding/polishing wheels have been allocated a relevant tool number and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. The learner will also be required to produce tool path information for each set-up, and to edit where required. This will involve loading and proving component programs, checking for errors/faults, and editing and saving program changes.</p> <p>The learner must produce trial components</p>

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and prove that the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine related problems during production, will also form part of their role.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 the setting-up procedures used. The learner will understand the CNC optical grinding and polishing machine used, and its application, and will know about the workholding devices, grinding and polishing wheels, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. set CNC optical grinding and polishing machines for production
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant</li></ul>

- safety regulations and procedures to realise a safe system of work
- confirm that the correct operating program has been loaded
  - obtain the correct grinding and polishing wheels, and check that they are in a safe and usable condition and are appropriate to the operations being performed
  - ensure that components are correctly positioned and held securely, without damage or distortion
  - update program tool data, as applicable
  - position and adjust machine guards
  - apply safe working practices at all times
  - leave the work area in a clean and safe condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 determine what has to be done and how the machine will be set to achieve this
- 1.5 prepare two of the following CNC optical process machines in readiness for production:
- CNC optical grinding machine
  - CNC optical polishing machine
  - CNC optical smoothing machine
  - CNC optical edging machine
  - CNC special purpose machines
- 1.6 prepare the machine for operation by carrying out six of the following activities, as applicable to the machine:
- pre-setting grinding wheels/spindles using balancing units and setting jigs/fixtures (where appropriate)
  - setting grinding/polishing tool datum
  - positioning grinding wheels/polishing tools in the correct position in the machine spindle, magazine or carousel
  - checking that wheels/polishing tools have a specific tool number in relation to the operating program
  - entering all relevant tooling data to the operating program (wheel/spindle position offsets)
  - saving changes to the program
- 1.7 mount and set the required workholding devices, workpiece and cutting tools
- 1.8 position and secure workpieces using two of the following workholding methods and devices:
- chucks
  - collets
  - jigs and fixtures
  - fourth axis indexer
  - other
- 1.9 select/mount grinding and polishing wheels for all of the following operations:
- rough grinding/forming
  - finish grinding
  - polishing

<ul style="list-style-type: none"> <li>• edging</li> </ul> <p>1.10 set the machine tool operating parameters to achieve the component specification</p> <p>1.11 machine five different types of material from the following:</p> <ul style="list-style-type: none"> <li>• germanium</li> <li>• silicon</li> <li>• zinc selenide</li> <li>• zinc sulphide</li> <li>• cleartran</li> <li>• lanthanum crowns</li> <li>• dense flints</li> <li>• flints/light flints</li> <li>• barium crowns</li> <li>• borosilicate crowns</li> <li>• barium dense flints</li> <li>• anomalous dispersion flour crowns</li> <li>• other appropriate optical material</li> </ul> <p>1.12 make trial components to prove that the machine is operating to the required specification, and in compliance with one of the following standards:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.13 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.14 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>
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<p><b>Learning outcome</b></p> <p>The learner will:</p> <p>2. know how to set CNC optical grinding and polishing machines for production</p>
<p><b>Assessment criteria</b></p> <p>The learner can:</p> <p>2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC optical grinding and polishing machines</p> <p>2.2 explain how to start and stop the machine in normal and emergency situations</p> <p>2.3 describe the hazards associated with working on CNC optical grinding and polishing machines (such as moving machinery, automatic machine operation, lifting and handling workholding devices, and glass and infra-red/special material particles), and how to minimise them and reduce any risks</p> <p>2.4 describe the grinding wheel regulations covering the use and operation of grinding wheels and equipment</p> <p>2.5 describe the importance of ensuring that the machine is in safe mode before mounting grinding wheels and workholding devices</p>

- 2.6 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.7 explain how to handle and store optical grinding and polishing wheels, and verify tapes and programs safely and correctly
- 2.8 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.10 describe the range of workholding methods and devices that are used on CNC optical grinding and polishing machines
- 2.11 explain why it is important to set the workholding device in relationship to the machine datums and reference points
- 2.12 describe the methods of setting the workholding devices, and the tools and equipment that can be used
- 2.13 describe the range of grinding and polishing wheels that are used on CNC optical grinding and polishing machines, and their typical applications
- 2.14 explain how to check that the grinding wheels are in a safe and serviceable condition
- 2.15 describe the plated bonded, ceramic and diamond bonded wheels, and the factors which determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
- 2.16 describe the various grinding tool holding devices that are used, and the methods of correctly mounting and securing the grinding wheels to the machine spindle and tool holders
- 2.17 describe the advantages of using pre-set tooling, and how to set the tooling using jigs/fixtures
- 2.18 describe the use of magazines and carousels, and how to position and identify the grinding wheels in relationship to the operating program
- 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 wheel datums, positions, lengths, offsets and radius compensation)
- 2.20 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
- 2.21 describe the settings that they need to check before allowing the machine to operate in full program run mode
- 2.22 explain how the various types of material used will affect the feeds and speeds that can be used
- 2.23 describe the application of cutting fluids in relationship to a range of materials being machined
- 2.24 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.25 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 442

# Machining components using CNC optical grinding and polishing machines

<b>UAN:</b>	D/600/5770
<b>Level:</b>	3
<b>Credit value:</b>	46
<b>GLH:</b>	150
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 156: Machining Components using CNC Optical Grinding and Polishing Machines (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to machine glass and infra-red/special material components, using CNC optical grinding and polishing machines, in accordance with approved procedures. The learner will be required to produce a range of components from various infra-red and visible materials, which combine a range of different features such as surface finish, cap height, diameters, bevels, profiles, parallelism, optical power and form analysis. The learner will also be required to check and verify finished components, using a variety of metrology equipment, to ensure that they meet the required specifications</p> <p>The learner will be required to operate the machine in line with safe working practices and approved procedures, and to continuously monitor the machining operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy</p>

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and procedures for the optical grinding and polishing activities undertaken, and to report any problems with these activities that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking full 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 applying optical grinding and polishing procedures. The learner will understand the CNC optical grinding and polishing processes, and their application, and will know about the equipment, materials and consumables, in adequate 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 optical grinding and polishing 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.

<b>Learning outcome</b>
The learner will: 1. machine components using CNC optical grinding and polishing machines
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the optical grinding and polishing activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being ground and polished (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and are correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held securely, without damage or distortion</li><li>• maintain grinding and polishing wheels in a safe and suitable</li></ul>

- condition
  - check that the operating program is at the correct start point
  - check that the workpiece is clear of the machine spindle
  - use safe working practices and machine start-up and operating procedures at all times
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate two of the following CNC optical grinding and polishing process machines:
- CNC optical grinding machine
  - CNC optical polishing machine
  - CNC optical smoothing machine
  - CNC optical edging machine
  - CNC special purpose machine
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce optical ground and polished components which combine different operations, and cover five of the following:
- centre thickness
  - bevels
  - optical form analysis
  - surface finish
  - component profile
  - optical power (radius of curvature)
  - cap height
  - concentricity
  - diameter/step feature, angles
- 1.7 grind and polish five different types of material from the following:
- germanium
  - silicon
  - zinc selenide
  - zinc sulphide
  - cleartran
  - lanthanum crowns
  - dense flints
  - flints/light flints
  - barium crowns
  - borosilicate crowns
  - barium dense flints
  - anomalous dispersion flour crowns
  - other appropriate optical material
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control, and report those that cannot be solved
- 1.9 control the computer process and ensure that the production

<p>output is to the required specification</p> <p>1.10 during production, carry out the necessary checks for accuracy, to include five of the following:</p> <ul style="list-style-type: none"> <li>• centre thickness</li> <li>• component profiles</li> <li>• surface/lens power error</li> <li>• angles</li> <li>• component surface finish</li> <li>• bevels/chamfers</li> <li>• surface form error</li> <li>• component cosmetic defects</li> <li>• lens diameter</li> <li>• cap height</li> </ul> <p>1.11 grind and polish optical components with dimensional accuracy, form and surface quality, to one of the following standards, as applicable to the operation:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 shut down the equipment to a safe condition on conclusion of the activities</p> <p>1.13 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation.</li> </ul>
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<p><b>Learning outcome</b></p> <p>The learner will:</p> <p>2. know how to machine components using CNC optical grinding and polishing machines</p>
<p><b>Assessment criteria</b></p> <p>The learner can:</p> <p>2.1 describe the safe working practices and procedures to be followed while operating CNC optical grinding and polishing machines/machining centres</p> <p>2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly</p> <p>2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency</p> <p>2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained</p> <p>2.5 describe the hazards associated with using CNC optical grinding and polishing machines (such as moving machinery, automatic machine operation, and glass and infra-red/special material particles), and how to minimise them and reduce any risks</p> <p>2.6 describe the importance of wearing the appropriate protective</p>

- clothing and equipment, and of keeping the work area clean and tidy
- 2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 read the visual display and understand the various messages displayed
  - 2.10 describe the function of error messages, and what to do when an error message is displayed
  - 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
  - 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
  - 2.13 explain how to operate the machine using single block run, full program run and feed/speed override controls
  - 2.14 explain how to make adjustments to the program operating parameters to take account of tool/wheel wear
  - 2.15 describe the various types of cutting tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel (including diamond abrasive wheels and polishing tools)
  - 2.16 describe the optical component mounting methods used to set up the workpiece, prior to operation, to minimise wedge error, concentricity and astigmatism
  - 2.17 explain how to handle and store all grinding and polishing wheels and tools required, safely and correctly
  - 2.18 describe the factors that affect the selection of cutting feeds pressures, speeds required and the depth of cut that can be taken (based on workpiece rigidity, machine condition, types of tooling used, material used, finish and tolerance required)
  - 2.19 explain how wheel wear affects surface finish and dimensional accuracy
  - 2.20 explain how the various types of material will affect the way the operation is performed
  - 2.21 describe the application of cutting fluids with regard to the range of material being machined
  - 2.22 explain how to recognise machine faults and how to identify when grinding and polishing tooling needs refurbishment
  - 2.23 describe the problems that can occur with optical grinding and polishing activities, and how they can be overcome
  - 2.24 describe the quality control procedures used, inspection checks to be carried out, and the equipment to be used for this
  - 2.25 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 443

## Machining optical cylinders and domes

<b>UAN:</b>	J/600/5813
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 157: Machining Optical Cylinders and Domes (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out machining and hand finishing operations on optical cylinders and domes, using optical process machines, in accordance with approved procedures.</p> <p>For domes, the learner will be required to machine components that combine a mixture of processes identified for optical domes, using a selection of specified optical dome materials. The learner will be expected to produce a range of components that combine a number of different features, such as centre thickness, diameters, generated blanks, optical form, and optical power (radius of curvature).</p> <p>For cylinders, the learner will need to carry out optical cylinder processing in accordance with optical approved procedures, including hand preparation, and smoothing and polishing, using a selection of specified optical cylinder materials. The learner will be expected to produce a range of cylinder components that combine different features, such as centre thickness, angles, axis, blocking, parallelism, and optical power and form error.</p> <p>The learner will be required to set up and operate the machines in line with safe working practices and approved procedures, and to continuously monitor the machining</p>

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operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining activities undertaken, and to report any problems with the machining activities, materials or equipment used that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying optical machining procedures. The learner will understand the optical cylinder and dome materials, the processes used, and their application and will know about the setting-up procedures, equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. machine optical cylinders and domes
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up and machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type</li></ul>

	<p>of optical cylinder or dome being machined (such as job instructions, component drawings and quality documentation)</p> <ul style="list-style-type: none"> <li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li> <li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li> <li>• ensure that components are correctly positioned and held securely, without damage or distortion</li> <li>• ensure that tooling is appropriate for the operations, and that it is maintained in a suitable condition</li> <li>• set the tooling and machine operating parameters to achieve the component specification</li> <li>• adjust machine settings, as required, during the machining activities to maintain component accuracy</li> <li>• use safe working practices and machine operating procedures at all times</li> <li>• leave the machine and work area in a safe and clean condition on completion of the machining activities</li> </ul>
1.3	confirm that the machine is set up and ready for the machining activities to be carried out
1.4	<p><b>either:</b> set up and operate all of the following types of optical cylinder processes:</p> <ul style="list-style-type: none"> <li>• cylinder preparation process</li> <li>• cylinder pitch polishing process</li> <li>• cylinder hand lapping to axis/angle process</li> <li>• cylinder silk polishing process</li> <li>• cylindrical test plate manufacture process</li> </ul> <p><b>or:</b> set up and operate four of the following types of optical dome processes:</p> <ul style="list-style-type: none"> <li>• dome preparation process</li> <li>• dome silk polishing process</li> <li>• dome surface generation process</li> <li>• dome pitch polishing process</li> <li>• dome polyurethane process</li> </ul>
1.5	manipulate the machine tool controls safely and correctly in line with operational procedures
1.6	produce components to the required quality and within the specified dimensional accuracy
1.7	<p>produce machined optical components that combine different operations, and cover six of the following:</p> <ul style="list-style-type: none"> <li>• cylinder/dome centre thickness</li> <li>• cylinder/dome concentricity</li> <li>• cylinder/dome cosmetic defects</li> <li>• cylinder/dome diameter</li> <li>• cylinder/dome truncation</li> <li>• dome preparation/smoothing process</li> <li>• cylinder/dome surface generation</li> </ul>

- cylinder/dome power analysis (radius)
- cylinder/dome form error analysis
- cylinder parallelism
- cylinder hand lapping process
- dome transmitted wave-front analysis
- dome transmission analysis

1.8 **either:** machine four different types of cylinder materials from the following:

- germanium
- barium crowns
- dense flints
- flints/light flints
- lanthanum crowns
- barium dense flints
- optical neutral density cut glass
- anomalous dispersion flour crowns
- optical orange filter glass
- optical blue filter glass
- borosilicate crowns
- magnesium fluoride
- other appropriate material

**or:** machine two different types of dome materials from the following:

- germanium
- zinc selenide
- zinc sulphide
- magnesium fluoride
- other

1.9 carry out quality sampling checks at suitable intervals

1.10 during production, carry out the necessary checks for accuracy, to include five of the following:

- dome diameter
- cylinder parallelism
- cylinder/dome truncation
- cylinder/dome centre thickness
- cylinder/dome cosmetic surface finishes
- cylinder/dome bevels
- cylinder/dome chamfers
- cylinder/dome cap height
- cylinder/dome surface power error
- cylinder/dome surface form error

1.11 produce components with dimensional accuracy, form and surface quality, to one of the following:

- BS, ISO or BSEN standards and procedures
- other accepted international standards
- customer (contractual) standards and requirements

<ul style="list-style-type: none"> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul> <p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved</p> <p>1.14 shut down the equipment to a safe condition on conclusion of the machining activities.</p>
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<b>Learning outcome</b>
The learner will:
2. know how to machine optical cylinders and domes
<b>Assessment criteria</b>
The learner can:
2.1 describe the safe working practices and procedures to be followed while operating optical cylinder/dome, generating, hand lapping, smoothing and polishing equipment
2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
2.3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained
2.5 describe the hazards associated with optical cylinder/dome process operations, and how to minimise them and reduce any risks
2.6 describe the importance of keeping the work area clean and tidy
2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 various optical cylinder/dome operations that can be performed, and the shapes and types of tooling that can be used (dome diamond abrasive wheels, dome polyurethane polishers, cylinder/dome pitch-polishers, silk polishers and smoothing tools)
2.10 describe the methods that can be used to set up the workpiece, prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool
2.11 describe the effect of backlash in machines slides, dials and screws, and how this can be overcome
2.12 explain how to handle and store all cutting tools and kit required, safely and correctly
2.13 describe the factors which affect the selection of cutting feeds, pressures and speeds required and depth of cuts that can be taken (such as workpiece rigidity, machine condition, types of tooling used, material used, finish and tolerance required)
2.14 explain how tool wear affects surface finish and dimensional

accuracy

- 2.15 explain how the various types of material will affect the way the operation is performed
- 2.16 describe the application of cutting fluids and polishing mediums with regard to the range of material being machined
- 2.17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 2.18 explain how to recognise machine faults and how to identify when tooling needs refurbishment
- 2.19 describe the problems that can occur with optical cylinder/dome machining activities, and how they can be overcome
- 2.20 describe the quality control procedures used, inspection checks to be carried out, and the equipment to be used for this
- 2.21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 444

## Machining optical plastic components

<b>UAN:</b>	L/600/5814
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 158: Machining Optical Plastic Components (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical plastic materials, using optical plastic process machines, in accordance with approved procedures. The learner will be required to set up and operate a range of machines, in order to produce components that combine a mixture of processes identified for plastic materials, using a selection of specified optical plastic lens and flat materials. The learner will be expected to produce a range of components that combine a number of different features, such as centre thickness, diameters, generated blanks, optical lens form, power, and stress and strain analysis.</p> <p>The learner will be required to set up and operate the machine in line with safe working practices and approved procedures, and to continuously monitor the machining operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining</p>

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activities undertaken, and to report any problems with the setting-up procedures, optical machining activities, materials or equipment used, that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying optical plastic machining procedures. The learner will understand the optical machining processes used, and their application, and be familiar with the equipment, materials and consumables, in adequate depth to provide a sound basis for setting up the equipment, carrying out the activities, correcting faults and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. machine optical plastic components
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being machined (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• ensure that components are correctly positioned and held securely, without damage or distortion</li><li>• ensure that tooling is appropriate for the operations and is</li></ul>

- maintained in a suitable condition
  - set the tooling and machine operating parameters to achieve the component specification
  - adjust machine settings, as required, during the machining activities to maintain component accuracy
  - use safe working practices and machine operating procedures at all times
  - leave the machine and work area in a safe and clean condition on completion of the machining activities
- 1.3 confirm that the machine is set up and ready for the machining activities to be carried out
- 1.4 set up and operate five types of optical plastic processes from the following:
- automated process
  - lens generating process
  - lens edging process
  - lens smoothing process
  - prism/flat smoothing process
  - hand smooth process
  - hand polish process
  - plastic stabilisation process
  - plastic diamond turning process
  - prism/flat polishing process
  - optical special materials process
  - special plastic cleaning process
- 1.5 manipulate the machine tool controls safely and correctly in line with operational procedures
- 1.6 produce components to the required quality and within the specified dimensional accuracy
- 1.7 produce machined optical components that combine different operations, and cover six of the following:
- centre thickness
  - lens diameter
  - lens concentricity
  - flat parallelism
  - lens form analysis
  - lens power analysis
  - lens surface generation
  - lens cosmetic defects
  - lens truncation and cap height
  - angular collimating
- 1.8 machine one of the following types of plastic material:
- cyclic olefin
  - polyetherimide
  - acrylic
  - sulfones
  - polyethylene
  - polycarbonate

<ul style="list-style-type: none"> <li>• other optical grade plastics</li> </ul>
1.9 carry out quality sampling checks at suitable intervals
1.10 during production, carry out the necessary checks for accuracy, to include five of the following: <ul style="list-style-type: none"> <li>• optical bevels</li> <li>• optical lens wedge</li> <li>• optical parallelism</li> <li>• lens centre thickness</li> <li>• truncations</li> <li>• optical truncations</li> <li>• lens cap height</li> <li>• lens chamfers</li> <li>• lens surface form error</li> <li>• lens diameters</li> <li>• lens surface finish</li> <li>• lens surface power/radius error</li> <li>• prism angles</li> </ul>
1.11 produce components with dimensional accuracy, form and surface quality to one of the following: <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul>
1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people: <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul>
1.13 deal promptly and effectively with problems within their control and report those that cannot be solved
1.14 shut down the equipment to a safe condition on conclusion of the machining activities.

<b>Learning outcome</b>
The learner will: 2. know how to machine optical plastic components
<b>Assessment criteria</b>
The learner can: 2.1 describe the safe working practices and procedures to be followed while operating the generating, smoothing and polishing equipment used for plastic optical components 2.2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly 2.3 describe the operation of the machine controls, and how to stop the machine in an emergency 2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained

- 2.5 describe the hazards associated with carrying out plastic lens machining operations, and how to minimise them and reduce any risks
- 2.6 describe the importance of keeping the work area clean and tidy
- 2.7 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 various plastic prism/lens operations that can be performed, and the shapes and types of tooling that can be used (such as fly cutters, diamond abrasive wheels, polyurethane polishers, pitch polishers)
- 2.10 describe the methods that can be used to set up the workpiece, prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool
- 2.11 explain what plastics do in their respective parts and make-up
- 2.12 explain how to achieve the required level of finish using hand smoothing and polishing techniques
- 2.13 describe the effect of backlash in machines slides, dials and screws, and how this can be overcome
- 2.14 explain how to handle and store all cutting tools and kit required, safely and correctly
- 2.15 describe the factors which affect the selection of cutting feeds, pressures and speeds required and the depth of cut that can be taken (such as workpiece rigidity, machine condition, types of tooling used, material used, finish and tolerance required)
- 2.16 explain how tool wear affects surface finish and dimensional accuracy
- 2.17 explain how the various types of materials will affect the way the operation is performed
- 2.18 describe the application of cutting fluids with regard to the range of material being machined
- 2.19 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 2.20 explain how to recognise machine faults, and how to identify when tooling needs refurbishment
- 2.21 describe the problems that can occur with plastic lens/prism machining activities, and how they can be overcome
- 2.22 describe the quality control procedures used, inspection checks to be carried out, and the equipment used for this
- 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 445

## Polishing and smoothing of lens or mirror surfaces

<b>UAN:</b>	R/600/5815
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 159: Polishing and Smoothing of Lens or Mirror Surfaces (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out the polishing and smoothing of lenses or mirrors either individually or as a block-mounted group, in accordance with approved procedures. The learner will be required to use appropriate drawings, specifications and test documentation to set up the equipment and to polish and smooth the lenses or mirrors. The learner will be expected to use the specified/appropriate techniques to carry out the polishing and smoothing procedures in the correct sequence. The process will include setting up and operating the equipment in line with safe working practices and approved procedures, and to monitor the polishing and smoothing operations, making any necessary adjustments to ensure that the finished lenses or mirrors are to the required quality and accuracy.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the polishing and smoothing activities undertaken, and to report any problems with the activities, components or equipment that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for</p>

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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 the finishing of lenses or mirrors by polishing and smoothing. The learner will understand the lens or mirror being polished and smoothed and its application. The learner will know about the polishing and smoothing techniques, procedures, test equipment and methods, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the polishing and smoothing is carried out to the required specification.

The learner will understand the safety precautions required when carrying out the polishing and smoothing operations. 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.

<b>Learning outcome</b>
The learner will: 1. polish and smooth lens or mirror surfaces
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the polishing and smoothing of the lens or mirror surfaces: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the lens or mirror to be polished (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that machine guards/safety mechanisms are in place and correctly adjusted at all times</li><li>• use safe working practices and machine operating procedures at all times</li><li>• clean down the polishing machines after each stage of polishing, to avoid contamination of differing grit sizes</li><li>• check that all tools, templates and equipment to be used are within their calibration dates</li><li>• return all tools and equipment to the correct location on completion of the activities</li><li>• leave the machine and work area in a safe and clean condition</li></ul>

- on completion of the polishing and smoothing activities
- 1.3 follow the correct specifications for the component being produced
  - 1.4 determine what has to be done and how the machine will be set to achieve this
  - 1.5 perform polishing and smoothing for one of the following:
    - individual lens/mirror forming through grinding, polishing and smoothing
    - block forming of lenses/mirrors through grinding, polishing and smoothing
  - 1.6 prepare to carry out the polishing and smoothing activities, to include carrying out all of the following:
    - select the correct 'right curve' or test templates for the lens/mirror to be polished
    - prepare the series of abrasive grits ready for polishing, ensuring that each is handled correctly to avoid cross contamination
    - prepare the polishing and smoothing machinery, ensuring its correct and safe operation as well as cleanliness
  - 1.7 mount and set the required workholding devices, workpiece and polishing tools
  - 1.8 prepare and mount the lens/mirror for the polishing and smoothing activities, to include carrying out all of the following:
    - ensure that any steep radius surfaces have undergone correct machining prior to polishing and smoothing
    - perform any necessary rough shaping of the lens/mirror surface, if required
    - prepare the pitch mixture to the correct viscosity, according to the material type to be polished
    - application and forming of pitch to correct shape
    - application of a backing pitch and correct runner
    - cutting of grooves into pitch surface
    - careful heating of components (such as runner) to ensure correct mounting of the lens/mirror
    - mounting of lens/mirror into pitch, ensuring correct orientation and position
  - 1.9 set the machine tool operating parameters to achieve the component specification
  - 1.10 carry out polishing and smoothing of lenses/mirrors, to include all of the following:
    - correct mounting of lenses/mirrors onto the polishing machine in the correct orientation
    - checking that the polishing or smoothing machine is set up correctly to give the required profile
    - applying the appropriate grit and carrying out the polishing or smoothing process
    - carrying out appropriate checks to confirm that the profile is correct
    - adjusting polishing conditions based on the results of checks/tests
    - cleaning down of the polishing machine between each grit size
    - carrying out the polishing and smoothing activities with finer

<p style="text-align: center;">grades of grit until the final specification is achieved</p> <ul style="list-style-type: none"> <li>• preparing the lenses/mirrors for the cleaning process</li> </ul> <p>1.11 carry out polishing and smoothing of lens/mirror surfaces, in compliance with one of the following:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• computer records</li> <li>• company-specific documentation</li> </ul> <p>1.13 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.14 perform three of the following inspection tests during the polishing process:</p> <ul style="list-style-type: none"> <li>• Foucault test</li> <li>• radius check</li> <li>• use of test plates to check for correct number of 'rings' as per specification</li> <li>• inspecting for surface defects</li> <li>• lens centre thickness</li> <li>• lens cap height</li> <li>• lens surface form error</li> <li>• prism angles</li> </ul> <p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>
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<b>Learning outcome</b>
The learner will:
2. know how to polish and smooth lens or mirror surfaces
<b>Assessment criteria</b>
The learner can:
2.1 describe the safe working practices and procedures to be followed while carrying out lens/mirror smoothing and polishing activities, and for the equipment and materials being used (such as safe use of polishing and smoothing equipment, handling of polishing compounds and pitches)
2.2 describe the safety mechanisms on the equipment, and the procedure for checking that they function correctly
2.3 describe the importance of wearing protective clothing and other appropriate safety equipment during the polishing and smoothing process; the type of equipment to be used, and where to obtain it
2.4 describe the hazards associated with the lens/mirror polishing and smoothing surface forming process (such as handling pitch, polishing mixes, heating of pitch, making grooves in the pitch, handling test templates, applying and heating the runner), and how

- to minimise them and reduce any risks
- 2.5 describe the importance of keeping the equipment and work area clean and tidy
  - 2.6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 for the lens/mirror polishing and smoothing activities (such as obtaining the correct workholding jigs, selecting and preparing the various grades of grits, preparing the pitch to hold the lens/mirror)
  - 2.9 explain how to mount the lens/mirror ready for the polishing activities (such as preparing the pitch, mounting of the lens/mirror in the correct position and orientation)
  - 2.10 explain how to set up the polishing and smoothing equipment to give the required lens/mirror profile
  - 2.11 describe the various quality checks that can be used, and how they are applied (such as foucault test, ring counting) during the forming process
  - 2.12 describe the surface quality tests to be performed as part of the quality process (such as dig, scratches and sleeks) and to confirm that they are within the specification
  - 2.13 describe the problems that can occur with the lens/mirror polishing and smoothing activities, and how they can be overcome
  - 2.14 explain how to analyse and evaluate possible characteristics and causes of specific faults/problems
  - 2.15 explain how to prepare documentation after completing the surface forming tasks, ready for the next stage (such as cleaning process)
  - 2.16 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 446

## Vacuum coating optical materials

<b>UAN:</b>	Y/600/5816
<b>Level:</b>	3
<b>Credit value:</b>	30
<b>GLH:</b>	91
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 160: Vacuum Coating Optical Materials (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out optical thin-film coating operations, using optical thin-film coating process machines, in accordance with approved procedures. The learner will be required to set up and use a range of equipment, in order to produce components that combine a mixture of processes identified for optical thin-film coating, using a selection of specified optical materials. The learner will be expected to produce a range of components that combine a number of different features, such as optical transmission, flatness, surface defects and transmitted wavelength.</p> <p>The learner will be required to set up and operate the coating machine in line with safe working practices and approved procedures, and to continuously monitor the coating operations, making any necessary adjustments to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the optical coating activities undertaken, and to report any problems with the coating activities,</p>

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materials or equipment that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying optical coating procedures. The learner will understand the optical thin-film coating processes, and their application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the work output is to the required specification.

The learner will understand the safety precautions required when working with the 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.

<b>Learning outcome</b>
The learner will: 1. vacuum coat optical materials
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the vacuum coating activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of lens being coated (such as job instructions, material data sheets, component specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure that the vacuum coating equipment safety mechanisms (such as guards, fume extraction) are in place and working at all times</li><li>• ensure that components are correctly handled and processed without damage or distortion</li><li>• set the vacuum coating equipment processing parameters to achieve the component specification</li><li>• adjust process settings, as required, to maintain component</li></ul>

- accuracy
  - use safe working practices and vacuum coating process operating procedures at all times
  - leave the equipment and work area in a safe and clean condition on completion of the vacuum coating activities
- 1.3 ensure that the material surfaces to be treated are suitably prepared for the finishing operations to be carried out
- 1.4 check that the finishing equipment and treatment solutions are set up and maintained at satisfactory operating conditions and levels
- 1.5 set up and operate three of the following types of optical thin-film coating process machines from the following:
  - infra-red/special material coating
  - visible dichroics/edge filters coating
  - graded coating
  - polycarbonate material coating
  - basic anti-reflection coating
  - other coating processes
- 1.6 carry out the treatment process in accordance with operating procedures and the component specification requirements
- 1.7 carry out six of the following during the thin-film coating activities:
  - prepare coating tooling
  - clean the coating tooling
  - prepare coating materials
  - prepare components for the coating operation
  - clean components before and after coating operations
  - load components ready for coating
  - unload components after coating
- 1.8 thin-film coat four different types of component materials from the following:
  - germanium
  - polycarbonate
  - barium crown
  - dense flints
  - optical blue filter glass
  - zinc selenide prisms and flats
  - borosilicate crown
  - flint/light flints
  - anomalous dispersion flour crown
  - optical neutral density glass
  - zinc sulphide prisms and flats
  - barium dense flints
  - lanthanum crowns
  - optical orange filter glass
  - other appropriate material
- 1.9 ensure that the treated workpiece achieves the required characteristics and meets the finishing specification
- 1.10 during production, carry out the necessary checks for accuracy, to include three of the following:

<ul style="list-style-type: none"> <li>• transmission measurement</li> <li>• surface defect measurement</li> <li>• flatness measurement</li> <li>• coating adhesion test</li> <li>• coating humidity test</li> </ul> <p>1.11 produce components with dimensional accuracy, form and surface quality, to one of the following:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> </ul> <p>1.12 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• company-specific documentation</li> <li>• computer records</li> <li>• test documents</li> </ul> <p>1.13 deal promptly and effectively with problems within their control and report those that cannot be solved</p> <p>1.14 dispose of waste and excess materials, in line with agreed organisational procedures</p> <p>1.15 shut down the finishing equipment to a safe condition on completion of the processing activities.</p>
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<b>Learning outcome</b>
The learner will:
2. know how to vacuum coat optical materials
<b>Assessment criteria</b>
The learner can:
2.1 describe the safe working practices and procedures to be followed while operating optical vacuum coating process equipment
2.2 describe the safety mechanisms on the equipment, and the procedure for checking that they function correctly
2.3 describe the operation of the equipment controls, and how to shut down the equipment in an emergency
2.4 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained
2.5 describe the hazards associated with optical vacuum coating process operations, and how to minimise them and reduce any risks
2.6 describe the importance of keeping the work area clean and tidy
2.7 explain where to obtain the component drawings, specifications and/or job instructions, in order to produce the required components to be coated
2.8 explain how to extract the necessary information from the drawings and specifications, in order to apply the required coating to the optical components
2.9 describe the factors which affect the equipment set-up, in order to achieve the correct coating specification

- 2.10 describe the preparation of the coating materials
- 2.11 explain how to load and unload the optical components correctly into/from jigs and fixtures
- 2.12 explain how to clean and store the optical components prior to the coating operations
- 2.13 explain how to prepare the vacuum coating plant prior to the coating process
- 2.14 explain how to correctly identify the optical component face to be coated
- 2.15 explain how to strip the coating plant after coating operations have been carried out
- 2.16 describe the problems that can occur with optical thin-film coating activities, and how they can be overcome
- 2.17 describe the quality control procedures used, inspection checks to be carried out, and the equipment used to achieve the required component specification
- 2.18 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 447

# Inspecting optical components using mechanical instruments

<b>UAN:</b>	D/600/5817
<b>Level:</b>	3
<b>Credit value:</b>	30
<b>GLH:</b>	91
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 161: Inspecting Optical Components using Mechanical Instruments (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out inspection operations on optical components, using optical inspection techniques and equipment, in accordance with approved procedures. The learner will be required to check components made from a variety of optical materials, using a range of inspection equipment, as appropriate. The learner will be expected to inspect a range of components that combine a number of different features, such as centre-thickness, diameters, generated blanks, optical lens form and power, angles, profiles, and with cosmetic defects.</p> <p>The learner will be required to operate the inspection equipment in line with safe working practices and approved procedures, and to continuously monitor the equipment operations, making any necessary adjustments in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the optical inspection</p>

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activities undertaken, and to report any problems with the inspection activities, equipment or materials that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying optical inspection procedures. The learner will understand the inspection procedures used, and their application, and be familiar with the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, identifying out-of-specification components, and ensuring that accepted components meet the required specification.

The learner will understand the safety precautions required when working with the inspection 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.

<b>Learning outcome</b>
The learner will: 1. inspect optical components using mechanical instruments
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following activities during the inspection activity: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the optical components to be inspected (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• check that the required inspection equipment is within current calibration dates</li><li>• follow specified and appropriate inspection procedures to check the components</li><li>• identify, and record in the appropriate format, any out-of-tolerance dimensions/features</li></ul>

- investigate and obtain concessions for out-of-specification products (where appropriate)
  - place products in the correct location on completion of the inspection activities (in and out of specification)
  - leave the work area in a safe and tidy condition on completion of the inspection activities
- 1.3 follow the correct specification for the product or equipment being inspected
- 1.4 use the correct equipment to carry out the inspection
- 1.5 use six types of optical inspection equipment from the following:
- lens centring rig
  - centre thickness gauge
  - microscopes
  - micrometers
  - optical measuring equipment
  - focometer test equipment
  - auto collimators
  - optical spheres
  - optical flats
  - dial test indicators
  - slip gauges
  - Vernier equipment
  - interferometry and phase analysis equipment
  - shadowgraph test equipment
- 1.6 identify and confirm the inspection checks to be made and the acceptance criteria to be used
- 1.7 carry out all required inspections, as specified
- 1.8 inspect five optical components from the following:
- infra-red lens
  - optical cylinder
  - glass lens
  - combiners
  - glass prisms
  - optical mirrors
  - infra-red glass flats
  - infra-red prisms
  - profiled optical components
  - infra-red glass domes
  - plastic lens components
- 1.9 inspect ten features of machined optical components from the following:
- prism angles
  - concentricity
  - profiles
  - focal length
  - flats power error
  - lens diameter

- lens form error
- sag depth
- lens centring
- cosmetic defect
- cap height
- flats form error
- centre thickness
- refractive index
- other features
- truncation
- lens wedge
- flat/parallelism
- lens power (radius)

1.10 use inspection methods and techniques suitable for components made from six different types of materials from the following:

- germanium
- barium crowns
- dense flints
- flints/light flints
- infra-red glass 4,5,6
- barium dense flints
- zinc selenide
- zinc sulphide
- silicon
- plastics
- lanthanum crowns
- anomalous dispersion flour crowns
- optical neutral density glass
- optical orange filter glass
- optical blue filter glass
- other appropriate optical material
- thallium ideobromide
- borosilicate crowns

1.11 inspect optical components in accordance with one of the following specifications:

- BS, ISO or BSEN standards and procedures
- other accepted international standards
- customer (contractual) standards and requirements
- company standards and procedures

1.12 identify any defects or variations from the specification

1.13 record the results of the inspection in the appropriate format

1.14 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:

- job cards
- quality control documentation
- concession report

- company-specific documentation
- 1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.

<b>Learning outcome</b>
The learner will: 2. know how to inspect optical components using mechanical instruments
<b>Assessment criteria</b>
The learner can: 2.1 describe the safe working practices and procedures to be followed while using inspection equipment 2.2 describe the Personal Protective Equipment (PPE) to be worn, and where this can be obtained 2.3 describe the hazards associated with carrying out optical inspection operations, and how to minimise them and reduce any risks 2.4 describe the importance of keeping the work area clean and tidy 2.5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN 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 methods of calculating data from engineering drawings/specifications 2.8 describe the various optical inspection operations to be performed, and the types of equipment used 2.9 explain how to calibrate equipment before inspection operations are carried out 2.10 explain how to recognise the various cosmetic defects 2.11 explain how to handle and store all inspection equipment, safely and correctly 2.12 explain how tool wear affects surface finish and dimensional accuracy 2.13 explain how the various types of material may affect the way the inspection operation is performed 2.14 explain how to recognise inspection equipment faults, and how to identify when the inspection equipment needs recalibrating 2.15 describe the problems that can occur with optical inspection activities, and how they can be overcome 2.16 describe the quality control procedures used, inspection checks to be carried out, and the equipment used for this 2.17 describe the extent of your own responsibility, and to whom you should report if you have problems that you cannot resolve.

## Unit 448

## Inspecting optical components using co-ordinate measuring machines (CMM)

<b>UAN:</b>	K/600/5819
<b>Level:</b>	3
<b>Credit value:</b>	46
<b>GLH:</b>	150
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 162: Inspecting Optical Components using Co-ordinate Measuring Machines (CMM) (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to inspect optical components, using manual and/or CNC co-ordinate measuring machines, in accordance with approved procedures. The learner will be required to prepare and set up the equipment in readiness for the inspection operations. This will involve obtaining and using the correct issue of drawings, job instructions and specifications including, where appropriate, downloading the correct CNC measuring program.</p> <p>The learner will be expected to set up the co-ordinate measuring machine, to position and secure the component/product in a suitable location and to select and mount the correct inspection probes. In carrying out the inspection activities, the learner will be expected to check the components/product for both dimensional and geometrical accuracy, and this may be required to be undertaken at various stages of the engineering/manufacturing process, such as first-off inspection, during production and final inspection.</p> <p>The learner's responsibilities will require them to comply with organisational policy</p>

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and procedures for the setting-up and operating activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 the inspection procedures used. The learner will understand the co-ordinate measuring equipment being used and its application, and will know about the inspection probes, setting-up and operating procedures, in adequate depth to provide a sound basis for effectively using the equipment, identifying faults and for ensuring that the inspection activities are carried out to the required specification.

The learner will understand the safety precautions required when working with the machine and with its associated 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.

<b>Learning outcome</b>
The learner will: 1. inspect optical components using Co-ordinate Measuring Machines (CMM)
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the inspection activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the optical component to be inspected (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• follow specified and appropriate inspection procedures</li><li>• identify, and record in the appropriate format, any out-of-tolerance dimensions/features</li><li>• investigate and obtain concessions for out-of-specification</li></ul>

- products (where appropriate)
  - place products in the correct location on completion of the inspection activities (in and out of specification)
  - shut down the equipment, using the correct procedure
  - leave the work area in a safe and tidy condition on completion of the inspection activities
- 1.3 follow the correct specification for the product or equipment being inspected
- 1.4 use the correct equipment to carry out the inspection activities
- 1.5 use one of the following types of manual and/or CNC co-ordinate measuring machines:
  - vertical
  - horizontal
  - gantry/bridge
  - other specific type
- 1.6 check all of the following, as applicable to the machine type:
  - check that datums for each machine axis are set in relation to equipment, components and probes selected
  - where applicable, download the CNC program into the controller, safely and correctly
  - select and mount suitable inspection probes for the different features to be checked
  - calibrate the inspection probe (where applicable)
  - enter the probe information correctly into the machine controller/operating system
  - ensure that probe changes are carried out safely and clear from obstructions
  - check that all inspection operations and probe movements are executed safely and correctly
  - ensure that any alterations to programs are communicated fully to the appropriate personnel
- 1.7 identify and confirm the inspection checks to be made and the acceptance criteria to be used
- 1.8 carry out all required inspections, as specified
- 1.9 inspect five of the following types of optical component:
  - infra-red lens
  - cylinders
  - glass lens
  - combiners
  - glass prisms
  - optical mirrors
  - infra-red glass flats
  - infra-red prisms
  - profiled optical components
  - infra-red glass domes
  - plastic lens components
- 1.10 mount the workpiece in a suitable position, using two of the following:
  - direct to machine table

- on angle plates
  - in special jigs
  - in pitch/malleable material
  - on parallels
  - on vee blocks
  - other specific mounting methods
- 1.11 carry out two of the following inspection procedures:
- first/one-off
  - in-process sample inspection
  - one-hundred-percent final inspection of components or products
  - statistical quality control
- 1.12 inspect optical components that have a range of different features, and cover twelve of the following:
- prism angles
  - concentricity
  - profiles
  - focal length
  - flats power error
  - lens diameter
  - lens form error
  - sag depth
  - lens centring
  - cosmetic defect
  - cap height
  - flats form error
  - centre thickness
  - refractive index
  - other features
  - truncation
  - lens wedge
  - flat/parallelism
  - lens power (radius)
- 1.13 inspect optical components in accordance with one of the following specifications:
- BS, ISO or BSEN standards and procedures
  - other accepted international standards
  - customer (contractual) standards and requirements
  - company standards and procedures
- 1.14 identify any defects or variations from the specification
- 1.15 record the results of the inspection in the appropriate format
- 1.16 complete the inspection documentation, to include one from the following, and pass it to the appropriate people:
- job card
  - quality control documents
  - company-specific documentation
  - concession report

- customer-specific documentation
- 1.17 deal promptly and effectively with problems within their control and report those that cannot be solved.

<b>Learning outcome</b>
The learner will: 2. know how to inspect optical components using co-ordinate measuring machines (CMM)
<b>Assessment criteria</b>
The learner can: 2.1 describe the specific safety precautions to be taken when inspecting components/products (such as specific legislation or regulations governing the activities or work area, safe working practices and procedures to be adopted, general workshop safety practice) 2.2 describe the health and safety requirements of the work area in which they are carrying out the inspection activities, and the responsibility these requirements place on them 2.3 describe the COSHH Regulations with regard to the substances used in the inspection process 2.4 describe the hazards associated with inspecting components/products, and how to minimise them and reduce any risks 2.5 describe the appropriate Personal Protective Equipment (PPE) and clothing to be worn during the inspection activities 2.6 explain how and where to obtain the required drawings and/or CNC operating program and related specifications 2.7 describe the importance of checking that all inspection documentation, programs and specifications are current and complete 2.8 explain how to extract information from engineering drawings and/or CNC operating programs and related specifications (to include codes, symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to the inspection work being undertaken 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.10 describe the use of British, European and international standards for determining if components and products are fit for purpose 2.11 describe the general principles of inspection systems and procedures 2.12 describe the preparations to be undertaken before the component/product is inspected 2.13 describe the application of different co-ordinate measuring machines (such as vertical, horizontal and gantry/bridge) 2.14 describe the function keys and operating system used on co-ordinate measuring machines 2.15 describe the application of different types of inspection probe that are available 2.16 describe the importance of ensuring that equipment is set up correctly and is in a safe and useable condition 2.17 describe the systems of measurement that are used on co-ordinate

measuring machines

- 2.18 explain how to ensure that inspection probes are correctly calibrated before undertaking the inspection activities
- 2.19 explain how to deal with equipment and/or program error messages
- 2.20 describe the effects that the environment may have on the measurements taken, particularly where precision measurements are required
- 2.21 explain the need to select and use set datum points, and the effects of taking readings from different datums (such as accumulation of limits leading to errors)
- 2.22 explain why sampling is used, and when it is an effective means of quality assurance
- 2.23 describe the typical defects and variations that can be found on optical components/products, and how to identify them
- 2.24 describe the procedure to be followed when inspected products are out of specification (including obtaining concessions, where appropriate)
- 2.25 describe the importance of completing inspection documentation; what needs to be recorded and where records are kept
- 2.26 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 449

## Carrying out laser/optical metrology

<b>UAN:</b>	D/600/5820
<b>Level:</b>	3
<b>Credit value:</b>	46
<b>GLH:</b>	150
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 163: Carrying Out Laser/Optical Metrology (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out laser/optical metrology, in accordance with approved procedures. The learner will be required to use high-precision machinery to carry out metrology on optical surfaces. The learner will be expected to use a variety of methods and techniques. From the process carried out, the learner will be expected to record metrology data relating to optical surfaces.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the laser/optical metrology activities undertaken, and to report any problems with these activities, tools and equipment used that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.</p> <p>The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying laser/optical metrology procedures. The learner will understand the various laser/optical metrology methods and techniques used, and their application. The</p>

learner will know how to apply and interpret information obtained from the metrology equipment, in adequate depth to provide a sound basis for carrying out the activities, and identifying faults or conditions that are outside the acceptable specification. The learner will know about the interaction of the other associated integrated technologies, and will have adequate knowledge to carry out metrology accurately.

The learner will understand the safety precautions required when carrying out laser/optical metrology activities, in particular those relating to exposure to laser light. 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.

<b>Learning outcome</b>
The learner will: 1. carry out laser/optical metrology
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the laser/optical metrology activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the optical components to be inspected (such as job instructions, component drawings and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• ensure the safe operation of the metrology equipment (such as mechanical or electrical)</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• carry out the metrology activities, using approved techniques and procedures at all times</li><li>• record the measurements of the inspection/metrology checks, as per the operating procedures</li><li>• return all tools and equipment to the correct location on completion of the metrology activities</li><li>• leave the metrology equipment and work area in a safe and clean condition on completion of the activities</li><li>• dispose of any waste items in a safe and environmentally acceptable manner</li></ul>
1.3 follow the correct specification for the product or equipment being

inspected

- 1.4 use the correct equipment to carry out the inspection
- 1.5 identify and confirm the inspection checks to be made and the acceptance criteria to be used
- 1.6 carry out all required inspections, as specified
- 1.7 carry out laser/optical metrology on four of the following types of optical component:
  - infra-red lens
  - optical cylinder
  - glass lens
  - combiners
  - glass prisms
  - optical mirrors
  - infra-red glass flats
  - infra-red prisms
  - profiled optical components
  - infra-red glass domes
  - plastic lens components
  - flat surface
  - spherical surface
- 1.8 perform a complete metrology method, to include two of the following:
  - two beam interference
  - Fizeau interferometer
  - Mach Zehnder interferometer
  - Twyman Green interferometer
  - Mirau interferometer
  - Linnik interferometer
  - Shack interferometer
  - Smartt point diffraction interferometer
  - Sommargren diffraction interferometer
  - lateral shear interferometer
  - radial shear interferometer
  - long wavelength interferometer
  - two wavelength holography interferometer
  - Ritchey-Common test
  - Shack-Hartmann test
  - cylindrical surface test
  - Lyot test
  - null optic tests (such as Offner test)
  - hyperboloid test (such as Meinel test)
  - conic tests (such as Hindle test)
  - concave parabolic test
  - elliptical test
  - holographic null test
  - testing windows/prisms in transmission

- autocollimator test
  - interferograms
  - scatterplate interferograms
  - dye laser interferograms
  - FECO (fringes of equal chromatic order)
  - Normarski interferometer
  - phase-shifting interface microscope
  - Moiré fringe patterns
- 1.9 identify any defects or variations from the specification
- 1.10 record the results of the inspection in the appropriate format
- 1.11 record the metrology data from sources appropriate to the method being used, to include five of the following:
- measure power density
  - record an image of the surface contours
  - perform null testing using compensators
  - perform tilting to measure sagittal focus
  - analyse and record interferometric fringe patterns
  - take measurements and interpret data
  - using graphics tablets
  - using a scanner
  - using a CCD camera
  - recording of P-V (peak to valley) data
  - record interferogram images, using software methods
  - record data using detector arrays
- 1.12 use a variety of analytical methods to process the data collected from the metrology method being used, to include five of the following:
- direct phase measurement
  - phase measurement calculations
  - carry out diffraction calculations (such as phase shifting and Modulation Transfer Function (MTF))
  - analysis of synthetic wavefronts
  - perform computer analysis of interferograms
  - produce slope maps
  - analyse P-V and RMS data using computer software
  - run an algorithm for phase measurement
  - resolve any phase ambiguities
  - resolve error sources for vibration, stray-reflections, detector non-linearity, frequency stability, quantisation errors
- 1.13 provide a record of the outcome of the metrology process, which should contain all of the following:
- step-by-step analytical report
  - a record of the method chosen and the algorithms used
  - an analysis of the measurements taken, with associated errors
- 1.14 deal promptly and effectively with problems within their control and report those that cannot be solved.

<b>Learning outcome</b>
The learner will: 2. know how to carry out laser/optical metrology
<b>Assessment criteria</b>
The learner can: 2.1 describe the specific safety precautions to be taken when carrying out laser/optical metrology checks on components (such as specific legislation or regulations governing the activities or work area, safe working practices and procedures to be adopted, general workshop safety practice) 2.2 describe the health and safety requirements of the work area in which they are carrying out the metrology activities, and the responsibility these requirements place on them 2.3 describe the importance of wearing protective clothing and other appropriate safety equipment during the measurement process, the equipment to be used, and where to obtain it 2.4 describe the hazards associated with carrying out metrology (such as laser safety), and how to minimise them and reduce any risks 2.5 explain where to obtain, and how to interpret, drawings, specifications, quality control documentation, equipment manuals and other documents needed in the metrology process 2.6 describe the importance of checking that all metrology inspection documentation and specifications are current and complete 2.7 explain how to extract information from engineering drawings and related specifications (to include codes, symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to the metrology inspection work being 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 use of British, European and international standards for determining if components and products are fit for purpose 2.10 describe the general principles of inspection systems and procedures 2.11 describe the preparations to be undertaken on the components before they are inspected 2.12 describe the various optical inspection operations to be performed, and the types of equipment used 2.13 describe the importance of ensuring that equipment is set up correctly and is in a safe and useable condition 2.14 explain how to handle and store the laser/optical metrology inspection equipment, safely and correctly 2.15 explain how to calibrate the equipment before metrology inspection operations are carried out 2.16 describe the effects that the environment may have on the measurements taken, particularly where precision measurements are required 2.17 explain the need to select and use set datum points, and the effects of taking readings from different datums (such as accumulation of limits leading to errors) 2.18 explain why sampling is used and when it is an effective means of quality assurance 2.19 explain how to evaluate the various types of information available

during the metrology process (such as user reports, monitoring equipment, sensory input and any software being used to analyse results)

- 2.20 describe the procedures to be followed to set up and record the measurements needed (this includes handling optical components and setting up and using laser-based machinery)
- 2.21 explain how to use the various aids and reports available for fault diagnosis during the metrology
- 2.22 describe the typical defects and variations that can be found on the components, and how to identify them
- 2.23 describe the procedure to be followed when inspected products are out of specification (including obtaining concessions, where appropriate)
- 2.24 describe the importance of completing inspection documentation; what needs to be recorded and where records are kept
- 2.25 explain how to prepare a report which describes the measurements undertaken, the algorithms used to process the data and the accuracy of the results obtained
- 2.26 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

<b>UAN:</b>	K/600/5822
<b>Level:</b>	3
<b>Credit value:</b>	30
<b>GLH:</b>	91
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 164: Terminating Fibre-Optic Cables (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out the termination of fibre-optic cables, using appropriate optical termination techniques and equipment, in accordance with approved procedures. The learner will be expected to complete the fibre-optic terminations, combining a number of different operations and features. The learner will be required to use the correct termination equipment in line with safe working practices and approved procedures, and to check the completed terminations, using a range of inspection equipment and making any necessary adjustments to ensure that the work output is to the required quality and accuracy.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the fibre-optic cable termination activities undertaken, and to report any problems with the activities, equipment or materials that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.</p> <p>The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to carrying out the</p>

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fibre-optic cable termination procedures. The learner will understand the fibre-optic termination procedures used, and their application, and will be familiar with the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, identifying and correcting defects, and ensuring that the completed terminations meet the required specification.

The learner will understand the safety precautions required when working with the fibre-optic cable termination 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.

<b>Learning outcome</b>
The learner will: 1. terminate fibre-optic cables
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the fibre-optic cable termination activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of cable being terminated (such as job instructions, system drawings, cable specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• maintain safe access and working arrangements for the work area</li><li>• use safe and approved fibre-optic termination techniques and procedures at all times</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• return all tools and equipment to the correct location on completion of the fibre-optic cable termination activities</li><li>• leave the work area in a safe and clean condition on completion of the cable termination activities</li></ul> 1.3 follow the relevant instructions, assembly drawings and any other specifications 1.4 ensure that the specified components are available and that they are in a usable condition 1.5 use the appropriate methods and techniques to assemble the components in their correct positions 1.6 perform fibre-optic cable terminations on both of the following

types of cable:

- simplex
- duplex

1.7 perform two of the following types of fibre-optic cable termination:

- Lucent connector (LC)
- Pigtail Termination
- ST LC
- FC
- MTRJ
- E2000
- SMA
- ESCON
- MU
- LX.5
- MPO/MTP
- FDDI
- TAP8
- specialised termination

1.8 select and use six of the following tools and consumables, according to the procedure being followed:

- buffering tool
- jacket scissors
- stripping tool
- rule
- cleave plate
- curing oven
- heat sleeve
- crimping tool
- approved adhesive
- polishing film
- syringe needle

1.9 produce fibre-optic cable terminations, to include carrying out all of the following:

- connection of the ferrule and body
- cutting the jacket to the correct length
- stripping the fibre jacket to correct length
- crimping the connector
- sliding on the boots
- buffering the outer sheath
- mixing the adhesive
- placing connectors into a curing oven
- allowing connectors to cool

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 assembly meets the required specification

<p>1.12 finish the fibre-optic cable termination, to include carrying out all of the following:</p> <ul style="list-style-type: none"> <li>• checking that the termination is correctly made</li> <li>• cleaving the fibre end, and removing excess fibre and epoxy</li> <li>• polishing the fibre-optic connectors</li> <li>• testing to ensure that the completed termination meets the required quality standards</li> </ul> <p>1.13 terminate fibre-optic cables in compliance with one of the following standards:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures (such as BS:EN 61300)</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> <li>• specific equipment requirements/manufacturer's data</li> <li>• recognised compliance agency/body's standards</li> </ul> <p>1.14 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• company-specific documentation</li> <li>• computer records</li> <li>• test documents</li> </ul> <p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>
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<p><b>Learning outcome</b></p> <p>The learner will:</p> <p>2. know how to terminate fibre-optic cables</p>
<p><b>Assessment criteria</b></p> <p>The learner can:</p> <p>2.1 describe the specific safety practices and procedures that they need to observe when carrying out fibre-optic cable termination procedures (including any specific legislation, regulations and codes of practice for the activities, equipment or materials)</p> <p>2.2 describe the health and safety requirements of the work area where they are carrying out the fibre-optic cable termination, and the responsibility they place on them</p> <p>2.3 describe the safety procedures that must be carried out before work is started on the cable termination</p> <p>2.4 describe the protective equipment that they need to use for both personal protection of themselves and others, and protection of the fibre-optic cable components</p> <p>2.5 describe the hazards associated with the fibre-optic cable termination process, and with the tools and test equipment used, and how to minimise them and reduce any risks</p> <p>2.6 explain how to obtain and interpret drawings, standards, quality control procedures and specifications used in the fibre-optic cable termination process (including, for example, BS, ISO or BSEN schematics, symbols and terminology)</p>

- 2.7 explain how to carry out currency/issue checks on the specifications they are working with
- 2.8 describe the type of fibre-optic cable being terminated
- 2.9 describe the basic principle of operation of the fibre-optic cable and the termination
- 2.10 describe the properties of light which allow it to be used for transmission of information via optic cable, and how the termination allows the light to pass through a connector
- 2.11 describe the adjustments/corrections required to bring the fibre-optic cable and its termination to the correct standard through a full range of parameters
- 2.12 describe the quality control procedures to be followed during the fibre-optic cable termination process
- 2.13 describe the types of test equipment to be used, and their selection for particular types of tests following the cable termination
- 2.14 explain how to recognise defects (such as under or over performance)
- 2.15 explain how to interpret the test readings obtained, and the significance of the readings
- 2.16 describe the importance of ensuring that equipment is used only for its intended purpose and within its specified range and limits
- 2.17 describe the potential problems or errors that could occur with the fibre-optic cable termination operations, and how these can be overcome
- 2.18 describe the environmental control and company operating procedures relating to the fibre-optic cable termination activities
- 2.19 describe the documentation required and the procedures to be followed on completion of the fibre-optic cable termination activities
- 2.20 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

<b>UAN:</b>	M/600/5823
<b>Level:</b>	3
<b>Credit value:</b>	78
<b>GLH:</b>	175
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 165: Building Optical Systems (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to build an optical system, in accordance with approved procedures. The learner will be required to handle and assemble high precision components to carry out the tasks. The learner will be expected to use a variety of assembly methods and techniques. From the process carried out, the learner will be expected to record assembly data relating to the optical system they have built.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the build/assembly activities undertaken, and to report any problems with these activities, or with the tools and equipment used that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.</p> <p>The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying build/assembly practices for optical systems. The learner will understand the various assembly techniques used, and their application. The learner will know how to apply and interpret information obtained from the build drawings/specifications, in</p>

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adequate depth to provide a sound basis for carrying out the assembly activities, identifying and correcting faults and ensuring that the completed assembly meets the specification requirements.

The learner will understand the safety precautions required when carrying out the assembly activities. 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.

<b>Learning outcome</b>
The learner will: 1. build optical systems
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the assembly activities: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of optical system being assembled (such as job instructions, equipment/system drawings, equipment specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant laser safety regulations and procedures to realise a safe system of work</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• provide and maintain safe access and working arrangements for the work area</li><li>• carry out the assembly activities using safe and approved techniques and procedures</li><li>• return all tools and equipment to the correct location on completion of the assembly activities</li><li>• leave the equipment and work area in a safe and clean condition on completion of the assembly activities</li><li>• dispose of any waste items in a safe and environmentally acceptable manner</li></ul> 1.3 follow the relevant instructions, assembly drawings and any other specifications 1.4 prepare for the assembly activities, to include carrying out all of the following: <ul style="list-style-type: none"><li>• obtain all the required optical system components and check that they are undamaged and fit to use</li><li>• obtain all the required tooling and assembly jigs/fixtures</li><li>• preparation and alignment of fixtures to correct accuracy using an appropriate metrology method</li></ul>

- obtain and prepare any necessary adhesives for the assembly operation
  - obtain and prepare any cleaning materials required for the assembly operation
- 1.5 ensure that the specified components are available and that they are in a usable condition
- 1.6 use six of the following types of component in the assembly:
- cables and wires
  - plugs
  - sockets
  - switches
  - sensors
  - motors
  - lamps/lighting
  - junction boxes
  - earthing devices
  - circuit boards
  - optical components
  - electronic modules
  - instrumentation
  - relays
  - mechanical components
  - other
- 1.7 use the appropriate methods and techniques to assemble the components in their correct positions
- 1.8 carry out the assembly of one of the following types of optical system:
- sensing
  - measuring
  - data
  - imaging
  - display
- 1.9 assemble an optical system, to include carrying out eight of the following:
- positioning the housing, ensuring correct seating
  - setting up the correct datums, using an appropriate metrology
  - positioning and locating the optical components along the optical axis, avoiding generating debris, and ensuring correct seating
  - performing any alignment checks required (such as centring)
  - priming any surfaces to be bonded
  - applying the adhesive according to the approved method
  - monitoring the components during the curing of the adhesive
  - removing any excess adhesive and performing a final clean
  - making further alignment checks and tests
  - fitting appropriate mechanical fastening devices, tightened to the required torque
  - making all required electrical connections and correctly

<p>routing cables and wires</p>
<p>1.10 secure the components using the specified connectors and securing devices</p>
<p>1.11 check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification</p>
<p>1.12 carry out the required checks, using the correct tools and equipment, to include all of the following:</p> <ul style="list-style-type: none"> <li>• completeness of the assembly</li> <li>• freedom from damage or foreign objects</li> <li>• position and alignment of optical components</li> <li>• component security</li> <li>• electrical inputs and outputs</li> <li>• electronic inputs and outputs</li> <li>• assembly function</li> </ul>
<p>1.13 assemble optical imaging systems in compliance with one of the following standards:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> <li>• specific equipment requirements/manufacturer's data</li> <li>• recognised compliance agency/body's standards</li> </ul>
<p>1.14 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• company-specific documentation</li> <li>• test documents</li> <li>• computer records</li> </ul>
<p>1.15 deal promptly and effectively with problems within your control and report those that cannot be solved.</p>

<p><b>Learning outcome</b></p>
<p>The learner will:</p> <p>2. know how to build optical systems</p>
<p><b>Assessment criteria</b></p>
<p>The learner can:</p> <p>2.1 explain the health and safety requirements of the area in which they are carrying out the optical assembly activities</p> <p>2.2 explain the specific safety precautions to be taken while carrying out the optical assembly activities (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)</p> <p>2.3 explain the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them</p> <p>2.4 explain the COSHH regulations with regard to the substances used in the assembly process</p>

- 2.5 describe the hazards associated with producing optical assemblies, and how to minimise them and reduce any risks
- 2.6 explain what Personal Protective Equipment (PPE) and clothing needs to be worn during the assembly activities
- 2.7 explain how to extract and use information from engineering drawings, specifications, manufacturers' manuals (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 2.8 explain how to extract the necessary information in order to fit and align the various optical assemblies and electrical and electronic components
- 2.9 describe the general principles of optical, electrical and electronic assembly techniques; the purpose and function of the components (including identification systems such as colour codes, manufacturer's specification)
- 2.10 explain what preparations need to be undertaken on the optical, electrical and electronic components prior to fitting them into the assembly
- 2.11 describe the correct component handling procedures (including relevant handling equipment and procedures to avoid electrostatic discharge)
- 2.12 explain the assembly and securing methods and procedures to be used, and the importance of adhering to these procedures
- 2.13 explain how the components are to be routed, aligned, adjusted and positioned prior to securing, and the tools and equipment that are used for this
- 2.14 explain the importance of using the specified optical, electrical and electronic components and securing devices for the assembly, and why you must not use substitutes
- 2.15 describe the quality control procedures to be followed during the assembly operations
- 2.16 explain how to conduct any necessary checks to ensure the accuracy, position, security, function, completeness and electrical continuity of the assembly
- 2.17 explain how to detect assembly defects, and what to do to rectify them (such as ineffective joining techniques, component damage)
- 2.18 explain how to check that the tools and equipment to be used are correctly calibrated and are in a safe and serviceable condition
- 2.19 explain the importance of ensuring that all tools are used correctly and within their permitted operating range
- 2.20 explain the importance of ensuring that all tools, equipment and components are returned to their correct location on completion of the assembly activities
- 2.21 describe the problems with the assembly operations, and the importance of informing appropriate people of non-conformances
- 2.22 describe the extent of their own responsibility and explain to whom they should report if they have problems that they cannot resolve.

## Unit 452

## Performing laser optical system alignment

<b>UAN:</b>	F/600/5826
<b>Level:</b>	3
<b>Credit value:</b>	46
<b>GLH:</b>	150
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 166: Performing Laser Optical System Alignment (Level 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to set up and align laser optical systems, in accordance with approved procedures. The learner will be required to use appropriate drawings, specifications and test documentation to set up and align the various items of equipment. The learner will be expected to use the specified/appropriate techniques to carry out the setting-up and alignment procedures in the correct sequence, in order to integrate the various elements into the laser system. The process will include setting up the various components/lenses, making adjustments to bring the settings within specification and final fixing of lenses in their correct positions.</p> <p>The equipment to be set up and aligned could be from a wide range of industries from manufacturing, construction and processing of materials, where alignment is critical to the correct operation of the equipment.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the laser optical setting-up and alignment activities undertaken, and to report any problems with the activities, components or equipment that they cannot personally resolve, or that are outside their</p>

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permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking personal responsibility for their own actions, 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 applying setting-up and alignment techniques and procedures to laser optical systems. The learner will understand the laser optical system being set up and aligned, and its application, and will know about the setting-up and alignment techniques and procedures, test equipment and methods, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the laser system functions to the required specification.

The learner will understand the safety precautions required when carrying out the setting-up and alignment operations, in particular those relating to exposure to laser light. 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.

<b>Learning outcome</b>
The learner will: 1. perform laser optical system alignment
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting up and alignment of the laser optical system: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of laser system being aligned (such as job instructions, system drawings, laser specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• obtain clearance to work on the system, and observe power isolation and safety procedures</li><li>• provide safe access and working arrangements for the work</li></ul>

- area
  - carry out the setting-up and alignment activities, using safe and approved techniques and procedures
  - return all tools and equipment to the correct location on completion of the activities
  - leave the equipment and work area in a safe and clean condition on completion of the setting-up and alignment activities
- 1.3 follow all relevant setting-up and operating specifications for the products or assets being configured
- 1.4 set up and align laser optical systems for one of the following types of equipment:
  - laser welding
  - laser drilling
  - laser cutting
  - laser marking out
  - laser inspection
  - laser heat treatment
  - laser guidance
  - laser imaging
  - telemetry systems
  - holographic systems
  - other specific application
- 1.5 follow the defined procedures and set up the equipment correctly, ensuring that all operating parameters are achieved
- 1.6 set up and align all of the following optical system components, as applicable to the system being aligned:
  - control units
  - interferometers
  - lenses
  - mirrors
  - lasers
  - receiver units
- 1.7 carry out alignments, adjustments and tests, using a range of tools and equipment, to include two of the following:
  - optical alignment scope
  - centring detector
  - beam targets
  - rotating pentaprism
  - laptop computer
  - signal injection tests
  - oscilloscope
  - Foucault tests
  - null test
- 1.8 use twelve of the following setting-up and alignment methods and techniques:
  - positioning equipment/components
  - levelling of equipment

<ul style="list-style-type: none"> <li>• aligning of equipment</li> <li>• assembly/connection of system components or sub-assemblies</li> <li>• setting and sealing lenses in position</li> <li>• cleaning optics</li> <li>• determining and setting depth of focus</li> <li>• setting spot size and location</li> <li>• checking laser power output</li> <li>• optimising system parameters</li> <li>• lifting and handling</li> <li>• connecting wires and cables</li> <li>• securing by using mechanical fixings</li> <li>• securing by using adhesives</li> <li>• sealing</li> <li>• applying screw fastener locking devices</li> <li>• earth bonding</li> <li>• ensuring the system cleanliness (such as covering lenses or components)</li> </ul> <p>1.9 deal promptly and effectively with problems within their control and report those that cannot be solved</p> <p>1.10 check that the configuration is complete and that the equipment operates to specification</p> <p>1.11 set up and align laser optical equipment in compliance with one of the following standards:</p> <ul style="list-style-type: none"> <li>• BS, ISO or BSEN standards and procedures</li> <li>• other accepted international standards</li> <li>• customer (contractual) standards and requirements</li> <li>• company standards and procedures</li> <li>• specific equipment requirements/manufacturer's data</li> <li>• recognised compliance agency/body's standards</li> </ul> <p>1.12 complete all relevant documentation, accurately and legibly</p> <p>1.13 complete the relevant paperwork, to include one from the following, and pass it to the appropriate people:</p> <ul style="list-style-type: none"> <li>• job cards</li> <li>• quality control documentation</li> <li>• company-specific documentation</li> <li>• computer records</li> <li>• test documents.</li> </ul>
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<b>Learning outcome</b>
The learner will: 2. know how to perform laser optical system alignment
<b>Assessment criteria</b>
The learner can: 2.1 describe the specific safety practices and procedures that they need to observe when carrying out the setting up and alignment of laser optical equipment (including any specific legislation, regulations and codes of practice for the activities, equipment or

- materials, especially those for working with laser beams)
- 2.2 describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility they place on them
  - 2.3 describe the safety procedures that must be carried out before work is started on setting up the laser optical equipment
  - 2.4 describe the protective equipment that they need to use for both personal protection of themselves and others, and protection of the system components
  - 2.5 describe the hazards associated with setting up and aligning laser optical systems, and with the tools and test equipment that is used, and how to minimise them and reduce any risks
  - 2.6 explain how to obtain and interpret drawings, standards, quality control procedures and specifications used in the setting up and alignment process (including, for example, BS, ISO or BSEN schematics, symbols and terminology)
  - 2.7 explain how to carry out currency/issue checks on the specifications they are working with
  - 2.8 describe the type of equipment that is to be set up and aligned
  - 2.9 describe the basic principle of operation of the equipment being set up and aligned
  - 2.10 describe the properties of light which lend itself to being used for alignment (such as how interferometers work, the basic laws of reflection and refraction)
  - 2.11 describe the laser components to be set up and aligned, and their function within the particular laser system
  - 2.12 describe the adjustments/corrections/tuning required to bring the equipment/system to operational standard through full range parameters
  - 2.13 describe the quality control procedures to be followed during the setting-up and testing operations
  - 2.14 describe the types of test/alignment equipment to be used, and their selection for particular types of test
  - 2.15 explain how to check/calibrate the test/alignment equipment to be used; or the organisational procedures for ensuring that the equipment is maintained and correctly calibrated
  - 2.16 explain how to conduct any necessary checks/tests to ensure the integrity, functionality, accuracy and performance of the system and its dependences
  - 2.17 explain how to recognise defects (such as under or over performance)
  - 2.18 explain how to display/record alignment test results, and the documentation to be used
  - 2.19 explain how to interpret the alignment/test readings obtained, and the significance of the readings
  - 2.20 describe the importance of ensuring that equipment is used only for its intended purpose and within its specified range and limits
  - 2.21 describe the potential problems or errors that could occur with the setting-up and alignment operations, and how these can be overcome
  - 2.22 describe the environmental control and company operating procedures relating to the setting-up and alignment activities
  - 2.23 describe the documentation required and the procedures to be followed on completion of the setting-up and alignment activities

2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 453

## Aligning and setting up holographic equipment

<b>UAN:</b>	J/600/5827
<b>Level:</b>	3
<b>Credit value:</b>	77
<b>GLH:</b>	161
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 167: Aligning and Setting Up Holographic Equipment (Suite 3).
<b>Endorsement by a sector or other appropriate body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to align and set up holographic equipment for the production of a hologram, in accordance with approved procedures. The learner will be required to use appropriate drawings, specifications and test documentation to set up and align the various items of equipment. The learner will be expected to use the specified/appropriate techniques to carry out the setting up and production of the hologram in the correct sequence. The process will include alignment of the various shutters, lenses or spatial filters, mirrors and holographic plates, making adjustments to bring the settings within specification, and the final fixing of these components in their correct positions. The learner will need to use an optical power meter to measure the power density incident on the surface of the plate. The learner will need to work in the appropriate lighting conditions to avoid exposure of the plate during the setting-up phase.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the holographic setting-up activities undertaken, and to report any problems with the activities, components or equipment that they cannot personally resolve, or that are outside their permitted</p>

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authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking 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 applying setting-up and alignment techniques and procedures to produce a hologram. The learner will understand the hologram production system being set up and aligned. The learner will know about the setting-up and alignment techniques and procedures, test equipment and methods, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the hologram is produced to the required specification.

The learner will understand the safety precautions required when carrying out the holographic alignment and setting-up operations, in particular those relating to exposure to laser light. 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.

<b>Learning outcome</b>
The learner will: 1. align and set up holographic equipment
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting up of the hologram equipment: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the type of holographic equipment being aligned/set up (such as job instructions, system drawings, laser specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant laser safety regulations and procedures to realise a safe system of work</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• obtain clearance to work on the system, and observe power isolation and safety procedures</li><li>• provide safe access and working arrangements for the work</li></ul>

- area
  - carry out the setting-up activities, using safe and approved techniques and procedures
  - return all tools and equipment to the correct location on completion of the activities
  - leave the machine and work area in a safe and clean condition on completion of the alignment/setting up
- 1.3 follow all relevant setting-up and operating specifications for the products or assets being configured
- 1.4 set up the system for one of the following types of hologram:
  - to generate a reflection hologram
  - to generate a transmission hologram
- 1.5 follow the defined procedures and set up the equipment correctly, ensuring that all operating parameters are achieved
- 1.6 set up and align all of the following optical system components, as applicable to the system being aligned:
  - shutter
  - beam expander or spatial filter
  - reference beam mirror
  - the subject of the hologram
  - holographic plate or holographic blank
  - lasers
  - mirrors
- 1.7 carry out alignments, adjustments and tests, using a range of tools and equipment, to include all of the following:
  - use a power meter to measure the incident energy on the plate (to calculate exposure time)
  - check that the suspension system for the equipment is functioning properly
  - ensure that the holographic plate is handled correctly
  - ensure that the reflective surfaces are clean
- 1.8 following exposure of the hologram, remove the plate and prepare it for the developer stage, ensuring that:
  - the laser is shut down safely
  - the holographic plate is removed and stored correctly
- 1.9 deal promptly and effectively with problems within their control and report those that cannot be solved
- 1.10 check that the configuration is complete and that the equipment operates to specification
- 1.11 set up hologram equipment in compliance with one of the following standards:
  - BS, ISO or BSEN standards and procedures
  - other accepted international standards
  - customer (contractual) standards and requirements
  - company standards and procedures
  - specific equipment requirements/manufacture's data
  - recognised compliance agency/body's standards
- 1.12 complete all relevant documentation accurately and legibly
- 1.13 complete the relevant paperwork, to include one from the

following, and pass it to the appropriate people:

- job cards
- quality control documentation
- company-specific documentation
- test documents
- computer records.

### **Learning outcome**

The learner will:

2. know how to align and set up holographic equipment

### **Assessment criteria**

The learner can:

- 2.1 describe the specific safety practices and procedures that they need to observe when setting up the holographic equipment (including any specific legislation, regulations and codes of practice for the activities, equipment or materials, working with laser beams)
- 2.2 describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility they place on them
- 2.3 describe the safety procedures that must be carried out before work is started on setting up the holographic equipment
- 2.4 describe the protective equipment that they need to use for both personal protection of themselves and others, and protection of the system components
- 2.5 describe the hazards associated with setting up a holographic system, and with the tools and test equipment that is used, and how to minimise them and reduce any risks
- 2.6 explain how to obtain and interpret drawings, standards, quality control procedures and specifications used in the setting-up and alignment process (including, for example, BS, ISO or BSEN schematics, symbols and terminology)
- 2.7 explain how to carry out currency/issue checks on the specifications they are working with
- 2.8 describe the basic principle of operation of the holographic equipment being set up
- 2.9 describe the optical components to be set up and aligned, and their function within the holographic system
- 2.10 describe the adjustments/corrections/tuning required to bring the equipment/system to operational standard through full range parameters
- 2.11 describe the quality control procedures to be followed during the setting up and testing operations
- 2.12 describe the types of test/alignment equipment to be used, and their selection for particular types of test
- 2.13 explain how to interpret holographic plate specifications, power meter readings and calculations relating to exposure time
- 2.14 describe the properties of laser light which allows holograms to be produced both in mono-chromatic and colour form
- 2.15 explain the need for a reference beam as well as an image beam to create the 3d image
- 2.16 explain how to check/calibrate the test/alignment equipment to be

- used; or the organisational procedures for ensuring that the equipment is maintained and correctly calibrated
- 2.17 explain how to conduct any necessary checks/tests to ensure the integrity, functionality, accuracy and performance of the holographic system and its dependences
  - 2.18 explain how to recognise defects (such as under or over performance)
  - 2.19 explain how to interpret the alignment/test readings obtained, and the significance of the readings
  - 2.20 describe the importance of ensuring that equipment is used only for its intended purpose and within its specified range and limits
  - 2.21 describe the potential problems or errors that could occur with the setting-up operations, and how these can be overcome
  - 2.22 describe the environmental control and company operating procedures relating to the alignment/setting-up activities
  - 2.23 describe the documentation required and the procedures to be followed on completion of the alignment/setting-up activities
  - 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

## Unit 454

## Following clean room and clean work area protocols

<b>UAN:</b>	R/600/5829
<b>Level:</b>	3
<b>Credit value:</b>	16
<b>GLH:</b>	57
<b>Relationship to NOS:</b>	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 168: Following Clean Room and Clean Work Area Protocols (Level 3).
<b>Unit endorsed by a sector or regulatory body:</b>	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
<b>Aim:</b>	<p>This unit covers the skills and knowledge needed to prove the competences required to follow clean room and/or clean work area protocols, in accordance with approved procedures. The clean rooms and clean work areas will include optical component assembly and test facilities. In particular, the learner will be expected to follow any prescribed preparatory activities for the clean work area, to use work methods which satisfy organisational and industry protocols, to wear and care for appropriate personal protective clothing and to follow requirements in relation to their own clothing and accessories.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures relating to the clean room and clean work area protocols, and to report any problems with the protocols, that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work with a minimum of supervision, taking full responsibility for their own actions and ensuring that all their actions comply with approved organisational procedures relating to the clean room and clean work areas.</p> <p>The learner's knowledge will provide a good understanding of their work, and will provide</p>

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an informed approach to complying with approved clean room and clean work area procedures. The learner will understand the organisation's requirements for clean room and clean work areas, and their application, and will know about the clean room and clean work area requirements in adequate depth to provide a sound basis for carrying out their activities to the required specification.

The learner will understand the safety precautions required when working in a clean room or clean work area environment, and with the equipment that is used. 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.

<b>Learning outcome</b>
The learner will: 1. follow clean room and clean work area protocols
<b>Assessment criteria</b>
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 complete all of the following tasks related to clean room and clean work area working: <ul style="list-style-type: none"><li>• obtain and interpret correctly the documentation for the activities being carried out (such as job instructions, system drawings, specifications and quality documentation)</li><li>• adhere to procedures or systems in place for risk assessment, COSHH, Personal Protective Equipment and other relevant safety regulations and procedures to realise a safe system of work</li><li>• check that all tools and test equipment to be used are within their calibration dates</li><li>• provide and maintain safe access and clean room working arrangements/protocols for the work area</li><li>• carry out their activities in line with organisational procedures</li><li>• return all tools and equipment to the correct location on completion of the activities</li><li>• store records of their activities, in accordance with appropriate procedures</li></ul> 1.3 use clean room/work area protocols for one of the following: <ul style="list-style-type: none"><li>• photolithography</li><li>• optical component assembly</li><li>• optical inspection</li><li>• optical alignment tests</li><li>• other specific applications</li></ul> 1.4 follow protocol methods and procedures which satisfy all of the

following:

- the safety of people
- contamination/integrity of the product
- contamination/integrity of the clean room/work area
- appropriate industry standards and protocols

1.5 satisfy all of the following company clean room/clean work area methods and procedures:

- use appropriate clothing/Personal Protective Equipment (PPE) (such as suits, gowns, coats, hoods, hats, caps, helmets, other headwear, boots, overshoes, other forms of footwear, safety goggles, visors, gloves)
- comply with hazard protection (such as breathing apparatus, gloves, apron/smock, other forms of PPE or clothing required)
- deal appropriately with damaged or dirty clothing/PPE (such as reporting damage, replacement, safe removal and cleaning or disposal, subjected to acid/hazardous substance spills, damaged/dirty labelling)
- correctly storing specified clothing/PPE when not in use
- ensuring the cleaning/laundrying/maintenance of clothing/PPE

1.6 meet company clean room/clean work area regulations/procedures relating to all of the following:

- body lotions (such as make up, deodorants, perfumes, aftershaves)
- jewellery
- own clothing worn
- contact lenses
- footwear

1.7 recognise industrial processes, tools, equipment and materials that have the potential to cause harm

1.8 check for hazards in the workplace, in line with agreed and approved procedures

1.9 identify any potential hazards and take appropriate action to minimise the risk from them

1.10 report any hazards identified and any actions they have taken.

### **Learning outcome**

The learner will:

2. know how to follow clean room and clean work area protocols

### **Assessment criteria**

The learner can:

2.1 describe the specific safety precautions to be taken when working in a clean room or clean work area environment

2.2 describe the correct fitting and use of clothing and Personal Protective Equipment (PPE) that must be worn in a clean room or clean work area (such as for body, hands, eyes, ears, feet, mouth and face)

2.3 describe the hazards associated with working in a clean room or clean work area with optical assembly and test equipment (such as heat, radiation, chemicals, static electricity, high voltages, trapping points on equipment), and how to minimise them and reduce any

risks

- 2.4 explain how to deal with hazards and their consequences (such as laser light, hazardous substances, heat and radiation)
- 2.5 explain how to obtain the necessary authority to enter the clean room or clean work area, and any specific permit-to-work procedures that are used
- 2.6 describe the classification of the relevant clean room or clean work area, and how this impacts upon them
- 2.7 describe the industry standards/classifications for clean rooms and clean work areas
- 2.8 describe the company requirements for the clothing and Personal Protective Equipment required, and their reasons
- 2.9 describe the procedures and methods for maintaining issued clothing and Personal Protective Equipment
- 2.10 explain how to apply procedures for dealing with damaged or dirty clothing and Personal Protective Equipment
- 2.11 explain how to store issued clothing and Personal Protective Equipment correctly
- 2.12 describe the laundering/cleaning/maintenance procedures relating to the issued clothing and Personal Protective Equipment
- 2.13 describe the policy and procedures relating to personal items (such as body lotions, jewellery, contact lenses, footwear, own clothing)
- 2.14 explain how certain body lotions can contaminate the optical components and seriously effect the quality of the finished product
- 2.15 describe the sources of expert help when they have problems with the activities that they cannot resolve or that are outside their permitted authority
- 2.16 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.



## 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 3 NVQ in Mechanical Manufacturing Engineering (1682).

### 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](http://www.cityandguilds.com/functionalskills)
- Essential Skills (Northern Ireland) – see [www.cityandguilds.com/essentialskillsni](http://www.cityandguilds.com/essentialskillsni)
- Essential Skills Wales – see [www.cityandguilds.com/esw](http://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](http://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

<b>UK learners</b> General qualification information	T: +44 (0)844 543 0033 E: <b>learnersupport@cityandguilds.com</b>
<b>International learners</b> General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: <b>intcg@cityandguilds.com</b>
<b>Centres</b> 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: <b>centresupport@cityandguilds.com</b>
<b>Single subject qualifications</b> 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: <b>singlesubjects@cityandguilds.com</b>
<b>International awards</b> 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: <b>intops@cityandguilds.com</b>
<b>Walled Garden</b> 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: <b>walledgarden@cityandguilds.com</b>
<b>Employer</b> Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: <b>business@cityandguilds.com</b>
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