**-SQA- SCOTTISH QUALIFICATIONS AUTHORITY**

**HIGHER NATIONAL UNIT SPECIFICATION**

**GENERAL INFORMATION**

| | |
|---|---|
| **Unit Number** | **D3R4 04** |
| **Unit Title** | MECHANICAL PLANT SYSTEMS |
| **Superclass Category** | XH |
| **Date of Publication (month and year)** | |
| **Originating Centre for Unit** | Cleveland Open Learning Unit |

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**DESCRIPTION**

**GENERAL COMPETENCE FOR UNIT:**

Applying design and construction principles to the selection and operation of plant units and systems.

**OUTCOMES:**

1. appraise the performance and operational constraints of gas turbines;
2. evaluate reciprocating internal combustion engine performance;
3. evaluate gas compressor performance;
4. make recommendations on the selection and installation of compressed air systems;
5. select appropriate types of valve for given process applications.

**CREDIT VALUE:** 1 HN Credit

**ACCESS STATEMENT:**

Access to this unit is at the discretion of the centre. However, it would be beneficial if the student had competence in basic thermodynamics. Evidence of this competence could be the successful completion of modules in Applied Heat or Engineering Thermodynamics or their equivalents at National Certificate level.

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Additional copies of this unit can be obtained from: The Administrative Services Unit, SQA, Hanover House, 24 Douglas Street, Glasgow G2 7NQ (Tel: 0141-242 2166).

At the time of publication, the cost is £2.50 (minimum order £5.00)

# HIGHER NATIONAL UNIT SPECIFICATION

# STATEMENT OF STANDARDS

## Unit Number

## Unit Title MECHANICAL PLANT SYSTEMS

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the specification. All sections of the statement of the standards are mandatory and cannot be altered without reference to SQA.

**OUTCOME**

**1. APPRAISE THE PERFORMANCE AND OPERATIONAL CONSTRAINTS OF GAS TURBINES**

**PERFORMANCE CRITERIA**

(a) The representation of gas turbine operational cycles is correct in terms of established T-S diagrams.
(b) Evaluations of gas turbine performance parameters are correct.
(c) Performance limitations are correctly related to physical design constraints.

**RANGE STATEMENT**

| | |
|---|---|
| Gas turbine cycles: | 'ideal' cycle; 'practical' cycle; single shaft; twin-shaft with 'reheat'. |
| Performance parameters: | power output; power input; thermal efficiency; work ratio. |
| Performance limitations: | non-'ideal' cycle; blade material; blade design; temperature limitations; speed limitations. |

**EVIDENCE REQUIREMENTS**

Written and graphical evidence of ability to represent gas turbine cycles
Written evidence of ability to evaluate each of the gas turbine performance parameters given in the range.
Written evidence of ability to relate performance limitations to design constraints.

**OUTCOME**

**2. EVALUATE RECIPROCATING INTERNAL COMBUSTION ENGINE PERFORMANCE**

**PERFORMANCE CRITERIA**

(a) Explanations of the operating principles of reciprocating internal combustion engines correctly relate to the type of engine.
(b) Comparisons between practical and theoretical engine cycles are correctly related to the appropriate p-V diagrams.
(c) Solutions to problems involving performance parameters are correct and indicate a logical approach.

**RANGE STATEMENT**

| | |
|---|---|
| Engine types: | spark ignition; compression ignition; two-stroke engines; four-stroke engines. |
| Engine cycles: | four-stroke spark ignition cycle; compression ignition dual cycle. |
| Performance parameters: | compression ratio; mean effective pressure; thermal efficiency; indicated and brake power; specific fuel consumption. |

**EVIDENCE REQUIREMENTS**

Written evidence showing ability to explain the operating principles of reciprocating internal combustion engines.
Written and graphical evidence showing ability to compare practical and theoretical engine cycles.
Written evidence showing ability to solve a spark ignition engine problem and a compression ignition engine problem which collectively involve the performance parameters indicated in the range.

**OUTCOME**

**3. EVALUATE GAS COMPRESSOR PERFORMANCE**

**PERFORMANCE CRITERIA**

(a) Explanations of the operating principles of different types of gas compressor are clear and concise.
(b) Sketches of compression cycle p-V diagrams relate correctly to the types of compressor.
(c) Solutions to problems involving performance parameters are correct and indicate a logical approach.

**RANGE STATEMENT**

| | |
|---|---|
| Compressor types: | reciprocating compressors; positive displacement rotary compressors; dynamic compressors. |
| Cycle diagrams for: | single-stage reciprocating compressor; two stage reciprocating compressor; 'Roots' blower. |
| Performance parameters: | volumetric efficiency; delivery rate; delivery temperature; indicated power; pressure ratio. |

**EVIDENCE REQUIREMENTS**

Written evidence showing ability to explain the operating principles of different types of gas compressor.
Written and graphical evidence showing ability to relate cycle p-V diagrams to compressor types.
Written and graphical evidence showing ability to determine volumetric efficiency from cycle data.
Written evidence showing ability to solve single stage and two stage compressor problems which collectively involve the performance parameters indicated in the range.

**OUTCOME**

**4. MAKE RECOMMENDATIONS ON THE SELECTION AND INSTALLATION OF COMPRESSED AIR SYSTEMS**

**PERFORMANCE CRITERIA**

(a) Selection of compressor units is appropriate to the intended function of the compressed air system.
(b) Consideration of the siting and layout requirements of a compressed air system are in accordance with current practice.

(c) Descriptions of the functions of compressed air system components are clear and concise.

**RANGE STATEMENT**

| | |
|---|---|
| Compressor units: | reciprocating; rotary positive displacement type; dynamic type. |
| Siting and layout: | air intake requirements; noise 'insulation'; centralised system; branch system; ring main system. |
| System components: | intercooler; aftercooler; air receiver and attachments; control system; air lubricators; air operated hand tools; water traps; air filter/dryer units. |

**EVIDENCE REQUIREMENTS**

Written evidence of ability to select appropriate types of compressor unit for given system functions.
Written evidence of ability to consider the requirements for the siting of a compressed air system.
Written evidence of ability to describe the functions of compressed air system components.
Written and graphical evidence of the ability to compare branch and ring main compressed air system layouts.

**OUTCOME**

**5. SELECT APPROPRIATE TYPES OF VALVE FOR GIVEN PROCESS APPLICATIONS**

**PERFORMANCE CRITERIA**

(a) Descriptions of the operating principles of different valve types are clear.
(b) Selection of valves is appropriate in terms of application.
(c) Determination of the flowrate through a valve is correct in terms of given data.

**RANGE STATEMENT**

| | |
|---|---|
| Valve types: | plug; gate; butterfly; globe; diaphragm. |
| Flowrate data: | pressure drop; relative density; flow coefficient. |

**EVIDENCE REQUIREMENTS**

Written and graphical evidence of ability to describe the operating principles of different valve types.
Written evidence of ability to select appropriate valves for five common applications.
Written evidence of ability to determine a valve flowrate from given flow data.

**MERIT**

To gain a pass in this unit, a candidate must meet the standards set out in the outcomes, performance criteria, range statements and evidence requirements.

To achieve a merit in this unit, a candidate must demonstrate a superior or more sophisticated level of performance. In this unit this might be shown by:

(a) demonstrating ability to use a number of different performance criteria in an integrative way by solving a problem more complex than is necessary for the achievement of an individual performance criteria.
(b) suggesting possible future developments in internal combustion engine design (reciprocating or turbine).

**ASSESSMENT**

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the SQA assessment model and an integrative approach to assessment is encouraged. (See references at the end of support notes.)

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should be kept. These records will be available for external verification.

**SPECIAL NEEDS**

Proposals to modify outcomes, range statements or agreed assessment arrangements should be discussed in the first place with the external verifier.

*Continuation*

# HIGHER NATIONAL UNIT SPECIFICATION

## SUPPORT NOTES

**Unit Number**

**Unit Title** MECHANICAL PLANT SYSTEMS

**SUPPORT NOTES:**

This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

**NOTIONAL DESIGN LENGTH:**

SQA allocates a notional design length to a unit on the basis of time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 40 hours. The use of notional design length for programme design and timetabling is advisory only.

**REFERENCES**

1. Guide to unit writing.
2. For a fuller discussion on assessment issues, please refer to SQA's Guide to Assessment.
3. Information for centres on SQA's operating procedures is contained in SQA's Guide to Procedures.
4. For details of other SQA publications, please consult SQA's publications list.