

Guide for procurement of power station equipment —

Part 2-5: Electrical equipment — Motors

The European Standard EN 45510-2-5:2002 has the status of a
British Standard

ICS 27.100; 29.160.30

National foreword

This British Standard is the official English language version of EN 45510-2-5:2002.

The UK participation in its preparation was entrusted to Technical Committee E/-/20, Power engineering steering committee, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

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EUROPEAN STANDARD

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EUROPÄISCHE NORM

August 2002

ICS 27.100; 29.160.30

English version

**Guide for procurement of power station equipment
Part 2-5: Electrical equipment -
Motors**

Guide pour l'acquisition d'équipements
destinés aux centrales de production
d'électricité
Partie 2-5: Equipements électriques -
Moteurs

Leitfaden für die Beschaffung von
Ausrüstungen für Kraftwerke
Teil 2-5: Elektrische Ausrüstung -
Motoren

This European Standard was approved by CEN and CENELEC on 2001-03-06.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CENELEC Central Secretariat or to any CEN or CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN or CENELEC member into its own language and notified to the CENELEC Central Secretariat has the same status as the official versions.

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Contents

| | |
|---|-----------|
| Foreword | 4 |
| 1 Scope | 6 |
| 2 Normative references | 6 |
| 3 Definitions | 7 |
| 3.1 Organisational terms | 7 |
| 3.2 Technical terms | 8 |
| 3.3 General terms | 8 |
| 4 Brief overall project description | 9 |
| 4.1 Role and organisation of purchaser | 9 |
| 4.2 Site location | 9 |
| 4.3 Equipment task | 10 |
| 4.4 Equipment to be purchased | 10 |
| 4.5 Control and instrumentation | 10 |
| 4.6 Electrical supplies and other services | 10 |
| 4.7 Other interfaces | 11 |
| 4.8 Project programme | 11 |
| 4.9 Equipment identification systems | 11 |
| 5 Extent of supply | 11 |
| 6 Terminal points | 12 |
| 7 Operational requirements | 13 |
| 7.1 Operating environment | 13 |
| 7.2 Manning levels | 13 |
| 7.3 Normal operation | 13 |
| 7.4 Operating hours | 13 |
| 7.5 Start-up and shut-down | 13 |
| 7.6 Abnormal conditions | 13 |
| 7.7 Further operational requirements | 14 |
| 8 Life expectancy | 14 |
| 8.1 Design life | 14 |
| 8.2 Components requiring periodic maintenance | 14 |
| 9 Performance requirements | 14 |
| 9.1 Duty | 14 |
| 9.2 Performance | 15 |
| 9.3 Equipment margins | 16 |
| 9.4 Availability | 16 |
| 9.5 Levels of component redundancy | 17 |
| 9.6 Further performance requirements | 17 |
| 10 Design and fabrication | 17 |
| 10.1 Specific equipment features | 17 |
| 10.2 Design justification | 21 |
| 10.3 Material selection | 21 |
| 10.4 Safety | 21 |
| 10.5 Interchangeability | 22 |
| 10.6 Fabrication methods | 22 |

| | | |
|------------------------------|--|-----------|
| 11 | Maintenance requirements | 22 |
| 11.1 | Planned maintenance | 22 |
| 11.2 | Personnel safety | 22 |
| 11.3 | Requirements for access | 23 |
| 11.4 | Lifting requirements | 23 |
| 11.5 | Special tools | 23 |
| 11.6 | Test equipment | 23 |
| 11.7 | Spare parts strategy | 23 |
| 11.8 | Special precautions | 24 |
| 12 | Technical documentation requirements | 24 |
| 12.1 | Tender documentation | 24 |
| 12.2 | Contract documentation | 24 |
| 13 | Applicable legislation, regulations, standards and further requirements | 24 |
| 13.1 | Legislation and regulations | 24 |
| 13.2 | Standards | 25 |
| 13.3 | Further requirements | 25 |
| 14 | Evaluation criteria | 25 |
| 14.1 | General | 25 |
| 14.2 | Technical criteria | 25 |
| 15 | Quality measures | 26 |
| 15.1 | General | 26 |
| 15.2 | Approvals procedure | 26 |
| 15.3 | Inspection requirements | 26 |
| 15.4 | Non-conformity | 26 |
| 16 | Site factors | 27 |
| 16.1 | Access | 27 |
| 16.2 | Facilities | 27 |
| 16.3 | Site specific requirements | 27 |
| 17 | Verification of specified performance | 28 |
| 17.1 | General | 28 |
| 17.2 | Works tests | 28 |
| 17.3 | Tests during installation and commissioning | 28 |
| 17.4 | Technical conditions for trial run | 28 |
| 17.5 | Functional and performance tests | 29 |
| Annex A (informative) | Bibliography | 30 |

Foreword

This standard takes the form of a recommendation and is therefore entitled a "Guide".

This Guide for procurement has been prepared by the CEN/CENELEC Joint Task Force Power Engineering (JTFPE) of which the secretariat is held by the British Standards Institution.

The text of the draft was submitted to the formal vote and was approved by CEN and CENELEC as EN 45510-2-5 on 2001-03-06.

The following dates were fixed:

- *latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement* (dop) 2003-03-01
- *latest date by which the national standards conflicting with the EN have to be withdrawn* (dow) 2004-04-01

This Guide for procurement has been prepared under mandates given to CEN and CENELEC by the European Commission and the European Free Trade Association.

This Guide for procurement is a part of a series of Guides mandated to cover the procurement of power station plant and equipment in conformity with European Procurement Directives. The Guides are:

EN 45510: Guide for procurement of power station equipment

Part 1: Common clauses

Part 2-1: Electrical equipment - Power transformers

Part 2-2: Electrical equipment - Uninterruptible power supplies

Part 2-3: Electrical equipment - Stationary batteries and chargers

Part 2-4: Electrical equipment - High power static convertors

Part 2-5: Electrical equipment - Motors

Part 2-6: Electrical equipment - Generators

Part 2-7: Electrical equipment - Switchgear and controlgear

Part 2-8: Electrical equipment - Power cables

Part 2-9: Electrical equipment - Cabling systems

Part 3-1: Boilers - Water tube boilers

Part 3-2: Boilers - Shell boilers

Part 3-3: Boilers - Boilers with fluidized bed firing

Part 4-1: Boiler auxiliaries - Equipment for reduction of dust emissions

Part 4-2: Boiler auxiliaries - Gas-air, steam-air and gas-gas heaters

Part 4-3: Boiler auxiliaries - Draught plant

Part 4-4: Boiler auxiliaries - Fuel preparation equipment

Part 4-5: Boiler auxiliaries - Coal handling and bulk storage plant

Part 4-6: Boiler auxiliaries - Flue gas desulphurization (De-SO_x) plant

Part 4-7: Boiler auxiliaries - Ash handling plant

Part 4-8: Boiler auxiliaries - Dust handling plant

Part 4-9: Boiler auxiliaries - Sootblowers

Part 4-10: Boiler auxiliaries - Flue gas denitrification (De-NO_x) plant

Part 5-1: Turbines - Steam turbines

Part 5-2: Turbines - Gas turbines

Part 5-3: Turbines - Wind turbines

Part 5-4: Turbines - Hydraulic turbines, storage pumps and pump-turbines

Part 6-1: Turbine auxiliaries - Deaerators
Part 6-2: Turbine auxiliaries - Feedwater heaters
Part 6-3: Turbine auxiliaries - Condenser plant
Part 6-4: Turbine auxiliaries - Pumps
Part 6-5: Turbine auxiliaries - Dry cooling systems
Part 6-6: Turbine auxiliaries - Wet and wet/dry cooling towers
Part 6-7: Turbine auxiliaries - Moisture separator reheaters
Part 6-8: Turbine auxiliaries - Cranes
Part 6-9: Turbine auxiliaries - Cooling water systems

Part 7-1: Pipework and valves - High pressure piping systems
Part 7-2: Pipework and valves - Boiler and high pressure piping valves

Part 8-1: Control and instrumentation

*EN 45510-1 contains those clauses common to all the above Guides giving the provisions of a non **equipment** specific nature for use in the procurement of power station plant. EN 45510 is the responsibility of JTFPE. The so called "common clauses", as appropriate, also appear in italics in the documents specific to particular **equipment**.*

In this Guide, words in bold type indicate that they have the meaning given in the definitions, clause 3.

In this Guide, words and sentences not in italics are specific to this Guide and refer to the particular **equipment** covered.

1 Scope

*This standard gives guidance on writing the technical **specification** for the procurement of motors for use in electricity generating stations (power stations). This Guide for procurement is not applicable to **equipment** for use in the nuclear reactor plant area of nuclear power stations. Other possible applications of such **equipment** have not been considered in the preparation of this Guide.*

This Guide covers motors within installations primarily concerned with the generation of electrical power. However, as a complete electrical drive system is not defined in this Guide, attention is drawn to the possible additional electrical and mechanical stresses to which the motor may be subjected e.g. by a static AC converter/inverter. Reference should be made to IEC 60034-17.

*The **equipment** covered by this Guide is defined by its function rather than design type. Therefore, the guidance to the **specification** is stated in performance terms rather than being specified by a detailed description of the **equipment** to be supplied.*

*This Guide indicates to potential **purchasers** how their **specification** should be prepared so that:*

- the **equipment** type and capacity interfaces correctly with other elements of the systems;*
- predicted performance is achieved;*
- ancillary **equipment** is properly sized;*
- **reliability, availability** and safety requirements are achieved;*
- proper consideration is given to the evaluation process and the quality measures to be applied.*

*This Guide does not determine the type of **specification** (e.g. detailed, performance, functional) or the extent of supply for any given contract which is normally decided on the basis of the **purchaser's** project strategy. It does not cover:*

- any commercial, contractual or legal issues which are normally in separate parts of an **enquiry**;*
- any allocation of responsibilities which are determined by the contract.*

*This Guide does not prescribe the arrangement of the documents in the **enquiry**.*

*NOTE As a comprehensive European environmental policy is still under preparation, this Guide does not address the environmental implications of the **equipment**.*

2 Normative references

This Guide for Procurement incorporates by dated or undated reference, provisions from other publications. These normative references are cited in the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Guide only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

European Standards

| | |
|----------------------------|--|
| EN ISO 9001 | Quality systems - Model for quality assurance in design, development, production, installation and servicing |
| EN ISO 9002 | Quality systems - Model for quality assurance in production, installation and servicing |
| EN 45510-2-7 | Guide for procurement of power station equipment – Part 2-7: Electrical equipment - Switchgear and controlgear |
| EN 45510-2-9 ¹⁾ | Guide for procurement of power station equipment – Part 2-9: Electrical equipment - Cabling systems |

¹⁾ In preparation.

| | |
|--------------------|--|
| EN 50347 | General purpose three-phase induction motors having standard dimensions and outputs - Frame numbers 56 to 315 and flange numbers 65 to 740 |
| EN 60034-1 | Rotating electrical machinery - Part 1: Rating and performances (IEC 60034-1, mod.) |
| EN 60034-2 | Rotating electrical machines - Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (IEC 60034-2 + IEC 60034-2A) |
| EN 60034-5 | Rotating electrical machines - Part 5: Classification of degrees of protection provided by enclosures for rotating machines (IEC 60034-5, mod.) |
| EN 60034-6 | Rotating electrical machines - Part 6: Methods of cooling rotating machinery (IEC 60034-6) |
| EN 60034-9 | Rotating electrical machines - Part 9: Noise limits (IEC 60034-9) |
| EN 60034-12 | Rotating electrical machines - Part 12: Starting performances of single-speed three-phase cage induction motors for up to and including 660 V and 50 Hz (IEC 60034-12, mod.) |
| EN 60034-14 | Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of the vibration severity (IEC 60034-14) |
| EN 60034-15 | Rotating electrical machines - Part 15: Impulse voltage withstand levels of rotating AC machines with form-wound stator coils (IEC 60034-15) |
| EN 60034-18 series | Rotating electrical machines - Part 18: Functional evaluations of insulation systems (IEC 60034-18 series) |

Harmonization Documents (HD)

| | |
|---------|---|
| HD 53.8 | Rotating electrical machines - Part 8: Terminal markings and direction of rotation of rotating machines (IEC 60034-8) |
| HD 566 | Thermal evaluation and classification of electrical insulation (IEC 60085) |
| HD 637 | Power installations exceeding a.c. 1 kV |

International Standards

| | |
|---------------|--|
| IEC 60034-17 | Rotating electrical machines - Part 17: Guide for the application of cage induction motors fed from converters |
| IEC 60050-191 | International electrotechnical vocabulary - Chapter 191: Dependability and Quality of Services |
| IEC 60050-411 | International electrotechnical vocabulary - Chapter 411: Rotating machines |

3 Definitions

For the purposes of this Guide, the following definitions apply:

3.1 Organisational terms

3.1.1

purchaser

*recipient of a product and/or a service provided by a **supplier***

3.1.2**supplier**

person or organisation that provides a product and/or a service to the **purchaser**

3.1.3**specification**

document stating technical requirements of the **purchaser**. It may form part of an **enquiry** issued by a **purchaser**

3.1.4**enquiry**

invitation to **tender** issued by a **purchaser**. It will normally include a **specification** together with the necessary contractual and commercial conditions

3.1.5**tender**

offer made by a **tenderer** in response to an **enquiry**

3.1.6**tenderer**

person or organisation submitting a **tender** for the **equipment** in response to the **enquiry**

3.1.7**site**

place to which the **equipment** is to be delivered or where work is to be done by the **supplier**, together with so much of the area surrounding as the **supplier** may, with the consent of the **purchaser**, use for the purposes of the contract

NOTE Further definitions of useful organisational terms may be found in EN ISO 8402 (see annex A).

3.2 Technical terms

The technical terms applicable to the design, description, construction and performance of electric motors are defined in IEC 60050-411 and the relevant component standards.

3.3 General terms**3.3.1****equipment**

plant, component, system and/or associated service to be provided in response to the **enquiry**

3.3.2**conformity**

fulfilment of specified requirements by a product, process or service

3.3.3**performance**

obligations verified by specified tests

3.3.4**operating period**

time between planned outages or maintenance periods during which the **equipment** is in operation and/or does not restrict operational requirements of the power station

3.3.5**life expectancy**

time period over which the **equipment** might be expected to operate with planned maintenance but without replacement of a significant component. For example a rotor is a significant component

3.3.6

design life

operating hours of the **equipment** on which design calculations are based

3.3.7

acceptability

compliance with criteria defined by the **purchaser** for assessing the suitability of **equipment**

3.3.8

equipment margins

allowance for design, fabrication or operating contingency defined in the **specification**. These are separate to those normally included by the **supplier** for his own purposes

3.3.9

proven equipment

equipment which may be demonstrated to be similar to that offered and has operated for a sufficient time to have demonstrated performance and availability

3.3.10

availability

as defined in IEC 60050-191

3.3.11

reliability

as defined in IEC 60050-191

3.3.12

maintainability

as defined in IEC 60050-191

4 Brief overall project description

4.1 Role and organisation of purchaser

The **enquiry** should define the **purchaser's** role in the project, including whether the **purchaser** will assume responsibility for the planning and technical coordination of the project, or whether other organisations will be appointed to carry out all or part of this function. The **enquiry** should define all organisational interfaces and the procedures to be employed for managing the contract and the **site**.

4.2 Site location

The **specification** should describe the geographical location of the **site** which may include surveying points, the previous use of the **site** and any local features such as impact of industrial or military activities and planning restrictions.

Where applicable, the **specification** should indicate **site** datum on **specification** drawings and specify **site** and drawing orientation and define co-ordinate axes (x,y,z) and numbering order to ensure consistency between suppliers of connected equipment.

Where appropriate, the **specification** should define the permitted ground loading, dimensional and time restrictions on access routes up to but not including public roads or railways.

The **specification** should identify, where appropriate, the environment of the **site** in which the **equipment** will operate. The following factors may normally be included if appropriate:

- climatic e.g. atmospheric pressure, annual variation of air and cooling water temperature, relative humidity, rain fall, icing, snow, wind velocity (normal and maximum), lightning;

- geological e.g. seismic conditions and characteristics of subsoil (e.g. caverns, gliding stratifications, load bearing capability of subsoils);
- geographic e.g. elevation, influence of local topography and structures;
- hydrological e.g. flooding and tides.

4.3 Equipment task

The **specification** should describe in general terms the function, task or role of the **equipment** to be purchased. e.g. whether it is part of a new power generating plant, a modification to an existing power generating plant or replacement **equipment**.

Where appropriate, the **specification** should define the function and the known limitations, if any, in the **equipment** connected to that which is being supplied so that the **equipment** may avoid imposing adverse conditions or the **supplier** may suggest modifications to connected **equipment** which would ensure satisfactory operation.

4.4 Equipment to be purchased

The **specification** may define the **equipment** type or arrangement to be purchased.

For example, the **purchaser** may specify:

- synchronous or asynchronous (induction) motor.

The **specification** may state any preferences with regard to the extent of the supply. For example, the **Purchaser** may wish to include an integral or separate bearing lubricating system.

The **specification** may state requirements for the type of enclosure selected, particularly if the motor is to be installed in a hazardous area.

The **specification** may also define preferences for equipment types (or give information) regarding compatibility with existing **equipment**, if required.

The **specification** should define the intended methods or local practice for maintenance, inspection and operation.

The **specification** should define requirements with regard to the general appearance of the **equipment** (e.g. dimensions, shape or colour) to meet local planning requirements or specific criteria, where such requirements exist.

NOTE Attention is drawn to European, national and/or local legislation which may place restrictions in this area.

4.5 Control and instrumentation

The **specification** should define the general requirements for the control and instrumentation system, the level of operator intervention allowed or required, integration with other control systems, localised control loops, commonality and redundancy.

NOTE Guidance on the procurement of control and instrumentation systems for power stations, including advice on interfaces, can be found in EN 45510-8-1.

4.6 Electrical supplies and other services

The **specification** should define the electrical supplies available for the operation of the **equipment**, their voltages and frequencies, with their range of variation, phases available and, where appropriate, the acceptable values of maximum load (kW) and short circuit level at each voltage level and the harmonic content. Requirements for terminals and terminal boxes should be stated; these should be to a recognised European or international standard.

The **specification** should define the type and capacity of other services for the operation of the **equipment** such as service fluids.

4.7 Other interfaces

*The **specification** should define the interfaces with existing ancillary or new ancillary **equipment** to be supplied under separate contracts which interact directly with the **equipment**.*

For example, protection, metering, cabling, auxiliary electrical systems, civil works, crantage, or temporary systems.

4.8 Project programme

*The **specification** should describe the overall programme and timescale in which the project is to be carried out. This may include the principal dates associated with tendering, placement of orders, access to **site**, start and completion of installation, commissioning, take-over and final acceptance.*

4.9 Equipment identification systems

*The **specification** may specify the equipment identification system for use during the operating life of the plant. If applicable to the project, a recognised European or international system should be used.*

5 Extent of supply

*The **specification** should define the extent of supply of all the **equipment**.*

This may include the motor(s) with its main and auxiliary terminal boxes (if applicable), earth terminal, anti-condensation heaters, temperature detectors and/or other condition monitoring devices (if applicable).

For synchronous motors, integral field excitation systems should be included, but if a separate excitation package is required it should be clearly stated.

For machines with oil lubricated plain bearings, the **specification** should state if the oil supply is to be:

- self contained (if technically possible),
- provided from a separately mounted oil conditioning unit, or
- provided from a source outside the scope of supply. In this case, the **specification** should state the oil grade, temperature, viscosity and available flow rate which may be subject to agreement.

The extent of supply may also include spare parts, installation and maintenance manuals, test reports, other specified documentation, transportation, installation and commissioning. The shaft coupling is normally outside the scope of the motor manufacturers supply.

If the motor is to be subjected to external thrust loading, the **specification** should define whether a special thrust bearing is to be included.

Unless otherwise specified or agreed the **supplier** should provide first fillings of all fluids to be used in the **equipment**.

Consideration should also be given to the Guide for Procurement on Switchgear prEN 45510-2-7 where, for example, a motor control centre or AC distribution switchgear, is required, or to the Guide for Procurement on Cabling Systems prEN 45510-2-9 where, for example, local cabling is required.

If the **purchaser** wishes to have a contract for control and instrumentation separate from the **equipment** supply contract, the **specification** may require the **supplier** to provide information on all the necessary interfaces. In addition provision may need to be made in the contract to ensure the availability of information necessary to allow a satisfactory control system to be obtained. For example, this may include a requirement for cooperation between the **purchaser** and **supplier**. Alternatively, the **specification** may define the technical information on **equipment** characteristics to be provided by the **supplier** and the programme for its delivery.

If the **purchaser** wishes to have a contract for electrical systems, electrical **equipment**, cables, etc. separate from the **equipment** supply contract, the **specification** may require the **supplier** to provide information on all the necessary interfaces (electrical loads, shaft heights, motor speeds and direction of rotation, terminal boxes, etc.). Provision may need to be made in the contract for cooperation between **purchaser** and **supplier** for system(s) to be developed or the **specification** may define the technical information to be provided by the **supplier** and the programme for its delivery.

Similar provisions may be made for other services, etc.

The extent of supply may include training, technical and layout studies, requirements for cooperation with the **purchaser** and/or other suppliers and information on necessary interfaces, if any.

The **specification** should define the requirements with regard to weather protection, the surface finish (e.g. painting), thermal insulation, noise insulation or cladding, etc.

The **specification** may require that all parts of the **equipment** should be protected at all stages of delivery, storage and installation. Subsequent to final manufacture all **equipment** items should be protected against deterioration due to corrosion.

The **specification** may also define exclusions, for example civil works such as buildings, foundations, structures and **equipment** obtained separately by the **purchaser**.

The **specification** may indicate the acceptability of alternative offers being included in the **tender**.

6 Terminal points

The **specification** should define the main process input and output terminal points such that the function and performance of the **equipment** and its major components, e.g. as defined in the extent of supply, may be demonstrated to meet the requirements of the **purchaser**.

The **specification** should define the motor supply boundaries which should normally include but extend no further than:

- the shaft end(s), with tongued and grooved or oil-pressure joint, as appropriate;
- the main and auxiliary terminal boxes (including handing);
- the mounting feet for horizontal foot mounted motors;
- the flange(s) or skirt(s) for vertical shaft motors (some small horizontal shaft motors may be flange mounted);
- the pipe flanges for input and output of cooling water and lubricating oil as appropriate;
- foundation plate (if required) together with mounting materials;
- mounting and alignment plates and auxiliaries;
- coupling and coupling guard;
- lifting devices, including position and type;
- connections to cooling and lubrication sources.

The **specification** should also define terminal points for existing or proposed services, support structures or civil works. These may, for example, include ancillary services, control and instrumentation system, heating and ventilation systems, cranes, general access arrangements and fire fighting systems.

It may be necessary for design and analytical work to extend beyond the physical terminal points. The **specification** should define such requirements, if any.

7 Operational requirements

7.1 Operating environment

The **specification** should describe the operating environment in which the **equipment** will be required to function. Factors such as temperature, humidity, extent of weather protection, dust, vibration and electromagnetic environment (this may include both emission and immunity requirements) should be included for both normal and abnormal conditions by reference to the EN 60034 series of standards. The type of installation, whether indoor or outdoor, should be stated.

The **specification** should also state the policy in the following operational areas:

- risks e.g. loss of electrical supplies, loss of cooling systems, dust or water ingress, explosions or overvoltage surges;
- obligations e.g. noise limits;
- restrictions e.g. waste disposal, oil spillage.

7.2 Manning levels

The **specification** should define the power station manning levels where they may influence the **equipment** supply.

7.3 Normal operation

The **specification** should define in broad terms the expected normal operation of the power station and of the **equipment**.

7.4 Operating hours

The **specification** should define the total life time required of the power station and the **equipment** (e.g. hours) and the required operating period of the **equipment**.

7.5 Start-up and shut-down

The **specification** should identify specific duties of the driven plant where these could influence the selection of motors (e.g. base load, peak load, start up/shut down requirements, standby, etc.).

Refer also to 8.1.

The **specification** should define the expected changeover strategy where standby **equipment** or bypasses are provided.

7.6 Abnormal conditions

The **specification** should provide information on the known abnormal conditions to which the **equipment** might be subjected. The **supplier** should take these into account in the design or selection of components/materials.

The **specification** should identify where motor operating modes may be linked to fast transfer of supply systems and advise of any special requirements for the motors under such conditions.

7.7 Further operational requirements

Not applicable to this Guide.

8 Life expectancy

8.1 Design life

8.1.1 General

This should be a specific period which takes into account the anticipated operating regime and recommended maintenance and will broadly equate to the stated operating hours (see 7.4).

*The **specification** should define the **design life** of components which may be subject to periodic replacement.*

*The **supplier** should define limitations on **equipment** life, if any, and these should be included in the **tender** evaluation process.*

8.1.2 Number of start-up and shut-down cycles

*The **specification** should include an estimate of the number of cycles to which the **equipment** will be subjected.*

*The **specification** should state the number of starts required per year of the motor, the normal distribution and any special starting distribution(s) which may occur during commissioning periods.*

8.1.3 Equipment for monitoring remaining life

*The **specification** may request proposals for monitoring the remaining life of components which are subject to fatigue, wear, erosion and/or corrosion. In some cases specific requirements may be stated.*

For example:

- recording of the cumulative number of motor starts,
- incorporation of means to monitor motor circuits, (e.g. motor management schemes, protection relays with communications facility).

8.2 Components requiring periodic maintenance

*The **specification** should request the **supplier** to provide a schedule of components which require periodic maintenance or replacement. This should include the frequency of these operations. This schedule should include estimates of maintenance man-hours and cost of components. The **supplier** should identify those maintenance replacement operations which require shut-down of the process more frequently than the planned maintenance shut-downs.*

9 Performance requirements

9.1 Duty

*The **specification** should define the **performance** targets for the **equipment** at defined operating points and at other defined conditions. These may include efficiency and margins at full load operation and **availability**. The **specification** may also define the flexibility requirements over the full range of operating conditions.*

The **specification** should define the type of duty which the motor(s) has to perform in accordance with EN 60034-1. This should be a statement of the load(s) to which the machine is subjected, including if applicable, starting, electric braking, no-load, rest and de-energised periods, including durations and sequence.

The **specification** should state the required **performance** of the motor during and following specified supply variations such as short time interruption, voltage unbalance or reduction, harmonics etc., where these are not in accordance with EN 60034-1.

9.2 Performance

9.2.1 General

*The **specification** may define the operating points and other defined conditions at which the **equipment performance** requirements are to be demonstrated immediately after commissioning and/or at other points in the life of the **equipment**.*

The **specification** should state the requirements for the **performance** of the motor during starting, operation at rated or partial loads under specified conditions. The **specification** should also provide information on the type and characteristics of the driven machine (eg. torque/speed profile, moment of inertia, etc.).

9.2.2 Starting conditions

The **specification** should provide information on:

- Frequency of starting:
 - number of successive starts required under the specified conditions of load, torque, inertia and supply,
 - acceptable interval between starting sequences.
- Minimum voltage during starting:
 - minimum value of voltage at the motor terminals during starting.
- Starting characteristics of cage induction and synchronous motors:
 - method of starting,
 - maximum permitted starting current and/or kVA,
 - locked rotor and starting torque.
- Restart from any speed:
 - assumptions to be applied to the voltage levels and times applicable, following a system disturbance resulting in a temporary loss of supply for a defined period,
 - maximum permitted reacceleration time.

Attention is drawn to EN 60034-1 and to EN 60034-12 for machines with a rated supply voltage of 690 volts or less.

9.2.3 Rated load conditions

Motors should operate within the supply variations identified in 9.1 without prejudicial overheating.

The **specification** should state the time period for operating at rated frequency and load with a defined reduction in voltage. The **supplier** should state the resulting heating in conformity with EN 60034-1 and evaluate the **reliability**.

The **specification** may state the heating classes to be applied for the planned operational loads.

The method of determining efficiency should be one of the methods described in EN 60034-2. In the absence of a specific request, the summation of losses method should be assumed.

9.2.4 Thermal performance

The **specification** should specify the minimum thermal class of insulation (e.g. Class B or F) and state the permitted temperature rise of the windings. The temperature rises should be selected and determined with reference to EN 60034-1.

The **specification** may also require temperature rises lower than those corresponding to the selected thermal class (eg. Class B temperature rise with Class F insulation system).

In those applications where the motor temperature may be appreciably affected by conducted or radiated heat, the conditions should be stated in the **specification** and appropriate temperature rises agreed with the **supplier**.

9.2.5 Mechanical performance

– Vibration levels:

- the permitted limits of vibration severity and method of measurement should be as detailed in EN 60034-14 unless otherwise stated.

– Acoustic performance:

- the **specification** should state the permitted acoustic **performance** of the motor. In the absence of specific information, the levels and method of measurement contained in EN 60034-9 should be assumed.

– Insulation performance:

- the **specification** should indicate the value of the maximum reference voltage U_m to be used in the choice of insulation levels in accordance with EN 60034-1;
- the **specification** should state the required time limits of motor operation with one phase grounded either as a maximum continuous period or a cumulative period during motor lifetime.

In the absence of specific insulation **performance** information, the recommendations of HD 566, EN 60034-1 and EN 60034-18 should be assumed.

The **specification** may stipulate a higher test voltage than that specified in EN 60034-15.

NOTE Performance tests are sometimes conducted off site and may be carried out at conditions different from the operating point. The results may require scaling according to agreed rules.

9.3 Equipment margins

The **specification** should identify required **equipment margins**.

In the absence of specific information, the schedule of tolerances on quantities involved in the rating of electrical machines to EN 60034-1 should be assumed.

9.4 Availability

The **specification** may specify **availability** requirements. In order to demonstrate conformity with these requirements, the **specification** may request the **supplier** to use data on **availability**, **reliability** and **maintainability** to carry out an analysis to show that the target **availability** will be met.

9.5 Levels of component redundancy

The **specification** may define requirements for component redundancy.

These requirements may provide either additional operational security or cover extremes of operating conditions.

The **supplier** should only use these additional plant components in meeting **performance** requirements in the conditions defined in the **specification**.

If the **specification** does not specify levels of component redundancy, the **purchaser** may ask the **supplier** to demonstrate that the level of redundancy included is adequate to meet the availability requirements.

9.6 Further performance requirements

Not applicable to this Guide.

10 Design and fabrication

10.1 Specific equipment features

10.1.1 Materials of construction

The component parts of motors should have mechanical strength and robustness suitable for the specified conditions of service and should be able to withstand long periods at standstill in ambient conditions of high humidity, saline contamination and vibration.

In all cases the material combinations and fasteners should be selected to avoid electrolytic action between them.

The casing should be protected against corrosion (e.g. by paint system) in a manner appropriate to the environment specified in 4.2.

If the **specification** does not include requirements for materials and corrosion prevention, the **supplier** should state the measures included.

The **specification** may state if any process or materials are to be excluded as a result of adverse experience, eg. for the cage bars, short-circuiting rings, and their method of connection/locking.

10.1.2 Enclosures and method of cooling

The **specification** should state the type of enclosure required.

Attention is drawn to EN 60034-5 for degree of protection and EN 60034-6 for methods of cooling. In many applications and duties in power stations a minimum degree of protection of IP 54 is selected with method of cooling IC 411, IC 511, IC 611 or IC 81W for larger machines.

If the **purchaser** requires machines with "weather protected" degree of protection, e.g. IPW24, the operating environment should be fully described.

The **specification** should state the type of drain device required for condensate.

10.1.3 Heat exchangers (where fitted)

The **specification** may state the type and position of the heat exchangers in all cases except for motors with IC 411 cooling, ie. Totally Enclosed Fan Ventilated (TEFV) ribbed frame machines.

The **specification** may state the features required for the type of heat exchanger selected.

– Air-cooled heat exchangers:

- the **specification** may state the design margin to be included in the design to allow for fouling of cooling tubes or ducts under service conditions.
- any requirement for in-situ or on-load cleaning of cooling tubes or ducts should be stated together with any requirement for heat exchanger instrumentation (thermometers etc.)
- the **supplier** may be asked to demonstrate the method employed to avoid electrolytic corrosion between heat exchanger components and between the heat exchanger and the frame or air ducts.

– Water-cooled heat exchangers:

- the **specification** should advise the cooling water temperature, pressure, volume and analysis in order to avoid excessive fouling and corrosion due to electrolytic action. The **purchaser** may specify the materials of the heat exchanger;
- the required or preferred position of the heat exchanger should be stated together with any requirements for spray baffles and water catchment;
- if emergency doors are required permitting running with method of cooling IC 01 and degree of protection IP22, this should be clearly stated;
- the relative positions of the water inlet and outlet flanges and heat exchanger instrumentation should be stated (including leakage detector if fitted);
- the **specification** should state any requirements for leakage detectors/alarm sensors.

10.1.4 Shafts

The **specification** should state the requirements for shaft end tapping. If requested, data and drawings required for torsional vibrational analysis should be provided by the **supplier**.

10.1.5 Bearings

The **specification** should state the requirements for bearings and lubrication taking account of, but not being limited to:

- load limit/limit speed;
- bearing L10 life;
- insulation requirements;
- pressure grease relief features;
- shock pulse monitoring points;
- oil conditioning;
- instrumentation;
- regreasing intervals;
- type of grease nipple;
- run-down features;
- anti-seizure performance and redundancy of oil supply;
- horizontal and vertical thrusts;
- type and position of thrust bearings, if any.

For machines that have plain (sleeve) bearings, the **supplier** should provide:

- maximum axial clearance;
- maximum permitted axial thrust;
- details of rotor locking arrangement provided for transportation purposes.

The **supplier** should advise of any provisions to prevent damage to bearings by shaft currents and methods provided to test the insulation of bearings.

10.1.6 Radial air gaps

If required, the **specification** may state the requirements for minimum radial air gaps.

The **specification** may also state requirements for measurement of air gaps without dismantling of a motor, i.e. by provision of inspection covers on motor casing/end-covers with access to air gap.

10.1.7 Windings and insulation

The windings should be designed to withstand the forces generated during direct-on-line starting and supply system transfer (see 7.5 and 7.6). If requested, the supplier should describe the design and insulation system of the windings.

Attention is drawn to the requirements of HD 566 and EN 60034-18.

If the **purchaser** requires a "sealed" winding, this should be clearly stated in the **specification**.

10.1.8 Terminal boxes

The **specification** should state the requirements for main and auxiliary terminal boxes.

Unless otherwise specified by the **purchaser**, the main terminal box should be positioned to enable cabling from the right hand side of the motor looking at the main shaft extension.

The **specification** should identify any specific needs for protection or measuring devices, e.g. surge arresters, surge capacitors, current transformers, etc.

The **specification** may define the functional **specification** of the power terminal box, e.g:

- type, output and location of motor;
- supply voltage;
- system fault capacity;
- type, size and number of cables, including diameter range;
- the need for certified and/or approved (e.g. by a trade association) terminal box;
- degree of enclosure protection required;
- need for phase insulated, phase separated or phase segregated arrangements of fault containing or pressure relief types and the need for cable support clamps;
- high voltage connectors with degree of protection IP 65;
- plug connections.

The **specification** should state if an internal, or accessible but concealed neutral point or a neutral point terminal box is required.

The **specification** should define any requirements for the type of insulators/bushings, cable entry, cable gland plates, trifurcating boxes or spreading chambers and the permitted methods of cable end sealing (e.g. the use of hot or cold pouring compounds), and the connecting cables.

The **purchaser** may specify the proposed method for terminating the supply cables, e.g. crimped/soldered connector or punched conductor, together with the conductor type, e.g. copper or aluminium.

The **supplier** should state the material and maximum withstand torque of connection studs and the torques required to ensure adequate joints.

10.1.9 Direction of rotation and permitted overspeed

The **specification** should state the requirements for direction of rotation and overspeed. Attention is drawn to HD 53.8 for direction of rotation, to EN 60034-1 for overspeed requirements and to the fact that maximum efficiency and lowest noise emission levels are attained with shaft mounted fans which are unidirectional.

10.1.10 Brushgear, commutators and slip-rings

The **specification** should state the requirements for the **performance** of brushgear, commutators and slip-rings with respect to adjustment, observation, useful life and replacements.

10.1.11 Motor auxiliary **equipment**

The **specification** should state the type of auxiliary **equipment** to be fitted to the motor and the type of termination required. These may include, but are not limited to:

- embedded temperature detectors in the stator winding of the resistance or thermocouple type;
- embedded or immersed temperature detectors in bearing housings, shells, lubricating oil or air circuits;
- temperature or vibration monitoring devices with alarm contacts;
- anti condensation heaters - supply voltage to be stated;
- purge and pressurisation **equipment**;
- separately driven fan;
- leakage control of the cooler;
- backstop/brakes;
- coupling guards;
- oil pumps at the second shaft end.

10.1.12 Couplings

Motors with keyed shafts should be balanced in accordance with EN 60034-14. The coupling(s) is within the scope of supply of the driven **equipment** manufacturer and is assumed to be similarly balanced.

The **specification** may include requirements for finish boring and fitting of free issue motor half couplings.

10.1.13 *Maintenance features*

Design of motors should allow assembly and removal of parts, checking and repairs, especially at **site**, as simply and economically as possible. All parts requiring supervision should be easily accessible. For heavy parts, suitable handling and lifting facilities should be provided.

The frequency and extent of maintenance required for satisfactory operation of motors and accessories should be stated by the **supplier**.

The **specification** may define preferences for specific maintenance features and may take account of maintenance man-hours or operating cost deviations in the evaluation.

The **tenderer** may offer alternative features, but these should be justified by additional information or references.

10.1.14 Measuring and sampling points

*The **specification** may define where measuring and sampling points for tests during the lifetime of the **equipment** should be provided.*

*The **specification** should indicate the type of **performance** tests (see clause 17) and routine tests to be carried out, but the **supplier** should use experience of similar **equipment** supplied to ensure that adequate provision is made for testing in the design of the **equipment**.*

10.1.15 Legislation measurement points

*The **specification** should normally define the legislation and codes of practice for which operating data are required and the provision for measurement and/or sampling points to allow these data to be obtained.*

NOTE Emissions, noise, vibration and temperature measurement are frequently required for this purpose.

10.2 Design justification

*The **supplier** should provide **equipment** descriptions as part of the justification of selection, description of the basic principles employed, extent of extrapolation, degree of innovation, references to the options considered, economic implications and conformity with the **purchaser's** requirements. In addition, the **specification** may define requirements for justification of specific design features.*

10.3 Material selection

*The materials of construction should normally be selected by the **supplier**. The **specification** may, however, define the preferred materials selection and request an alternative offer using these materials.*

*Where the **supplier** has made the selection of materials, the **supplier** should provide justification for the selection of materials and proposed fabrication methods. This should be done with reference to operating conditions, **life expectancy**, inspection strategy, maintenance methods, final disposal and economic factors.*

*The material selection by the **supplier** should also take into account the potential material degradation modes during manufacturing, storage, assembly, testing, start-up, operation and shut-down periods.*

10.4 Safety

10.4.1 General

*The **equipment** should comply with international, national and local safety requirements during installation and operation. The **supplier's** personnel on **site** should also comply with such requirements.*

*In addition, the **specification** should define the requirements for safety issues such as noise levels, maximum temperature of surfaces accessible to personnel, control of spillage and guarding, taking into account the installation requirements (HD 637).*

10.4.2 **Equipment protection**

The **specification** may request information regarding the measures taken to confine the **equipment** within safe operating limits, prevention of fire, protection against lightning, protection against rain water ingress, etc.

10.5 **Interchangeability**

The **purchaser** may wish to secure interchangeability or commonality (use of identical components) within the **site** or between sites operated by the **purchaser**. This may be achieved either by specifying the type of components or supplying the components for incorporation into the plant.

For example, adherence to the provision of motors which comply with the standard dimensions listed in EN 50347, IEC 60072-1 and IEC 60072-2 is recommended.

NOTE If the **purchaser** wishes to specify a particular **supplier** the requirements of relevant European and national legislation should be noted.

10.6 **Fabrication methods**

Welding, electrical connections, tube expansion, plate forming, heat treatment etc. should be in accordance with specified standards (see 13.2). The **specification** may include supplementary requirements for qualification of personnel, non-destructive testing, etc.

For example, any specific requirements for materials, methods of construction, type of joints, winding connection and treatments should be clearly stated. These may include:

- use of high voltage round wire windings;
- vacuum pressure impregnation (VPI) treatment;
- use of mica;
- specific anti-corona protection and stress control;
- winding and connection bracing;
- type of stator slot;
- type of stator slot wedges;
- type of adhesives and impregnant.

11 **Maintenance requirements**

11.1 **Planned maintenance**

The **specification** should define the frequency and duration of major and intermediate shut-downs for planned maintenance and indicate on-load maintenance requirements, if any.

11.2 **Personnel safety**

The **specification** should identify the procedures that will be employed for ensuring safety of personnel during on-load and off-load maintenance. This should include electrical isolation, the extent of isolation of work areas from the operating plant (i.e. compatibility with standards or, where these do not exist, Company standards, interlocking systems and/or safety rules) and the permit to work system.

Maintenance procedures which may be carried out on loaded motors without risk to personnel are limited to:

- greasing of motor bearings, provided they are fitted with grease escape features;
- cleaning of the tubes of air-to-air heat exchangers fitted with access panels, provided that when the panels are removed there is a degree of protection of the fan to at least IP 20.

11.3 Requirements for access

The **specification** should define whether permanent access is required for all operation and maintenance of the **equipment** or whether temporary staging or scaffolding is acceptable for specific operational and maintenance activities. Where permanent platforms are to be installed, the **specification** should define the maximum distance of any point on the platform to stairs, the requirement for landings on the stairs, if any, and whether it is permissible for platforms to be closed at one end. Requirements for platform width, load carrying capacity, handrails, etc. should be stated. Where possible, these requirements should comply to European or international standards.

11.4 Lifting requirements

The **specification** should define in the extent of supply (see clause 5) whether permanent lifting devices are to be installed and where mobile cranes, fork lift trucks, etc. are permitted for some operations. The **specification** should define whether the permanent **equipment** should be provided by the **supplier** and, if not, the information exchange required for its design and installation.

All items likely to be required to be removed for maintenance should be provided with appropriate lifting points.

11.5 Special tools

The **specification** should request the **supplier** to identify where special tools are required for operation and maintenance and to recommend the number to be supplied.

The **specification** should define whether special tools intended for long term use may be employed during installation.

11.6 Test equipment

The **specification** should request the **supplier** to identify test **equipment** required for routine testing of the **equipment**. If specific, this may be offered by the **supplier** as a separate item in the supply.

11.7 Spare parts strategy

The **specification** should request the **supplier** to make recommendations for holdings of spare parts based on estimated replacement rates and delivery times.

The **purchaser** may modify the **supplier's** recommendation on the basis of understanding of the maintenance needs of the **equipment** and possible effects on **availability**.

Where the **enquiry** includes **availability** targets, the **supplier** should state the estimated holdings and delivery times of replacement items required to ensure that this **availability** is achieved.

The **specification** should describe the conditions under which spare parts will be stored. Spare parts should be protected and preserved in a manner appropriate to these storage conditions and clearly marked with reference numbers.

11.8 Special precautions

The **supplier** should be asked to identify special precautions required during maintenance operations. For example, the protection of parts against mechanical or corrosive damage and storage protection requirements for dismantled **equipment**.

12 Technical documentation requirements

12.1 Tender documentation

The **specification** should request **tenderers** to provide sufficient information in the **tender** to:

- facilitate system studies;
- demonstrate that the **tender** matches the **purchaser's** requirements set out in the **enquiry**;
- allow evaluation by the **purchaser**.

This information may include design parameters, drawings, schedules, schematic functional and instrumentation diagrams, type test certification and reference installations.

12.2 Contract documentation

The **specification** should define a list of documents to be provided by the **supplier**. This should include a definition of when or at what stage the documents should be made available. In particular the **supplier** should provide all drawings giving information on interfaces and terminal points.

The **specification** may request general layout drawings, detailed arrangement drawings and assembly drawings.

The **specification** may request supporting information regarding the construction programme, major civil works, design submissions, design studies, construction studies, reliability studies, test procedures, commissioning procedures, operating and maintenance instructions and quality control information.

The **specification** may specify the general layout of all documents (to be transmitted or made available) and provide specific schedules for completion by the **supplier**.

The **specification** should define the method of data transfer (software compatibility), its form (paper, microfiche, electronic), the addresses to which they should be sent, the number of copies and status notation (i.e. provisional, definitive, final).

13 Applicable legislation, regulations, standards and further requirements

13.1 Legislation and regulations

The international, national and local legislation and regulations having significant influence on design of the **equipment** should be identified in the **enquiry**. These may include health and safety requirements, environmental protection and waste disposal and planning constraints. The **enquiry** should also identify specific construction features and **site** activities covered by local legislation.

The **enquiry** should state that such information is not necessarily exhaustive and does not modify the legal obligations of the **supplier**.

13.2 Standards

The **specification** should identify those standards whose use is obligatory and other standards or codes with which the **equipment** should comply, if any.

Examples of such standards are given in clause 2 and annex A.

The **purchaser** may ask the **tenderer** to define other standards or codes, in addition to those identified in the **specification**, applicable to the **tender**.

13.3 Further requirements

The **purchaser's** own guidelines for design, manufacture and construction may be specified.

NOTE Attention is drawn to European, national and/or local legislation which may place restrictions in this area.

The **specification** should define the units of measurement to be employed in the **tender** and the contract.

14 Evaluation criteria

14.1 General

NOTE European legislation designed to promote the Single Market identifies some criteria on which the contracting parties may base the award of contracts. Provision is also made for auditing evaluations.

The **enquiry** should advise the **tenderer** of the method of **tender** evaluation.

With the complexity of **equipment** covered by this Guide, the most economically advantageous **tender** evaluation will normally be applied.

Criteria, such as the following, should be considered, depending on the contract in question:

- delivery or completion date;
- running costs;
- cost-effectiveness;
- quality;
- aesthetic and functional characteristics;
- technical merit;
- after-sales service and technical assistance;
- commitments with regard to spare parts;
- security of supplies;
- price.

14.2 Technical criteria

The **enquiry** should define the method of incorporation of the following factors, where appropriate, in the evaluation.

14.2.1 Quality

Availability is a measure of total quality and the **purchaser** may evaluate the **tender** in terms of data on **availability, reliability and maintainability**.

14.2.2 Functional characteristics

This may be based not only on information declared by the **supplier** but also on independent information obtained by the **purchaser**. The evaluation may take into account the **performance** requirements given in clause 9 including plant capacity, **equipment margins**, flexibility, **maintainability**, operational security and ease of operation taking into account the anticipated number of operators and maintenance staff.

14.2.3 Technical merit

Where the **specification** calls for **proven equipment**, the demonstration should be in the form of either documentation, which may be audited, and/or **site** visits. The **purchaser** may evaluate the **tender** in terms of whether the **equipment** is novel or has been used extensively for similar applications.

14.2.4 Running costs

The main technical factors for running costs are absorbed power and consumables at defined operating conditions and additional outages, where off load maintenance is required between scheduled outages.

14.2.5 Technical assistance

The **purchaser** may assess the technical competence and resources at the disposal of the **supplier** and the **supplier's** record of technical fulfilment of similar contracts.

15 Quality measures

15.1 General

The **enquiry** may specify minimum requirements relating to the quality system of the **supplier**. The **enquiry** may refer to the European standards series EN ISO 9000 and particularly EN ISO 9001, which covers design, development, production, installation and servicing and/or to EN ISO 9002, which does not cover design or development, as appropriate.

The **enquiry** should define the audit requirements between the parties, if applicable. If there are any, the audit programme should be agreed between the **purchaser** and the **supplier** and adequate access should be given by the **supplier** for audit.

15.2 Approvals procedure

The **enquiry** may define the requirements for submission of drawings, calculations and manufacturing procedures for approval. The **supplier** may submit a quality plan (or equivalent document) for the supply and the **enquiry** may indicate hold points, beyond which work may not be continued without informing or obtaining the agreement of the **purchaser**.

The **supplier** should give adequate notice to the **purchaser** when hold points are reached. Adequate time should be allowed for the **purchaser** to examine submissions and the notification by the **purchaser** of approval or rejection should be in sufficient time reasonably to avoid delays in the project.

15.3 Inspection requirements

The **enquiry** should state the inspection requirements, if any. In that case, the inspection programme should be agreed between the **purchaser** and **supplier** and adequate access to carry out inspection should be given by the **supplier**.

15.4 Non-conformity

The **enquiry** should define policy with respect to non-conformity and rectification of defects.

16 Site factors

16.1 Access

The **enquiry** should define the location of immediate access to the **site** and dimensional, time, weight and other restrictions.

The **enquiry** may indicate (subject to verification) where access from the main rail, road and water transport systems is available and define the dimensions, time, weight and other restrictions for transport from these locations.

16.2 Facilities

16.2.1 General

The **enquiry** should define the facilities to be made available to the **supplier** at the **site** during installation and commissioning of the **equipment**. Such facilities may include the following:

16.2.2 Accommodation

If the **purchaser** provides accommodation on **site** for the **supplier's** personnel, the extent of this accommodation, its location and the facilities provided should be stated in the **enquiry**, for example, **site** huts, heating, lighting, telephones, car parking, first aid, toilets and canteen.

16.2.3 Site services

The **enquiry** should state the location and conditions of use of **site** services, such as connections for electricity, water and other services provided for **site** construction. The supply voltages and maximum capacity of the supplies should be stated. Information on the capacity of lifting **equipment**, anchorage points, etc. should be given where appropriate, together with other **site equipment** which is available for use by the **supplier**.

16.2.4 Disposal of waste

The **enquiry** should identify **site** waste disposal requirements and disposal points and provisions for maintenance of cleanliness in working areas.

16.2.5 Storage and handling

The **enquiry** should identify the areas where the **supplier** may store materials, components, etc. and provide information on storage conditions.

16.2.6 Working hours

The **enquiry** should identify any **site** specific restrictions placed on the times of working, for example normal allowable hours of work, week-end working, etc.

16.3 Site specific requirements

The **enquiry** should state **site** specific requirements for installation and commissioning. These may include:

- sequence of works that may be necessary for the installation of other **equipment** or the continued operation of plant, particularly in cases of retrofit operations;
- detailed plans for tests of integration of **equipment**;
- components and systems which have to be operable for commissioning of other plant;
- definition of the commissioning process and the necessary documentation required.

17 Verification of specified performance

17.1 General

Tests will, in general, be required on the **equipment** at various stages of the contract to verify its **performance**. The **specification** should define the tests required and their conditions and organisation. This may include definition of the provision of **site** services, personnel, etc.

17.2 Works tests

Tests during manufacture may include type tests, special tests and routine tests. Test requirements are identified in the reference standards, where these exist, with special tests being carried out only when required by the **specification**.

The **specification** should define the tests to be carried out during the manufacturing process for the verification of **performance** and the **supplier** should give adequate notice to allow witnessing of the tests.

Repetition of type tests is usually not required.

The **supplier** should recognise the need for testing in the programme of work and define when and how (i.e. what testing methods or standards) the tests are to be conducted.

17.3 Tests during installation and commissioning

The **specification** should define the requirements (methods and criteria) for tests during installation and commissioning together with a list of the testing standards.

The test **equipment** required for demonstration of design requirements should be agreed between the **purchaser** and **supplier**.

The **supplier** should provide a schedule of tests for components and systems during the installation and commissioning period. This should be agreed by the **purchaser**. The necessary services to allow the tests to be carried out should be agreed between the parties.

NOTE The contractual consequences of the outcome of the tests during installation and commissioning should be stated in the **enquiry**, where appropriate.

17.4 Technical conditions for trial run

Upon initial start up of the **equipment**, the date of which should be agreed with the **purchaser**, the **supplier** should carry out the continuous trial run if specified. The purpose of the trial run is to prove the functional capability of the **equipment** and to show that it will, with high probability meet its **performance** targets. During the run, therefore, all significant components should be in operation.

The **specification** may define in what circumstances breakdown of a significant component will constitute an interruption of the trial, with the start of operation after reinstatement of the component becoming the trial commencement. The **purchaser** may also give concessions criteria for breakdowns of a very short period, for example simply extending the period of the trial by the outage time.

The **purchaser** may consider that multiple breakdowns occurring during the trial run are unacceptable and therefore define the circumstances in which concessions will be withdrawn, for example giving the number and duration of breakdowns that may not be exceeded.

The conditions that have to be met for the successful completion of the trial run should be defined in the **specification**. These may include fulfilment of minimum **performance** requirements, fulfilment of legal and safety requirements applicable to the **site** and obligations to make minor corrections and changes and rectify minor defects, etc. within a specified time.

NOTE The contractual consequences of the outcome of the trial run should be stated in the **enquiry**, where appropriate.

17.5 Functional and performance tests

The **specification** should define the minimum requirements for both functional and **performance** tests, the applicable standards, if any, and the criteria against which the test results will be assessed. The **supplier** should provide a schedule of the tests to be conducted for approval by the **purchaser** who should be given adequate notice to allow witnessing of the tests.

Functional tests are carried out to demonstrate the ability of the **equipment** to satisfy the operational requirements, such as automatic start-up and shut-down, modulating capabilities and subsystem suitability.

Performance tests are conducted at agreed predefined operating points. Where appropriate, the **supplier** should provide correction curves to allow the interpretation of results.

In addition to the **performance** tests, the **specification** may also define a period of operation during which additional tests may be required.

The **specification** may also define a period during which the **equipment** should operate to specified levels of, for example, target efficiency and/or target availability. The nature and frequency of testing to verify the relevant requirements, if applicable, should be defined in the **specification**. The **specification** should define the level of maintenance that may be carried out before tests.

NOTE The contractual consequences of the outcome of **performance** tests should be stated in the **enquiry**, where appropriate.

Annex A
(informative)

Bibliography

European Standards

| | | |
|-----------------|--------|--|
| EN ISO 8402 | | Quality management and quality assurance - Vocabulary |
| EN 45510-8-1 | | Guide for procurement of power station equipment - Part 8-1: Control and instrumentation |
| EN 50014 | | Electrical apparatus for potentially explosive atmospheres - General requirements |
| EN 50016 | | Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "P" |
| EN 50018 | | Electrical apparatus for potentially explosive atmospheres - frameproof enclosure 'd' |
| EN 50019 | | Electrical apparatus for potentially explosive atmospheres - Increased safety 'e' |
| EN 50209 | | Test of insulation of bars and coils of high voltage machines |
| EN 60034-4 | | Rotating electrical machines - Part 4: Methods for determining synchronous machine quantities from tests (IEC 60034-4, mod.) |
| EN 60034-7 | | Rotating electrical machines - Part 7: Classification of types of construction and mounting arrangements (IM Code) (IEC 60034-7) |
| EN 60034-16 | | Rotating electrical machines - Part 16: Excitation systems for synchronous machines (IEC 60034-16) |
| EN 60068/HD 323 | series | Environmental testing (IEC 60068 series) |
| EN 60071 | series | Insulation co-ordination (IEC 60071 series) |
| EN 60216/HD 611 | series | Electrical insulating materials - Thermal endurance properties (IEC 60216) |
| EN 60243 | series | Methods of test for electric strength of solid insulating materials (IEC 60243) |
| EN 60270 | | High-voltage testing - Partial discharge measurements (IEC 60270) |
| EN 60276 | | Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip rings (IEC 60276) |
| EN 60529 | | Specification of degrees of protection provided by enclosures (IEC 60529) |
| EN 60721 | series | Classification of environmental conditions (IEC 60721 series) |

Harmonization documents (HD)

| | | |
|--------|--|--|
| HD 214 | | Recommended method for determining the comparative tracking index of solid insulating materials under moist conditions (IEC 60112) |
| HD 472 | | Nominal voltages for low voltage public electricity supply systems (IEC 60038, mod. + IEC title) |

International Standards

| | | |
|--------------|--|---|
| IEC 60034-10 | | Rotating electrical machines - Part 10: Conventions for description of synchronous machines |
| IEC 60034-11 | | Rotating electrical machines - Part 11: Built-in thermal protection |

| | |
|--------------|--|
| IEC 60072-1 | Dimensions and output series for rotating electrical machines - Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1 080 |
| IEC 60072-2 | Dimensions and output series for rotating electrical machines - Part 2: Frame numbers 355 to 1 000 and flange numbers 1 180 to 2 360 |
| IEC 60079-0 | Electrical apparatus for explosive gas atmospheres - General requirements |
| IEC 60079-1 | Electrical apparatus for explosive gas atmospheres - Flameproof apparatus |
| IEC 60079-2 | Electrical apparatus for explosive gas atmospheres - Electrical apparatus with type of protection "p" |
| IEC 60079-7 | Electrical apparatus for explosive gas atmospheres - Electrical apparatus with type of protection "e" |
| IEC 60079-15 | Electrical apparatus for explosive gas atmospheres - Electrical apparatus with type of protection "n" |
| IEC 60136 | Dimensions of brushes and brush-holders for electrical machinery |
| IEC 60279 | Measurement of the winding resistance of an a.c. machine during operation at alternating voltage |
| IEC 60356 | Dimensions for commutators and slip rings |
| IEC 60413 | Test procedures for determining physical properties of brush materials for electrical machines |
| IEC 60560 | Definitions and terminology of brush-holders for electrical machines |
| IEC 60681-1 | Dimensions of small power motors for definite purpose application - Part 1: Oil burner motors |
| IEC 60773 | Test methods and apparatus for measurement of the operational characteristics of brushes |
| IEC 60778 | Brush-holders for slip-rings group R - type RA |
| IEC 60892 | Effects of unbalanced voltages on the performance of 3-phase cage induction motors |
| IEC 61015 | Brush-holders for electrical machines - Guide to the measurement of the static thrust applied to brushes |

Examples of National standards are:

| | |
|-------------------|-------------------------------------|
| In Germany | ZLM for HV Motors VIK for LV Motors |
| In United Kingdom | BS 5000 art 40 |
| In France | Normes Françaises NF |

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