BRITISH STANDARD

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Guide for procurement of power station equipment —

Part 7-1: Pipework and valves — High pressure piping systems

The European Standard EN 45510-7-1:1999 has the status of a British Standard

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National foreword

This British Standard is the English language version of EN 45510-7-1:1999.

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

— aid enquirers to understand the text;

— present to the responsible 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

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

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This European Standard was approved by CEN/CENELEC on 1 October 1999.

CEN/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 Central Secretariat or to any CEN/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/CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Contents:

Foreword

This European Standard has been prepared by Technical Committee CEN/CLC JTFPE, Joint Task Force Power Engineering, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2000, and conflicting national standards shall be withdrawn at the latest by April 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

This European Standard has been prepared by Technical Committee ", the Secretariat of which is held by BSI.

This document is currently submitted to the Formal Vote.

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

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 converters

Part 2-5: Electrical equipment - Motors

Part 2-6: Electrical equipment - Generators

Part 2-7: Electrical equipment - Switchgears 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 desulfurization (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 Part 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 plants. 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**.*

Where minor changes have been made to sentences in the "common clauses" these are marked by a vertical line in the left margin.

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* **high pressure piping systems** *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:

- Live steam lines
- Hot reheat lines
- Cold reheat lines
- Feedwater lines
- Spray water lines for HP and RH-attemperators and steam-bypass-systems
- Pump minimum flow and balancing leak off lines
- Auxiliary steam supply lines
- Condensate lines
- Safety valve discharge pipelines
- Bled steam pipelines
- Steam and water drains, vents and warming lines

*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 **purchaser**s 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 the **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.

EN ISO 9001 *Quality systems - Model for quality assurance in design, development, production, installation and servicing (ISO 9001:1994)*

EN ISO 9002 *Quality systems - Model for quality assurance in production, installation and servicing (ISO 9002:1994)*

IEC 60050-191 *International electrotechnical vocabulary - Chapter 191: Dependability and quality of service*

3 Definitions

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

3.1 Organizational terms

3.1.1 purchaser: *Recipient of a product and/or a service provided by a* ***supplier.***

3.1.2 supplier: *Person or organization 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 organization 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 organizational terms may be found in EN ISO 8402 (see Bibliography).

3.2 Technical terms

3.2.1 high pressure piping system: System of pipes, valves, etc. conveying steam and water to and from a boiler, turbine etc. and to points of discharge.

3.2.2 terminal conditions: Conditions imposed on the plant at the terminal points of the piping system. These may typically comprise:

- feedwater condition

- main steam conditions, cold and hot reheat steam conditions

3.2.3 design conditions: Values of conditions used in design calculations such as the design pressure and temperature for a defined piping section.

3.2.4 medium conditions: Conditions which define the thermodynamic and chemical state of the medium

3.2.5 running hours: Number of hours during which the plant has been in operation.

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 stations.*

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 pipe bend 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 organization 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 organizations will be appointed to carry out all or part of this function. The **enquiry** should define all organizational **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 coordinate axis (x, y, z) and numbering order to ensure consistency between **supplier**s 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 and other phenomena;*
- *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 generation plant, a modification to an existing power generation plant, or replacement **equipment**.*

*Where appropriate, the **specification** should define the function and any 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:

Live steam piping system manufactured from seamless tubes with defined connection loads and torques, and pressure loss; totally drainable.

The **specification** should define whether a complete piping system is to be supplied comprising, for example all **equipment** between the boiler steam outlet header and turbine inlet valves or whether some equipment is to be purchased under separate contracts, for example, valves, supports, etc.

Before deciding to purchase equipment and services under contracts separate from the **high pressure piping system** contract, the **purchaser** should be satisfied that the **performance** of the equipment not provided within the **high pressure piping system** contract can be unambiguously demonstrated and that the **piping system supplier** can provide all the data necessary for the design of the separately purchased equipment and services. Where there is likely to be significant interaction between equipment, for example between pipes and valves, it may be preferable to purchase the equipment within the **high pressure piping system** contract.

*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 any 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 systems

*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, localized 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 recognized European or international standard.*

The **specification** should define the type and capacity of other services for the operation of the **equipment** such as compressed air, cooling air, cooling water, auxiliary steam, etc., available to the supplier, (normally not available during the installation period).

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 steel structures, valves.

The **specification** should state, if applicable, whether the **supplier** is to provide data or information to enable the purchaser to purchase equipment or services under separate contracts.

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 recognized European or international system should be used.*

The **specification** may also define the extent to which the identification system will be applied on labels, in documentation, on operator displays and within computer software and databases.

5 Extent of supply

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

This may include:

Main equipment	- Pipes, bends
	- Fittings
	- Flanged joints
	- Expansion joints
	- Supports, hangers
	- Supporting steel structures
	- Insulation, cladding
	- Painting
	- Spare parts
Auxiliary equipment	- Instrumentation and controls for piping systems, for valves, actuators with local electrical and/or air supplies, cabling
Site activities	- Transport
	- Storage
	- Dismantling at **site**, where applicable
	- Installation
	- Facilities for installation; cranes, scaffolding, welding equipment, etc.
	- Acid cleaning, steam blowing (including temporary equipment), flushing
	- Commissioning activities
Inspection	- At works and on **site**
Tests	- At works, on **site** during pre-commissioning and commissioning, functional and performance tests
Documentation	- Equipment and system details, operation and maintenance manuals.

Where the extent of supply includes the conceptual design the **specification** should provide sufficient plant layout and **equipment** details to permit development of that design consistent with the limitations of pressure losses, pipe stress, loading at terminals, maintenance philosophy and any ergonomic requirements.

Where the extent of supply does not include the conceptual design, the **specification** should include pipework schematic diagrams with data on design parameters, fluids and instrumentation requirements together with dimensioned conceptual design isometric drawings, flowsheets, civil and steel construction drawings.

*If the **purchaser** wishes to have a contract for control and instrumentation systems separate from the **equipment** supply contract, the **specification** may require the **supplier** to provide information on all the*

necessary interfaces (e.g. tapping points for temperature gradient control for heavy walled pressure parts). *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 provision 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* ***supplier****s and information on any 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 may be demonstrated to meet the requirements of the* ***purchaser****.*

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, cranage, 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 identify any 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. 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;*
- *obligations, e.g. operational staff shift patterns;*
- *restrictions, e.g. process waste disposal.*

7.2 Manning levels

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

This may cover control room manning, plant operational manning, maintenance manning and engineering support.

7.3 Normal operation

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

This normal operation may include

- period of full load operation to the expected **availability** of the boiler/turbine
- period of full or part load operation for a reduced number of hours between planned unit shut-downs
- period of intermittent operation with frequent short shut-downs.

Alternatively the **equipment** may be required only for peak load operation with frequent start-up and shut-down or may have a load cycling requirement.

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 define the total numbers and types of start-up/shut-down required of the **high pressure piping system**. For new plant this number should be the same as that specified for the boiler/turbine unit. The **purchaser** should distinguish between normal and emergency start-up/shut-down.

The frequency of start-up and shut-down should be specified, particularly when there are numerous starts in a short period.

The philosophy of start-up/shut-down should be defined by the **purchaser** together with minimum and maximum rates of temperature gradients for the **high pressure piping system**. The **purchaser** may carry out start-up/warming calculations or place this responsibility upon the **supplier**.

If the **high pressure piping system** is to be used to warm **components** not included in the extent of supply these requirements should be specified and sufficient data presented to permit the necessary calculations.

*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.*

Abnormal conditions could include:

- boiler or turbine trips
- accidental water ingress to steam pipes
- occasional abnormal pressure, temperature or flow excursions outside design values
- abnormal ambient conditions
- abnormal characteristics of services (e. g. service air, electric power supply).

7.7 Further operational requirements

7.7.1 Load changes

The **specification** should define the number and rate of load changes envisaged for the **equipment**. The number and rate should be the same as that specified for the boiler/turbine unit.

7.7.2 Out of service conditions

The **specification** should state requirements for when the **equipment** is out of service, for example:

- corrosion protection
- anti-freezing protection.

7.7.3 Extreme conditions

The **specification** should define extreme conditions under which the piping system must operate.

This may include:

- peak load operation
- overload

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 **specification** should define **design life** for components, which may be subject to creep rupture strength calculation.

*The **supplier** should define limitations on **equipment** life 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 and their frequency to which the **equipment** will be subjected.*

8.1.3 Equipment for monitoring remaining life

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

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 pressure losses 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 **performance** and operating requirements for each **high pressure piping system.** These may include:

Fluid: - superheated steam, wet steam, feed water, condensate

Design conditions:	- flow rate, temperature, pressure, differential pressure
Operating conditions:	- flow rate, range of flow rate, temperature, pressure loss
	or valves: pressure difference in closed position, operating time for opening/closing
Installation:	- orientation (horizontal, vertical), indoor, outdoor

9.2 Performance

*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**.*

Performance tests may include:

- measurement of pressure loss
- functionality under operation conditions
- demonstration of leak tightness
- vibration level measurements
- noise emissions measurements
- demonstration of free expansion of the piping system
- demonstration that the support loads conform to design

*NOTE: **Performance** tests are sometimes 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.***

9.4 Availability

*The **specification** may specify **availability** requirements. In order to demonstrate **conformity** with this 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

The **specification** may state the rates of change of temperature and/or pressure to which the **equipment** will be subjected. The ability to accommodate these changes may be demonstrated by tests or calculations.

10 Design and fabrication

10.1 Specific equipment features

10.1.1 Calculations

The **specification** should define that the design calculations should be executed in accordance with a specified code or standard and identify those calculations to be reported. Where the **purchaser** wishes to review or approve design calculations, the arrangements for transfer of documents and programming should be specified.

10.1.2 System stresses and flexibility

Proprietary computer programs are commonly used to determine the flexibility required in **high pressure piping systems**. The **purchaser** should request:

- the name of the program that will be used in the analysis
- a list of design options taken by the **supplier** where such are available in the program e. g. pipe saddle dimensions, friction factors, cold spring (where allowed by applicable standard), foundation stiffness, hanger characteristics, etc.
- the extent of analysis, particularly where this is to extend beyond the system terminal points.

For in-house computer programs the **purchaser** should request the validation of the program to be used in the analysis.

10.1.3 Conditions

The **specification** should define the conditions to which the **high pressure piping system** is to be designed which may include but are not limited to:

- design temperature
- design pressure
- design flow rate
- operating temperature
- operating pressure-
- operating flow rate
- normal operating mode, e. g. sliding or fixed pressure
- noise limits
- vibration limits
- seismic conditions
- permissible terminal loads and moments
- permissible fluid velocities and pressure loss
- steam blowing requirements
- flushing and acid cleaning requirements
- load transients and thermal gradients

10.1.4 Design report

When the **specification** requires a design report as minimum this should cover cases required for analysis in accordance with the code specified but analysis of additional cases may be required e.g. with the piping system all hot, all cold, part hot, part cold. The **purchaser** should define the dynamic or occasional load cases (e.g. earth quake, turbine trips) required if not mandatory and should state the combinations of cases to be included. The design report should identify the computer program used and any **design conditions** taken.

The design report should include an analysis sketch or similar drawing to define the system covered by the report and identify the data used.

It should report the „n“ highest stressed parts, loads and movements at support locations and forces and moments at terminal points. Code compliance should be confirmed or agreed concessions reported.

10.1.5 Desirable system features

The **specification** may state any preferences for such system features as:

- system isolation

- protection of isolated pipe sections against overpressure, e.g. caused by a rise of temperature

- flow control

- measurement methods for checking system movements

- permanently fixed scales on constant and variable effort supports

- equipment for monitoring throughout the system life.

10.1.6 Noise and vibration

The **specification** should define the maximum allowable noise levels. The **supplier** should justify the chosen steam and water velocities in relation to this requirement.

The specification should define the maximum allowable level of vibrations under the specified conditions of operation.

The **supplier** should design the **high pressure piping system** and its support system to avoid the transmission of damaging vibrations to external equipment. The **purchaser** may ask for supporting information to show that this requirement has been met.

10.1.7 Branch connections

The angle between connecting line and the main line should not be smaller than 45°.

NOTE: The preferred angle is 90°.

10.1.8 Constant load support units

Constant load supports should be designed to permit in-situ adjustment of the pipe load. When the **specification** does not specify a required adjustment range, a range of approximately ±20% of the calculated design load may be considered typical.

The **supplier** may be required to identify the proportion of the adjustment range used by pipe weight and installation tolerances and to define the acceptable load deviation of constant load supports.

Where separate design and installation contracts are envisaged, the **purchaser** should require the **supplier** to provide detailed installation procedures for those aspects which are essential for the integrity of the design.

10.1.9 Water hammer

The **specification** should define that in the development of the piping system design the possibility of water hammer should be considered and appropriate design features for its avoidance should be included.

10.1.10 Corrosion and erosion

The **supplier** should identify the design features included to avoid erosion and corrosion. In this connection, attention should be paid to reducing ledges and pockets inside the pipes where solid particles could accumulate.

10.1.11 Thermal insulation

The optimization of thermal insulation serves to determine the actual insulation thickness by considering heat losses, space conditions and additional loads on the piping system.

When thermal insulation is not in the extent of supply the pipework **supplier** should be informed in the **specification** of the arrangements made for its design and application (weight of lagging) and especially of any devices to be included in the pipe, valve or support system to support or protect it.

The **supplier** should identify any item for which insulation is required which does not carry process fluid, e. g. structural/support items required to expand with pipework.

10.1.12 Flushing, chemical cleaning, steam blow

The **specification** should define the procedures proposed for cleaning the boiler and other main components and connected water and steam piping systems after installation.

The **purchaser** should provide to the **supplier** a time scale compatible with the pipe system supply programme, flow diagrams and description of the cleaning process, to enable the **supplier** to design pipe connections and support arrangements associated with the **supplier**'s extent of supply.

If the cleaning operations are to be undertaken fully or partly by the **supplier** the extent should be described in the **enquiry**. The responsibility for cleaning (surface quality) and for removal of waste arising from chemical cleaning or flushing should be stated in the **specification**.

The **specification** should define if a special silencer may be required to be fitted to the temporary pipe vent during the steam blow together with a projectile guard.

10.1.13 Wall penetrations

Wall and ceiling penetrations included in the extent of supply should be illustrated by the **supplier** at least in the form of sketches indicating overall lengths, clearances for movement, anchorage, corrosion protection, sealing, etc.

10.1.14 Drains and vents

The **specification** should define the design and arrangement condition of drains and vents.

The following design features should be included:

Piping systems should be laid in such a way that proper filling, draining, venting, and discharging is ensured and that only a minimum number of drains is required. Adequate slope should be ensured in steam lines under all drainage conditions. A minimum slope of 1.0% preferably in flow direction, should be the objective. A change of inclination due to thermal expansion of the piping and the component connected or the points of attachment should be considered. Drains, ventilation and vent assemblies should be arranged in such a way that no upset conditions occur during piping warming-up and operation and that the piping system is not endangered as a result of inadequate draining of the steam lines.

Discharge lines into the atmosphere and drain lines should be combined in tun dishes. Tun dishes for drains and vents should be located at a safe distance at approximately 2 m away from adjacent isolating valves and they should be so arranged that they can be observed when actuating the valve.

10.1.15 Site run pipework

The **specification** should identify pipe sizes and systems which may be **site** run and for which simplified single line drawings may be sufficient provided that such drawings identify the location of interfaces/terminal points relative to defined base lines and datums.

10.1.16 Marking of pipe system

Piping systems should be marked by coloured coding for fluid nature and arrows for flow direction.

10.1.17 Maintenance features

The **specification** should state requirements for external and/or internal access to the piping systems for inspection and maintenance. Strain measuring points should be located in accessible locations.

10.1.18 Measuring and sampling points

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

- creep strain measuring points

  For monitoring of the permanent elongation of components which are calculated with time-dependent design strength values, strain measuring points are required. Strain measuring points should be located in accessible locations.

In boilers with several header outlets one strain measuring point should be installed in each connecting line and one additional point along the line at least for each other pipe line section

- creep measurement

  Creep may be measured at machined studs welded to the pipe or component on in at least two axes perpendicular to each other. Creep is measured by a slide gauge or a micrometer gauge to determine any change in diameter. The stud surface should be slightly crowned and polished with a finish not subject to rust or scale.

  The measuring points should be identified permanently in such a way that measurements can always be performed at the same site. The measuring point surface should be such that ultrasonic wall thickness measurements are possible in the immediate vicinity of the studs.

  Design and number of measurement points should be agreed as early as possible.

  The **supplier** should provide documents indicating base diameters to the **purchaser** after the pressure test.

- metering sections for flow measurements

  When planning the inclusion of a flow measuring device in a pipe line the device should be installed in a section subject in undisturbed flow in order to exclude additional measurement uncertainties.

- measuring points for **performance** and routine tests.

*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**.*

10.1.19 Legislation measurement points

*The **specification** should normally define the legislation and codes of practice for which operating data are required and 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 any 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 (e.g. cutting, welding procedures, welder qualification, heat treatment, surface protection). 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 level, gas egress, harmful materials, maximum temperature of surfaces accessible to personnel, control of spillage and guarding.

10.4.2 Equipment protection

*The **specification** may request information regarding the measures taken to confine the **equipment** within safe operating limits, protection against rain water ingress into insulation, 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.*

The **specification** may ask the **supplier** to ensure that, for those components for which continued service is based on a routine of maintenance, refurbishment or replacement (see 8.2), interchangeability should be maximized in order to minimize the range of spare parts. For such components, the plant should be designed so that this work can be carried out without interference from other plant items or from the building structure. The **supplier** should identify cases where this requirement cannot be met.

> *NOTE: If the **purchaser** wishes to specify a particular manufacturer 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.*

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 any on-load maintenance requirements, if any.*

The **purchaser** may ask the **supplier** to provide for a maintenance plan, based on the purchaser's intention.

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 and the permit to work system.*

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 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 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 portable 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 ~~e~~**equipment**. If specific, this may be offered by the **supplier** as a separate item in the **tender**.*

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 contract includes **availability** targets, the **supplier** should state the 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.*

Spare parts are necessary for the full service life **expectancy** of the equipment. The **supplier** should state how long the supply of identical or compatible spare parts will continue.

11.8 Special precautions

*The **supplier** should be asked to identify special precautions required during maintenance operations,* for example: double isolating of piping sections.

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) indicate the category of each document, 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).*

The **specification** may request specific informations such as:

- loading calculations
- calculations and drawings for statutory approval
- inspection certificates, such as ultrasonic tests, X-ray tests, etc.
- material test certificates
- spare part lists
- identification system
- general arrangements of the system including plans, elevations and cross sections with full dimensions including as built drawings as agreed
- detail drawings of each support
- calculation schematic diagrams
- design and installation isometric drawings
- vent and drain schematics
- hydraulic test flow diagrams
- detailed interfaces with boiler, turbine, instrumentation, and electrical equipment
- arrangements, location and reference numbers of welds
- nozzle and extraction point detail drawing
- piping and instrumentation diagrams
- measuring point detail layout
- loading diagrams
- support schedule with full details
- material/dimensional transition piece detail drawing
- wall and ceiling penetration information
- vessel drawings and calculations as required
- wiring diagrams as required

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 **specification** 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 any other standards or codes with which the **equipment** should comply, if any.*

*The **purchaser** may ask the **tenderer** to define any other standards or codes, in addition to those identified by 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 safety 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 will be capitalized costs of absorbed power and consumables at a defined operating condition 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 **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 condition of use of **site** services, such as connections for electricity, water and other services provided for the **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 organization. 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 recognize 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 Test 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. These 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 boiler/turbine unit or after installation of a new **high pressure piping system**, *the **supplier** should carry out the continuous trial run if specified. The date of the trial run should be agreed with the **purchaser.** The purpose of the trial run is to prove the functional capability of the* **high pressure piping system** *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 run, 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 any 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.*

***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 an operating period during which additional tests may be required*. These additional tests might include

- check of tightness by pressure tests

- conformity of piping system movement with design conditions.

*The **specification** may also define a period during which the **equipment** should operate to specified levels of, for example,* quality of insulation (temperature on external surface of pipes), pressure loss and vibrations on main and tapping lines, *target availability. The nature and frequency of any 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 before any tests*.

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

Bibliography

EN ISO 8402	*Quality management and quality assurance - Vocabulary (ISO 8402:1994)*
EN 45510-8-1	*Guide for procurement of power station equipment - Part 8-1: Control and instrumentation*

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