



GS 126-2

Guidance for Specification 126-2

**AIR COOLED HEAT EXCHANGERS
TO API 661**

April 1995

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SCOPE AND PURPOSE This Specification modifies the April 1992 Third Edition of API 661 to include BP specific requirements for all process-type air coolers. API 661 is the industry standard providing general requirements for the purchase of air coolers. This Specification is intended to be used directly for the purchase of all new equipment, any project specific requirements being incorporated in the data sheet requisition.											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

This Guidance for Specification substitutes, adds to or qualifies certain of the [API 661](#) clauses, using BP's knowledge and experience worldwide.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

It is a transparent supplement to [API 661](#) 3rd Edition, dated April 1992, showing substitutions, qualifications and additions to the API text as necessary. As the titles and numbering of the BP text follow those of API, gaps in the numbering of the BP document may occur. Where clauses are added, the API text numbering has been extended accordingly.

Text in italics is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of 'Specification' and 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Specification Ready for Application

A Specification (BP Spec 126-2) is available which may be suitable for enquiry or purchasing without modification. It is derived from this BP Group Guidance for Specification by retaining the technical body unaltered but omitting all commentary, omitting the data page and inserting a modified Foreword.

Principal Changes from Previous Edition

Now supplemental to [API 661](#), 3rd Edition.



Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSEs to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP Engineering or the Custodian. See Quarterly Status List for contacts.



1. GENERAL

1.1 Scope

- 1.1.1** This specification states BP requirements for design, materials, fabrication, inspection, testing and preparation for shipment of process-type air-cooled heat exchangers having a maximum design temperature of 400°C (752°F).

This specification is not applicable to non-process type air coolers (e.g. combustion air coolers for gas turbines).

- 1.1.3** This document applies to all air coolers designed to [API 661](#).

1.2 General Requirements

- 1.2.4** API 661 shall be applied as modified by this specification.

NOTE THAT THE **BOLD** SECTION NUMBERING OF THIS SPECIFICATION FOLLOWS THAT USED IN [API 661](#) 3RD EDITION, APRIL 1992. API CLAUSES APPLY IN FULL UNLESS EXPLICITLY NOTED OTHERWISE. API OPTIONAL CLAUSES (MARKED WITH A BULLET) APPLY UNLESS NOTED OTHERWISE.

- 1.2.5** The vendor shall be responsible for the co-ordination and satisfactory operation of the complete unit, regardless of the source of supply of individual component parts.

- 1.2.6** In cases where the heat exchanger vendor does not supply a component part he shall either specify its detailed design or approve the appropriate aspects of the design where the details are supplied by others.

- 1.2.7** For any group of air-cooled heat exchangers, the units shall be designed to permit, wherever practical, interchangeability of components including fans, drivers, belts, tubes, tube bundles and the control system components.

- 1.2.8** The units shall be designed for maximum shop assembly of all component parts including platforms and auxiliary equipment.

Only bolted construction shall be used for field assembly.

1.3 Referenced Publications

Refer to Appendix E for additional references.



1.4 Definitions

Refer to Appendix D for additional definitions.

1.5 Alternative Standards

Alternative standards are listed in Appendix F

2. PROPOSALS

2.1 Purchaser's Responsibilities

2.1.1 The purchaser shall complete the API checklist (API Appendix) and the relevant information included on the data sheet.

2.2 Vendor's Responsibilities

2.2.1 In his proposal, the vendor may use his own standard data sheets, providing they give all the relevant information required by Appendices B and C.

2.2.13 Information Required with Vendor's Proposal

The vendor's proposal shall include the following:

- (1) For the pressure-containing parts, the relevant information necessary for appraisal of the mechanical design by the purchaser, including drawings, specifications and a list of any proposed sub-contractors.
- (2) For each operating case, including specified summer and winter conditions, the performance data sections of Appendices B and C shall be completed.
- (3) Unless shown on the proposal drawing, a sketch for each tube bundle, showing details of the arrangement of the headers, including passes, row location and numbers of tubes per pass.
- (4) The arrangement of tube bundles together with nozzle or nozzles and interconnecting piping sizes in case of multi-bundle units. This data should where possible be included on the unit specification sheet.
- (5) Completed fan data sheets including estimated performance curves.



3. DOCUMENTATION

3.1 Approval Information

INFORMATION REQUIRED SHALL INCLUDE THE FOLLOWING (in addition to the API listing):-

3.1.1 (Outline Drawing):-

- g. Nozzle 'mark' to be in line with the purchaser's system.
- i. Location of lifting points.

3.1.3 (Additional Information)

The following shall also be provided for purchaser review:-

- (a) Procedures for Post Weld Heat Treatment, NDT, hydrotest, painting.
- (b) Thermal calculations and guarantee (if by vendor).
- (c) Structural calculations (including provision for anchoring and expansion; information to include resultant forces, shears, and moments on support structure, or foundation).
- (d) Detailed Drawings:

For the unit, the drawings shall show sufficient detail to identify how all components fit together, and shall include cross reference to all component detail drawings.

For the headers the drawings shall be fully dimensioned showing all details.

For the tube bundle the drawing shall show layout, tube support, and provision for thermal expansion.

- (e) Quality Plan.
- (f) Any restrictions regarding testing or operation of the heat exchanger unit (or any other units if part of a bank).
- (g) Details of instrumentation, including fan-blade and louvre actuators and positioners, also vibration switches.
- (h) Estimated performance curves for fans, including the effect of auto-variable pitch mechanisms or range of manual adjustment where fitted with louvres.



- (i) The estimated efficiency, or steam rates, of the fan drivers shall be supplied either as curves or as numbers for the 25, 50, 75, 100 and 110% full load rating points.

3.1.5 Weld procedures and qualifications shall be submitted for purchaser review.

3.1.6 Installation, operation and maintenance manuals. Details of spares required for each phase to be identified separately.

3.2 Final Records

3.2.1 In addition to the information specified in API 3.2.1, the vendor shall supply the following:-

- c. Material test certificates for all pressure containing parts. These shall be to [BS EN 10204](#): 1991 3.1B unless otherwise specified by BP
- k. Driver and speed reducer performance curves.
- l. All drawings at 'as built' status.
- m. All design calculations.
- n. Quality plan signed by all inspection parties.
- o. The following documents associated with the headers:-
 - (1) Weld seam identification chart (or cross reference notes on the drawing).
 - (2) Qualified weld procedures.
 - (3) Radiography and other NDT records.
 - (4) Heat treatment record.
 - (5) Hydraulic test certificate.
- p. Motor and instrument protection certificates.

The dossier containing all final records shall to be identified by the item number, ultimate user's name, project name and location, purchase order number, vendor's shop number (and the manufacturer's number if different).



4. DESIGN

4.0 Thermal Design

Thermal design should be performed using HTFS or HTRI methods and software. An exception may be made where the unit differs significantly from the normal range covered. When other methods and software are used, then in the event of a dispute regarding the design of the unit, the purchaser will require a cross check using HTFS/HTRI software.

HTFS and HTRI are two independent private organisations who are industry leaders in producing heat exchanger software. BP subscribes to both organisations, and has access to their software.

4.1 Tube Bundle Design

4.1.1 General Requirements

4.1.1.3 Provision for thermal expansion of tubes shall be by floating head or U-tube design. The tube bundle shall be free to expand independently of the structure.

4.1.1.4 The individual finned tube bundles shall be self-supporting using steel channels to hold the headers. These steel channels shall support steel bar, angle or channel tube supports. Tube supports shall be installed in such a manner so as to be fixed in position. On forced draught units, the need to protect the tube fins from mechanical damage shall be given specific consideration.

Tube fins are easily damaged, particularly by foot traffic, and many sites have experienced problems on forced draught units which are in accessible positions. To avoid such damage it is strongly recommended that the bundle is fitted with standard walkway grating.

4.1.1.13 Nozzles between tube bundles shall be at the fixed header end to minimise thermal expansion stresses.

4.1.1.14 Tube bundles shall not exceed 10 tonnes (10 tons) in weight.

Bundle weight is limited to suit handling facilities normally available at site.

4.1.1.15 The bolting of connecting nozzles of stacked tube bundles shall be removable without moving the bundles.

4.1.1.16 Tube Velocity

The maximum allowable tube-inlet design velocity for gas streams containing no liquid or solid particles shall be 30 m/s (98.4 ft/s). Where particles or droplets are anticipated in service, the purchaser



shall specify a suitable lower velocity not exceeding 20 m/s (65.6 ft/s).

4.1.1.17 Tube Bundle Design Loadings

The following loadings shall be taken account of in the design of the tube bundle to the UPV design code:-

1. Pressure (4.1.4)
2. Applied nozzle loads (4.1.10)
3. Reactions from thermal expansion (4.3.3)
4. Lifting (4.3.6)

4.1.3 Tube Bundle Design Temperature

4.1.3.3 The maximum material design temperatures using the types of fin listed in 5.1.12.7, shall not exceed:-

- | | | |
|----|--|---------------|
| 1. | Embedded | 400°C (752°F) |
| 2. | Integral | 288°C (550°F) |
| 3. | Overlapped footed
(L-shaped) | 180°C (302°F) |
| 4. | Footed (L-shaped) | 120°C (248°F) |
| 5. | Bonded (carbon steel tubes and
fins galvanised) | 350°C (662°F) |

Other forms of finning or bonded construction together with temperature limitations, may be proposed.

4.1.5 Corrosion Allowance

If clad plate is used, the clad portion of the plate shall be considered as corrosion allowance only. The cladding shall extend beyond the gasket contact surfaces. (If weld overlay is used instead of clad plate the same requirements apply).

4.1.6 Headers

4.1.6.1 General

4.1.6.1.4 Header flow area shall be 125% of the tube pass flow area.

(Substitution for [API 661](#))



Header flow area is increased to avoid the risk of uneven flow, which in extreme cases can cause header distortion.

4.1.6.1.10 Partition plates shall have holes for draining and venting of tube bundles and header compartments where necessary.

4.1.6.1.11 Welds of partition plates and stiffeners shall not interfere with tube flow characteristics or entry to tube holes.

4.1.6.2 Headers - Removable-Cover-Plate and Removable-Bonnet Type

4.1.6.2.3 Header joint type shall be confined and flanged as per [API 661](#) Fig 4 (B) only.
(Qualification of [API 661](#))

4.1.6.2.5 A dismantling clearance, not jack screws, shall be used.
(Qualification of [API 661](#))

4.1.6.2.7 Through-bolting, not studs, shall be used.
(Qualification of [API 661](#))

* 4.1.6.2.10 Space shall be provided for the use of air operated impact wrenches or hydraulic bolt tensioners as applicable with particular attention to multi bundle arrangements.

Hydraulic bolt tensioners shall be used on:-

- (a) all joints with nominal bolt diameter 50 mm (2 in) and over,
- (b) Class 600 joints and over, with nominal bolt diameter 38 mm (1 1/2 in) and over,
- (c) when specified by BP for nominal bolt diameter 25 mm (1 in) and over.

The hydraulic tensioning equipment supplier shall be subject to approval by BP.

The bolting arrangement shall be designed to suit the chosen bolt tensioner. Excess thread shall be protected by a third nut or thread protector.

4.1.7 Tube-Access Plugs

4.1.7.6 Plugs shall not project into the header box.



4.1.7.10 For corrosive service, when specified, plugs shall be generally in accordance with Figure 2.

4.1.8 Gaskets

4.1.8.1 For carbon steel plugs, the gaskets shall be of soft iron.

(Qualification of [API 661](#))

4.1.8.5 Jointing shall be in accordance with BP Group [GS 142-7](#).

4.1.8.8 In preparing gasket drawings and ordering spare gaskets, the dimensions specified shall take into account the tolerance permitted in the header and cover plate grooving.

4.1.9 Nozzles and Other Connections

4.1.9.0 For non-ferrous exchangers, details of nozzle and other connections shall be proposed.

Minimum branch size shall be NPS 1 1/2.

Maximum branch size shall normally be limited to NPS 12, and where possible shall be restricted to NPS 8 by splitting large flows between more than one nozzle, if necessary.

Refer to Welding (6.1) for limitation on nozzle to header attachment details.

4.1.9.1 In no case shall pipe couplings or studed connections be used at headers.

4.1.9.2 Bolt holes shall straddle main equipment centre lines.

Flange facings shall be raised face type for classes 150 to 900, and ring joint type for classes above 900.

* 4.1.9.8 Transition pieces shall normally be forged. Castings or fabrications, may only be used subject to specific BP approval. Centrifugally cast flanges shall not be used.

(Qualification of [API 661](#))

4.1.9.10 Slip on flanges shall not be used on items subject to fatigue.

4.1.9.13/14 Thermowell and pressure gauge connections shall be located in the piping adjacent to main nozzle connections.

(Substitution for [API 661](#))



- 4.1.9.16** Chemical cleaning connections shall be NPS 2 minimum.
- 4.1.9.17** Instrument connection preferred location is in the piping adjacent to main nozzle connections.
(Qualification of [API 661](#))

- * **4.1.9.20** Vents and drains shall not be required unless specified by BP.
(Substitution for [API 661](#))

Vents and drains are normally provided via connections in the attached pipework adjacent to the header box nozzles; when required for layout or operability, they may be located in the headers (this will be as stated in the P & ID). Some sites prefer the facility of 2 off NPS 1 1/2 vents and drains per header to use as required for local venting and pressure testing; these shall be provided only if requested.

4.1.10 Maximum Allowable Movements and Forces for Nozzles and Headers

The vendor shall submit full design calculations to show compliance with the design code.

4.1.11 Tubes

- 4.1.11.0** (a) Internal turbulence promoters may be proposed.

Internal turbulence promoters can be used for viscous cooling applications to significantly reduce the size of new air coolers.

- (b) When specified for carbon and low alloy tubes in a marine or corrosive environment, the following provisions shall be applied:-

The exposed tube ends shall be cleaned of all dirt, grease and rust contamination and coated with two pack epoxy paint to a dry film thickness of 50 to 75 microns. The coating shall extend back on to the first fin so that the dissimilar metal joint is protected. Applies to operating temperature below 120°C only.

Additionally for critical duties the tube end detail in Figure 1 may be specified.

- 4.1.11.2** A straight tube length of 9.2 m (30 ft) or 12.2 m (40 ft) is preferred. If required by specific design considerations, the use of other lengths within the maximum length specified, may be proposed.

- 4.1.11.3** Wall thickness for additional materials are given below; these apply as per API.

- e. Cupro-nickel and Monel 1.83 mm (0.072 in)



- f. Incoloy 800 1.65 mm (0.065 in)

For integral finned tube construction the wall thicknesses shall apply to the inner tube.

4.1.11.5 Fins serrated on the outside edge shall not be used.

4.1.11.6 Each end of the finned tubes shall be free of grooves over a length as necessary for insertion into the headers; for integral finned tube, the outer tube shall be stripped back. These unfinned lengths shall be free of gripping marks both inside and outside.

4.1.11.7

Notes on tube type:-

Embedded: Used on inland (non-corrosive) sites only, Corrosion protection of tube ends (as given in 5.1.12) has no value for this tube type.

Integral: Is the preferred type for coastal (marine/corrosive) sites. Is the preferred type for use on tubes of the following materials:- Austenitic Stainless Steel, Monel, Incoloy 800, Incoloy 825, Copper alloy tubes including Cupro-Nickel.

Overlapped

Footed: Acceptable as an economic alternative to the integral type for carbon steel tubes.

Bonded Rarely if ever used.

4.2 Air-Side Design

4.2.1 General Requirements

- 4.2.1.1**
- (a) The fan and motor shall be sized so that the design air flowrate can be maintained when there is a uniform fouling layer on the tubes and fins of 0.125 mm (.005 in) thick.
 - (b) In cases where rain may influence the process performance, induced draft air coolers shall be used.
 - (c) The height of the fan inlets (forced draft units) or of the underside of the bundle (for induced draft units) shall be at least one fan diameter above the nearest solid horizontal obstruction to air flow.
 - (d) In the case of open piperacks the clearance shall be 2.4 m (8 ft) minimum from the tops of the pipes.



- (e) Air coolers of different fan intake elevations shall not be located adjacent to one another.
- (f) In the siting of air coolers due consideration shall be taken of the hazards associated with release of flammable fluid from, or fire in, equipment/piping beneath or adjacent to the cooler.

* **4.2.1.2** Exchanger design shall take into account operation at part load. This is particularly important for viscous materials (5 cP and greater) and those with high pour points.

The inside tube wall temperature shall be a minimum of 10°C (18°F) above the fluid pour (freeze) point given on the purchaser's data sheet (see Appendix C). This condition shall be satisfied for the lowest part-load design case with air entering at winter design ambient temperature. The provision of counter or parallel flow piping arrangements or air recirculation may be necessary to achieve this.

In cases where the process fluid may solidify or become highly viscous when flow is interrupted, the purchaser shall specify the provision of heating means and manual louvres for use when starting-up and shutting-down. Steam heating is preferred. The use of electric heaters will require special precautions in hazardous areas.

For the handling of flammable fluids, BP may specify the incorporation of fusible links located at the fan inlet to stop the fan motor and possibly initiate other actions in the event of fire.

A local emergency stop shall be included.

4.2.1.5 Drivers, gear boxes, transmissions, instrumentation, louvre actuators and positioners shall not be installed in the hot-air stream.

4.2.2 Noise Control

4.2.2.1 Noise limits will be specified by the purchaser.

4.2.2.2 Noise emission shall be determined by [CONCAWE Report No. 5/78](#).

4.2.3 Fans and Fan Hubs

- 4.2.3.0
 - (a) The design of fans shall be checked to ensure no vibration of the fan blades.
 - (b) The direction of rotation of all rotating parts shall be clearly marked so as to be visible at all times.
 - (c) Fans shall be provided with locking devices to prevent rotation due to natural convection during maintenance.



- (d) Controlled air recirculation units are considered to be a special case and their use shall be subject to approval by the purchaser.

4.2.3.1 All fans in a bay shall be capable of independent operation.

4.2.3.5 Maximum fan tip speed shall be 61 m/sec (12000 ft/min).

(Qualification of [API 661](#))

The fan tip speed restriction is in order to minimise noise.

4.2.3.10 Where close control of the fluid outlet temperature is not required, e.g. product cooling, fixed pitch fans may be specified.

Where close control of the outlet temperature is required and the unit is served by a number of fans, only that number of fans required for control, determined by the amplitude of possible temperature fluctuations, are required to have blades of the automatically adjustable type. The automatically-adjustable-blade fans shall be at the hotter end of the bundle. The remaining fans shall be of a type which require the fan to be shut down to adjust the pitch.

4.2.3.11 Pneumatic actuators: Requirements for each actuator:-

- (a) Equipped with a pneumatic positioner. The positioner shall have mechanical pitch-position feedback with full range adjustment. For electrical or electronic control signals, a current-to-air transducer located at grade or local platform shall be used. Minimum and maximum mechanical stops, adjustable over the full range of pitch movement, shall be provided.

The minimum blade pitch will need to be negative to achieve zero air flow with a hot bundle.

- (b) Repeatable to within 1° for the same instrument air pressure signal, increasing or decreasing.
- (c) Diaphragm actuated.
- (d) Rotating joints requiring periodic maintenance shall be provided with accessible grease nipples.

4.2.3.13 The characteristic fan-performance curves shall be generated in accordance with a recognised test procedure, e.g. [BS 848](#) Part 1, [AMCA 210-74](#), or [ASHRAE 51-75](#).

The fan shall be selected so that the design point under fouled conditions satisfies the following requirements with respect to the fan-performance curves:-



- (a) The design point shall lie on a performance curve for which the fan blade angle is at least 5 degrees and preferably 10 degrees less than the largest blade angle at which the fan can operate satisfactorily.
- (b) The design point shall not lie on a performance curve in proximity to the stall region which the manufacturer shall indicate on the fan curves.

4.2.4 Fan Shafts and Bearings

- 4.2.4.0 (a) Fan assemblies shall be fitted with their own thrust bearing situated at the drive end and a steady bearing at the outer end. The thrust bearing shall be capable of carrying any thrust loads transmitted by the driver. Where the driver incorporates its own thrust bearing, a flexible membrane type coupling may be used to absorb differential shaft expansion between the driven and driving members.
- (b) The design of fan shafts, hubs and pulleys shall incorporate means of dismantling, e.g. jacking points and lifting eyes.

4.2.4.2 All bearing houses shall be provided with facilities to enable accelerometers to be fitted.

4.2.7 Drivers

- 4.2.7.0 (a) Drives and drivers shall be supported by suspended drive supports from the structural steel plenum to permit the space under the units to be used for other purposes (i.e. [API 661](#) Figure 7, Alternatives E and F).
- (b) The use of drivers other than electric motors may be proposed.
- (c) Lubrication facilities as per 4.2.5 shall be provided for all grease filled bearings.
- (d) All bearing houses shall be provided with facilities to enable accelerometers to be fitted.
- (e) All drivers and gearboxes shall be fitted with jacking screws for alignment in all three axis (applies to all driver power ratings).

4.2.7.1 General Requirements



4.2.7.1.2 The static head against which the fan has to operate shall include the sum of the pressure drops across the following components:-

- (a) Fan guard
- (b) Plenum chamber
- (c) Air cooler bundle
- (d) Steam coils)
- (a) Louvres) where fitted
- (f) Splitter silencers)

4.2.7.2 Electric Motor Drivers

4.2.7.0 Electric Motors shall be in accordance with BP Group [GS 112-3](#).

4.2.7.2.1 All electrical equipment shall be selected to suit the specified area classification.

Exposed motors shall be in accordance with [IEC 529](#), degree of protection IP 55 (minimum)

Some sites choose a higher degree of protection (e.g IP 65).

4.2.7.2.9 Variable speed motor drivers shall comply with the following:-

- (1) Rated torque shall be maintained throughout the specified speed range considering losses (especially harmonics) and reduced efficiency of cooling.
- (2) The driver shall not have a critical speed within the specified speed range.
- (3) For hazardous area applications the motor shall be certified for use with the speed control equipment proposed.
- (4) Temperature detection in accordance with BP Group [GS 112-3](#) shall be provided.
- (5) Where specified by the purchaser the motor shall be rated for Direct-On-Line starting at the voltage and frequency stated.

4.2.8 Couplings and Power Transmissions

4.2.8.2 Belt Drives

4.2.8.2.1 Toothed belt drives may be used within the specified V-belt power range.



- 4.2.8.2** V-belt drive tensioning means shall be adjustable without the need to remove the guard, and without losing the alignment of the pulleys.
- 4.2.8.2.5** V-belt drives shall be heavy-duty oil-resistant, fire-resistant and anti static to [NCB Specification 244/1961](#) or [RMA Bulletin 3](#) Second Edition where applicable.
- 4.2.8.2.11** For suspended V-belt drives, a jacking arrangement shall be provided to facilitate the alignment of drive pulleys.
- 4.2.8.2.14** Pulley wheels shall be cast iron or steel. Aluminium shall not be used.
- 4.2.8.2.15** The selection of belt size shall ensure that on a plant with several exchangers the number of sizes of belts is kept to a minimum.
- 4.2.8.4 Mechanical Power Transmission Guards**
- 4.2.8.4.1** Rotating parts shall be guarded in accordance with BS 5304 or equivalent national standard. The guard shall be steel unless conditions specifically require an alternative. Any alternative materials shall be suitable for use in hazardous areas, where such service is specified. Guards shall be sufficiently robust to resist distortion in normal industrial use, to avoid risk of sparking due to contact with moving parts.
- 4.2.8.4.2** Where suitable and practical, parts of the guard shall be hinged to allow access to equipment for maintenance without removal of the complete guard.
- 4.2.9 Vibration Cut-out Switches**
- For 'Vibration cut-out switches', read 'Vibration switches and alarms'.
- (Substitution for [API 661](#))
- 4.2.10 Louvres**
- 4.2.10.15** Pneumatic actuators: Requirements for each actuator:-
- (a) The positioner shall have mechanical louvre position feedback. For electrical or electronic control signals, a current-to-air transducer located at grade or local platform shall be used.
 - (b) Each change in signal shall give a proportional change in louvre angle from fully closed to fully open.
 - (c) Repeatable to within 5 degrees for the same instrument air pressure signal, increasing or decreasing.



- (d) Provided with an auxiliary hand actuator.
- (e) There shall be a minimum of one actuator per bay, a minimum of one actuator per unit and a minimum of one actuator per 15 m² (161.5 ft²) of louvre surface area.

4.2.10.16 Louvres shall be operable from grade by a local operating station.

4.3 Structural Steel Design

4.3.1 General

4.3.1.4 All structural steel ducts and plenum chambers shall be completed in the shop.

4.3.1.7 Foundation bolt design stress shall be 100N/mm² (14500 psi). Minimum diameter shall be M20 (3/4 in).

Support bearing stress (on concrete) shall be 4.0N/ mm² (600 psi).

4.3.3 Structural Design Loads and Forces

The following shall apply:-

4.3.3.2 Live loads shall include: parts of equipment loads that may be placed on the supporting structure during dismantling for maintenance.

4.3.3.4 Thermal force reaction shall be based upon an effective co-efficient of friction of 0.5.

4.3.3.6 Wind and Earthquake loads for other locations shall be specified
4.3.3.7 by the Purchaser.

4.3.3.11 Dynamic loads from vibrating equipment and wind excited oscillators shall be considered.

General:-

- (a) Loads and Forces requiring Purchasers agreement shall be proposed by the vendor.
- (b) Loads listed under 'fireproofing' shall include 'insulation' and 'cladding'.

4.3.4 Plenums

Plenums shall not contact headers or other pressure-containing parts.



4.3.5 Mechanical Access Facilities

4.3.5.1 Requirements for platforms, stairways, ladders and handrailing shall be in accordance with [EEMUA Publication 105](#).

4.3.6 Lifting Devices

Lifting facilities may be required if not available at site, or if access for mobile equipment is not available.

4.3.6.1 Positioning of lifting lugs shall be such that horizontal balance of bundles is obtained.

4.3.6.4 Note the possible requirement for jacking points for V-belt drives.

4.3.6.7 Note that lifting devices must be tested in accordance with local statutory requirements.

5. MATERIALS

5.1 General Requirements

- 5.1.0**
- (a) Material specifications for tube bundles are listed in Table 1 and requirements for specific services are given in Appendix A.
 - (b) Bare austenitic stainless steel (300 series) tube bundles in a marine type environment shall not be used for operating temperatures above 60°C.
 - (c) For any welded component the carbon content shall not exceed 0.25%, and the maximum allowable phosphorus and sulphur content shall not exceed 0.025% each in the ladle analysis.
 - (d) Butt-welding fittings shall be in accordance with [ANSI B16.9](#). They shall be seamless and in the case of austenitic fittings, only forgings shall be used.
 - (e) ERW (seam welded) tubes shall not be used for onerous duties, where corrosive attack on the weld can occur, or for design pressures in excess of 50 bar(ga).

Duties are considered onerous when substances such as the following are present in any quantity: hydrogen, hydrogen sulphide, hydrofluoric acid, caustic, cyanide, nitrate, sulphur dioxide, toxic chemicals, and substances likely to promote stress corrosion cracking.



ERW tubes may be considered for higher pressures subject to a review of the tube vendor's manufacturing, QA and QC procedures.

- 5.1.3** Cast iron, including nodular ductile iron, shall not be used in any services
(Substitution for [API 661](#))

5.2 Headers

- 5.2.1.0** Plate material for headers designed using the following features shall have a sulphur content not exceeding 0.008% (ladle analysis):-

- Stiffened (or partition plates fully welded in)
- Corner joints welded to the face of a plate
- Large set-on connections

5.3 Louvres

- 5.3.1** Louvre pivot pins shall be of stainless steel only.
(Qualification of [API 661](#))

- 5.3.2** Louvre bearings shall be filled PTFE material. The design shall ensure that, with the heat exchanger operating at maximum inlet design temperature, the bearing temperature shall not exceed 200°C (392°F).

(Qualification of [API 661](#))

5.4 Other Components

- 5.4.1** Aluminium fin material shall be not less than 99.7% pure.

- 5.4.2** Aluminium alloys for fan blades shall be selected to be resistant to stress corrosion cracking. Cast construction is preferred, but fabrications may be proposed.

Reinforced plastics material may be proposed provided the maximum outlet temperature does not exceed 90°C (194°F). In order to prevent the generation of static charges the material shall have a surface resistivity of less than 1×10^8 ohms, determined in accordance with BS 2782 : Part 2, Method 203A.

- 5.4.3** Tube access plugs for corrosive or sour service or for use with clad plate shall be generally in accordance with Figure 2.

- 5.4.4** Plenums and ducts shall be of galvanised steel.

Galvanising shall be applied after fabrication where possible. Cut and sheared edges of sheet, coil, etc. shall not be painted, or dressed e.g. by grinding.



- 5.4.7 Galvanised bolting is required on galvanised structural steel.
- 5.4.8 Any material requirements for thermal and acoustic insulation shall be in accordance with BP Group [GS 152-1](#)
- 5.4.9 All aluminium alloys used in areas classified as hazardous in connection with the specification of electrical equipment shall comply with the IEC standard.
- 5.4.10 Clad plate or weld overlay may be proposed for use on header boxes. Weld overlay shall be deposited in a minimum of two layers, the first layer being more highly alloyed to allow for dilution, and the second layer being subject to a surface test for alloy composition.

6. FABRICATION

6.1 Welding

6.1.1 General

- 6.1.1.3** (a) Connection to header welds shall be set in design with full penetration welds, welded from both sides, with back gouge where access permits.

For branch thickness less than $\frac{1}{3}$ of the Header thickness, partially set in (depth equal to branch thickness) design may be used, welded with full penetration weld. Alternatively a double sided partial penetration design may be used, subject to the same limits as in [API 661](#) 4.1.9.10, and when access permits.

Exceptionally, when the above are not possible, set on design may be used with full penetration welds.

Refer to , 7.2.10, 10.2.5 and 10.4

- 6.1.1.4** Permanent backing strips shall not be used.
- 6.1.1.5 Structural welding shall be in accordance with the structural code.
- 6.1.1.6 Repairs to base material and welds shall not be made without the approval of the purchaser's inspection engineer.
- 6.1.1.7 Welding after heat treatment (i.e. of headers) shall not be permitted.

6.2 Post Weld Heat Treatment



6.2.3 Heat-treatment details for materials other than carbon steel shall be proposed by the vendor.

6.3 Tube-to-Tubesheet Joints

6.3.0 For the majority of the applications involving non-corrosive and non-penetrative services, tube ends shall be expanded into the tubesheets. For other more onerous operating conditions and services, where total leak tightness must be guaranteed, welded tube-to-tubesheet joints shall be used.

6.3.1 Tube Hole Diameters and Tolerances

6.3.1.2 Special close fit shall be used for stainless steel and titanium, and other work hardening materials. Holes shall be produced by drilling and reaming.

The use of drilling followed by reaming is known to produce a high quality result which is of the correct tolerance and surface finish. The vendor may impose an alternative, but must prove its suitability on a comparison test piece.

6.3.4 Welded Tube-to-Tubesheet Joints

6.3.4.3 For strength welds, where light expansion after welding is specified, tube hole grooving is not required.

6.3.4.4 Welded joints shall be in accordance with BP Group [GS 118-8](#) for ferritic and austenitic materials; welding of other materials shall be subject to a proposal in line with BP Group [GS 118-8](#).

6.6 Alignment and Tolerances

6.6.5 The maximum tolerance on the outside diameter of the fins shall be + 1 mm (0.039 in).

6.6.6 Flange orientation (bolt holes) shall be within $\pm 1^\circ$ of specified position.

7. INSPECTION, EXAMINATION AND TEST

7.0 Quality Assurance

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services proved by sub-contractors and to any free issue materials.



Further suggestions may be found in the BP Group RPSEs Introductory Volume

7.1 General

7.1.0 Dimensional inspection shall be carried out before heat treatment and/or hydrostatic testing. This check shall be carried out by the vendor's inspection engineer and may be witnessed by the purchaser. It shall cover all main dimensions, nozzle locations, flange ratings, etc.

Prior to visual and dimensional inspection, the tube bundle shall be cleaned.

7.1.1 Air-cooled heat exchangers shall be inspected to the requirements of the design code by an independent inspection agency appointed by BP, and/or any statutory authority as may be required.

7.2 Quality Control

7.2.0 Plate material for headers designed using internal stiffeners (or having partition plates fully welded in) shall be ultrasonically checked for laminations in accordance with [ASME VIII](#), Appendix 20, before and after welding.

7.2.1 When full radiography is specified, Header main weld seams shall comply with [API 661](#) 9.2.2, or shall be subject to 100% ultrasonic inspection.

7.2.8 Testing of finished welds shall apply also to all header materials greater than 38 mm (1.5 in) thick.

7.2.10 For set on and partially set in connections, the header shall be subject to ultrasonic inspection (as per [API 661](#) 9.2.5) before and after welding.

7.2.15/16 Tubes shall be manufactured full length without circumferential welds.

(Substitution for [API 661](#))

7.2.20 The inner surface of tubes shall be free of helical marks resulting from excessive pressure during grooving.

7.2.21 Tests for Embedded-Fin Tubes

7.2.21.1 Destructive Tests

(a) One tube in every 500 shall be destructively tested by the following methods:-



- (1) A pull-test, shall be carried out on fins at every 300 mm (12 in) of tube length.
 - (2) Two cross-section cutaways shall be made for inspection of tube grooving and fin bonding.
- (b) Pull-Test: A fin shall be cut in such a way that the sector to be pulled out is obtained with chord of 13 mm (1/2 in) at the root of the fin. To ensure there is no material connection in the groove between the sector and the remaining fin part, a small strip shall be cut from the remaining fin material to each side of the sector and removed before carrying out the pull-test. For determining the force required to pull out this sector, a spring balance with suitable gripping device may be used. A minimum pulling force of 45N (10 lb) will be acceptable for medium-duty service.
- (c) In the event of any test failing to comply with requirements, a further two tubes shall be re-tested and, if the results are satisfactory, the tubes can be accepted. If, however, the further test results are unsatisfactory, the tubes shall be rejected.

7.2.21.2 Ringing and Bending Tests

Random ringing and bending tests shall be performed on the fins of tubes not subjected to destructive testing, to establish that the quality of the fin fixing is maintained.

7.3 Pressure Test

7.3.1 Hydrotesting of units with welded tube to tube sheet joints shall include the requirements of BP Group [GS 118-8](#).

7.3.7 Leak testing of welded tube to tubesheet joints shall be in accordance with BP Group GS 118-8. If special tests are specified, the methods and procedures shall be proposed by the vendor.

7.5 Nameplates

7.5.3 The following information shall be included:

- (a) BP Works Identification Number.
- (b) Manufacturer's name.
- (c) Manufacturer's serial number.



- (d) Date of order.
- (e) Purchaser's order number.
- (f) Information required by the pressure vessel design code specified by the purchaser.

8. PREPARATION FOR SHIPMENT

- 8.1.1** All units shall be dry, thoroughly cleaned and free from loose scale and other foreign matter before shipment.
- 8.1.4** Fin tubes shall be protected with hardboard sheet or equivalent means.
- 8.2.1** Treatment of all external surfaces shall be in accordance with BP Group [GS 106-2](#).

9. SUPPLEMENTAL REQUIREMENTS

- 9.1** The supplemental requirements shall apply under the conditions stated in API 661 and related to pressure, temperature and thickness.
- 9.2.5** The ultrasonic examination shall apply before and after welding.
- 9.5** Plate material for headers designed using the following features shall have a sulphur content not exceeding 0.008% (ladle analysis) and shall be supplied with through thickness properties and testing in accordance with [ASME VIII](#), Appendix 20:-
 - Stiffeners (or partition plates fully welded in).
 - Corner joints welded to the face of a plate.
 - Large set-on connections.
- 9.6** Fabrication
 - Root runs on single sided welds shall be by the TIG process.

10. GUARANTEE

- 10.1** The vendor shall guarantee the exchanger against improper design and defective workmanship and materials but not against corrosion or erosion.



- 10.2 The vendor shall guarantee the exchanger to perform as specified at design conditions.
- 10.3 The vendor shall guarantee the noise level will not exceed that specified.
- 10.4 The vendor shall guarantee that the materials of construction comply with the material specifications established by the purchase order.
- 10.5 The vendor shall repair or replace free of charge, f.o.b. at his shop, and any defective parts or workmanship found within the guarantee period. Other charges, if any, shall be subject to negotiation with the purchaser.
- 10.6 The guarantee period shall extend for 1 year after the unit is placed in operation in the specified service but not exceeding 18 months from the date of notice that equipment is ready for shipment.
- If the vendor performs the thermal design he shall also provide a thermal guarantee; this guarantee shall include the air flowrate and electrical power consumption at the specified design conditions.
- The vendor may be requested to provide a thermal guarantee only, in which case he shall check the proposed design.

11. EQUIPMENT PERFORMANCE TESTING

If the purchaser requests that a performance test be carried out, e.g. to check the guaranteed performance of the exchanger unit, the test procedures shall be selected by agreement between the vendor and purchaser to permit extrapolation of test results to the specified design conditions.

The exchanger tests shall be based on the AIChE Equipment Testing Procedure for Air-Cooled Heat Exchangers. Any other industry procedure or standard may be proposed for approval.

Testing shall take place as soon as possible after equipment delivery and allowance made for the clean tubes and prevailing air/process conditions.



TABLE 1 - TUBE BUNDLE MATERIALS

HEADER MATERIALS

COMPONENT	SPECIFICATION			
	CARBON STEEL		STAINLESS STEEL (NOTE 5)	
Plate	ASTM A 515 (A285 C)	BS 1501 pt 1	ASTM A 240	BS 1501 pt 3
Seamless Pipe	A 106	3602 HFS	A 312	3605
Forging	A 105	1503	A 182	1503
Tube Access Plugs	A 696	1502	A 479	1502

TUBE MATERIALS

MATERIAL	SPECIFICATION		NOTES
FERROUS:	ASTM	BS	
Carbon Steel Seamless	A 179	3606 - CFS	4
Carbon Steel ERE	A 214	3606 - ERW	1,2
Carbon 1 1/4% Molybdenum	A 209 (IT or T16)	3606 - 245	4
1 1/4% Chromium 1 1/4% Molybdenum	A 199 Gr. T11	3606 - 621	4
5% Chromium 1 1/4% Molybdenum	A 199 Gr. T5	3606 - 625	4
Chromium/Nickel, Austenitic Stainless	A 213 TP. 304	3606 - 304 S25	1,2,5
	A 213 TP. 321/347/304L	3606 - 321 S22	4,5
		347S17/304 S22	
Chromium/Nickel/Molybdenum, Austenitic Stainless	A 312 TP. 316	3606 - 316 S25	1,2,5
	A 213 TP. 316L	3606 - 316 S24	4
			1,2,7
11/13% Chromium, Ferritic Stainless (Seamless Only)	A 268 TP. 410		
NON-FERROUS:			
Admiralty Brass	B111 C44300	2871 pt 3 CZ111	1,4,6
Aluminium Brass	B111 C68700	2871 pt 3 CZ110	1,4,6
Aluminium Bronze	B111 C60800	2871 pt 3 CA102	4,6
Cupro-Nickel 90/10	B111 C70600	2871 pt 3 CN102	4,6
Cupro-Nickel 70/30	B111 C71500	2871 pt 3 CN107	4,6
Monel	B163 N04400	3074 pt 3 NA13	3,4,6
Incoloy 800	B163 UNS N08800	3074 pt 3 NA15	
Incoloy 825	B163 UNS N08825	3074 pt 3 NA16	
Titanium	B 338 Gr. 2/7		7



NOTES:

1. Ferrous: Shall not be used with tube-end welding.
Non-Ferrous: Not suitable for tube-end welding.
2. Shall not be used for U-tubes.
3. Tubes are available in either annealed or stress-relieved tempers. Selection of temper depends upon process conditions as well as mechanical requirements and shall be subject to approval by BP. When stress-relieved tubes are used, tube ends shall be annealed if required for use with expanded tube-to-tubesheet joints.
4. Stress-relief is required for U-bends, details to be proposed by the vendor.
5. All austenitic stainless steels shall be supplied in the solution-annealed condition.
6. To be supplied in the annealed condition for use on expanded tube to tubesheet joints.
7. BS not available.



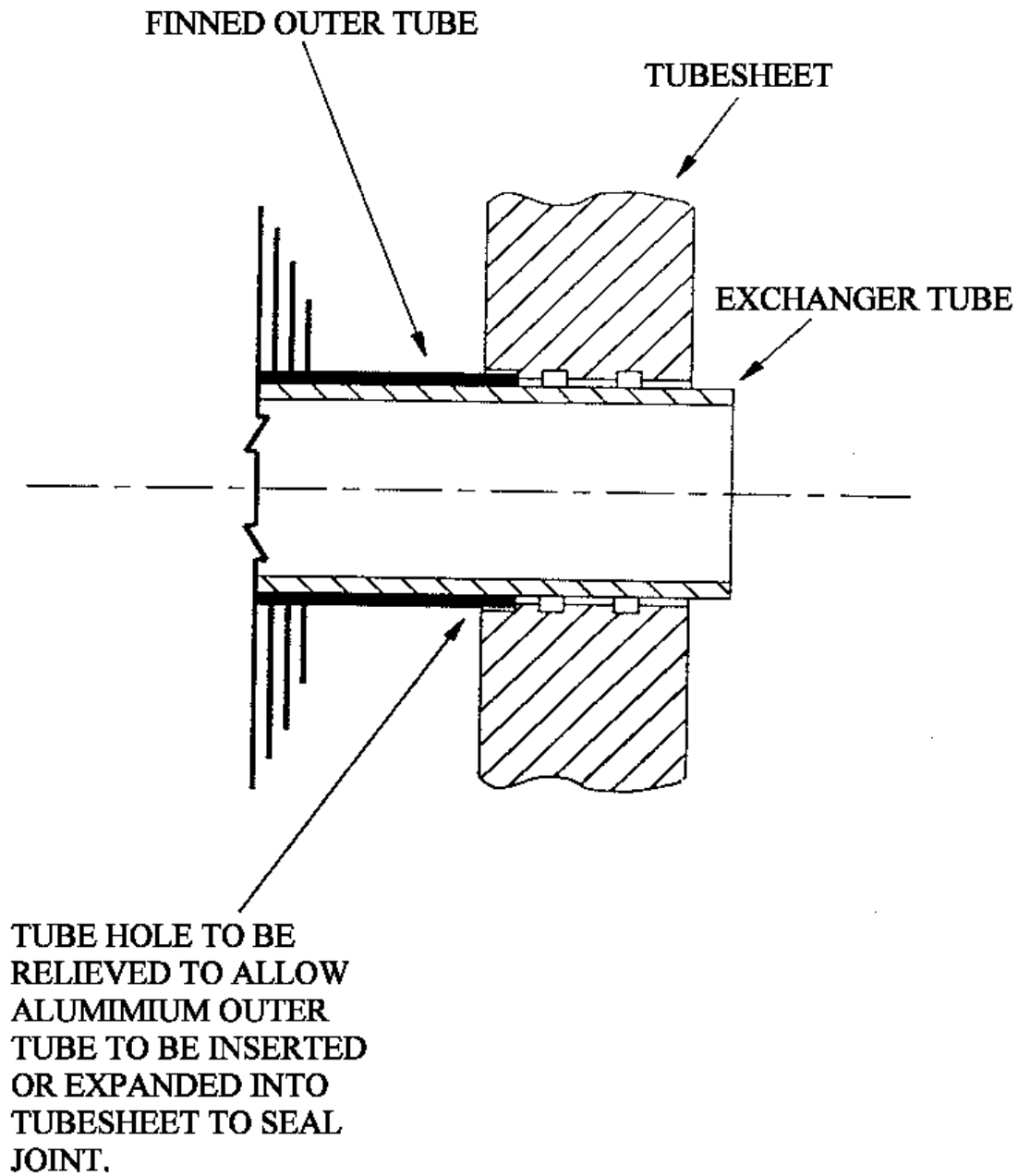


FIGURE 1

TYPICAL ARRANGEMENT OF OUTER TUBE
ATTACHMENT FOR INTEGRAL FINNED TUBES



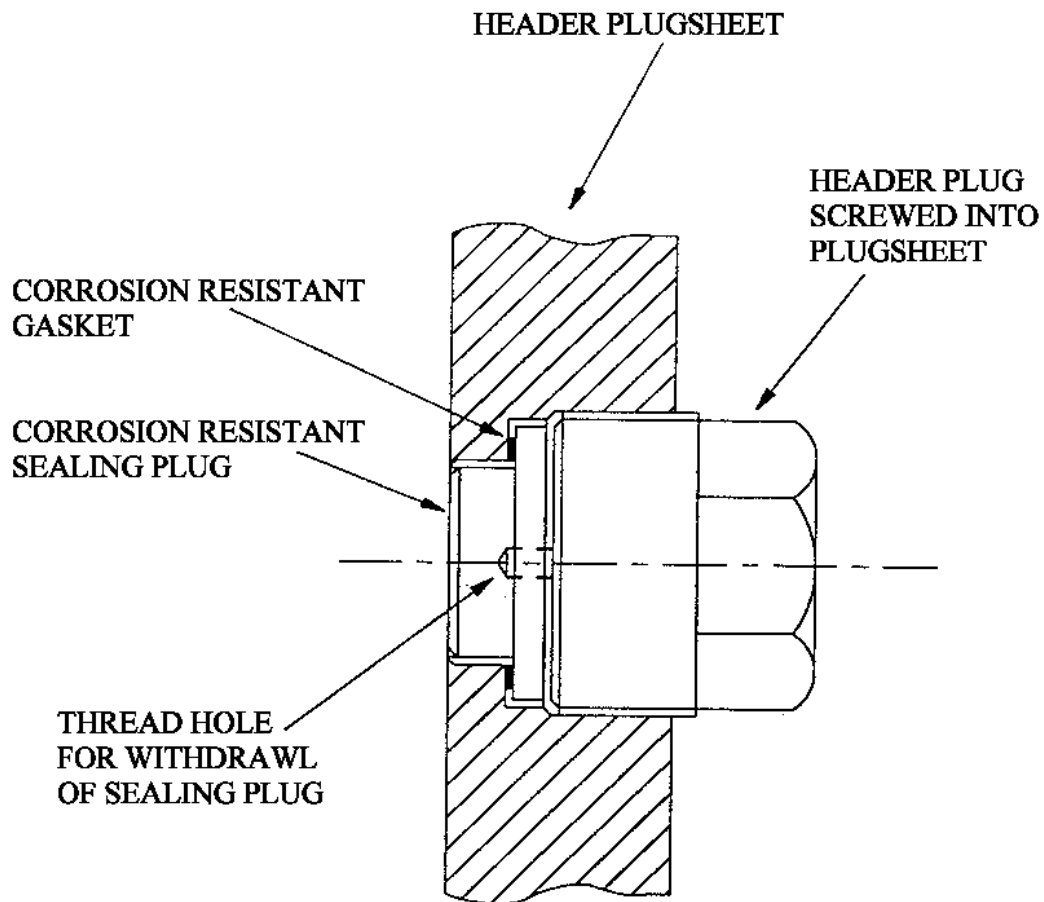


FIGURE 2

TYPICAL ARRANGEMENT OF TUBE ACCESS PLUGS FOR CORROSIVE OR SOUR SERVICE



REQUIREMENTS FOR SPECIFIC SERVICE

A.1 GENERAL

This appendix contains additional requirements to be met when the applicable service condition is specified.

A.2 SOUR SERVICE

A.2.1 NACE Standard [MR 0175-90](#) applies together with BP Group [GS 136-1](#).

A.2.2 For Sour Service in the presence of chlorides, alkalis and amines the following appendices of BP Group [Spec 136-1](#) additionally apply:-

- (a) Aqueous hydrogen charging environment - Appendix C.
- (b) Chlorides - Appendix D.
- (c) Alkalis and Amines - Appendix E. (Includes Caustic Soda, Potassium Carbonate, MEA, DEA, ADIP).

A.2.3 Screwed connections shall not be used.

A.2.4 Tube access plugs shall be generally in accordance with Figure 5.

A.3 CAUSTIC SODA (AND OTHER ALKALINE SOLUTIONS)

BP Group [GS 136-1](#) Appendix E1 only applies; i.e. refers to chart Figure E1 giving stress relief requirements to avoid stress corrosion cracking.

A.4 HYDROGEN SERVICE

A.4.1 Material selection shall be in accordance with [API 941](#).

Carbon 1/2% Mo material shall not be used.

A.4.2 Tubes shall be seamless.
Tube-to-tubesheet joints shall be seal or strength welded.



- A.4.3 Gaskets shall be spiral wound or corrugated jacketed asbestos for below class 900, and ring joint type for class 900 and above.
- A.4.4 Screwed connections shall not be used.
- A.4.5 For multi-bundle units, designs eliminating flanged joints shall be used where corrosion and fouling are not problems and where assembly requirements permit.
- A.4.6 Connections for vents, drains, thermowells and pressure gauges shall be limited to those in adjacent piping. Any other connections required for venting, draining, etc., shall be located in the intermediate piping loops. If the piping arrangement does not permit this, then suitable points on the headers shall be specified.
- A.4.7 Vents and drains shall be limited to one per header,
- A.4.8 Hydraulic bolt tensioners shall be used on joints with nominal bolt diameter 38 mm (1 1/2 in) and over.

A5. ACETYLENE SERVICE

Materials containing more than 60% copper shall not be used.



APPENDIX B 1

AIR COOLED HEAT EXCHANGER PROCESS AND PHYSICAL PROPERTY SHEET METRIC UNITS

Manufacturer		Reference No.		Date	
Site Location		Unit		Item No.	
Project				Sheet of	

1	Total Heat Load	kW				
2	Fluid Name					
3	Fluid Condition					
4			In		Out	
5	Temperature	°C				
6	Total Fluid Flow	Kg/h				
7	Liquid	Kg/h				
8	Vapour	Kg/h				
9	Non-condensables	Kg/h				
10	Steam	Kg/h				
11	Water	Kg/h				
12						
13	Operating Pressure	barg	Max. Allowable Pressure Drop		bar	
14	Fouling Resistance	m ² C/W				
15						
16	Process Data					
17						
18	Reference Temperature	°C				
19	Liquid Density	Kg/litre				
20	Liquid Specific Heat	kJ/Kg°C				
21	Liquid Viscosity	cP				
22	Liquid Conductivity	W/m°C				
23						
24						
25						
26						
27	Reference Temperature	°C				
28	Vapour Density	Kg/M ³				
29	Vapour Specific Heat	KkJ/Kg°C				
30	Vapour Viscosity	cP				
31	Vapour Conductivity	W/m°C				
32	Vapour Molecular Weight					
33						
34						
35						
36	Dew Pt	°C	Bubble Point	°C	Pour Point	°C
37	Hydrate Formation Temp.	°C				
38						
39	Heat Release Curve					
40						
41	Reference Temperature	°C				
42	Specific Enthalpy/Heat Load	KJ/Kg(KJ/Kg°C)				
43	Vapour Quality					
44						
45						

REMARKS					

Rev					
Date					
By					
App					



APPENDIX B 2

AIR COOLED HEAT EXCHANGER PROCESS AND PHYSICAL PROPERTY SHEET IMPERIAL UNITS

Manufacturer		Reference No.		Date	
Site Location		Unit		Item No.	
Project				Sheet of	

1	Total Heat Load	Btu/h			
2	Fluid Name				
3	Fluid Condition				
4			In	Out	
5	Temperature	°F			
6	Total Fluid Flow	lb/h			
7	Liquid	lb/h			
8	Vapour	lb/h			
9	Non-condensables	lb/h			
10	Steam	lb/h			
11	Water	lb/h			
12					
13	Operating Pressure	psig	Max. Allowable Pressure Drop		psi
14	Fouling Resistance	ft ² uh F/Btu			
15					
16	Process Data				
17					
18	Reference Temperature	°F			
19	Liquid Density	lb/ft ³			
20	Liquid Specific Heat	Btu/lb F			
21	Liquid Viscosity	cP			
22	Liquid Conductivity	Btu/hft F			
23					
24					
25					
26					
27	Reference Temperature	°F			
28	Vapour Density	lb/ft ³			
29	Vapour Specific Heat	Btu/lb F			
30	Vapour Viscosity	cP			
31	Vapour Conductivity	Btu/hft F			
32	Vapour Molecular Weight				
33					
34					
35					
36	Dew Pt	°F	Bubble Point	°F	Pour Point
37	Hydrate Formation Temp.			°F	
38					
39	Heat Release Curve				
40					
41	Reference Temperature	°F			
42	Specific Enthalpy/Heat Load	(Btu/lb) (Btu/h)			
43	Vapour Quality				
44					
45					

REMARKS

Rev					
Date					
By					
App					



AIR COOLED HEAT EXCHANGER SPECIFICATION SHEET METRIC UNITS

1 Service of Unit									
2 Arrangement		HORIZONTAL/VERTICAL			Draught		FORCED/INDUCED		
3 No. Units		No. Bays/Unit			No Bundles/Bay				
4 Total Duty		kW			Eff MTD °C				
5 Surface/Unit		m ² Extended			Bare				
6 Transfer Rate		W/m ² °C Extended			Bare - Service		Clean		
Performance Data - Tube Side									
8 Fluid Name									
		IN		OUT				IN OUT	
10 Total Fluid		kg/h				Temperature		°C	
11 Liquid		kg/h				Density (vap/liq)		kg/m ³	
12 Vapour		kg/h				Specific Heat (vap/liq)		kJ/kg °C	
13 Non-condensables		kg/h				Conductivity (vap/liq)		W/m °C	
14 Steam		kg/h				Viscosity (vap/liq)		cP	
15 Water		kg/h				Molecular Weight			
16 Inlet Pressure		barg				Latent Heat		kJ/kg	
17 Pressure Drop Allow/Calc		bar		/		(Pour) (Freeze) Point		°C	
18 Fluid Velocity		m/s		/		Bubble Point		°C	
19 Heat Transfer Coeff		W/m ² °C				Fouling Resistance (ref to id)		m ² °C/W	
Performance Data - Air Side									
21 Total Air Rowrate		kg/h				Face Velocity		m/s	
22 Inlet Temperature		°C				Altitude		m	
23 Outlet Temperature		°C				Static Pressure		mm H ₂ O	
24 Minimum Design Ambient		°C				Dirt Film Thickness		mm	
Design - Materials - Construction									
26 Design Pressure		barg		Test Pressure		Design Temperature		°C	
27 TUBE BUNDLE		HEADERS		TUBES					
28 Flow Arrangement		CO/COUNTER CURRENT		Material		Material			
29 No. in Parallel		No. in Series		Type		SEAMLESS/WELDED			
30 Inclination (mm/m)				Depth of Inlet Header (m)		Fixing WELDED/EXPANDED			
31 Size (LxD m)				Corrosion Allowance (mm)		OD (mm)		Thickness (mm)	
32 Rows		No. Passes		No. and Size of Outlet Nozzles (mm)		Length (mm)		No./Bundle	
33 Rows/Passes				No. and Size of Inlet Nozzles (mm)		Pitch (mm)		Layout	
34				Other Nozzles		FIN			
35				Rating and Facing		Material		Type	
36 Miscellaneous				Gasket Material		Design Temp (°C)		No./m	
37 Structure Mounting		Piperack/Grade		Plug Material		Thickness (mm)		OD (mm)	
38 Access Requirements						Code & Specs			
39 Walkway		YES/NO Ladder YES/NO				ASME VIII API 661			
40									
41 FAN		DRIVER		SPEED REDUCER					
42 Mfr & Model		RPM		Mfr & Model		Mfr & Model			
43 Diameter (m)		Blade Angle		Type		Type			
44 No. Blades				Enclosure		Service Rating (kW)			
45 Fans/Bay		kW/Fan		RPM		Ratio			
46 Pitch Adjustment		MAN/AUTO		kW/Driver		Support (Structure) (Pedestal)			
47 Blade Material				Vibration Switch		YES/NO			
48 Hub Material				Volt/Phase/Cycle					
Miscellaneous									
49 Louvres Fitted		YES/NO MAN/AUTO		Steam Coils Fitted		YES/NO			
51 Control Action on Instrument Air Failure:		Fan Blade		MAX/MIN		Louvres		OPEN/CLOSE	
52 Depth of Plenum Chamber		m		Length		Width			
53 Dimensions of Structure		m							
54 Weight of Unit		kg Complete				Weight/Bundle			
55									
Notes						PLOT PLAN			
(1) Provide details of tube/pass arrangement if not symmetrical									
(2)									
(3)									
(4)									
(5)									
Contractor/Purchaser									
Contractor's Proposal/Contract No.									
Plant/Unit/Facility		Sect No.							
Purchaser's Enquiry/Req No.						Rev			
Vendor/Manufacturer		Quote/Order No.				Date			
Order No.		Date				By			
Service		Item No.				App			
Client									
Project						Air Cooled Exchangers			
Location						Sheet Of			



AIR COOLED HEAT EXCHANGER SPECIFICATION SHEET IMPERIAL UNITS

1 Service of Unit									
2 Arrangement		HORIZONTAL/VERTICAL			Draught		FORCED/INDUCED		
3 No. Units		No. Bays/Unit			No Bundles/Bay				
4 Total Duty		kW			Eff MTD °C				
5 Surface/Unit		m ²			Bare				
6 Transfer Rate		W/m ² °C			Extended		Bare - Service		
							Clean		
Performance Data - Tube Side									
8 Fluid Name									
		IN		OUT				OUT	
10 Total Fluid		kg/h				Temperature		°C	
11 Liquid		kg/h				Density (vap/liq)		kg/m ³	
12 Vapour		kg/h				Specific Heat (vap/liq)		kJ/kg °C	
13 Non-condensables		kg/h				Conductivity (vap/liq)		W/m °C	
14 Steam		kg/h				Viscosity (vap/liq)		cP	
15 Water		kg/h				Molecular Weight			
16 Inlet Pressure		barg				Latent Heat		kJ/kg	
17 Pressure Drop Allow/Calc		bar		/		(Pour) (Freeze) Point		°C	
18 Fluid Velocity		m/s		/		Bubble Point		°C	
19 Heat Transfer Coeff		W/m ² °C				Fouling Resistance (ref to id)		m ² °C/W	
Performance Data - Air Side									
21 Total Air Rowrate		kg/h				Face Velocity		m/s	
22 Inlet Temperature		°C				Altitude		m	
23 Outlet Temperature		°C				Static Pressure		mm H ₂ O	
24 Minimum Design Ambient		°C				Dirt Film Thickness		mm	
Design - Materials - Construction									
26 Design Pressure		barg		Test Pressure		Design Temperature		°C	
27 TUBE BUNDLE		HEADERS		TUBES					
28 Flow Arrangement		CO/COUNTER CURRENT		Material		Material			
29 No. in Parallel		No. in Series		Type		Type SEAMLESS/WELDED			
30 Inclination (mm/m)				Depth of Inlet Header (m)		Fixing WELDED/EXPANDED			
31 Size (LxD m)				Corrosion Allowance (mm)		OD (mm)		Thickness (mm)	
32 Rows		No. Passes		No. and Size of Outlet Nozzles (mm)		/		Length (mm) No./Bundle	
33 Rows/Passes				No. and Size of Inlet Nozzles (mm)		/		Pitch (mm) Layout	
34				Other Nozzles		FIN			
35				Rating and Facing		Material		Type	
36 Miscellaneous				Gasket Material		Design Temp (°C)		No./m	
37 Structure Mounting		Piperack/Grade		Plug Material		Thickness (mm)		OD (mm)	
38 Access Requirements						Code & Specs			
39 Walkway		YES/NO Ladder YES/NO				ASME VIII API 661			
40									
41 FAN		DRIVER		SPEED REDUCER					
42 Mfr & Model		Mfr & Model		Mfr & Model					
43 Diameter (m)		RPM		Type					
44 No. Blades		Blade Angle		Enclosure		Service Rating (kW)			
45 Fans/Bay		kW/Fan		RPM		Ratio			
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Order No.			Date			By			
Service			Item No.			App			
Client									
Project									
Location									



DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

equipment item number: where there is more than one tube bundle in a unit, each bundle shall be identified by a suffix. The particular system of identifying bundles in parallel, or service for a particular project, will be specified by the purchaser.

Abbreviations

AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Mechanical Engineers
BS	British Standard
CONCAWE	Conservation of Clean Air and Water - Europe
ERW	Electric Resistance Welded
HTFS	Heat Transfer and Fluid Flow
HTRI	Heat Transfer Research Inc.
IEC	International Electrotechnical Commission
NACE	National Association of Corrosion Engineers
NCB	National Coal Board
NPS	Nominal Pipe Size
OD	Outside Diameter
PTFE	Polytetrafluoroethylene
RMA	Rubber Manufacturers Association
TIG	Tungsten insert gas
UPV	Unfired Pressure Vessels



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

ASME VIII	Boiler and Pressure Vessel Code. Section VIII. Rules for Construction of Pressure Vessels. Division 1.
AMCA 210-74/ ASHRAE 51-75	Laboratory Methods of Testing Fans for Rating.
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings.
API 661	Air-Cooled Heat Exchangers for General Refinery Services,
3rd	Edition, April 1978
API 941	Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants.
BS 848	Fans for General Purposes. Part 1. Methods of Testing Performance.
BS 2782	Methods of Testing Plastics. Part 2. Electrical Properties.
BS 5304	Code of Practice. for Safety of Machinery.
BS EN 10204: 1991	Metallic Products - Types of Inspection Documents.
CONCAWE Report No. 5/78	Method for Determining the Sound-Power Levels of Air Cooled (Air-Fin) Heat Exchangers.
EEMUA 105 Platforms	Factory Stairways, Ladders and Handrails (including Access and Ramps)
IEC 529	Classification of degrees of protection provided by enclosures
NCB 244/1961	Fire-Resistant and Anti-Static Endless V-Belts.



RMA

Bulletin 3 Static Conductive Belts.

BP Group Documents

BP Group GS 106-2	Painting of Metal Surfaces (replaces BP Std 141)
BP Group GS 118-8	Tube End Welding of Heat Exchanger Tubes (replaces BP Std 191)
BP Group GS 136-1	Materials for Sour Service to NACE Standard MR 0175-90 (replaces BP Std 153)
BP Group GS 142-7	Gaskets and Jointing (replaces BP Std 173)
BP Group GS 152-1	Materials for Thermal and Acoustic Insulation (replaces BP Std 172)
BP Group GS 112-3	Low-Voltage Induction Motors (replaces Std 221)



ALTERNATIVE STANDARDS

This Specification refers to national and international standards which are widely accepted. Codes and standards of the country where the equipment is manufactured or operated will be accepted where they can be used to achieve equivalent technical results. (In the case of ASME VIII Div. 1, any substitution must include a supplementary specification which covers header box design, and is therefore not recommended.)

British Standard alternatives are listed below, together with reference to the clause for which they apply.

- BS 729** Hot Dip Galvanised Coatings on Iron and Steel Articles. (**API 6.1.12/6.1.13**)
- BS 2989** Hot-Dip Zinc Coated Steel Sheet and Coil. (**API 6.1.12**).
- BS 5950** Structural use of Steelwork in Buildings. (**API 5.3.1.1**).

