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730.0 AIR COOLED EXCHANGERS

731.0 CODES AND STANDARDS

731.1 Specific Codes

Exchangers shall be designed, fabricated, and tested in accordance with the following codes and standards:

732.1.1 General Design - API 661 Air Cooled Heat Exchangers.

731.1.2 Steel Coils - ASME Power Boiler Code Section 1.

731.1.3 Welding - ASME Boiler and Pressure Vessel Code Section IX

731.1.4 Pressure Parts - ASME Boiler and Pressure Vessel Code Section VIII

731.1.5 Structural Steel - American Institute of Steel Construction, and Standards of American Welding Society

731.1.6 Flanges - ANSI B16.5. Ring joints, gaskets, grooves - ANSI B16.20.

731.1.7 Tapered Pipe Threads - ANSI B2.1.

731.1.8 Bolts and Nuts - ANSI B1.1.

731.1.9 Materials - ASTM Part 1.

731.1.10 Gears - American Gear Manufacturers Association

731.1.11 V-Belts - API 661

731.1.12 Tube Dimensions - API Standard 640.

731.1.13 Fouling - TEMA Standards.

731.1.14 All additions and modifications to the above standards set forth in this specification.

731.2 Special Conditions

731.2.1 Specific permission must be obtained from the purchaser to delete the Code Stamp.

731.2.2 Reference to any Standard or Code shall mean the latest edition of that Standard or Code including addenda, supplements, interpretations, or revisions thereto.



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732.0	EQUIPMENT AND MATERIAL SPECIFICATIONS	
732.1	<u>Specific Materials</u> (suggested)	
732.1.1	<u>Tubes</u>	
	a. <u>Carbon Steel</u>	
	1. Seamless (Natural gas or Hydrocarbon vapor coolers)	ASTM A-179
	2. Welded (water coolers)	ASTM A-214
	b. <u>Admiralty</u> (water coolers)	ASTM B-111
	c. <u>Aluminum</u>	ASTM B-234
732.1.2	<u>Fins</u>	
	Aluminum	ASTM B-209
732.1.3	<u>Headers</u>	
	a. <u>Steel</u>	ASTM A-515 ASTM A-516 ASTM A-285
	b. <u>Aluminum</u>	ASTM B-221
732.1.4	<u>Structural Steel</u>	ASTM A-36
732.1.5	<u>Sheet Steel</u>	ASTM A-283
732.1.6	<u>Nuts</u>	ASTM A-194
732.1.7	<u>Bolts</u>	ASTM A-193
732.1.8	<u>Nozzles</u>	
	a. <u>Forged</u>	ASTM A-181, Gr. 2 ASTM A-105
	b. <u>Pipe</u>	ASTM A-53, A-106
732.1.9	No copper or copper alloys must be used in H ₂ S services.	



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732.2 Preparation for Shipment

732.2.1 Manufacturer shall properly prepare the air cooler for the shipment to the jobsite.

733.2.2 After the final hydrostatic test, each unit shall be dried and cleaned thoroughly of all grease, loose scale, rust, flux, weld spatter, rubble.

732.2.3 Structural steel, sheet steel, and tube support surfaces shall be painted in accordance with purchaser's paint specifications.

732.2.4 Machined surfaces and flange faces shall be coated with heavy rust preventative grease.

732.2.5 All threads of bolts, including exposed parts, shall be coated with a metallic base waterproof lubricant to prevent galling in use and corrosion during shipment and storage.

732.2.6 Connections

- a. All flanged openings shall be protected with full face wood or metal blanks held in place by four full diameter bolts.
- b. Screwed connections are to be protected with threaded forged steel plugs.
- c. The fabricator shall provide any necessary approved wood skids or crates for shipment and protection against damage. Export shipments shall be covered by special instructions.

732.2.7 In general, where shipping requirements permit, as much fabrication shall be done in the manufacturer's shop as is possible.

732.3 Identification

Each unit shall be proved with a stainless steel name plate securely attached to the unit. This name plate shall contain the following data:

- Manufacturer's Name
- Year of Manufacturer
- Manufacturer's Serial Number
- Purchase Order Number
- Maximum Test Pressure
- Date Tested
- Maximum Design Pressure at _____ °F.
- Maximum Design Temperature at _____ psig.
- Square Feet of Cooling Surface Bare Tube
- Square Feet of Extended Surface
- Customer's Tag Number



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- 732.4 Drawings and Other Data Required
- 732.4.1 Vendor will be required to supply eight sets of the following, unless otherwise specified:
- a. Certified outline drawings with all dimensions.
 - b. Complete assembly drawings showing all manufacturers parts, numbers and assembly order.
 - c. Complete parts list (bills of materials) with relevant drawings for identification of parts.
 - d. Recommended Spare Parts Lists, showing part number, description, recommended quantity, unit price; FOB vendor's plant, also name and address of vendor's area representative. Vendor must include a quotation for spare parts for commissioning and two years operation.
 - e. Foundation outline drawings.
 - f. Complete and comprehensive operating manual. Also a comprehensive maintenance manual must be included.
- 732.4.2 Guarantees and Performance
- a. The complete assembly shall be guaranteed for pressure, capacity and power consumption at the specified design operating conditions and satisfactory application in all respects to the operating conditions specified on the specification sheet.
 - b. A performance test under these specified operating conditions may be conducted by Purchaser after startup. If a unit fails to perform as specified, Vendor shall repair, alter or replace the unit to meet the guarantees. Repairs, alterations or replacements shall be at Vendor's expense.
 - c. Compliance with the provisions of these specifications does not relieve the contractors and/or suppliers of the responsibilities of furnishing material, equipment and accessories of proper design, mechanically suited to meet operating guarantees at the specified service conditions.



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- 733.0 DESIGN CRITERIA
- 733.1 General Requirements
- 733.1.1 Specific performance, design requirements and type of exchanger shall be indicated by the Purchaser on the Heat Exchanger Schedule and/or the Exchanger Specification Sheet.
- 733.1.2 If an item of this section is in conflict with the Exchanger Specification Sheet, the individual data sheet shall govern.
- 733.2 Air Cooler Rating
- 733.2.1 All heat transfer surfaces and coefficients shall be based on total effective outside tube and fin surface.
- 733.2.2 Corrosion allowances specified shall apply to the headers but not the tubes.
- 733.2.3 Process side fouling factors shall be provided by the purchaser on the Exchanger Specification Sheet. Otherwise the factor specified in TEMA Standards for the specific fluid shall be used.
- 733.2.4 Design ambient air temperature shall be chosen from site weather data such that actual ambient dry bulb temperature shall not exceed design more than one percent of the time in the five warmest summer months.
- 733.2.5 Banks of air fin coolers shall be placed on a plot plan to minimize air recirculation. Placement near buildings or other structures enhances recirculation. Banks of coolers should be placed in rows that are perpendicular to the prevailing wind.
- 733.2.6 Fouling resistance shall be applied to the inside surface of the tubes.
- 733.2.7 When calculating heat transfer coefficients, the inside fouling and outside fluid film resistance shall be multiplied by the ratio of the total effective outside surface to the total inside surface.



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- 733.2.8 The effective tube wall and fin metal resistance shall be included in calculating heat transfer coefficients.
- 733.2.9 Pressure drops shall not exceed the maximum allowed values specified, this indicates the total pressure drops across the nozzles, headers and the tubes.
- 733.3 Design Pressure and Temperature
 - 733.3.1 The design pressure shall be at least 10% above the maximum operating pressure with a minimum differential of 25 psi (1.75 kg/cm²).
 - 733.3.2 The design temperature shall be at least 50°F (28°C) above the maximum operating temperature.
- 733.4 Specific Design
 - 733.4.1 Headers
 - a. Headers shall be of the removable coverplate type or of the box type which uses a shoulder plug opposite each tube end to permit access to each tube hole for cleaning and rolling. Coverplate design shall be used for severely fouling service.
 - b. Headers may be cast iron for water services below 150 psig (10 kg/cm²). Cast steel or fabricated steel headers shall be used for hydrocarbon services and for pressure 150 psig (10 kg/cm²) and greater. Where fabricated steel headers are used, a 1/8" (3 mm) corrosion allowance shall be applied.
 - c. Headers shall be provided with 3/4" (20 mm) pipe connections complete with plugs for venting and for draining. Baffled sections of headers shall be vented separately. Drains between sections may be internal.
 - d. For extremely high pressures manifold type headers are acceptable.
 - e. Design of headers shall be in accordance with the provision of the ASME Code, Section VIII, Unfired Pressure Vessels. One header shall be free to float with thermal expansion of the tubes.
 - f. All fabricated steel headers shall be stress-relieved after fabrication.
 - g. Split headers shall be used in order to prevent bowing and overstressing tubes when cooling range is great enough to require this.



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733.4.2 Tubes

- a. Preferably each finned tube section shall be designed with an even number of tube passes so that inlet and outlet connections are at the same end of the section.
- b. Type of fin used shall be determined by the design temperature in accordance with the following:
 1. Up to Design Temperature of 400°F (204°C)

Tension wrapped aluminum footed fins. All tube surface between adjacent fins shall be completely covered by fin feet. Fin ends shall be firmly secured to the tube. Wire stapling of fins is not satisfactory.
 2. Up to Design Temperature of 600°F (400°C)

Tubing with aluminum fins wrapped under tension and embedded in a groove spirally cut into the outside surface of the tube. Depth of groove shall be approximately 0.008" (.2 mm). Tube thicknesses shall be measured from the bottom of the groove to the inside of the tube wall.
- c. The individual finned tube sections shall be self-supporting. Channels will support headers. These steel channels will also support steel bar, angle or channel tube supports, the tube supports being a maximum of 6 feet (1.75 m) apart for 1" (25 mm) tubes and shall be in accordance with Table R-4.52, of TEMA "R" Standards. Individual supports shall be provided to prevent meshing and deformation of finds.
- d. Tubes may be rolled or expanded into headers.
- e. Adequate lifting lugs shall be provided for handling tube sections.

733.4.3 Fans

- a. Fans shall be cast or wrought aluminum or plastic with solid hubs. All units shall have two fans per bay except where indicated on the data sheet.
- b. Fans shall have individually adjustable blades except where auto-variable pitch fans are specified on the data sheet. Where auto-variable pitch fans are specified, hub mechanism shall be of the low hysteresis type (less than 0.5%).
- c. Maximum fan tip speed permitted is 12,000 feet per minute (65 m/sec).
- d. Each fan shall have its own driver.



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- e. Connections shall be provided in fan shaft bearings to permit lubrication without shutdown of the equipment. Bearings shall be of a non-sealed type.
- f. Either fan, belt, and gear guards or a perimeter chain link fence with gate shall be provided.

733.4.4 Motors

See Section 500 for motor specifications.

733.4.5 Bearings, Belts, Gears

- a. V-belt drive shall be designed in accordance with API 661, latest edition. Specification for multiple V-belt drives with horsepower rating minimum of 200% of actual required horsepower. V-belt drives shall not be used in induced draft units where the belts are subjected to air temperature in excess of 170°F (75°C).
- b. A flexible coupling shall be provided between fan and gear assembly and drive.
- c. Gear or V-belt drive with motor shall be as close coupled as possible to the fan. V-belt drive assemblies, suspended from the structure may be used with motors rated up to and including 30 HP (22 KW). Right angle gear drives will be pedestal mounted with motors rated above 30 HP (22 KW).
- d. Each drive assembly shall be provided with a vibration shutdown switch.
- e. Gear drives shall be designed with a service factor of 2.0 as defined in AGMA Standard 430.03.
- f. If reduction gear drives are used, the type specified shall be "helical bevel" designed in accordance with American Gear Manufacturer's code for continuous duty.

733.4.6 Plenum Chambers

- a. Air coolers which have more than one fan shall have plenum chambers partitioned for each fan so as to prevent bypassing of air when only one fan is operating.
- b. Sheet metal used in plenum chambers shall be steel. Flat panels shall be minimum 10 gauge sheet. Where ribbed panels are used, sheet may be 16 gauge.



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733.4.7 Structural Steel

- a. Structural steel shall be in accordance with AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, latest edition.
- b. In areas subject to blowing sand, the structural supports shall elevate the fans and cooler to minimize exposure to abrasive sand.
- c. The structure shall be capable of supporting platforms in locations where normally installed. It shall also be capable of supporting the inlet and outlet manifolds and reasonable lengths of connecting piping under the operating and test conditions.
- d. Refer to Section 200 for structural load design basis.
- e. Vendor shall shop fabricate the structural steel to the point that no welding will be required in the field. Each piece shall be clearly marked for identification in the field.

733.4.8 Nozzles and Couplings

- a. Threaded connections shall be consistent with piping standards in Section 400.
- b. Cast iron nozzles shall be flat face to 125 lb. flange dimensions.
- c. Steel nozzles shall be raised face to ANSI B16.5 flange dimensions unless otherwise specified.
- d. Minimum nozzle size is 2" (50 mm).
- e. Nozzles 2" (50 mm) and larger shall be flanged.

733.4.9 Miscellaneous

- a. Hail guards shall be provided for all forced draft coolers.
- b. Turbulators for any service may be offered only in an alternate quote.
- c. Process temperature control shall be by automatic control of louvers unless otherwise specified.
- d. Vendor shall be supplied the lowest recorded temperature at the site where the air exchanger is to be operating. Vendor shall advise of what winterization procedures must be taken to prevent the exchanger fluids from freezing during operation and shutdown.



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733.4.10 Welding

Welding procedures, welding operators and welders for header welding shall be qualified in accordance with the ASME Code Section IX. Welds shall be fully penetrated and merge smoothly with the base metal. Weld metal shall, in principal alloys, meet the specification of the base metal. Welds shall be preheated and heat traced as required by the Code. Manual submerged arc welding shall not be used for welding pressure parts unless the welds are 100 percent radiographed.



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734.0 INSTALLATION AND CONSTRUCTION

734.1 General

734.1.1 If air fin coolers are placed above pipe racks containing flammable fluids, the cooler legs should be insulated with a material having a two hour exposure rating to fire.

734.1.2 Air fin coolers should not be placed over pumps in a flammable hydrocarbon service.

734.2 Installation

734.2.1 Air coolers shall be mounted on their foundations to the tolerances specified in API-661.

734.2.2 Fan motors should be decoupled from the fans and "bumped" to check for proper direction of rotation.

734.2.3 It is most important to inspect the fan blade alignment with respect to the fan orifice ring. Clearances should be according to API 661.

734.2.4 Operability of the louver control, or fan pitch control if specified, should be checked.

734.2.5 Tension of V-belts should be inspected. Mechanical couplings must be inspected.

734.2.6 During initial operation the vibration levels should be monitored closely.



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735.0 INSPECTION AND TESTING

735.1 Inspection

735.1.1 The company shall have the right to inspect exchangers at any time during fabrication to assure that the materials and workmanship are in accordance with this specification and with the applicable code.

735.1.2 The approval of any work by the company and their release of a vessel for shipment shall in no way relieve the manufacturer of any responsibility for carrying out the provisions of this specification.

735.2 Testing

735.2.1 Each completed unit shall be subjected to hydrostatic test in the vendor's shop to a test pressure 1-1/2 times design pressure.

735.2.2 All hydrostatic tests shall be made in the presence of an inspector, authorized by the purchaser and with his approval. Units shall not be previously tested by the manufacturer.

735.2.3 The vendor's fan alignment procedure must be checked by the inspector. The clearances between fan blades and fan ring must be according to API 661.