

MATERIAL AND EQUIPMENT STANDARD
FOR
STEAM JET EJECTORS

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0. INTRODUCTION

The purpose of this standard is to define general rules for the structural design of ejector stage assemblies and to set a purchasing procedure which gives minimum requirements to be met by a vendor when submitting quotations for and when supplying the ejector(s).

In those instances where complete details and procedures are not specified, it is intended that the manufacturers will utilize design and construction procedures, which have been demonstrated as being adequate for the service intended and conforms to accepted engineering practice.

1. SCOPE

1.1 This Standard gives minimum requirements for mechanical design, material supply, shop fabrication, spare parts, inspection and testing of STEAM JET EJECTORS.

1.2 It is intended for use in oil refineries, chemical plants, gas plants and where applicable, in exploration and production, and new ventures.

2. SOURCES AND REFERENCES

2.1 Sources

In preparation of this Standard, in addition to the Referenced Codes and Standards mentioned in 2.2, the following standards and publications have also been considered:

LUDWICK

"Applied Process Design for Chemical and Petrochemical Plants"
1991 Edition Published by Gulf Publishing Company

IPS (IRANIAN PETROLEUM STANDARDS)

E-PR-745 "Process Design of Vacuum Equipment" 1992

NIOC (NATIONAL IRANIAN OIL COMPANY)

Esfahan Refinery Specification

SP-457304-47-1 "Vacuum Producing Equipment" 1976

Arak Refinery Specification

SP-2219-47-312 "Job Specification for Ejectors" 1991

2.2 References

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor.

HEI (HEAT EXCHANGE INSTITUTE)

"Standards for Steam Jet Ejectors"
"Standards for Steam Surface Condensers"
"Standards for Direct Contact Barometric Low Level Condensers"
"Construction Standards for Surface Condensers"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

- B16.5 "Flange & Flange Fitting"
- B31.3 "Chemical Plant and Petroleum Refinery Piping"
- B31.1 "Power Piping"
- B2.1 "Pipe Threads (except Dryseal)".

ANSI / ASME PTC 24 "Performance Test Code for Ejectors".

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)**ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)**

- Section VIII div. 1 "Pressure Vessels"
- Section IX "Welding and Brazing Qualifications"

3. UNITS

International System of Units (SI) in accordance with IPS-E-GN-100 shall be used.

4. DESIGN**4.1 General**

4.1.1 Safety, ease of operation, inspection, maintenance, repair and cleaning are of major concern, Nozzles, nozzle inspection ports and pressure taps shall be readily accessible.

4.1.2 Where there is danger from freezing during operation which can affect parts that cannot be drained, protection against such freezing shall be provided.

4.1.3 Adequate personnel protection or insulation shall be provided for all surfaces hotter than 60°C.

4.1.4 The design criteria for ejector components are functions of several variables.

The minimum thicknesses required are not only stress dependent, but they also depend upon the minimum thickness required for fabrication, welding and/or casting.

For applications where explosive mixtures are present, the components may be designed for higher pressure. For these applications the design stress and pressure shall be mutually agreed upon.

4.2 Design Basis

4.2.1 Process design of steam ejectors shall be in accordance with Iranian Petroleum Standard IPS-E-PR-745 "Process Design of Vacuum Equipment (Vacuum Pumps and Steam Ejectors)".

4.2.2 Mechanical Design of steam ejectors shall be in accordance with "Standards for Steam Jet Ejectors" published by the Heat Exchange Institute.

4.2.3 All motive steam piping shall be designed in accordance with ANSI pressure piping code B31.1.

4.3 Capacity

4.3.1 When any stage of an ejector system line-up consists of two parallel elements (ejectors), the following shall apply:

- a) The two elements of the stage shall be designed to handle 1/3 rd and 2/3rd respectively of the total design load of that stage. This will give better matching of ejector capacity to load, resulting in energy savings.
- b) Provision shall be made to individually isolate each ejector on the vapor side in order to prevent recycling of Gas through an idle parallel set.

4.4 Noise Limitations

4.4.1 Unless otherwise specified, the maximum allowable sound pressure level shall be 90 dB(A) in the work area (i.e. any position accessible to personnel at a distance of 1 m from equipment surfaces).

4.4.2 If the equipment produces impulsive and/or narrow band noise, the above limit shall be taken 5 dB(A) more stringent, i.e. 85 dB(A).

4.4.3 The above requirements apply in absence of reverberation and background noise from other sources and for all operating conditions between minimum and design load.

4.4.4 The requirements do refer to the overall noise level, produced jointly by all components of the installation. Noise limits for individual components, to be derived from the overall limit, shall therefore generally be lower than 90 dB(A).

Notes:

- 1) A reduction of 3 dB(A) shall be made for each item of a 2-component train and a reduction of 5 dB(A) for each item of a 3-component train.
- 2) A further reduction of the equipment noise limit by 3 dB(A) shall be made when several items or trains are to be mounted close together, i.e. when the distance between equipment surfaces is less than the largest equipment dimension, or when equipment is located in a reverberant area.

4.5 Specification Sheet

4.5.1 For each ejector system a specification sheet shall be prepared in order to give the main characteristics and the process requirements of the ejectors.

4.5.2 As a guide, a sample specification sheet for steam ejectors is given in Appendix A.

5. EXTENT OF SUPPLY

5.1 The equipment shall be supplied complete with all the accessories necessary for their correct performance including, but not limited to, the following:

- Body
- Internals
- Interconnecting flanges
- Spare parts for commissioning and two years of operation.

5.2 Vendor shall also provide technical documentations, inspection and testing reports and packing list.

5.3 Additional requirements will be specified in the equipment purchase order.

6. MATERIAL

6.1 Material of construction for steam jet ejectors shall be selected as specified in the "Standards for Steam Jet Ejectors" published by the Heat Exchange Institute (HEI), part Two "Material and Details of Construction".

6.2 Appendix B of this Standard lists typical materials of construction and allowable stress values. The table is given as a guide and does not cover all possible materials of construction. Other materials which are equally suitable may be used.

6.3 Materials equivalent to ASTM standard may be used with the prior approval of the Company.

6.4 The full material specifications of the ejectors and their relative accessories shall be stated on the data/requisition sheets.

6.5 The supplier shall certify or obtain independent certification that all materials of construction used, meet the requirements specified on the data/requisition sheets.

7. FABRICATION

7.1 General

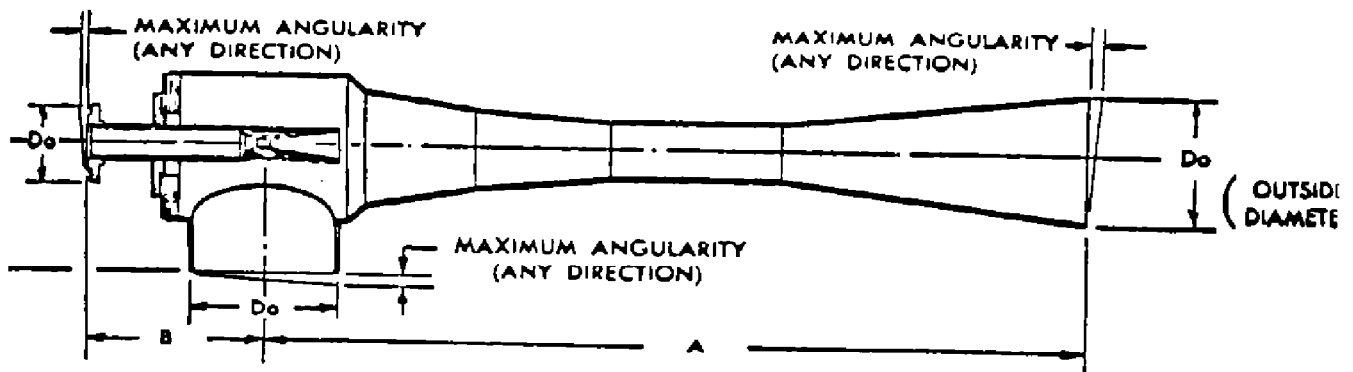
7.1.1 Fabrication of ejectors parts shall be in accordance with the Standards for Steam Jet Ejectors published by the Heat Exchange Institute (HEI) and their relative shop fabrication drawings.

7.1.2 Threaded connections shall be in accordance with ANSI B2.1 "Pipe Threads".

7.1.3 Fabrication tolerances for ejectors are given in Fig. 1.

7.1.4 Flanged connections shall be in accordance with ANSI B16.5 "Flange and Flanged Fitting".

LENGTH TOLERANCES	MAXIMUM ANGULARITY
6m < A , B , C ; ± 10 mm	600 mm < Do ; 8 mm
3m < A , B , C < 6m ; ± 6 mm	250 mm < Do < 600 mm ; 6 mm
1.5m < A , B , C < 3m ; ± 4.5 mm	125 mm < Do < 250 mm ; 3 mm
A , B , C < 1.5m ; ± 3 mm	Do < 125 mm ; 1.5 mm



The same tolerance apply to flanged connections as are shown for butt welded connections.

END CONNECTION TOLERANCES FOR EJECTORS

Fig. 1

7.2 Welding

7.2.1 Joints shall be made by welding whenever possible, unless otherwise specified; all tube ends and pipework shall be suitably prepared for welding.

7.2.2 All welding shall conform to the requirements of the ASME Boiler and Pressure Vessel code/section VIII, division 1, and section IX.

7.2.3 Welding procedure qualification and welder's performance qualification shall conform to the requirements of section IX of the ASME code.

7.2.4 Welding procedure specification and procedure qualification records shall be submitted for purchaser's review and approval, prior to start of fabrication.

7.2.5 Welder's performance qualification record shall be made available for company's review, upon request.

7.2.6 All weld bevels and welding surfaces shall be free of cracks, excessive porosity, slag inclusions and other defects indicative of poor workmanship.

8. INSPECTION AND TESTING

8.1 Inspection and testing of ejectors and ejector parts shall be carried out as specified in the "Standards for Steam Jet Ejectors" published by the Heat Exchange Institute (HEI).

8.2 Steam Chests shall be tested at the same pressure used for testing steam piping.

8.3 Diffusers and Suction Chambers should be hydrostatically tested at 1.5 times the internal design pressure, but not less than 310 kPa (45 psig).

8.4 It is recommended that the temperature of the water used to hydrotest the ejector components not be below 60°F, unless the materials of construction have sufficiently low Nil Ductility Transition Temperature. If the Company anticipates a field test temperature lower than 60°F, he will specify the materials of construction.

8.5 Test pressure shall be maintained for a period of time sufficiently long to enable the inspector to check the complete set for leaks, with a minimum of 15 minutes.

8.6 Performance Test

8.6.1 The manufacturer shall perform a type test for all ejector and ejector sets at its works for capacity and performance.

8.6.2 Testing shall be done in accordance with the latest edition of the "Standards for Steam Jet Ejectors" published by the Heat Exchange Institute.

Note:

As an alternative, performance test in accordance with ANSI/ASME PTC-24 "Performance Test Codes" for ejectors may be accepted at the option of the Company.

8.6.3 Ejectors shall be tested at air equivalent to actual design capacity with sufficient data taken to plot capacity and pressure curves.

8.6.4 The results of tests and test curves shall be forwarded to the Company.

9. CONDENSERS

9.1 Steam surface condensers shall be designed in accordance with "Standards for Steam Surface Condensers" published by the Heat Exchange Institute.

9.2 Direct contact Barometric condensers shall be designed in accordance with "Standards for Direct Contact Barometric Low Level Condensers" published by the Heat Exchange Institute.

9.3 Construction of surface condensers shall be in accordance with "Construction Standards for Surface Type Condensers for Ejector Services" published by the Heat Exchange Institute.

9.4 Selection of a suitable type and application of condensers shall be discussed with and approved by the company.

9.5 The steam jet ejector condenser used in a vacuum distillation unit for overhead vapor shall generally be a surface type.

10. SUPPLEMENTARY REQUIREMENTS

10.1 Quotation

Technical quotations shall include the following information:

10.1.1 Fabrication materials offered.

10.1.2 Completed specification sheet (A sample of which is given in Appendix A).

10.1.3 Any deviations or exclusions from the stipulations referred to in this standard.

If no deviations or exclusions are mentioned in the quotation, it will be deemed to be fully in compliance with said stipulations.

10.1.4 Vendor is free to offer as an alternative, before the purchase order is placed, deviations from the required standards, if these result in a reduction in costs.

10.1.5 The origin and name of sub-suppliers, if any, for the fabrication of any part thereof. Such sub-suppliers shall be subject to acceptance by the Company.

10.1.6 Any purchase order will be subject to all terms, conditions, etc. forming part of the enquiry and any agreed amendments to it.

10.1.7 Spare parts list.

10.2 Preparation for Shipment

10.2.1 Unmachined exterior surfaces shall be cleaned with a suitable method to remove oil and dirt. Weld splatter shall be removed by wire brushing, grinding or other suitable means.

10.2.2 Carbon steel exterior surfaces shall be painted with one coat of primer or machinery enamel.

10.2.3 Painting is not required for corrosion resistant materials unless otherwise specified.

10.2.4 Flange facing and surfaces in contact with one or both streams shall not be painted. These parts shall be thoroughly cleaned and shall be effectively protected against corrosion with proper protective coating. Flange facing, where applicable, shall be fitted with suitable protective covers securely attached.

10.2.5 All tapped openings shall be plugged with solid steel plugs with 40 mm extension.

10.2.6 Weld connection ends shall be covered with suitable waterproof paper and/or tape sealed.

10.3 Spare Parts

10.3.1 Spare parts for commissioning

Vendor shall supply minor parts which are to be or may be replaced during the commissioning period.

10.3.2 Spare parts for two years operation

Vendor shall also supply spare parts for two years operation. The selection of these parts shall be made by vendor on the basis of his experience.

10.4 Drawings and Documentation

10.4.1 The supplier shall provide all drawings/design details, operation and maintenance manuals, and other information necessary for the design assessment, manufacturing, operation and maintenance of the ejector set.

10.4.2 All information, especially the manuals for operation and maintenance shall be clear and not open to misinterpretation and shall apply specifically to the equipment supplied.

10.4.3 Four copies of each drawing, operation and maintenance manuals shall be submitted.

10.4.4 The English language shall be used throughout all drawings and documentation unless otherwise specified.

However, descriptions on drawings may be in other languages, provided English translations are given.

10.4.5 All documents shall be furnished with equipment tag number which is specified in the purchase order.

10.5 Guarantee

10.5.1 Vendor shall guarantee the performance of the equipment as specified in the specification sheet for one year of operation.

10.5.2 In the event the performances are not achieved, vendor shall make all required modifications at his expenses until the guaranteed performances are achieved.

APPENDICES

APPENDIX A STEAM EJECTOR SPECIFICATION

PERFORMANCE

Make _____ Type _____
 Services _____ Condenser: ☐ Barometric ☐ Surface
 No. of Stages _____ No. of Ejectors per Stage _____
 Suct. Press _____ MM HgAbs. Suct. Temp. _____ °C Max. Disch. Press _____ MM HgAbs.
 Steam: Min. Press _____ kPaA. Temp. _____ °C Quality _____ %
 Water: Source _____ Max. Press _____ kPaA. Max. Temp. _____ °C
 Vol. of Evacuated System _____ Cu. m
 Expected Air Leakage _____ kg/Hr.
 Max. Evacuating Time _____ Min.
 Ejector Load kg/Hr. _____ Mol. Wt. _____ Cp. kcal/kg°C _____ Latent Ht. kcal/kg _____
 Condensables _____
 Non. Condensables _____

DESIGN

	1st. Stage	2nd. Stage	3rd. Stage	4th. Stage	5th. Stage
Propelling Steam, kg/Hr.					
Steam: Inlet Size					
Press. Class&Facing					
Water, m ³ /hr					
Water ΔT, °C					
Water: Inlet Size					
Press. Class&Facing					
Water: Exit Size					
Press. Class&Facing					
Suct. Chamber Press					
MM HgAbs					
suct. Chamber Temp. °C					
Condensers:					
Pre. Inter. After					
Barometric:					
No. Contact Stages					
Surface: Outside					
Tube Area Sq. m					

MATERIALS OF CONSTRUCTION

Ejector: Steam Chest _____ Steam Nozzles _____
 Diffuser: Inlet _____ Discharge _____ Suct. Chamber _____
 1st. Stage Suct. Chamber Inlet (Size×Pr.Cl.×Facing) _____ × _____ × _____
 Barometric Condenser: Shell _____ Baffles _____ Nozzles _____

Surface Condenser: Shell _____		Head _____	
Tubes (O. D×BWG×L _____ × _____ × _____)		Material _____	
Tube Sheet _____	Baffles _____		P
Steam Strainer _____	Shut Off Valves _____		U
			R
REMARKS			C
Tail Pipes Furnished by _____			H
Interconnecting Piping by _____			A
			S
			E
By _____	Chk'd. _____	App. _____	Rev. _____
Date _____			
			O
			R
			D
P.O. To: _____			E
			R
			No.

APPENDIX B
TYPICAL MATERIALS OF CONSTRUCTION AND ALLOWABLE STRESS VALUES

Part	Material	Specification	Allowable Stress *
DIFFUSER:	Carbon Steel Plate	ASTM A-36 (except Bessemer Steel) ASTM A-283 ASTM A-285 ASTM A-515	
	Stainless Steel Plate	ASTM A-240 TP 304 ASTM A-240 TP 316	
	Carbon Steel Bar	ASTM A-36 ASTM A-675	
	** Stainless Steel Bar	ASTM A-276 TP 304 ASTM A-276 TP 316 ASTM A-276 TP 321 ASTM A-276 TP 347	
	** Cast Iron	ASTM A-48	0.1 × Min. Tensile
		ASTM A-278	0.1 × Min. Tensile
		ASTM A-395	0.1 × Min. Tensile
	Cast Steel	** ASTM A-27 ASTM A-216 ASTM A-217	
	Cast Bronze	ASTM B-62 ASTM B-584	
	Cast Stainless Steel	** ASTM A-296 ASTM A-351	
	Carbon Steel Forging	ASTM A-105 ASTM A-181	
SUCTION CHAMBER:	Carbon Steel Plate	ASTM A-36 (except Bessemer Steel) ASTM A-283 ASTM A-285 ASTM A-515	
	Stainless Steel Plate	ASTM A-240 TP 304 ASTM A-240 TP 316	

(to be continued)

APPENDIX B (continued)

**TYPICAL MATERIALS OF CONSTRUCTION AND
ALLOWABLE STRESS VALUES**

Part	Material	Specification	Allowable Stress	*
SUCTION CHAMBER)	Carbon steel Pipe	ASTM A-53 ASTM A-106		
(Continued):	Stainless Steel Pipe	ASTM A-312 ASTM A-376		
	** Cast Iron	ASTM A-48 ASTM A-278 ASTM A-395	0.1 × Min. Tensile 0.1 × Min. Tensile 0.1 × Min. Tensile	
	Cast Steel	** ASTM A-27 ASTM A-216 ASTM A-217		
	Cast Bronze	ASTM B-62 ASTM B-584		
	Cast Stainless Steel	** ASTM A-296 ASTM A-351		
	Carbon Steel Forging	ASTM A-105 ASTM A-181		
	Carbon Steel Wrought Stainless Steel Wrought	ASTM A-234 ASTM A-403 TP 304 ASTM A-403 TP 316		
NOZZLE:	Stainless Steel Bar	** ASTM A-276 TP 304 ** ASTM A-276 TP 316 ** ASTM A-276 TP 321 ** ASTM A-276 TP 347 ASTM A-479 TP 316 ** ASTM A-482 TP 303 ** ASTM A-582 TP 416		
	Stainless Steel Plate	ASTM A-240 TP 304 ASTM A-240 TP 316 ASTM A-240 TP 416		
	Nickel Copper	ASTM B-164		

(to be continued)

APPENDIX B (continued)

TYPICAL MATERIALS OF CONSTRUCTION AND ALLOWABLE STRESS VALUES

Part	Material	Specification	Allowable Stress	*
STEAM CHEST:	Carbon Steel Bar	ASTM A-36 ASTM A-675		

	Steel Pipe	ASTM A-53 ASTM A-106 ASTM A-335
	Cast Steel	ASTM A-216 ASTM A-217
	Cast Stainless Steel	ASTM A-296 ASTM A-351
	Carbon Steel Forging	ASTM A-105 ASTM A-181
	Low Alloy Steel Forging	ASTM A-182 F-11 ASTM A-182 F-22
	Stainless Steel Forging	ASTM A-182 F-316 ASTM A-182 F-321 ASTM A-182 F-347
	Cast Bronze	ASTM B-62 ASTM B-584
EXTENSION:	Stainless Steel Bar	**ASTM A-276 TP 304 **ASTM A-276 TP 316 **ASTM A-276 TP 321 **ASTM A-276 TP 347 ASTM A-479 TP 316 **ASTM A-482 TP 303 **ASTM A-582 TP 416
STEAM PIPING:	Steel pipe	ASTM A-53 ASTM A-106 ASTM A-335
	Stainless Steel Pipe	ASTM A-312 ASTM A-376
	Carbon Steel Forging	ASTM A-105 ASTM A-181

(to be continued)

APPENDIX B (continued)

TYPICAL MATERIALS OF CONSTRUCTION AND ALLOWABLE STRESS VALUES

Part	Material	Specification	Allowable Stress	*
STEAM PIPING: (Continued):	Low Alloy Steel Forging	ASTM A-182 F-11 ASTM A-182 F-22		
	Stainless Steel Forging	ASTM A-182 F-316 ASTM A-182 F-321 ASTM A-182 F-347		

VAPOR PIPING:	Carbon Steel Pipe	ASTM A-53
		ASTM A-106
	Carbon Steel Wrought	ASTM A-234

Carbon Steel Plate	ASTM A-285 Gr C
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FASTENERS:	Bolts	ASTM A-193
		ASTM A-325
	Nuts	ASTM A-194
		ASTM A-325

* Allowable Stress Values should be taken from Section VIII, Division I of the ASME Pressure Vessel Code, except where noted (**).

** Allowable Stress Values used should conform to accepted engineering practice.