ISLAMIC REPUBLIC OF IRAN
MINISTRY OF PETROLEUM

IPS-E-PM-110(1)

IRANIAN PETROLEUM STANDARD

IPS

ENGINEERING STANDARD
FOR
TECHNICAL EVALUATION
OF
MACHINERIES

FIRST EDITION
FEBRUARY 2005

DEPUTY MINISTER
FOR
ENGINEERING & TECHNOLOGY
RESEARCH AND STANDARDS

FOREWORD

This Standard is intended to be used within and for Iranian Ministry of Petroleum (N.I.O.C, N.I.G.C, N.P.C., N.I.O.R.D.C. and other affiliate organizations and companies) and has been prepared on the basis of the recognized standards, scientific publications, technical documents, accumulated knowledge and experiences in petroleum industries at national and international levels.

Iranian Petroleum Standards are prepared by Iranian Petroleum Standards Organization reviewed and amended by the relevant technical standard committees to incorporate acceptable comments made by oil, gas and petrochemical experts.

Standards are finally approved by the "Standards High Council" of Iranian Ministry of Petroleum.

Iranian Petroleum Standards (IPS) are subject to amendment withdrawal, if required, thus the latest edition of IPS shall be applicable.

Any comment or recommendation submitted to the "Iranian Petroleum Standards Organization" will be evaluated in the relevant technical committee and will be considered in the next revision, upon approval.

GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

"COMPANY" : Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company etc.

"PURCHASER" : Means the "Company " Where this standard is part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract documents.

"VENDOR" and **"SUPPLIER"** : Refers to firm or person who will supply and/or fabricate the equipment or material.

"WILL" : Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

"MAY" : Is used where a provision is completely discretionary.

"SHOULD" : Is used where a provision is advisory only.

"SHALL" : Is used where a provision is mandatory.

IRANIAN PETROLEUM STANDARDS.

No. 19, Street 14, North Kheradmand Karimkhan Avenue, Tehran, Iran.

Tel. : 66153055
: 88810460
Fax. : 88810462

February 2005

ENGINEERING STANDARD

FOR

TECHNICAL EVALUATION

OF

MACHINERIES

FIRST EDITION

FEBRUARY 2005

CONTENTS : PAGE No.

0. INTRODUCTION

The aim of this Standard is to provide a general guidance for technical bids evaluation of machineries.

General requirements to be concerned in technical evaluation of machineries are covered in Section 3 and specific requirements in Appendix **A**.

Quotation Analysis Report Tables are given in Appendix **A** as a reference for comparison of different supplier's offers.

Appendix **B** provides assistance in evaluating the received technical bids of centrifugal pumps.

Attention shall be paid that, although many subjects regarding the technical evaluation of machineries are discussed in this Standard for each individual case. Company's Engineer should consider the specific conditions and requirements concerned with that case, and prepare the Quotation Analysis Reports (QARs) accordingly.

1. SCOPE

This Standard covers general requirements and guidance for technical evaluation of machineries such as pumps, compressors, drivers and auxiliaries, for Iranian petroleum Industries.

Note: This is a revised version of the Engineering Standard for Technical Evaluation of Machineries, which is issued as edition (1). Edition (0) of the said standard is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards / codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this Standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-PM-105	"Material and Equipment Standard for Centrifugal Pumps for Process Services"
IPS-M-PM-115	"Material and Equipment Standard for Centrifugal Pumps for General Services"
IPS-M-PM-125	"Material and Equipment Standard for Centrifugal Fire Water Pumps"
IPS-M-PM-130	"Material and Equipment Standard for Positive Displacement Pumps - Reciprocating"
IPS-M-PM-135	"Material and Equipment Standard for Light Duty Centrifugal Pumps"
IPS-M-PM-140	"Material and Equipment Standard for Positive Displacement Pumps - Rotary"
IPS-M-PM-150	"Material and Equipment Standard for Positive Displacement Pumps - Controlled Volume"
IPS-M-PM-160	"Material and Equipment Standard for Vacuum Pumps"
IPS-M-PM-170	"Material and Equipment Standard for Centrifugal Compressors for Process Services"
IPS-M-PM-180	"Material and Equipment Standard for Package Integrally Geared Centrifugal Compressors for Utility & Instrument Air Services"
IPS-M-PM-190	"Material and Equipment Standard for Axial Flow Centrifugal Compressors"
IPS-M-PM-200	"Material and Equipment Standard for Reciprocating Compressors for Process Services"
IPS-M-PM-210	"Material and Equipment Standard for Reciprocating Compressors for Utility & Instrument Air Services"
IPS-M-PM-220	"Material and Equipment Standard for Positive Displacement

	Compressors-Rotary"
IPS-M-PM-230	"Material and Equipment Standard for Special Purpose Centrifugal Fans for Special Purpose Application"
IPS-M-PM-235	"Material and Equipment Standard for General Purpose Centrifugal Fans"
IPS-M-PM-240	"Material and Equipment Standard for General Purpose Steam Turbines"
IPS-M-PM-250	"Material and Equipment Standard for Special Purpose Steam Turbines"
IPS-M-PM-260	"Material and Equipment Standard for Combustion Gas Turbines"
IPS-M-PM-270	"Material and Equipment Standard for Expansion Turbines"
IPS-M-PM-290	"Material and Equipment Standard for Reciprocating Internal Combustion Engines
IPS-M-PM-320	"Material and Equipment Standard form Lubrication, Shaft Sealing and Control oil Systems an Auxiliaries for Process Services"
IPS-M-PM-330	"Material and Equipment Standard for Mixers"

3. GENERAL REQUIREMENTS

3.1 Delivery Time

Delivery time shall meet project schedule. The closer delivery times to project schedule shall be considered as priority in evaluation of equipment provided that this does not jeopardize the guarantee period.

3.2 Vendor's Experience and Reputation

Vendors shall be well reputed and experienced in manufacturing of equipment and ancillaries. The more reputed and experienced vendors and sub vendors are preferred and shall have preference in evaluation.

They shall be in Purchaser's Approved Vendor List, or have API conformity certificate from a well-known international third party Inspection Company.

3.3 Interchangeability

Regarding cost saving, the interchangeability of equipment parts is an essential factor when evaluating machineries. That equipment which have been previously purchased and their reliability approved by Iranian Oil Ministry, shall be preferred, and preceded at the time of machineries' evaluation.

The interchangeability of parts shall also be considered in bulk procurement of machineries for specific projects.

3.4 Guarantee and Warranty

Supplied equipment shall be guaranteed for proper performance, material and workmanship.

Longer guarantee periods are preferred and Company's engineer shall consider it as a priority when preparing Quotation Analysis Reports (QARs).

3.5 After Sales Services

Vendors shall guarantee after sale services of the equipment. Those companies which have service shops in I.R. of Iran are preferred.

After sale services cover any repair and technical guidance by the manufacturer and its previous behavior, after purchasing the equipment.

3.6 Spare Parts Supply

Vendor shall guarantee the supply of spare parts for the equipment at least for ten years after the date of shipment. The price of the spare parts shall be kept at a reasonable value regarding the inflation effects.

Vendors that guarantee the supply of spare parts for longer period shall be preceded in technical evaluation of machineries.

3.7 Size and Weight

For each machine the Company's engineer shall study all aspects of size and weight of equipment and consider any suitable preferences.

3.8 Ease of Dismantling and Repair

Repair time and costs may be reduced by proper design of equipment for ease of dismantling and repair. Company's Engineer shall study repair and disassembling details of the equipment. Equipment that is easily disassembled and repaired shall be preceded in technical evaluation.

3.9 Efficiency and Energy Consumption

Low efficiency and high energy consumption of the equipment will increase the operation costs. Equipment with high efficiency and low energy consumption is desirable and shall be preceded in technical evaluation of machineries.

4. COMPLIANCE WITH STANDARDS

Company's Engineer should check the compliance of the equipment with appropriate data sheets and Standards, as listed below. In case of deviations from related standard, Company's Engineer shall indicate them in respective QAR.

IPS-M-PM-105 , IPS-M-PM-115 , IPS-M-PM-125 , IPS-M-PM-130 , IPS-M-PM-135 , IPS-M-PM-140 , IPS-M-PM-150 , IPS-M-PM-160 , IPS-M-PM-170 , IPS-M-PM-180 , IPS-M-PM-190 , IPS-M-PM-200 , IPS-M-PM-210 , IPS-M-PM-220 , IPS-M-PM-230 , IPS-M-PM-235 , IPS-M-PM-240 , IPS-M-PM-250 , IPS-M-PM-260 , IPS-M-PM-270 , IPS-M-PM-290 , IPS-M-PM-320 , IPS-M-PM-330.

5. SUMMARY

Company's Engineer shall indicate in Quotation Analysis Report the preference of equipment quoted, according to general requirements noted in section 1 and also specific requirements indicated in appropriate standard.

Rotating machines may be sorted according to their compliance with IPS Standards in order to facilitate procurement procedure.

APPENDICES

APPENDIX A

QUOTATION ANALYSIS REPORTS

Quotation analysis reports for different machineries are as follows:

A1- QUOTATION ANALYSES REPORT FOR CENTRIFUGAL PUMPS
A2- QUOTATION ANALYSIS REPORT FOR RECIPROCATING PUMPS
A3- QUOTATION ANALYSIS REPORT FOR RECIPROCATING COMPRESSOR
A4- QUOTATION ANALYSIS REPORT FOR GENERAL PURPOSE STEAM TURBINE
A5- QUOTATION ANALYSIS REPORT FOR SPECIAL PURPOSE STEAM TURBINE
A6- QUOTATION ANALYSIS REPORT FOR ENGINES
A7- QUOTATION ANALYSIS REPORT FOR FANS AND BLOWERS
A8- QUOTATION ANALYSIS REPORT FOR CENTRIFUGAL COMPRESSORS
A9- QUOTATION ANALYSIS REPORT FOR GAS TURBINE ENGINES
A10- QUOTATION ANALYSIS REPORT FOR TURBO-EXPANDER
A11- QUOTATION ANALYSIS REPORT FOR MIXERS

IRANIAN PETROLEUM STANDARDS
A1-QUOTATION ANALYSES REPORT
FOR CENTRIFUGAL PUMPS

IRANIAN PETROLEUM STANDARDS
A2-QUOTATION ANALYSIS REPORT
FOR RECIPROCATING PUMPS

IRANIAN PETROLEUM STANDARDS
A3-QUOTATION ANALYSIS REPORT
FOR RECIPROCATING COMPRESSOR

IRANIAN PETROLEUM STANDARDS
A4-QUOTATION ANALYSIS REPORT
FOR GENERAL PURPOSE STEAM TURBINE

IRANIAN PETROLEUM STANDARDS
A5-QUOTATION ANALYSIS REPORT
FOR SPECIAL PURPOSE STEAM TURBINE

IRANIAN PETROLEUM STANDARDS
A6-QUOTATION ANALYSIS REPORT
FOR ENGINES

IRANIAN PETROLEUM STANDARDS
A7-QUOTATION ANALYSIS REPORT
FOR FANS AND BLOWERS

IRANIAN PETROLEUM STANDARDS
A8-QUOTATION ANALYSIS REPORT
FOR CENTRIFUGAL COMPRESSORS

IRANIAN PETROLEIUM STANDARDS
A9-QUOTATION ANALYSIS REPORT
FOR GAS TURBINE ENGINES

IRANIAN PETROLIUM STANDARDS
A10-QUOTATION ANALYSIS REPORT
FOR TURBO-EXPANDER

IRANIAN PETROLIUM STANDARDS
A11-QUOTATION ANALYSIS REPORT
FOR MIXERS

APPENDIX B

CENTRIFUGAL PUMPS TECHNICAL BID EVALUATION

1. INTRODUCTION

This appendix is intended to provide assistance in evaluating the received technical bids of centrifugal pumps. Generally following points should be investigated in a proper pump selection:

I. Reliability
- Simplicity
- Rigidity
- Bearing and lubrication

II. Efficiency
- Drive speed
- Pump speed
- Materials and Casting Techniques

III. Ease of Maintenance
- Monitoring of Pump Performance

IV. Cost
- Capital Expenditure (CAPEX)
- Operating Expenditure (OPEX)
- Performing Life Cycle Cost Analysis
- After Sales and Technical Services

There are two important parameters, namely, specific speed and suction specific speed, which are extremely useful in evaluating centrifugal pumps. Hereunder, it is devoted to make a better understanding of these two key factors and provide a guideline in using them effectively.

2. SPECIFIC SPEED

Specific speed is a key factor in comparing various pumps and selecting the most efficient and economical pumping equipment.
Specific speed is defined by the formula:

$$N_s = \frac{N\sqrt{Q}}{H^{0.75}} \qquad \text{(Eq. 1)}$$

Where,
N= operating speed in rpm
Q= flow rate in $m^3/\sec$ (GPM)
H= head developed in meters (feet)
Specific speed is always calculated at the best efficiency point (BEP) with maximum impeller diameter and single stage only.

For multistage pumps, specific speed is calculated on a basis of head per stage, and for a double suction impeller, specific speed is calculated using half the flow rate.

Actually there is a certain relationship between the specific speed of a pump, its geometry, and its performance. Figure 1 shows the general trend of how the geometry, efficiency, and shape of the head-capacity curve vary with the specific speed.

The data presented in Fig.1 give a helpful view in verifying the pump efficiency claimed by the manufacturer. It may be simply achieved by checking the specific speed, the flow rate and the proposed efficiency.

For instance, considering a pump of a specific speed of 2000 (in English units) for a flow rate of 200 GPM; if the manufacturer claims that the efficiency of this pump is 81%, the buyer should be suspicious. As can be seen in Fig.1, it is very doubtful as to whether this efficiency is correct. For safety, the buyer should demand that the claimed efficiency be verified by a witnessed test.

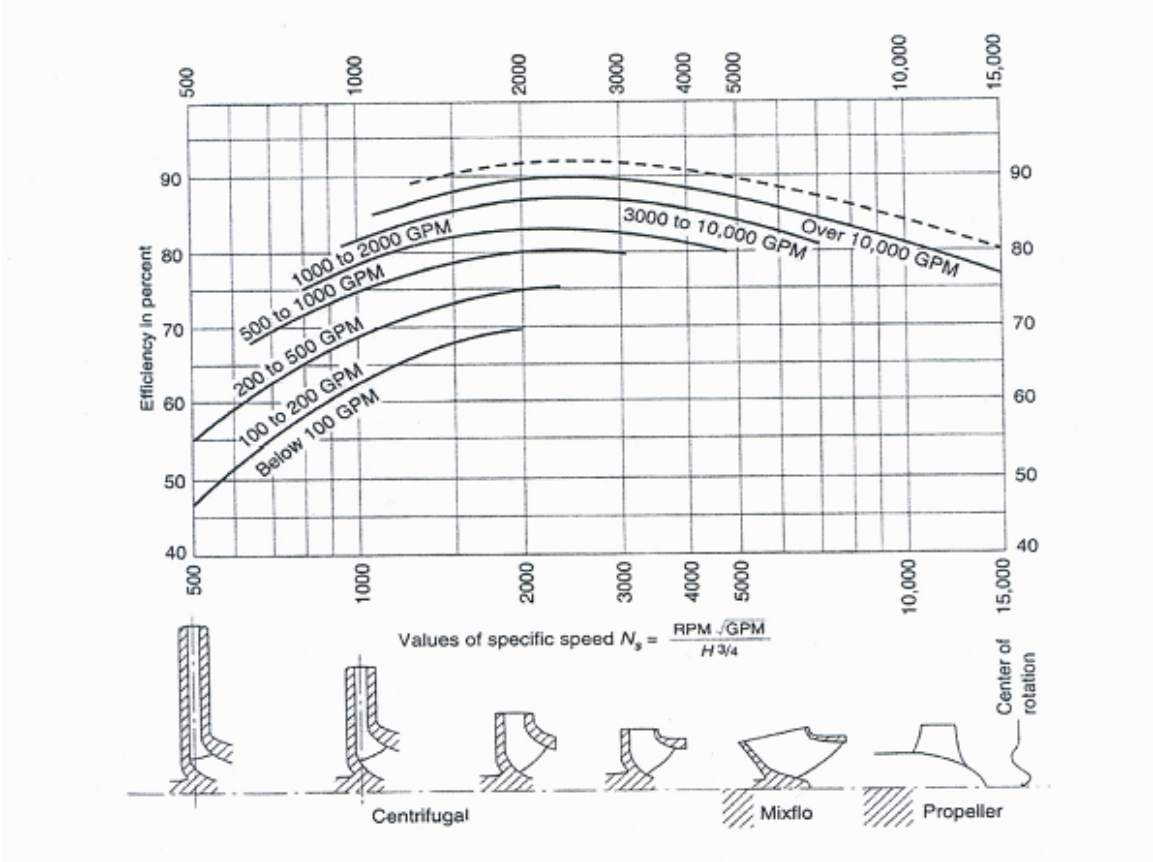

Figure 1: Effect of specific speed, the impeller's-geometry, and flow-rate, on efficiency, RPM (revolutions per minute), GPM (gallons per minute).

3. SUCTION SPECIFIC SPEED

Suction specific speed (N_{ss}) is calculated by the same formula as pump specific speed (N_s) but uses required NPSH values in place of (H).

The mathematical expression for the suction specific speed (N_{ss}) is:

$$N_{ss} = \frac{N\sqrt{Q}}{NPSHR^{0.75}} \qquad \text{(Eq. 2)}$$

Where,
N= operating speed in rpm
Q= flow rate in $m^3/\sec$ (GPM)
NPSHR= minimum required positive suction head in meter (feet)

Generally, the higher N_{ss} the value for a given pump, the better is its suction performance. However, great attention should be paid in using N_{ss} values for comparing the suction capabilities of different pumps.

As Eq. 2 shows, the magnitude of N_{ss} varies with flow rate. In fact, the N_{ss} value of each pump is zero at shutoff. It then rises quickly to a certain maximum at a certain partial flow rate.

Afterwards, it starts to decrease gradually, again asymptotically approaching the value of zero.

For instance, consider two pumps that the maximum N_{ss} value of one is 22000 (in English units), and the value of the other is 18000 (in English units). This does not necessarily mean that the first pump is better than the second when operating under reduced suction heads. On the one hand, the first pump may be able to attain its maximum N_{ss} value only at a flow rate that the pump is never expected to achieve under the given operating conditions. On the other hand, while operating within its assigned duties, the second pump may possess better suction capabilities than the first.

Another pitfall may result because the NPSH term in Eq. 2 refers to the minimum required NPSH. There are cases in which there is no absolute way to determine what is the minimum required suction head. This, again, may lead to different N_{ss} values without proving that the pump with the higher N_{ss} value has better characteristics than pumps with nominally lower N_{ss} values.

To avoid such pitfalls, it is highly recommended to check how the value of the minimum required NPSH was determined, as well as the flow rate to which the specified value N_{ss} refers

Note to Users

The IPS Standards reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS publications are based on internationally acceptable standards and include selections from the options stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement or diversity of conditions of each project or work.

For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The users of IPS publications are therefore requested to send their views and comments, including any addendum prepared for particular cases to the Ministry of Petroleum, Standards and Research Organization. These comments and recommendations will be reviewed by the relevant technical committee and will be incorporated in the formal revision of the relevant IPS. The IPS publications are reviewed and revised approximately every five years.

IRANIAN PETROLEUM STANDARDS

No. 19, Street 14, North kheradmand Karimkhan Avenue, Tehran, Iran
Tel: 66153055
88810460
Fax: 88810462
Email: petrostand@nioc.org