Quality Improvement Manual for Mechanical Equipment in Petroleum, Chemical, and Gas Industries

API RECOMMENDED PRACTICE 683
FIRST EDITION, SEPTEMBER 1993

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

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Manufacturing, Distribution and Marketing Department

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FOREWORD

This recommended practice is based on the accumulated knowledge and experience of suppliers, contractors, and users of mechanical equipment. The objective of this recommended practice is to facilitate the manufacture and procurement of mechanical equipment for petroleum, chemical, and gas industry service.

The use of this recommended practice in no way is intended to conflict with, supplement, or replace (where applicable) API Spec Q1, *Specification for Quality Programs*, which is concerned with standardization programs.

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Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Quality Improvement Manual for Mechanical Equipment in Petroleum, Chemical, and Gas Industries

SECTION 1—GENERAL

1.1 Scope

This recommended practice provides guidelines for improving the quality of mechanical equipment. It is intended to mutually benefit users, contractors, and suppliers and facilitate improved relationships between them by promoting trust, teamwork, and communication. It is not intended to determine certification to or compliance with a particular quality system specification.

A three-part approach for improving the quality of mechanical equipment is described in this recommended practice, consisting of (a) the traditional methods used to help assure quality; (b) techniques that can be used to identify those suppliers who have quality systems so effective that intense user involvement is unnecessary; and (c) suggestions on how users, contractors, and suppliers can work together to improve quality.

Section 2 describes methods by which users prequalify suppliers, prepare comprehensive specifications, conduct communication meetings, audit designs, institute manufacturing quality surveillance, sponsor intensive factory testing, and conduct equipment inspections at the site prior to start-up.

Section 3 (along with Appendix A) contains guidelines for evaluating the type of quality system and effectiveness of the quality system used by a supplier. Emphasis is placed on the commitment of management to the quality system, the structure of the system, relationships with subsuppliers, training, evidence of continuous quality improvement throughout the organization, and the supplier's performance on recent projects.

Section 4 addresses ways that users, contractors, and suppliers can all work together to improve their quality systems. It includes such topics as uniformity and joint development of equipment requirements, risk sharing, communication, training, and constructive feedback. Users are encouraged to reduce the use of lengthy supplemental specifications and rely more on API standards and data sheets.

This recommended practice is complementary to the referenced standards, but it goes beyond them to address the development and evaluation of systems incorporating continuous quality improvement. This recommended practice is specifically applicable to the mechanical equipment industry.

1.2 Definition of Terms

Some of the terms used in this recommended practice require clarification. The definitions found below will assist the reader in understanding the contextual meaning of some terms used throughout this recommended practice.

1.2.1 No attempt will be made in this recommended practice to create an original definition of quality. *Quality* may be thought of in terms of a traditional definition accompanied by clarifying statements.

Quality has traditionally been defined with phrases like "fitness for use" (by customers) and "conformance to customer requirements" (by suppliers). Clarifying statements include the following:

a. *Quality* is understanding who the customer is and what the customer requirements are and meeting those requirements without error, on time, every time.
b. *Quality* is performance leadership in meeting customer requirements by doing the right things right the first time.
c. *Quality* is defined by customers; customers want products and services that, throughout their lives, meet customer's needs and expectations at a cost that represents value.
d. *Quality* is meeting the needs, desires, and expectations of our customers.

1.2.2 A *Quality System* is the combination of activities, procedures, processes, resources, and organizational structure devoted to controlling, assuring, and/or improving the quality of products or services. The quality systems employed by users, contractors, and suppliers may incorporate any or all of the following elements:

a. *Quality control* denotes the measurement, checking, or testing required to verify and document conformance to a prescribed set of requirements or standards.
b. *Quality assurance* includes the process and procedures necessary to continually monitor the methods used to control quality and their results to make certain that the methods do, in fact, accurately and correctly verify conformance to requirements.
c. *Quality improvement* refers to the processes, procedures, and organization devoted to the continuous improvement of quality to all levels and in all functions of an organization.

1.2.3 A *Total Quality System*, in the context of this recommended practice, is defined as a quality system in which all three of the key elements described in 1.2.2 are present. It involves everyone in all functions of an organization and is dedicated to control, assurance, and improvement in quality.

1.2.4 The *user* is the ultimate purchaser and operator of mechanical equipment. It is the user's requirements and expectations for the suitability and reliability of mechanical equipment and related services that contractors and suppliers are dedicated to meet.

1.2.5 The *contractor* provides engineering, procurement, and/or construction services to users. The contractor often acts as an intermediary between user and supplier and is responsible for specifying, purchasing, and installing mechanical equipment.

1.2.6 *Supplier*, in the context of this recommended practice, refers to a manufacturer of mechanical equipment and/or subsuppliers of equipment components and assemblies.

1.3 How to Use This Recommended Practice

This recommended practice has been structured to assist users and contractors in identifying potential suppliers, evaluating their quality systems, and adopting the most appropriate approach to working together. In 2.2, considerations are outlined that identify a supplier's capability to furnish the equipment required for the intended service or services. Section 3 and Appendix A provide a list of major elements for assessing what kind of quality system a supplier has and how effective it is. This evaluation will enable the user or contractor to determine how best to work with the supplier [for example, by using traditional methods (Section 2) or minimizing user or contractor involvement]. The evaluation material in Section 3 and Appendix A is intended to be used primarily by those experienced with mechanical equipment and familiar with quality systems. Section 4 provides recommendations to help the user, contractor, and supplier move their relationship toward increased reliance on the supplier's internal quality system or systems and continuous quality improvement. Figure 1 is a diagram of the approach to using this recommended practice.

1.4 Referenced Publications

The following standards, codes, and specifications are cited in this recommended practice.

API

Std 617 *Centrifugal Compressors for General Refinery Service*

ASME[1]

Boiler & Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"

ISO[2]

9000 *Quality Management and Quality Assurance Standards—Guidelines for Selection and Use* (ANSI[3]/ASQC[4] Q90)

9001 *Quality Systems—Model for Quality Assurance in Design/Development, Production, Installation, and Servicing* (ANSI/ASQC Q91)

9002 *Quality Systems—Model for Quality Assurance in Production and Installation* (ANSI/ASQC Q92)

9003 *Quality Systems—Model for Quality Assurance in Final Inspection and Test* (ANSI/ASQC Q93)

9004 *Quality Management and Quality System Elements—Guidelines* (ANSI/ASQC Q94)

Malcolm Baldrige National Quality Award Application Guidelines—1991[5]

MIL[6]

MIL-I 45208A *Inspection System Requirements*

This recommended practice is compatible with the referenced documents and should be used to develop and enhance the concept and practice of continuous quality improvement. It is not intended to substitute for, or compete with, the referenced quality documents.

The ISO 9000 (ANSI/ASQC Q90) series of standards is generic in nature, intended for use with appropriate industry-specific quality assurance standards. This recommended practice is intended to complement the referenced publications to help build a strong foundation for quality systems specific to the mechanical equipment industry.

1.5 Continuous Improvement of This Recommended Practice

Constructive feedback is necessary for the continuous improvement of this recommended practice. Readers are encouraged to use the form in Appendix C, which may be forwarded to the director of the Manufacturing, Distribution and Marketing Department of API.

[1]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

[2]International Organization for Standardization. ISO publications can be obtained from the American National Standards Institute.

[3]American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

[4]American Society for Quality Control, P.O. Box 3005, 611 East Wisconsin Ave., Milwaukee, WI 53201-3005.

[5]Malcolm Baldrige National Quality Award. United States Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD 20899.

[6]Department of Defense. Obtain from Commanding Officer, Naval Publications Forms Center, Attn: NPFC 105, 5801 Tabor Avenue, Philadelphia, PA 19120.

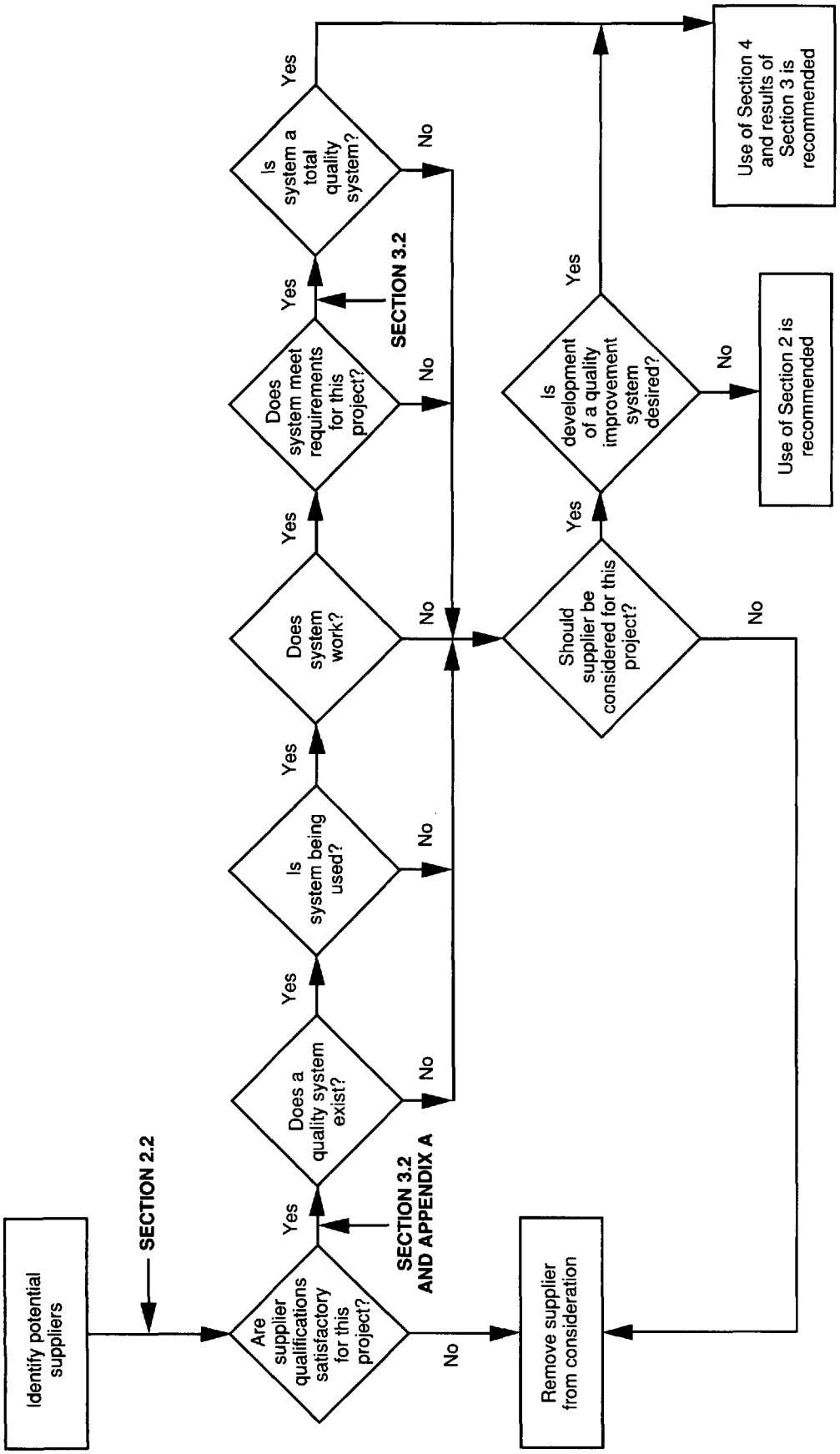

Figure 1—How to Use This Recommended Practice

SECTION 2—TRADITIONAL METHODS TO ASSURE QUALITY

2.1 General

2.1.1 The traditional approach, that is, the use of detailed specifications and monitoring by inspection, may be chosen for many reasons. The purchaser or user may not want to relinquish methods that have been successful. The purchaser or user may not have the time to audit a supplier's quality system or may have audited the system and deemed it to be inadequate. The purchaser or user may have reviewed a supplier's quality system and found it to be adequate but may want to oversee a test of the system to be sure that it works for the contract in question.

2.1.2 With the traditional approach, the need for proper communication cannot be overemphasized. There are several layers within a user's organization, a contractor's organization, and the supplier's and subsupplier's organizations that are involved from the conception of the requirements to the completion of the specified product, its installation, and its implementation. The organizations involved in each activity must be informed of, adhere to, and produce the intent of the specification.

2.1.3 The following are broad categories of major areas that must be addressed when the traditional approach is used and must be considered for the transition approach as well. Although all these areas may not pertain to everyone involved in a project, several of them are involved with everyone's scope of a project.

a. Supplier qualifications.
b. Comprehensive specifications.
c. Communication meetings.
d. Design audits.
e. Manufacturing quality surveillance.
f. Factory testing.
g. Field inspection prior to start-up.

2.2 Supplier Qualifications

2.2.1 APPROVED BIDDERS LIST

The most commonly used method for assuring that quality equipment will be purchased—whether for an entire plant, an expansion of facilities, or the revamping of existing facilities—starts with an approved bidders list. This list may be an existing list provided by the user and based on the user's own experiences and preferences; it might be one that the contractor has used successfully; or it could be one that is jointly developed by both user and contractor as the equipment required becomes better defined. The list may be suitable for worldwide competition or because of user preferences or project financing, be limited to one or more specific source countries, depending on the equipment involved and its availability throughout the world.

In the final configuration of the approved bidders list, when it is ready to be used for a specific inquiry, the bidders list should contain only names of acceptable, qualified suppliers. It need not contain the names of *all* suppliers of quality equipment, because any one of several commercial considerations could disallow bidding by an otherwise qualified supplier. The list should not, however, contain the name of any unqualified supplier.

2.2.2 SOURCES FOR EVALUATING SUPPLIER QUALIFICATIONS

A number of sources are available to both users and contractors for evaluating the qualifications of both suppliers and subsuppliers and for determining which of these will be placed on a particular approved bidders list. The most useful of these available sources are experience, supplier reference lists of operating installations, and feedback from the suppliers regarding their own experiences with subsuppliers.

2.2.2.1 Experience

Experience is the most useful basis upon which either a user or a contractor will decide whether a particular supplier is qualified for placement on a list of approved bidders. It is important that the experience upon which judgement is made be recent experience, preferably gathered within the past 3 to 5 years and, if possible, for the life of the equipment from its initial start-up to its present condition. The term *recent* is used here because equipment is designed, produced, tested, delivered, installed, and operated by people, not by corporations. In an era when corporate changes are common, it is important to know the effects of such changes on product quality. It is possible for a corporation to change its name and its organization while maintaining the same people and product quality level it has had for years. It is equally possible for a corporation whose name has been unchanged for generations to have undergone drastic changes in both personnel and product quality.

Experience may be either first-hand, based on equipment that the user or contractor purchased and is now operating, or acquired via contact with other users and contractors. In either case, the evaluation of that experience ought to be as objective as possible. If the experience is other than first-hand, contacts should be with people that have been directly responsible for the start up, operation, and maintenance of the equipment and if time permits, with others who may have participated in the original specification and shop testing of the equipment.

2.2.2.2 Suppliers' Reference Lists

2.2.2.2.1 Advantages

The supplier's own reference lists are another useful source of information available to both users and contractors when evaluating a supplier's qualifications. The amount of detail on such lists varies widely. Some lists are fairly comprehensive; others are almost worthless. Most, however, provide sufficient information to enable a user to proceed with the qualification process. The supplier should be asked to provide any missing information needed for a proper evaluation. Dates are very important. Installation and start-up dates are more important than shipping dates or order entry dates, but the latter may be the only ones for which the supplier has any first-hand information. Installation lists should contain the names of both users and contractors to facilitate contact with either. Most lists also provide model designations or frame sizes as well as some detail on the operating parameters of the equipment.

By itself, a reference list cannot usually provide clear evidence of a supplier's qualifications. Actual operating conditions may be significantly different from those originally specified. Follow-up contacts with users and contractors familiar with the referenced installations are normally required. On the other hand, a reference list can provide sufficient evidence regarding lack of current experience to justify exclusion of a particular supplier from an approved bidders list. The source of the referenced equipment is equally important. Many of today's suppliers have licensees or joint venture companies in foreign countries. Careful consideration must be given before the experience of one source is credited to any of the others.

As with the user's own experience, it is important that pertinent entries on a supplier's reference list also be sufficiently current if they are to be considered as evidence of a supplier's present-day qualifications.

2.2.2.2.2 Reference List Limitations

A supplier's reference list cannot demonstrate to the user or contractor the supplier's success rate in designing and building equipment for operating conditions well beyond those with which the supplier has had experience. Some suppliers have invariably done better than others in this regard, and the user or contractor, as part of his own risk management techniques, must find ways to evaluate this measure of success. Lacking any first-hand experience, the user or contractor can contact other users or contractors for this type of feedback: the more such feedback is positive, the more willing a user might be to assume some of the risks involved. Some extremely well-qualified suppliers have had fewer start-up and operational problems with prototype equipment than other less-qualified suppliers have had with "near-duplicate" equipment.

2.2.2.3 Supplier Feedback

Major equipment packages for process plant installation often contain a considerable amount of both raw materials and finished products that the primary supplier does not produce but purchases directly from subsuppliers. It is quite common for users and contractors to limit the source of much of this content, thereby assuring themselves that their own minimum quality levels are being maintained in certain areas. This is normally done by including, as part of the equipment specifications, lists of acceptable subsuppliers. These lists may cover such commodities as instruments, motors, bearings, and seals. In general, the lists do not cover sources for unfinished materials, such as castings and forgings, nor certain nonmetallic materials. For these items the principal source of information regarding quality is feedback from the primary supplier. Although a supplier may not be in a position to identify specific sources before a purchase commitment is made, it should be possible to obtain a listing of several probable sources for each major subsupplier purchase that would be required for the equipment involved. Such lists are rarely produced by a user or contractor, but to the suppliers they are the equivalent of a user's approved bidders list.

2.2.3 TECHNICAL ASPECTS

Beyond a supplier's proven ability to manufacture and deliver a quality product, there are a number of technical and commercial requirements that both the user and the contractor should see satisfied as part of their supplier qualification efforts. It should be noted that the user and contractor have a great many objectives in common, but they do have slightly different agendas and the supplier is expected to accommodate both. The user and contractor both are interested in the supplier's design tools, the supplier's in-house inspection and testing capabilities, and the field performance of the equipment produced. Both wish to see the equipment delivered and installed on time and within budget. In the engineering phase, while both are interested in scope of supply and compliance with specifications, the contractor normally takes a deeper interest in the scheduling and quality of the supplier's preliminary and certified drawings, particularly those affecting the progress of the contractor's civil, piping, electrical, and instrument design work. In the erection and start-up phase, while both may be interested in the completeness of installation and operating sections in the supplier's instruction manual, the user is more interested in those sections covering such topics as maintenance, special tools, and spare parts.

2.2.3.1 Compliance with Specifications

Both users and contractors often will judge a supplier's qualifications by the supplier's comments and exceptions to

the applicable specifications. Comments may be nothing more than correct interpretations of the specifications, in which case the comments may be readily acknowledged. Comments by the supplier that are incorrect interpretations of the specifications require clarification, after which the comments may or may not be noted as exceptions. Exceptions to the specifications fall into three broad categories: (a) those taken of necessity because a supplier's basic design differs from that specified, (b) those taken because the specification violates some mandatory code or safety regulation, and (c) those taken for purely economic and competitive reasons. Item a usually requires a decision by the user regarding whether or not the particular design difference is acceptable. Item b normally requires that the specification be rewritten to eliminate the conflict. Item c simply makes it more difficult to evaluate competing proposals and raises questions about the supplier's overall qualifications. A preferred approach to Item c would have the supplier include the cost of compliance in the proposal and offer a comment on the savings and effects on quality of the alternate offering.

2.2.3.2 Design and Analysis Capabilities

Users and contractors alike expect that every supplier on their approved bidders list will have the in-house capability to design and produce the equipment they propose. This would include not only the technical and engineering design talent required but also the state-of-the-art analytical tools and software necessary for meeting today's demand for shorter schedules and sophisticated designs of components, assemblies, and systems. This requirement (that is, in-house capability) is particularly important when the equipment required by new process technology has not been built before and some of the risks associated with unproven equipment can no longer be avoided.

2.2.3.3 Machine Tools and Plant Layout

Physical plant equipment and its layout are commanding more of the users' and contractors' attention. Electronic numerical controls on properly maintained machine tools can substantially eliminate or at least reduce human error in the machining of equipment components. Modern plant layout complements these advanced machining techniques by facilitating such innovative practices as the manufacturing cell concept and just-in-time inventory control. These concepts are usually not addressed in any user or contractor specification or standard but are reviewed in most current shop surveys.

2.2.3.4 Inspection and Test Facilities

Until all acceptable bidders are fully committed to the quality management process, both users and contractors will continue to review and rate their suppliers' inspection and test facilities. Shop inspection and shop testing, whether mandatory or optional, are primarily the suppliers' responsibility. Nevertheless, both users and contractors continue to find it necessary to periodically visit suppliers' shops to review documentation and to observe or witness certain parts of the test procedures as they are performed. The extent to which such surveillance is found necessary is often inversely proportional to the extent to which the supplier involved has implemented a total quality process.

2.2.3.5 Field Service

Perhaps no other facet of a supplier's overall operations can do more than the supplier's field service organization either to damage or to enhance the supplier's reputation in the eyes of the user. Ideally, a supplier should have extremely qualified field service personnel, conveniently located service facilities, and a minimum number of service calls that bear directly on equipment quality. The size of a supplier's service department depends on the nature of the equipment involved. Suppliers who furnish large, complex equipment packages often are required to have qualified field personnel available for routine erection and start-up services as well as for the training of customer personnel in the operation and maintenance of such equipment.

A quality service organization stays in touch with its customers, keeping them informed of design improvements and any recall for hidden defects that might compromise safety.

2.2.3.6 Spare Parts

The contractor's involvement with equipment spare parts normally involves capital spares only, such as spare rotors for major compressors or steam turbines or spare tube bundles for critical unspared exchangers. On certain projects, the contractor may be responsible for commissioning or start-up spares. Rarely, the contractor may be required to purchase spare parts for the first year or two of operation. Lead times for the manufacture of spare parts is seldom a problem. The user, however, is concerned about the availability of spare parts throughout the life of the equipment, especially their availability in an emergency. For this reason and for the reasons stated in 2.2.3.5, the user's rating of a supplier's qualifications will place more emphasis on spare parts and field service than will the contractor's rating of the same supplier's qualifications.

2.2.4 COMMERCIAL ASPECTS

Although the commercial aspects of a supplier's qualifications may not appear to be as critical as the technical ones covered in the preceding paragraphs, certain commercial aspects are extremely important to both user and contractor.

2.2.4.1 On–Time Delivery

Most qualified suppliers make an honest effort to quote realistic lead times for the delivery of their equipment and specified software; some, however, fail repeatedly to meet these commitments. Technically, their equipment may meet the most stringent requirements in terms of design, performance, reliability, and efficiency, but it seldom ships on time. On some projects this may pose no problem; on others it could be catastrophic. To qualify such a supplier, the user or contractor might consider automatically increasing the quoted lead time by some appropriate amount. If this is done, the supplier should be notified so that he may take corrective action on future proposals. Liquidated damages are sometimes used to remedy this problem but are seldom sufficiently punitive and tend to foster an adversarial relationship between user and supplier. The same situation described above can arise and the same remedial action can be taken regarding lead times for the submittal of drawings and other software required by either the user or the contractor.

It is important to remember that in evaluating any supplier's on-time delivery record, care must be taken to distinguish between delays caused by the supplier and those caused by the user or contractor. The former usually occur when the supplier fails to properly schedule his own engineering, procurement, and manufacturing operations or fails to properly oversee the quality and scheduling of the major subsuppliers. The latter normally occur if the user or contractor delays commitment well beyond the time slots anticipated by the supplier, makes significant changes in design or scope long after commitment, or fails to approve or comment on a supplier's drawings and data on a timely basis.

2.2.4.2 Terms and Conditions

Since users, contractors, and suppliers all have their own preferred terms and conditions for governing purchase orders, it is often necessary to compromise. For users and contractors wishing to qualify specific suppliers, the best approach is to develop overriding agreements well in advance of any particular project or purchase order. In the course of reviewing a supplier's terms and conditions, it is recommended that the supplier's financial status be checked via a third party agency.

2.2.4.3 Payment Terms

A supplier's proposed payment terms may have little to do with the quality of the equipment, but they often have a significant effect on cost. Progress payments vary widely in terms of percentages and lead times, and if possible, the payments should be negotiated and evaluated along with terms and conditions during evaluation of the supplier's overall qualifications. From the purchaser's point of view, progress payments should be tied to measurable milestones that can be readily verified.

2.2.4.4 Warranties

Mechanical warranty clauses are normally spelled out in the terms and conditions governing an order. If an overriding agreement with a particular supplier exists, the mechanical warranty clause is already agreed upon and need not be addressed further; the performance guarantee, however, will depend on the nature of the equipment and designated operating conditions. Guarantees relating to performance (such as efficiency or power consumption) or to acceptance criteria for test results (such as maximum leakage rates or maximum vibration or noise levels) should be covered in the technical specifications or data sheets and clearly identified as guaranteed levels.

A supplier of quality equipment often will go well beyond written guarantees after his equipment is put into service. The supplier does this by exhibiting a genuine interest in the actual field performance of the equipment, by keeping the user informed of any design improvements, and by readily issuing a recall notice involving any hidden design defects that, if ignored, could compromise the safe operation of the equipment.

2.2.4.5 Labor Agreements

The expiration of the current labor agreement should be defined as well as any labor disputes that may adversely affect the negotiation of a new contract.

2.3 Comprehensive Specifications

2.3.1 USER REQUIREMENTS CLEARLY STATED

A key item in the communication of a project requirement is the production of a written specification that clearly defines the commercial and technical aspects of the project. Specifications should be clear and concise so that the readers do not have to rely on references or interpretation of intent. The following are guidelines for specifications.

2.3.1.1 Standard Industry Specifications

Wherever possible, widely accepted industry standards, such as API standards, ASTM[7] standards, ASME codes, and ANSI standards, that have a broad base of distribution, understanding, and acceptance should be relied upon.

2.3.1.2 Standard Data Sheets

Where users, contractors, or suppliers are required to add specific information regarding a project, standard data sheets, such as API data sheets, that are easily recognized by all parties should be used.

[7]ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

2.3.1.3 In–House Specifications

In-house specifications should be used whenever standard specifications do not completely cover the topic being addressed. Every effort should be made to include only that portion of an in-house specification that is appropriate.

2.3.1.4 Early Supplier Meetings

If possible, meetings with qualified suppliers should be held to agree on data sheet information and the industry standards that will be involved by the overall project specification.

2.3.2 COMMERCIAL REQUIREMENTS CLEARLY STATED

The initial inquiry should contain all the information necessary for the supplier to quote the equipment. This should include not only complete technical requirements but also all commercial terms.

2.3.2.1 Comments and Exceptions

The supplier shall return his proposal with the required technical information. If the proposal is not in full accordance with the bid specifications, the proposal should contain comments and exceptions. Comments would cover areas of uncertainties in the bid specifications for the purpose of clarification. Exceptions would cover areas of the bid specifications that the supplier cannot or will not comply with. The comments and exceptions shall refer to the location of the relevant specification and, if possible, offer alternatives.

2.3.2.2 Delivery Terms

The proposal shall include price and terms of delivery.

2.3.2.3 Drawing Information

The proposal should include a list of supplier drawings and the period of submittal based upon the receipt of order date. A typical list of vendor drawings can be found in API mechanical equipment standards (for example, API Standard 617). Drawings are usually submitted for information or for approval.

Information drawings are submitted with the expectation that the purchaser will review them for compliance with the contract specifications. The supplier should be advised if the drawings do not reflect the scope of the contract or if the purchaser wishes to alter the scope of the contract. The supplier will continue to pursue his delivery target unless notified otherwise by the purchaser.

Approval drawings are submitted with the expectation that the purchaser will review them for compliance with contract specifications and return them to the supplier with approval or revisions. Normally, the supplier will not proceed until the drawings are returned with approval. The proposal should contain an expected turnaround time from the purchaser for approval drawings to satisfy the target delivery date.

2.3.2.4 Final Order

The final purchase order shall include all agreed upon comments and exceptions and commercial terms.

2.4 Communication Meetings

2.4.1 GENERAL

Of all the facets of a project, communication is probably the most important. Communications are the key to defining the needs of the user to the contractor and to the supplier and subsupplier. Although most communications are verbal, they will result in the final written commercial documents. The primary benefit of a clear line of communication is obtaining a product that satisfies a function or need at the least cost and with the fewest delays.

The pre-award meeting should produce a tentative time table for the various meetings necessary after a contract is awarded. A matrix of people representing the various involved disciplines should be developed and key contact personnel identified. After the meetings are held, the meeting minutes shall be published and distributed to the attendees or other personnel involved in the scope of the project.

2.4.2 TYPES OF MEETINGS

The following are some of the meetings that have been used in successful projects. The complexity of a project will usually determine how many of the following should be considered. The letters U (user), C (contractor), and MS (major supplier) are used to identify usual participants.

2.4.2.1 Project Scope and Machinery Requirements (U and C)

During preliminary project planning and prior to preparation of bid specifications, a meeting should be held to discuss the concept of the project and to further discuss what equipment would best fulfill the needs of the user.

2.4.2.2 Bid Conditioning (U, C, MS, and Major Subsuppliers)

After the bid specifications have been let and the proposals submitted, the purchaser will normally create a short list of suppliers. This list will be determined based on the commercial and technical aspects of the proposals.

The suppliers on the short list would be invited to discuss technical and commercial aspects of the contract. Any uncertainties should be presented and discussed. The bids shall

be subsequently modified to account for any of the items discussed.

2.4.2.3 Pre–Award (U, C, and MS)

After the bids are modified, a pre-award meeting should be conducted to define the final scope of the project.

2.4.2.4 Coordination (U, C, MS, and Major Subsuppliers)

After sufficient time to develop preliminary contract drawings and schedules has passed, a coordination meeting should occur. During this meeting all the technical aspects of the design shall be discussed to resolve all questions and assure compliance with the technical and commercial aspects of the contract.

2.4.2.5 Additional Meetings

Additional meetings may be needed to discuss details of the project as further design efforts evolve. The following topics should be considered:

a. Inspection plan.
b. Supplier and subsupplier.
c. Design audits.
d. Model reviews.
e. Test plans.
f. Installation plan.

Although most of the topics addressed above are for meetings between different companies, meetings to communicate between functions within a company in areas such as purchasing, engineering, marketing, drafting, manufacturing, quality assurance, testing, shipping, and field service are of equal importance and should be encouraged.

2.5 Design Audits

Design audits should be conducted by the supplier and may be requested by the contractor or user. The design audit should be performed as soon as the necessary information is available to finalize design analysis such as fluid dynamic or mechanical performance. It is anticipated that the supplier will perform his own audit prior to second or third party review.

2.5.1 To decide if a design audit is warranted, the purchaser should evaluate the critical nature of the equipment, the supplier's design history, previous industry experience, and the equipment to determine if it is fully spared. This evaluation should be considered prior to purchase so that the requirements are identified in the proposal stage.

2.5.2 The scope of the design audit should be defined in the proposal stage so that information milestones are identified and any additional work for the supplier is defined. The supplier and purchaser shall agree upon the scope of the audit and whether third party consultants will be involved.

2.5.3 The audit will be beneficial to both the supplier and the purchaser. Design functions and improvements, manufacturing problems, procurement definition, installation, and maintainability of the equipment are some of the areas that should be addressed. The intent of the audit is to define and correct design deficiencies before they delay a project or increase its cost.

2.5.4 Refer to Appendix B for a typical design audit checklist and logic diagram of areas to be addressed for a centrifugal compressor. These may be altered to apply to other process machinery.

2.6 Manufacturing Quality Surveillance

2.6.1 Quality surveillance may be used in varying degrees to ensure compliance with specifications. The extent of surveillance may vary considerably. It may consist of relying on the supplier's quality system and reporting mechanisms, or it may consist of active involvement through observed or witnessed testing and/or the use of visiting or resident inspectors.

The inspectors may perform a clerical function to verify contractual requirements for documentation such as chemical composition reports. For more technically detailed testing, the inspectors may include one or more persons, each with a broad technical knowledge of mechanical and functional performance. The user or contractor should identify the qualifications required for the inspectors.

2.6.2 The degree of the surveillance of the documentation and testing should be identified at the bid conditioning meeting and later reviewed at the coordination meeting. Whenever possible, the quality surveillance should utilize as many of the supplier's quality standards as possible.

2.7 Factory Testing

Factory testing is often considered the testing of equipment in part or in whole prior to shipment; however, it may include testing at the component level. These tests may or may not be part of the normal manufacturing inspection of the designed item.

2.7.1 INTENT OF TESTING

Testing is intended to verify the adequacy of a component to provide a function. Many tests are part of the normal procedure of manufacture. Tests are normally done to prevent

problems from being discovered either within or outside the supplier's plant. The problems are more easily resolved, and the design is more easily verified with the least delay and expense at the supplier's facility.

2.7.2 TYPES OF TESTS

The standard tests should be discussed at the proposal stage. Any additional testing should be identified and should become a part of the project scope at the bid conditioning meeting. The option to observe or witness tests should be discussed for each of the tests. Any tests of considerable complexity should be accompanied by a test plan that defines the tests to be performed and the acceptance criteria.

2.8 Field Inspection Prior to Start–Up

One valuable technique for equipment quality enhancement—one that is well worth its cost—is field inspection of the installed equipment just prior to start-up. Maximum benefit is derived when this inspection is made by the same user and contractor personnel that were involved from time of commitment, through drawing reviews, to final shop testing. Supplier quality is not directly enhanced by such inspections. The user benefits directly if any mistakes are discovered, whether they originated in the supplier's shop or were made during field installation, but feedback to the supplier about shop errors can often prevent such errors from being duplicated on subsequent orders for similar equipment.

SECTION 3—GUIDELINES FOR EVALUATION OF A SUPPLIER'S QUALITY SYSTEM

3.1 General

The intent of this section is to provide guidelines that can be used to determine the following:

a. If a supplier has a quality system.
b. If the quality system is based on the following:
   1. Quality control (for example, MIL-I 45208A).
   2. Quality assurance (for example, ISO 9001).
   3. Quality improvement (for example, this recommended practice).
c. How the system is implemented.
d. How well that system accomplishes the desired results.

The evaluation will identify specific areas for improvement (see 3.4). The techniques described in Section 4 can be used by all parties to move beyond the traditional approach.

The framework of a quality assurance system is described in 3.2.1 through 3.2.13. The major subdivisions of this model are based on ISO 9001 and 9004 with additions to suit the needs of users of API mechanical equipment. ISO 9001 defines a general framework for a quality assurance system, but ISO 9004 is a guideline for the implementation of that system. As a result, ISO 9004 is the more definitive of the two and is used as the basis for the evaluation section.

In addition to the quality assurance system guideline suggested by ISO 9004, a framework for quality improvement is provided in 3.2.14. This framework is based on the *Malcolm Baldrige National Quality Award Application Guidelines—1991*, and it is one way a supplier can pursue quality improvement. The addition of quality assurance and quality improvement to quality control results in a total quality system.

The evaluation process is described in 3.3. What to do with the results of an evaluation and the various actions that may be dictated by those results are discussed in 3.4.

Subsuppliers may be adhering to ISO 9002 or ISO 9003; therefore, some parts of Section 3 (and Appendix A) will not be appropriate for evaluation.

3.2 Major Elements of a Total Quality System

3.2.1 MANAGEMENT OF THE QUALITY SYSTEM

a. Responsibility and authority. This defines which functional areas are responsible for administration of the quality system and what their authority is.
b. Communication of quality philosophy. Top management communicates how quality relates to the mission of the company.
c. Quality objectives planning. How the company's business planning activity defines the quality objectives of the company.
d. Quality improvement planning. This planning activity leads to the achievement of the company's quality objectives.
e. System implementation procedures. How quality system operating procedures are installed and made functional.
f. System communication procedure. This is the mechanism used to communicate the quality system and operating procedures throughout the organization, including the policy on distribution of the particulars of the quality system outside the organization.
g. Quality system auditing. This is the method of auditing quality system policy and procedures to ensure applicability and compliance levels.
h. System change procedure. This is the method of revising and re-issuing quality system procedures.

3.2.2 MARKETING QUALITY ASSURANCE

a. Market requirements review. How the marketing/sales organization surveys the marketplace. What kind of information is acquired.
b. Marketing specification procedure. The method that marketing/sales uses to translate market needs and expectations into equipment specifications. Also, how those specifications are transferred to the internal organization.

c. Customer feedback processing procedure. How marketing/sales gets information from equipment users, how that information is processed, and what the uses of this information are.

3.2.3 PROJECT MANAGEMENT ASSURANCE

Project management assurance is not specifically identified in the ANSI or ISO specifications, but because of the importance of its role in the manufacture of equipment built according to API specifications, project management has been included in this quality system framework.

a. Responsibility and authority for the project management function. What this function is responsible for. Also, the authority needed to manage the responsibility.
b. Specification review and output procedure. How customer or marketing specifications are reviewed and translated into documents that can be used by the internal organization.
c. Procedure for communication of project information. How project related information is transmitted between internal and external organizations, how information is processed, who is responsible for what types of information, and who is responsible for information retention.
d. Installation, operation, maintenance, and technical data manuals. Who is responsible for these manuals, and what information is contained in them.

3.2.4 DESIGN QUALITY ASSURANCE

a. Responsibility and authority of the design function.
b. Requirements review and design objectives planning. Methods of reviewing project technical documents or marketing specifications so that design objectives may be defined and planned for.
c. Design output requirements. Definition of what the design project output will be (that is, concepts, drawings, and specifications).
d. Design review procedure. How designs are reviewed, and which functional areas are represented in the review process.
e. Design verification procedure. How designs are verified as conforming to the requirements. Use of tools such as alternative calculations, third-party audits of critical design aspects, or other means. This verification must consider any software or computer programs used in the design or verification process.
f. Design approval procedure (if not included in the design review procedure). How designs are accepted by the organization for productive use.
g. Configuration control procedure. How revision control is exercised over designs, and how design changes are made.
h. Design requalification. How designs are periodically reviewed for soundness, and what the general rules are governing re-release of existing designs.

3.2.5 SUPPLIER (PROCUREMENT) QUALITY ASSURANCE

a. Purchase order contents requirements. Definition of documents and terms associated with communicating requirements to suppliers.
b. Supplier evaluation and selection procedure. How suppliers are evaluated according to their history of performance or as potential suppliers with no history of performance.
c. Supplier rating procedure. Specifics of how historical performance data is gathered and evaluated to arrive at objective ratings. Key elements to be analyzed during the rating process are identified.
d. Purchased material and service quality verification requirements procedure. Planning that defines the quality level of purchased goods or services and how that quality level will be verified (for example, by receiving inspection or supplier certification).
e. Receiving and inspection of purchased goods and services procedure. Definition of controls to be used for receiving and inspection of purchased goods and services.
f. Receiving quality records. How results of receiving inspections are documented, and how these records are included in the supplier rating procedure.

3.2.6 PRODUCTION QUALITY ASSURANCE

a. Planning documents control procedure. Which functional area has the responsibility and authority for process planning, including the authority to make changes.
b. Product and process improvement planning. Identification of objectives and planning for their achievement in both product quality and process refinement.
c. Process capability analysis. How process capability is measured and improved.
d. Material control. How the identity and traceability (when required) of material are managed from receipt as raw material to shipment as finished goods.
e. Qualification of facilities and support equipment. How new or rebuilt process machinery and supporting auxiliaries are qualified for production.
f. Maintenance of precision in production facilities. Preventive maintenance of process machinery and periodic revalidation of performance capability, including disqualification or down-grading of production facilities when necessary.
g. Product verification planning. Guidelines for how and when verification inspections will be conducted on work in process and finished goods.
h. Special process planning. Planning for operations such as welding, heat-treating, and nondestructive testing, including qualification of personnel and machinery/instruments as applicable.

3.2.7 PRODUCT QUALITY VERIFICATION

a. Control of measuring and test equipment. How this equipment is kept in good repair, and what record-keeping requirements may apply.
b. In-process product verification. Guidelines for specification of inspection points for materials in-process.
c. Final product verification. Guidelines for specification of inspections of finished goods.
d. Nonconformance control. How nonconforming material is documented, identified, and disposed of, including means used to prevent mixing nonconforming material with conforming material.

3.2.8 CORRECTIVE ACTION

Note: The elements below deal with trend analysis rather than with individual situations that are documented in the nonconformance control procedure.

a. Responsibility and authority. This defines which functional areas are responsible for initiating corrective action and which functional area is responsible for coordinating the resolution of incomplete actions.
b. Analysis of problems. How problems are identified and designated for corrective action.

3.2.9 SHIPPING QUALITY ASSURANCE

a. Preservation and packaging. How preservation and packaging instructions are communicated to those performing the shipping, and what the responsibilities are in this activity.
b. Shipment identification. How shipment identification instructions are communicated to those performing the shipping, and what the responsibilities are in this activity.
c. Transit, handling, and storage care instructions. How instructions are prepared for and communicated to those responsible for preparing goods for storage or shipment and handling of material in process.

3.2.10 FIELD QUALITY ASSURANCE

a. Responsibility and authority. This defines which functional areas are responsible for field quality assurance and how authority is distributed.
b. Installation, maintenance, and operation instructions. How instructions are communicated to personnel responsible for field activities, and what information these instructions will generally contain.
c. Factory support of field service. Interface points and responsibilities for the flow of information and the handling of problems are defined.
d. Field information feedback. How information regarding product performance is communicated to the supplier's internal organization, and how negative trends are integrated into the corrective action system.
e. Customer information and training. How informational materials are communicated to customers or product users, and how training courses are organized.
f. Field repair facility administration. The relationship of field repair and refit centers to the parent factory and the responsibility/authority for support of these centers are defined.

3.2.11 QUALITY RECORDS SYSTEM

a. Responsibility and authority. This defines which functional areas are responsible for and have the authority for the actions necessary to effectively store quality records.
b. Quality documents requirements review. How requirements are created that define the need for quality records and documents.
c. Product quality verification records storage and retrieval. The responsibility for, authority for, and method of orderly storage and retrieval for all records that contain results of inspections, tests, and other attributes describing the final product configuration are defined.

3.2.12 HUMAN RESOURCE DEVELOPMENT AND TRAINING

a. Responsibility and authority. Which functional areas are responsible for training.
b. Training policy. What type of training is given to organization members.
c. Specific and cross-functional training. Requirements for creation of position-specific training are defined.
d. New employee training. How new employees are given early training that begins the process of integrating the company quality philosophy and other cultural elements.
e. Awareness and motivation training. How training is used to create an awareness of the impact individuals have on quality and to motivate quality performance.
f. Employee performance feedback. How performance feedback is used as a positive tool in the motivation process.
g. Succession planning. How planning is accomplished that targets key organizational positions and provides means of filling sudden vacancies in these key positions.

3.2.13 PRODUCT SAFETY

a. Safety of design evaluation. How designs are evaluated for safety hazards, and how hazards are dealt with.
b. Communication of safety hazard. How installers and users of product are made aware of safety hazards.
c. Product failure investigation. Methods of investigating product failure from all perspectives to eliminate safety hazards and to improve designs.
d. Process failure investigation. Methods of investigating failures in the processes used to manufacture product. These methods are oriented toward eliminating process-produced safety hazards.
e. Product recall procedure. How product is recovered from

field sites or internal storage locations when evaluations or investigations have determined that hazards exist in product already manufactured.

3.2.14 IMPROVEMENT

The following information goes beyond the requirements of ISO 9001 and 9004 to the concept of quality improvement. The following areas of focus are those presented in the *Malcolm Baldrige National Quality Award Application Guidelines—1991*.

CAUTION: This presentation is only one of many ways a company may actively seek improvement. The important elements to consider are the following: Does the supplier seek improvement, and do the efforts show positive results with benefits for both the supplier and his customers?

a. Leadership. How quality values and attitudes are created and reinforced by senior management, and how those values and attitudes are incorporated into the daily activity of the company.
b. Information and analysis. How the company gathers and analyzes information effectively for use in quality improvement and planning purposes.
c. Strategic quality planning. How the company's business plans use customers' needs and expectations to position the company for competitive advantage.
d. Human resource utilization. How the company uses input from the entire work force for quality improvement.
e. Quality assurance of products and services. How the company assures effective control of operational quality, and how control of quality is integrated with quality improvement.
f. Quality results. How the company measures levels of and improvements in quality compared to internal past performance, competing firms, and customer needs.
g. Customer satisfaction. How the company plans to meet customer needs and expectations, and what measurements are used to determine the success of those plans.

3.3 The Evaluation Process

The preceding elements of a total quality system can form the basis for the supplier evaluation process. It is the responsibility of users and contractors to define those elements that are most important in assuring that the product meets their requirements. As requirements vary, system elements change in importance; therefore, proper evaluation techniques are essential to the successful selection of a supplier. Regardless of the make-up of the evaluation team, individual members of the team should have at least some formal training in audit techniques, and the team leader should have some lead-auditor training.

A successful evaluation of suppliers depends upon the qualification of the evaluators. Evaluators must be capable of viewing the supplier's operation objectively, recognizing quality system elements at work, and analyzing the effect of those elements on operations.

Evaluators will identify pertinent questions to be asked during the evaluation. These questions should be sent to the supplier well in advance of the evaluation. The supplier would then prepare supporting evidence to answer the questions.

An effective evaluation of a supplier will help to establish the following:

a. If the supplier has a quality system.
b. What type of system the supplier has.
c. To what extent the system has been implemented.
d. If the system works.
e. How well this system will satisfy the requirements of the parties involved.

Refer to Appendix A for possible questions to be asked during a supplier evaluation.

3.4 Evaluating Results

Evaluators must analyze how well the supplier is suited to perform the proposed work. Evaluators will agree upon the values to be assigned to each answer given during the evaluation. Once these values have been agreed upon and the evaluation scoresheet (see Appendix A) has been completed, the evaluators should meet with the supplier representatives and explain the evaluation results. It is critical that all parties involved understand the basis for the results of the evaluation and have a final chance to provide information that may affect the final outcome. The evaluation will indicate where the supplier stands with quality system implementation and how the user or contractor may most effectively work with the supplier.

If the user or contractor wishes to establish a long-term relationship with the supplier, the evaluation will form a basis for structuring a program for future cooperation. The program will be oriented toward improvements in the respective organizations that will mutually benefit all participants. Refer to Sections 2 and 4 for specific ways of working with suppliers and for information on how improvements in results may be achieved.

SECTION 4—WORKING TOGETHER TOWARD CONTINUOUS QUALITY IMPROVEMENT

4.1 General

This section recommends ways in which users, contractors, and suppliers can work together to move from the traditional quality assurance method (Section 2) toward a total quality system. These recommendations may be used in conjunction with the results of a supplier evaluation (see Section 3) to work toward continuous quality improvement.

The use of this section should be a shared approach by the user, contractor, and supplier. This approach goes beyond traditional methods; it emphasizes the supplier's responsibility for quality. Moreover, users and contractors can help the supplier achieve and/or continuously improve a total quality system while identifying opportunities for improving their own processes. Mutual trust and working together as a team are fundamental principles in this process and are essential to the viability of this approach.

4.2 Improved Communications

4.2.1 MEETINGS

Users, contractors, and suppliers should plan the following meetings:

a. Advance review of project scope and machinery requirements. This meeting is held at the preliminary project planning stage prior to bid specification to discuss the project concept and to further discuss what equipment would best fulfill the user's requirements.
b. User/contractor kick off. This meeting is held at the time of contractor selection so that the user and contractor can know and understand each others' systems and personnel.
c. Single supplier determination. After the contractor team is established, the user and contractor meet to review their lists of prequalified suppliers to determine a single supplier for the project.

4.2.2 DOCUMENTS

A supplier's order entry documents should be prepared or reviewed jointly with the user and/or contractor. The documents should include order-specific data for major subsuppliers. The intent is to create documents that transcribe the customer's requirements to the supplier's in-house documents in an orderly fashion with discussion among all parties leading to common agreement.

4.2.3 ELECTRONIC DRAWING AND DATA TRANSMITTAL

Communications is one of the prime movers of quality enhancement, so the timeliness of communications is paramount. Today's technology contributes to the overall goal of *timely* and *accurate* transmission of data between the team members of any project. Suggested communications tools to be used are as follows:

a. Facsimile transmissions.
b. Direct electronic links between computer aided design (CAD) systems of the various team members. A concerted effort to develop these links is recommended so that the transmittal of drawings and the transfer of data from one team member's document or system to another can be optimized, time requirements can be minimized, and errors in the transmission of data can be prevented.
c. Electronic mail. Computerized proposals, contractual data (including contract data sheets), order records, progress reports, project progress status, nondestructive testing data, and material certificates are examples of information that can be transmitted by electronic mail. This effort can be accomplished using computer disks until the actual electronic mail process between parties is developed and implemented.

4.2.4 TEST AGENDA AND ACCEPTANCE CRITERIA

The team concept of developing the test agenda with the associated acceptance criteria is essential in establishing customer requirements that are realistic, meaningful, and achievable. Team members should direct their efforts at establishing requirements that are meaningful to the customer, documented in a usable form, achievable by the supplier, and cost-effective for all members of the team. API standards, industry standards, supplier standards based on positive experience, and customer standards based on operating experience should provide the basis for test and acceptance requirements.

4.2.5 INSTALLATION AND COMMISSIONING PLAN

To truly meet the customer's requirements, a necessary step in the project's evolution is a team meeting to review what was specified and to compare this to what was actually purchased and then finally designed. Also, the requirements of the installer and operator of the equipment must be considered. Involving the proper team members and introducing them not only to the job requirements in process but also to the final implementation phase will ensure error-free work during the installation, commissioning, start-up, and initial operating phase of the project.

4.3 Improved Feedback

Quality improvement requires improvement of the feedback process. This includes the interaction of all customer-supplier relationships within the order process from marketing through field service in a never-ending improvement cycle.

The true measure of meeting requirements is the feedback mechanisms established *and used* to determine how well the customer's requirements are being or have been met. Suggested methods for measuring this phase of the customer-supplier relationship are post-shipment review and user feedback.

4.3.1 POST–SHIPMENT REVIEW

Post-shipment feedback is often missed but is needed to provide the final measure of meeting requirements. A post-

shipment review meeting could be held to determine first hand if the requirements were met; to determine what went right so that it can be built upon; to determine what went wrong so that it can be corrected; and to mutually agree on changes requested by team members to improve the quality of the next relationship. In one sense, this is a continuation of the process described in 4.2.5.

4.3.2 USER FEEDBACK ON OVERALL EQUIPMENT EXPERIENCE

Order process feedback could be enhanced through the meetings in Section 2 and these additional meetings on an as-needed basis:

a. Pre-inspection (inspection/testing development). The purpose of this meeting is to discuss customer wants and needs for inspections, testing, and certification requirements and to compare desired results and information with suppliers' capabilities and with associated cost benefits. This meeting is held after the coordination meeting and prior to proceeding with manufacturing or production.
b. Project design audit. The object of this meeting is to do a detailed review of the supplier's designs, drawings, and analytical data to satisfy the concerns of all parties regarding designs, factors of safety, and reference data. This review is held after final design is completed and pertinent documents have been issued for user/contractor review but before the equipment is manufactured.
c. Installation and commissioning review. The purpose of this meeting is to familiarize parties responsible for the installation and commissioning of the equipment with those aspects of the equipment that are pertinent to installation requirements or concerns. This should be held at or prior to the equipment mechanical test.

4.3.3 ADDITIONAL MECHANISMS

Additional mechanisms for improving feedback are as follows:

a. Customer satisfaction surveys. After commissioning, an integral part of the measurement of meeting the customer's requirements is surveying the various post-order aspects of the customer-supplier relationship. These aspects should include the following:
   1. Operator and maintenance assessments.
   2. Process feedbacks on performance and reliability.
   3. Service support and response.
   4. Aftermarket (parts) support and response. A necessary part of this would be the supplier's internal tracking of both order history on parts used and specific parts usage history, which may help identify strengths, weaknesses, and areas for improvement.
b. Operation and maintenance seminars.
c. Bulletins that include product updates or improvements.
d. Technology seminars.
e. Technology bulletins.

Improved feedback needs to operate in both directions. A more open team concept in which information beneficial to all team members is shared will improve the quality process of each of the team members.

4.4 Joint Development of Long–Term Requirements

4.4.1 TECHNICAL

This is an area where customers can tell suppliers about long-term projected process needs (such as flows, pressures, temperatures, machine capabilities, and environmental concerns). The equipment supplier can describe development programs, either planned or under way, aimed at meeting perceived customer needs. Periodic discussions can help ensure that the supplier's perception of the customer's equipment needs are accurate and timely.

4.4.2 COMMERCIAL

4.4.2.1 Commercial terms and conditions can be a source of delays and protracted negotiation. Terms and conditions should be jointly developed on the following basis:

a. Are mutually acceptable for long-term or multiproject use.
b. Contain provisions for handling expectations.
c. Eliminate redundant clauses.
d. Contain provisions for periodic review by affected parties.

4.4.2.2 Sharing of strategic planning needs (such as plant sizes, market predictions that might influence equipment needs, or cost/pricing methods) focuses on partnering, blanket terms and conditions, or overriding agreements.

4.4.3 DEVELOPMENT OF QUALITY IMPROVEMENT TECHNOLOGY

A customer–supplier dedicated team focuses on the long-term quality improvement process for the mutual benefit of both parties in achieving a long-term quality relationship.

The suggestions listed herein should not be understood as any form of limitation in the contractual relationship between any individual customer or his supplier.

APPENDIX A—QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST

A.1 General

Most of the evaluation questions that follow are structured around the requirements of ISO 9001 using the implementation guideline of ISO 9004. The corresponding ISO 9004 paragraph number is listed in the reference column next to each question.

In addition to those derived from ISO 9004, certain questions (identified by "#") are derived from the *Malcolm Baldrige National Quality Award Application Guidelines—1991*. Also, there are questions that directly relate to the manufacture of mechanical equipment for the petroleum, chemical, and gas industries. These questions supplement the basic requirements of the ISO specifications by providing enhancements needed for mechanical equipment manufacturing.

A.2 Instructions

A.2.1 RESPONSIBILITIES OF PARTIES

A.2.1.1 Evaluators

It is the responsibility of evaluators to prepare for evaluations by determining which questions of the evaluation model are appropriate and applicable to the situation. Evaluators must then transmit the appropriate questions to the supplier being evaluated.

A.2.1.2 Suppliers

It is the responsibility of the supplier to prepare for the evaluation by assembling supporting evidence to properly answer the evaluation questions.

A.2.2 EVALUATION PROCESS

During the course of the evaluation, the evaluators will decide upon responses that reflect the level of implementation for each evaluation question. Evaluators should make every effort to view the supplier quality system elements that answer these questions within the context of the requirement at hand. It is critical that evaluators be as objective as possible in analyzing the levels of implementation. Once the evaluation is complete, the evaluators should collectively arrive at the levels of implementation to be assigned. The evaluation scoresheet (see Figures A-1 and A-2) should then be completed. Once the raw evaluation scores have been summarized, the evaluators should meet with the supplier representatives to discuss the results of the evaluation. There should be a clear understanding by all parties concerned about the final scores assigned to the evaluation.

A.2.3 PURPOSE OF EVALUATION

It must be emphasized that the purpose of this evaluation is not to determine a pass/fail score. The purpose is to determine if a supplier is capable of managing the quality aspects of the task at hand and how the user/contractor can best work with the supplier. Any attempt to confer certification or degrees of capability is beyond the purview of this recommended practice.

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST

Supplier:	Evaluator:	Date:

QUESTIONS	SOURCE[a]	LEVEL OF IMPLEMENTATION						COMMENTS (Provide support for high or low findings. Note those items not capable of being evaluated)
		Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
3.2.1 Management of the Quality System								
1. Has top management stated and communicated a corporate quality policy?	4.2							
2. Has the quality policy been organized into a formal, fully implemented quality system?	4.4, #							
3. Are functional areas aware of and able to execute their role in the quality system?	#							
4. Are adequate resources devoted to the quality system?	5.2.4							
5. Are customer quality assurance requirements managed effectively?	#							
6. Does the supplier perform periodic audits of the quality system and implement corrective action?	5.4.2							
7. Is this quality system qualified to national or international standards?	#							
8. Can this supplier demonstrate measurable quality improvement?	6.0							
3.2.2 Marketing Quality Assurance								
1. Does marketing/sales understand and communicate customer expectations for quality, prices, and delivery?	7.1							
2. Does a marketing system exist that gathers and monitors data on product field performance?	7.3 16.3							
3. Does marketing/sales obtain assurances from the internal organization before technical and commercial commitments are made?	#							
4. Does the supplier have an effective system to accurately transfer the customer's technical and commercial project requirements from marketing/sales to the internal organization after an order?	#							
3.2.3 Project Management Assurance								
1. Does the supplier have a project management function?	#							
2. Do persons staffing this function have demonstrable actual or related experience in managing similar projects?	#							
3. Does the organization structure confer adequate authority to these project managers?	#							
4. When does the project management function end its involvement with a project?	#							
5. Are instruction or installation manuals the responsibility of project management? Do these manuals contain correct and proper technical information?	# #							

[a]Questions derived from ISO 9004 are identified by the corresponding ISO 9004 paragraph number. Questions marked "#" are derived from the *Malcolm Baldrige National Quality Award Application Guidelines—1991* or relate directly to the manufacture of mechanical equipment for the petroleum, chemical, and gas industries.

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST—continued

Supplier: Evaluator: Date:

QUESTIONS	SOURCE	LEVEL OF IMPLEMENTATION						COMMENTS (Provide support for high or low findings. Note those items not capable of being evaluated)
		Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
3.2.4 Design Quality Assurance								
1. Does the supplier have a design function that is responsible for translation of customer and marketing specifications into internal company language?	8.1							
2. What are the duties of the personnel in the design function and how are the personnel made aware of their responsibility for the quality of product design?	8.2.1							
3. Are quality features of designs clearly stated? Do the quality features have clear acceptance criteria included? Are safety, reliability, maintainability, and serviceability factors considered by the design project?	8.2.5 8.2.5 8.2.5							
4. Are design reviews conducted at the end of each design phase or in total at the end of the design project?	8.5.1							
5. Are functional areas that affect quality represented in the design review process?	8.5.1							
6. Does the supplier use a system of design verification (such as alternate calculations, prototype testing, third party verification, or design audits) to validate designs and any supporting software that is used?	8.5.3							
7. Does the design approval process provide a formal authorization that releases the design for production?	8.6							
8. Does the design control system require approval of design changes before the changes are implemented? Does this system provide for the removal of superseded documents or software and a method to verify that changes were correctly effected?	8.8 8.8							
9. Are results of field performance information gathering used to further validate designs?	8.9							
3.2.5 Supplier (Procurement) Quality Assurance								
1. Does the supplier have a system of managing the quality of purchased goods and services?	9.1							
2. Does the supplier have a documented method of evaluating subsuppliers?	9.3							
3. Does the supplier periodically re-evaluate subsuppliers based on performance history and changes in the business environment?	9.3							
4. Does the supplier's communication of requirements include definition of quality elements the subsupplier is responsible for?	9.4							

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST—continued

Supplier: Evaluator: Date:

QUESTIONS	SOURCE	LEVEL OF IMPLEMENTATION						COMMENTS (Provide support for high or low findings. Note those items not capable of being evaluated)
		Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
3.2.6 Production Quality Assurance								
1. Are product operations planned with documented steps necessary to achieve an outcome?	10.1.1							
2. If plan steps are changed, does the planning authority validate those changes?	#							
3. Do production plans or supporting design documents show acceptance criteria for work being performed in the operations steps?	10.1.1							
4. Do production plans require verification of quality at logical points within the sequence?	10.1.2							
5. Does the supplier have documented evidence that the production facility is capable of producing the required levels of precision?	10.2							
6. Do material control procedures assure that origins of goods requiring traceability are maintained during receiving, storage, and production operations?	11.2							
7. Is there a preventative maintenance program that addresses those aspects of the production process that are key to the achievement of the required level of quality?	11.3							
8. Does the control system require certification of persons performing those special processes? Are certified personnel given training specific to the processes involved? Do the certification methods conform to accepted practices such as those provided by ASNT[b] and those found in Section IX of the ASME Code?	11.4 18.2 11.4 18.2 11.4 18.2							
9. Does the supplier have a document control system that provides assurance that only the correct revision work instructions, drawings, and specifications are available for use?	11.5							
10. Do processing documents allow distinction between verified and unverified material?	11.7							
11. Does the supplier have a system for control of nonconforming material?	11 8							
3.2.7 Product Quality Verification								
1. Are in-process inspections and tests planned to occur at appropriate points in the production cycle?	12.2							
2. Does the supplier use appropriate final product inspection or testing to determine product acceptance, performance, or design conformance?	12.3							
3. Does the supplier have a system to maintain and calibrate measurement equipment so that it is traceable to national standards?	13.1							
4. Does the supplier require subsuppliers to have an appropriate calibration system?	13.3							
5. Does the nonconformance system provide for review of nonconformances by designated and technically competent personnel?	14.4							
6. Is the nonconformance system documented in detailed procedures or instructions?	14.6							
7. Is historical nonconformance data analyzed to prioritize corrective actions?	14.7							

[b]American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228-0518.

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST—continued

Supplier:	Evaluator:	Date:

QUESTIONS	SOURCE	LEVEL OF IMPLEMENTATION						COMMENTS (Provide support for high or low findings. Note those items not capable of being evaluated)
		Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
3.2.8 Corrective Action								
1. Does the supplier have a formal corrective action system directed toward long-term problem resolution?	15.2							
2. Does the corrective action system confer responsibility and authority on a functional area to manage resolution of issues?	15.2							
3. Are valid statistical methods used in corrective action investigations when appropriate?	15.5							
4. Do corrective action investigations result in preventative measures appropriate to the problem at hand?	15.6							
5. Are effects of preventative measures monitored to ensure that expected results are achieved?	15.7							
6. Do preventative measures result in permanent changes to processes or procedures?	15.9							
3.2.9 Shipping Quality Assurance								
1. Does the supplier use documented procedures for packaging, protection, and identification requirements?	16.1.4							
2. Are the procedures adequate to ensure product identification and protection during transient storage and installation?	16.1.4							
3.2.10 Field Quality Assurance								
1. Does the supplier identify and provide special tooling or equipment for handling, assembling, and disassembling the machinery in the field?	16.2.1							
2. Is the design and function of special tooling or handling equipment proven before it is released for field use?	16.2.1							
3. Does the supplier issue appropriate instructions dealing with installation, commissioning, operation, and maintenance of product in a timely fashion? Do these instructions provide accurate and clear guidance to persons that must rely on the instructions?	16.2.3 16.2.3							
4. Does the supplier have a sufficient number of trained field service personnel?	16.2.4							
5. Do the supplier's field service centers have the same technical quality capability as the factory? Do field centers have on-site technical support or are they supported from the parent factory?	16.2.4 16.2.4							
6. Does a system exist that gathers and monitors data on product field history?	7.3 16.3							
7. Are problems defined by this system assigned to responsible parties for corrective action?	7.3 16.3							
8. Does the supplier have a field notification system that makes users of equipment aware of product enhancements or upgrades that could be used to improve the performance of existing machinery? Does the supplier issue field bulletins of information that could be helpful to users of the product?	# #							

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST—continued

Supplier:	Evaluator:	Date:

QUESTIONS	SOURCE	LEVEL OF IMPLEMENTATION						COMMENTS (Provide support for high or low findings. Note those items not capable of being evaluated)
		Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
3.2.11 Quality Records System								
Are quality records protected and stored for a specified period of time in a fashion that allows retrieval of specific data?	17.3							
3.2.12 Human Resource Development & Training								
1. Does the supplier have a means of identifying the need for training of personnel?	18.1.1							
2. Are technical personnel given training that will enhance their contribution to the success of the quality management system? Are production personnel, including supervisors, given training that enhances the quality of their performance?	18.1.3 18.1.4							
3. Are personnel given training in how their job performance influences product quality?	18.3.1							
4. Does the supplier measure achievements in quality improvement?	18.3.4							
5. Are persons or groups that make significant contributions to quality improvement recognized for their efforts?	18.3.4							
3.2.13 Product Safety								
1. Does the supplier have a program that addresses the safety aspects of the product or service?	19.0							
2. Are there relevant safety standards that can be applied to the product or service? If no relevant safety standards exist, has the supplier developed objective safety standards?	19.0 19.0							
3. Has the supplier conducted design evaluations or prototype testing to analyze safety factors? Are the results of these evaluations or tests documented?	19.0 19.0							
4. Has the supplier structured warnings, labels, and informational material in a fashion that clearly communicates warning or caution?	19.0							
5. Does the supplier have an effective means of reviewing discrepancies and field problems to analyze the need for corrective action?	19.0							

QUALITY ASSURANCE SYSTEM EVALUATION CHECKLIST—continued

Supplier:	Evaluator:	Date:

QUESTIONS	COMMENTS
3.2.14 Improvement	
1. Does the company gather information for use in quality improvement? Are results of analyses used in planning activity oriented toward further improvement?	
2. Does the supplier conduct long-term strategic quality improvement planning?	
3. Does this planning include analysis of customers' needs and expectations?	
4. Does this planning produce a prioritized set of quality objectives for both the short term and the long term?	
5. Does the company's human resource planning interface with the quality objectives planning for the short and long term?	
6. Does the supplier work to continuously improve the product or services offered? Does the supplier work to continuously improve the processes that support the product or services?	
7. Does the supplier evaluate the quality of material or services received from others? Does the supplier work with those providers of material or services to improve the as-received quality?	
8. Does the supplier summarize trends in quality improvement and report these summaries as management information?	
9. Do these summaries provide information on product or service factors that have been identified as key elements in achieving customer satisfaction?	
10. Are quality improvement results compared to and benchmarked against industry leaders and world leaders?	
11. Is there a continuous improvement mechanism included in the management of customer relationships?	
12. Is the customer included in the analysis of relationships and improvements?	
13. Are corrective actions taken when complaints occur or when negative trends develop?	
14. Does the supplier have a standardized method of handling customer complaints? Is complaint information analyzed as a source of quality improvement data?	
15. Does the supplier use results of customer satisfaction determinations as an element of the quality improvement process? Are trends in customer satisfaction summarized and reported as management information?	

Supplier:	Evaluator:	Date:

ELEMENTS	SCORES BY LEVEL OF IMPLEMENTATION						COMMENTS (Attach additional sheets if needed)
	Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
1. Management of the quality system							
2. Marketing quality assurance							
3. Project management assurance							
4. Design quality assurance							
5. Supplier quality assurance							
6. Production quality assurance							
7. Product quality verification							
8. Corrective action							
9. Shipping quality assurance							
10. Field quality assurance							
11. Quality records system							
12. Human resource development and training							
13. Product safety							
14. Improvement							
COLUMN TOTALS							

TOTAL _____

Figure A-1—Blank Evaluation Scoresheet

Supplier: XYZ Company, Houston, TX	Evaluator: Smith & Jones	Date: 1/24/90

ELEMENTS	SCORES BY LEVEL OF IMPLEMENTATION						COMMENTS (Attach additional sheets if needed)
	Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
1. Management of the quality system		X					
2. Marketing quality assurance		X					
3. Project management assurance				X			
4. Design quality assurance			X				
5. Supplier quality assurance				X			
6. Production quality assurance			X				
7. Product quality verification				X			
8. Corrective action		X					
9. Shipping quality assurance			X				
10. Field quality assurance			X				
11. Quality records system				X			
12. Human resource development and training			X				
13. Product safety		X					
14. Improvement	X						
COLUMN TOTALS	1	4	5	4	0	0	

TOTAL _____

Figure A-2—Sample Evaluation Scoresheets

Supplier: Improvement Company	Evaluator: Black & Green	Date: 4/5/91

ELEMENTS	SCORES BY LEVEL OF IMPLEMENTATION						COMMENTS (Attach additional sheets if needed)
	Not Applicable	Not Acceptable	Minimal	Acceptable	Good	Excellent	
1. Management of the quality system						X	
2. Marketing quality assurance				X			
3. Project management assurance						X	
4. Design quality assurance						X	
5. Supplier quality assurance					X		
6. Production quality assurance					X		
7. Product quality verification						X	
8. Corrective action						X	
9. Shipping quality assurance				X			
10. Field quality assurance				X			
11. Quality records system					X		
12. Human resource development and training						X	
13. Product safety					X		
14. Improvement						X	
COLUMN TOTALS	0	0	0	3	4	7	

TOTAL _____

Figure A-2—continued

APPENDIX B—TYPICAL DESIGN AUDIT CHECKLIST

A design audit is intended to define possible deficiencies in a project and allow correction before they delay or add cost to the project (see 2.5.3). A typical audit checklist and logic diagram (see Figure B-1) for a centrifugal compressor are presented here. These can be used as a guide when a design audit of other process machinery is being considered.

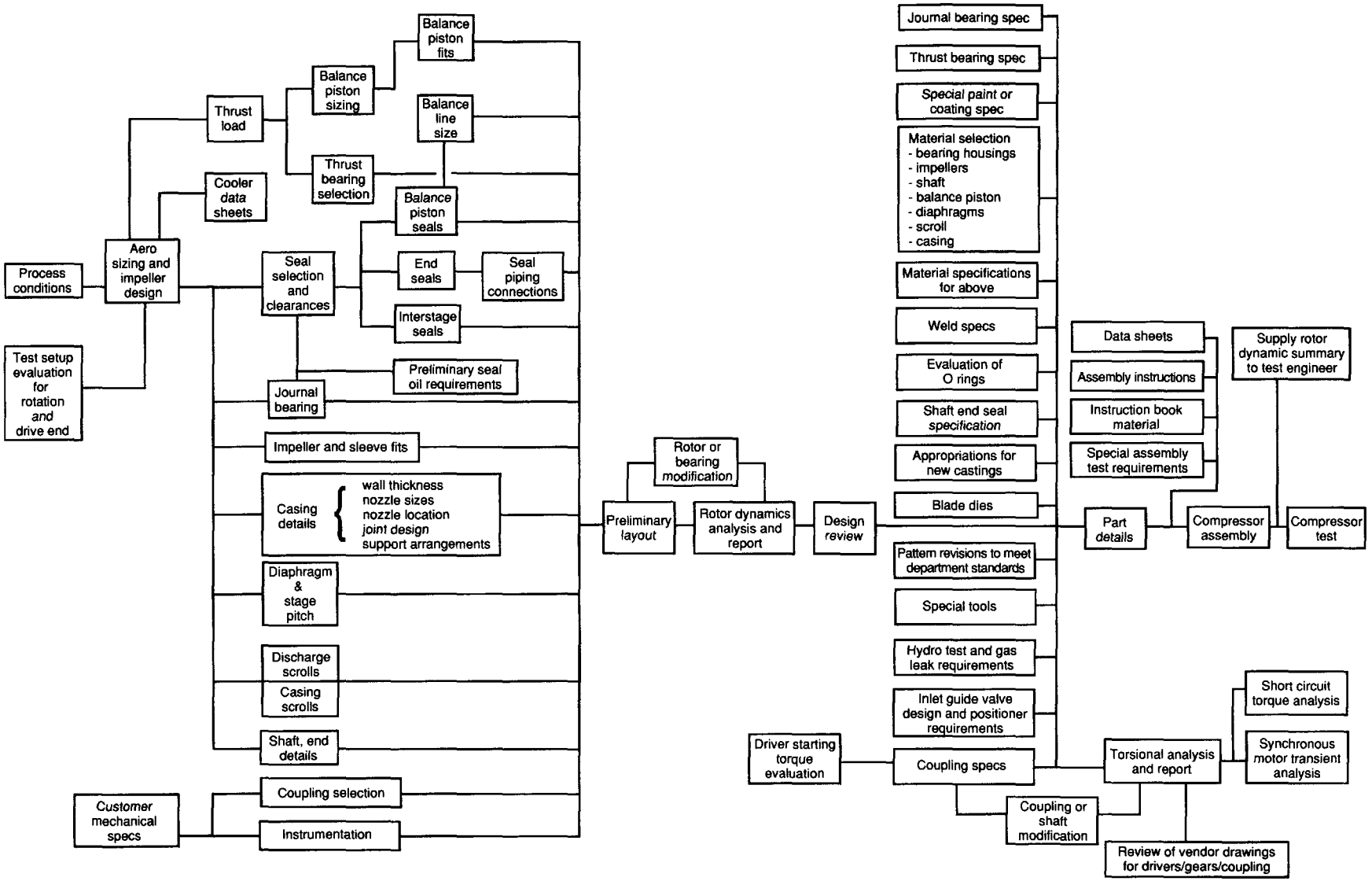

Figure B-1—Compressor Design Audit Logic Diagram

Compressor Design Audit Checklist

1. AERODYNAMIC DESIGN

1.1 Impellers

1.1.1 Rating, gas analysis, off-design operating points.
1.1.2 Impeller design, blading, slip, efficiency, blade frequency.
1.1.3 Calculated horsepower vs. guarantee.
1.1.4 Rotor thrust.

1.2 Stationary Flow Path Parts

1.2.1 Diffusers and return vanes—new or existing, flow path.
1.2.2 Discharge scroll.
1.2.3 Casing inlet and discharge areas, flange velocity.
1.2.4 Recirculation losses/balance piston leakage.
1.2.5 Equalizing line flow area.
1.2.6 Inlet guide vane.

2. MECHANICAL DESIGN

2.1 Rotor

2.1.1 Impeller, balance piston material and heat treatment. H_2S or other contaminants? Special materials required?
2.1.2 Impeller stresses—disc geometry, blade thickness.
2.1.3 Impeller, balance piston and sleeve interference fits, growth due to shrink fits.
2.1.4 Rotor seal clearances.
2.1.5 Critical speeds.
2.1.6 Shaft material and stresses.
2.1.7 Coupling and keys.
2.1.8 Torsional.
2.1.9 Balance provisions.

2.2 Casings

2.2.1 Design and hydrotest pressure.
2.2.2 Stresses—joint design.
2.2.3 Material.
2.2.4 Support and doweling arrangement.
2.2.5 Diaphragm support and stresses.
2.2.6 Upper half removal clearance.
2.2.7 Casing vents and drains.
2.2.8 Weldment review.
2.2.9 Seal housing.

2.3 Bearings and Bearing Housings

2.3.1 Radial bearings—size, type, load, clearance, oil flow.
2.3.2 Thrust bearings—size, type, load, axial float, oil flow.
2.3.3 Bearing housing material.
2.3.4 Bearing housing bolting and doweling.
2.3.5 Cavity drains.

2.4 Shaft Seals

2.4.1 Type.
2.4.2 Clearances.
2.4.3 Material.

2.5 Monitoring Equipment

2.5.1 Vibration monitors.
2.5.2 Temperature monitors.

3. COMPRESSOR TOOLING CHECKLIST

3.1 Impellers

3.1.1 Plug gauges.
3.1.2 Hub models.
3.1.3 2D and 3D impeller locating tools.
3.1.4 Blade position fixture.
3.1.5 Reamers.
3.1.6 Balance mandrels.
3.1.7 Overspeed mandrel, if not the same as the balance mandrels.

3.2 Balance

3.2.1 Drive coupling.
3.2.2 Keys for drive coupling.
3.2.3 Filler keys for check balance for shaft with single keyway.

3.3 Hydro

3.3.1 Ring gauges.
3.3.2 Special blind plates for seal housings.

3.4 Shaft

3.4.1 Ring gauges.
3.4.2 Thread gauges.

3.5 Lift Tools

3.5.1 Rotor.
3.5.2 Barrel—discharge diaphragm and bundle removal.
3.5.3 Multistage—top casing half, diaphragms.β.
3.5.4 Single stage—lift nuts, inlet nozzle.

3.6 Test

3.6.1 Special piping.
3.6.2 Coupling adapters.
3.6.3 Nozzles.

APPENDIX C—COMMENTS AND SUGGESTIONS FOR IMPROVEMENT OF API RECOMMENDED PRACTICE 683

COMMENTS AND SUGGESTIONS FOR IMPROVEMENT OF API RECOMMENDED PRACTICE 683

Suggested revisions to this recommended practice are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

Name: _____ Title: _____

Company: _____

Address: _____

_____

The above information is optional. Please answer the questions below and/or write in other comments.

1. Are you a ☐ Supplier? ☐ Contractor? ☐ User?
   ☐ Accredited Registrar? ☐ Other (please specify)? _____
2. Type of equipment: _____
3. Are you involved in evaluation of quality systems?
   ☐ Yes ☐ Somewhat ☐ No
4. Do you use ISO 9000 in these evaluations?
   ☐ Yes ☐ Somewhat ☐ No
5. Does your company have an audit guide for supplier quality management systems?
   ☐ Yes ☐ No
6. Does your company have written procedures for auditing suppliers' continuous quality improvement processes?
   ☐ Yes ☐ No
7. If you answered yes to question 5 or 6 and you have utilized or currently utilize third-party quality systems, indicate what you utilize the systems for:
   ☐ Evaluation ☐ Registration ☐ Both
8. Do you use appropriate industry-specific quality assurance standards in conjunction with generic standards like the ISO 9000 series?
   ☐ Yes ☐ No
   Please describe: _____
9. Is this the first time you have used API Recommended Practice 683? ☐ Yes ☐ No
10. What is your overall impression of API Recommended Practice 683? ☐ ☐ ☐ ☐ ☐
    Poor Average Excellent
11. How useful is it? ☐ ☐ ☐ ☐ ☐
    Not at All Somewhat Very Useful

    Please comment: _____

12. API Recommended Practice 683 is intended to complement the ISO 9000 (ANSI/ASQC Q90) series of standards. In your opinion, how well has this been accomplished?

☐ ☐ ☐ ☐ ☐
Not at All Somewhat Very Well

Please comment: _____

13. How useful are the questions in Appendix A?

☐ ☐ ☐ ☐ ☐
Poor Average Excellent

14. If you had to rate the questions in Appendix A, list a few of them that you would judge to be:

Excellent (Very Useful)	Average (Useful)	Poor (Not Useful)

Please provide any comments you wish to make regarding your answers above: _____

15. Explain how quality and service of mechanical equipment affect your company's performance. Also, how does (or how should) the use of quality standards and manuals like this recommended practice help you improve your performance (please be specific)?

16. This recommended practice was written to complement the ISO 9000 (ANSI/ASQC Q90) series of standards and individual product standards to improve quality by affecting the functionality of products in the mechanical equipment industry (in particular, those covered by API mechanical equipment standards).

a. Does this recommended practice accomplish this purpose?

☐ ☐ ☐ ☐ ☐
No Somewhat Yes

b. What should be changed to make this recommended practice more usable (be specific)?

Order No. 822-68300

1-1400—9/93—1M (4E)

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005