

FLUID SYSTEM COMPONENT SPECIFICATION PREPARATION CRITERIA

This AIR has been adapted from the Aerospace Fluid Component Designers' Handbook (Report No. RPL-TDR-64-25), prepared by TRW Systems, Redondo Beach, California, under contract to the Air Force Rocket Propulsion Laboratory, Edwards AFB, California.

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	3
2. SPECIFICATION TYPES	3
2.1 Performance Specification	3
2.2 Manufacturing Specification	4
2.3 Proprietary Specification	5
3. SPECIFICATION FORMAT	5
4. SPECIFICATION CONTENT	5
4.1 Scope	6
4.2 Applicable Documents	6
4.3 Requirements	6
4.4 Quality Assurance	7
4.5 Preparation for Delivery	12
4.6 Notes	12
5. SPECIFICATION LANGUAGE	12
5.1 General	12
5.2 Contractual Language	12
5.3 Measurement Terminology	12
5.4 Unenforceable Phraseology	13
5.5 Use of <u>or equal</u>	14

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TABLE OF CONTENTS (Continued)

	<u>Page</u>
6. APPLICABLE DOCUMENTS	15

TABLES

4. Specification Content	17
4.3 Performance Parameters for Typical Fluid Components	20
6. Applicable Documents	22

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1. **INTRODUCTION:** The importance of adequate component procurement specifications to the success of a hardware development program cannot be overemphasized. Specifications which are too stringent can be as detrimental as specifications which are too lax. Performance specifications, for instance, must not only clearly identify all the component requirements, but must also include sufficient quality assurance provisions so that compliance can be verified.

The purpose of this information report is to describe specification types, provide guidance for the adequate preparation of fluid component specifications, and identify applicable documents commonly referenced in fluid component specifications.

2. **SPECIFICATION TYPES:** Fluid component specifications can be categorized according to one of the following three basic types: performance, manufacturing, and proprietary. Each type is outlined below and discussed in detail in subsequent paragraphs.

- (1) **Performance Specification** - Identifies the constraining parameters, details the required performance, and specifies the tests needed to verify conformance of the product to performance requirements.
- (2) **Manufacturing Specification** - Identifies the complete design, including materials, processes, tolerances, dimensions, and configuration, in sufficient detail for any qualified manufacturer to produce the product.
- (3) **Proprietary Specification** - Identifies the exact make, model, or part number and allows no latitude for deviation from the specified item(s).

- 2.1 **Performance Specification:** A performance specification is a clear and accurate description of the design, construction, and performance requirements of a product, with provisions for determining compliance of the end product to the description. A performance specification is written as the basis for the procurement of an end product which will completely fulfill all specified requirements.

To accomplish this objective, a performance specification must provide complete and thorough answers to the following basic questions:

What is the product?

What physical, chemical, or mechanical constraints are imposed on the product?

When appropriately applied, what must the product accomplish?

In what environments must it function, and within what limits?

What tests and inspections will prove performance and compliance with requirements?

2.1 Performance Specifications (Cont'd.):

How is the product to be finished, marked, cleaned, packaged, etc.?

What documentation is required?

What are the life and reliability requirements, and how is compliance to be demonstrated?

What are the maintenance requirements?

What safety devices and features can be included in the design?

A well-written specification will answer each of the above questions clearly. If any question is not answered, it is possible that something has been overlooked, and trouble may be experienced during procurement or application of the product.

Many component problems in aerospace fluid systems can be traced to performance and test specifications which either lack important information, or are based on unrealistically stringent requirements. Specifications which do not adequately cover component requirements can result in components failing to meet their intended function and an expensive redevelopment and retrofit program.

Alternately, unnecessarily stringent or conservative specifications will require excessively long and expensive development programs which can result in over-designed units.

The added design complexity required to meet unreasonably severe functional requirements such as response time, leakage, regulation bands, and unrealistic environmental requirements, often results in excessive costs, long delivery times, and unreliable systems. A good performance specification, therefore, must not only consider all the requirements of the component for its intended function, but also avoid placing on the component severe performance or environmental margins which could seriously compromise the end result.

- 2.2 Manufacturing Specification: A manufacturing specification is a document containing enough detailed information to produce the end product described without requiring any additional design work. This specification contains the necessary design details, materials, manufacturing methods, and processes necessary to produce the product.

This type of specification is often used to obtain competitive procurement of a well-seasoned design, and if properly prepared and administered, can produce a competitive procurement of a very complex product at minimum cost.

Particular care should be taken to prevent inclusion of performance specifications and tests in a manufacturing specification. Such a combination of performance and manufacturing specifications may be

2.2 Manufacturing Specification (Cont'd.):

unenforceable, because if the specified design and manufacturing data do not produce a component with the specified performance, the specification is obviously in conflict within its own sections, and the contractor cannot be held responsible.

2.3 Proprietary Specification: The proprietary specification specifies the required product by make, model, and manufacturer's part or catalog number. This type of specification is the easiest means of delineating the required item, and helps to assure that the specific component desired will be furnished. The proprietary specification should never include the words or equal or similar phraseology, because the burden of proof of equality is on the purchaser. If the words or equal or similar phraseology are required by governmental regulations, then a performance specification should be used, with clearly defined tests and inspections included to verify equality. Sub-Topic 5.5 discusses the or equal clause. When performance and test requirements are included, the specification is no longer a proprietary specification, but becomes a performance specification.

3. SPECIFICATION FORMAT: The format of a specification should be as simple as possible, and arranged in such a manner that information of a specific type may be readily located and referenced. MIL-STD-490 presents the general format which is widely used both in governmental and industrial specifications. The major sections of a specification, listed below in the commonly accepted order are:

Scope
Applicable Documents
Requirements
Quality Assurance Provisions
Preparation for Delivery
Notes

The level of detail under each heading is a function of the complexity of the device or system, and the type of specification, either proprietary, manufacturing, or performance. Since the proprietary specification usually requires only the part number to describe an item, the standard format will contain sections which are not necessary, such as "Scope" and "Applicable Documents." The use of section headings is still suggested, however, so that quality assurance and preparation for delivery requirements are more easily recognized.

The manufacturing and performance specifications utilize all sections of the standard format and contain a high level of detail in each section.

4. SPECIFICATION CONTENT: The contents of each of the six standard specification sections are discussed in the following paragraphs. Table 4 lists the major topics which should be included in each section.

- 4.1 Scope (Section 1): The "Scope" section may be a very brief statement describing the coverage of the specification for a simple device, or it may require a long description of limiting parameters for a more complex device or system having a complicated interface definition.
- 4.2 Applicable Documents (Section 2): The proper use and application of referenced documents are the most difficult aspects of specification writing. The specification writer is often unable to investigate thoroughly the content and applicability of the referenced documents. As a result, specifications may not spell out the extent of applicability of referenced documents, and documents are often listed which are never again referenced or used in the specification. A tabulation of frequently-used applicable documents for fluid component specifications is shown in Table 6.

Several rules which are commonly followed as an aid in the preparation of an Applicable Documents section are:

- (a) List only those documents which are actually referenced in the specification text.
 - (b) In the specification text indicate the specific portions of the applicable document which are pertinent.
 - (c) Specify the date of issue or date of applicability of the referenced document. For example, the words "latest issue" are not enforceable and should not be used because a contractor can only bid on a definable set of specifications of a specific date. The date of bid is commonly used as date of applicability. In some procurements, an earlier issue of the referenced document may be desired and thus specified to utilize desirable features of an out-dated document.
 - (d) Review the referenced documents to assure that they are actually applicable.
- 4.3 Requirements (Section 3): "Requirements" should be the focal point for the specification, with all other sections supporting this key section. It should contain a complete description of the performance, design, construction, and other characteristics required of the product. The performance requirements of a performance specification should be clearly stated in this section, care being taken to insure that the full range of operating conditions are specified, and the remainder of the specification should be tailored to assure that the item is tested, packaged, inspected, and documented to assure this performance. Test requirements may be stated along with limiting parameters, but the detailed test procedures to implement the test requirements should be included under "Quality Assurance Provisions", Section 4.

The inclusion of all critical performance parameters in the "Requirements" section is of utmost importance in the preparation of a performance specification. As an aid in the preparation of performance requirements,

4.3 Requirements (Section 3) (Cont'd.):

Table 4.3 lists typical fluid component performance parameters, indicating the types of components to which they normally apply. Before a test or performance requirement is specified it should be examined for applicability unique to fluid components fabricated of non-metallic materials, (fuel cells, seals, coated fabrics, etc.)

The "Requirements" section of a performance specification should define each operating parameter under which the device being specified must perform. This definition should include the operating environment as well as the interaction of the component with the system in which it is installed. Performance requirements should include the number of operating cycles required of the component.

In addition to steady-state factors the performance requirements should include dynamic or transient conditions. Other applicable factors, such as thermal interaction and contamination should be clearly defined.

The ideal performance specification contains the actual required upper and lower performance limits of a component. In a new field involving research and development, however, the performance margins may not be well defined. Under these circumstances, a safety factor may have to be applied to certain performance parameters to help assure a successful piece of hardware. Safety factors should be selected with great care to assure a reliable end product as a minimum requirement, and still stay within the limits of practicability. Another precaution when assigning safety factors is to assure that the safety factor is applied only once. In large programs involving many persons, groups, and agencies, there have been instances of each taking an additional safety factor, compounding the original and valid requirement. When this happens, cost and weight are almost always excessive.

After the performance requirements have been specified, a cross-check should be made with test requirements to assure compatibility of the two sections. A performance requirement is meaningful only if a means of testing the performance can be accomplished. Therefore, a test should be provided for each performance requirement and each test requirement should relate to one or more performance requirements.

4.4 Quality Assurance Provisions (Section 4): This section should include all test methods, test procedures, and inspections necessary to support the "Requirements" section of the specification. (Testing provisions are normally applicable only to a performance specification.)

Test requirements should be stated in sufficient detail to establish communication between buyer and seller Test PLANS, which describe, in general, what testing is to be accomplished, should be included under Quality Assurance Provisions. The supplier usually produces detailed test procedures from the plans, unless the buyer has provided detailed test procedures.

4.4.1 Types of Tests: There are three basic reasons for testing a device or system: to determine (1) what the component or system will do, (2) the ability of a device or system to withstand the operating environment, and (3) how long or how reliably the component or system will perform without failure. The tests used to make these determinations are called:

- (a) Functional tests (performance)
- (b) Environmental tests
- (c) Reliability tests (life and limit)
- (d) Development tests
- (e) Design verification tests
- (f) Prequalification tests
- (g) Qualification tests
- (h) Preproduction, pilot model, pilot lot tests
- (i) Production acceptance tests
- (j) Production monitoring tests
- (k) System integration tests.

The extent of testing is usually a compromise between (1) testing which is necessary to assure reliability, and (2) the time, money, and facilities available to perform the test. This tradeoff is especially difficult to make for components which are to be utilized in space vacuum and zero gravity, because of the cost associated with environmental simulation.

4.4.1.1 Functional Tests - Functional tests are performed to determine the operating parameters of a component or system; they determine such characteristics as:

- Flow rate
- Pressure drop
- Strength (proof or burst)
- Internal leakage
- External leakage
- Flow and pressure control
- Response
- Power requirements
- Repeatability
- Contamination tolerance

4.4.1.2 Environmental Tests - Environmental tests are specified to simulate the most severe non-operating or operating conditions anticipated for the component or system. Compatibility of a component with its operating environment is normally determined by testing under separate environments; e.g., vibration, low temperature, etc. The effect of combined environments operating simultaneously is an important consideration, however, and should be evaluated as part of an environmental test program. As combined environmental testing is very expensive, complete combined environmental simulation is not always practical. Tests must be carefully devised to provide the best

4.4.1.2 Environmental Tests (Cont'd.):

simulation within the confines of budget and schedule. Typical exposures included in environmental test specifications are:

- Temperature
- Humidity
- Salt spray
- Sand and dust
- Altitude (vacuum)
- Mechanical shock
- Thermal shock
- Vibration
- Acceleration
- Acoustic noise
- Chemical compatibility
- Radiation
- Fungus

4.4.1.3 Reliability Tests - Reliability tests are performed to determine the probability that a component will fulfill its intended function. Components which are cyclic in operation are usually tested for a number of operating cycles until failure, and components which operate continuously are usually tested to determine the mean time to failure. Cyclic tests can usually be repeated with sufficient frequency to simulate the operating cyclic life in a reasonably short test period. On the other hand, continuous life tests may be difficult to simulate, particularly on components designed to operate thousands of hours in normal service.

Limit testing, or performance margin testing, determines the margin of safe operation over and above design conditions. Limit tests are conducted by progressively increasing the severity of a test parameter, such as temperature, until the component fails. The margin of safe operation over the design conditions is a measure of the component's functional reliability. Limit tests should not be confused with limit load tests performed to verify structural ability to withstand a design limit load without failure. The corresponding limit test for a structural element is the ultimate load test in which the element is loaded to failure.

Tests may also be categorized according to the time or phase of a program during which the tests are performed. Such tests are:

- Development Tests
- Design Verification Tests
- Prequalification Tests
- Qualification Tests
- Preproduction Tests

4.4.1.3 Reliability Tests (Cont'd.):

Production Acceptance Tests
Production Monitoring Tests
System Integration Tests

All of these include functional tests, and may also include environmental and reliability tests.

4.4.1.4 Development Tests - These tests are performed on initial prototype hardware or sub-assemblies to check out the design parameters during the development process. Development tests should be used to verify such factors as flow areas, pressure drop, sizing of subcomponents for power drain, and functional operation plus all other requirements necessary to produce a complete set of engineering drawings which will describe a component capable of meeting its specification requirements. The model used for such tests is usually a "breadboard," boiler plate," or "engineering model" which has been produced specifically for these tests. The tests should serve to provide data required to finalize a new design, or to optimize an existing design to comply with new requirements. Adjustments, rework, repair, and retest are normal functions during a development test. Specifications should require that all activities, adjustments, and repairs be accurately recorded during testing. Reasons for repair as well as details of all repairs and adjustments should be documented for future correlation with the production unit.

4.4.1.5 Design Verification Tests - These tests should be run on initial prototype hardware prior to release of production drawings and actual fabrication of production hardware. Design verification tests are planned to prove that a component has the capability of meeting all of its functional and the most critical of its environmental requirements. Component design verification tests allow system tests to be started with maximum assurance that components have proven the capability for performing their system function prior to performing time-consuming life or reliability tests.

4.4.1.6 Prequalification Tests - Prequalification tests (also called design approval tests, preliminary flight rating tests, and flight certification tests) are run on production hardware prior to its use for flight testing to determine whether the article fabricated by production tooling and techniques will perform as capably as when fabricated as a prototype. These tests should include all functional and environmental requirements, and some life-cycle tests. The tests must prove at this point that the production hardware is capable of meeting all of the required parameters for at least the length of time required by the flight test program. Special "stress to failure" tests are sometimes included as part of prequalification testing. These tests, which can be destructive, are designed to prove margins of safety over minimum design requirements.

- 4.4.1.7 Qualification Tests - Qualification tests are normally formal demonstrations (in contrast to evaluations) with production hardware, and are the final test requirements for the component or system. A primary difference between formal qualification tests and other tests is that this test is used to demonstrate rather than evaluate the product. They should consist of all the steps taken in prequalification tests, as well as the following:
- (1) The component tested should be randomly selected, representative production-type hardware and made entirely with the manufacturer's production tooling and processes.
 - (2) The number of samples tested should be adequate to prove that the components are statistically capable of meeting their reliability requirements.
- 4.4.1.8 Preproduction, Pilot Model, Pilot Lot Tests - When an extensive production run of products is anticipated, tests are often performed to check the conformance of the preproduction or pilot units prior to commencing a full scale production run. These tests are called preproduction tests, pilot model tests, or pilot lot tests. The individual tests may consist of any or all of the tests in the categories of functional, environmental, or reliability testing.
- 4.4.1.9 Production Acceptance Tests - These are tests run on deliverable production-type hardware to assure that they are identical in design and manufacture to those components which have previously completed the formal qualification and/or prequalification test programs. Although these tests are of a quality-control nature, they are an integral part of the step-by-step program to ensure a satisfactory end product. During early hardware production, acceptance tests may include limited environmental testing, e.g. temperature and vibration. Testing of this nature is commonly called Production Environmental Testing (PET). These tests usually start on a 100 percent basis, with the number of parts tested reduced to a sampling basis as confidence in the production is increased, until the PET testing is ultimately dropped with subsequent acceptance testing limited to the normal bench-type functional tests.
- 4.4.1.10 Production Monitoring Tests - These tests are conducted at prescribed intervals to subject the product to more intensive or extensive conditions than are encountered in the normal production acceptance test. These tests can be either destructive or non-destructive and are performed on a sampling basis.
- 4.4.1.11 System Integration Tests - These tests are performed to evaluate the compatibility of the components with system requirements, and serve to evaluate and optimize checkout and operating procedures. Although a component may have been correctly designed to fulfill its own function, its compatibility with related equipment and its workability as part of an integrated system must be demonstrated.

- 4.4.2 Criteria For Success: Each test section in a performance specification should contain a clear statement of criteria for successful completion of the test. Unless this is done, enforcement of performance requirements cannot be accomplished.

An example of the importance of success criteria was demonstrated on a pump procurement based on a test specification requiring a 1000-hour life test. However, criteria for successful test completion were not specified. The pump operated 1000 hours successfully, but disassembly after test revealed cracked and broken bearings. Since adequate criteria for success had not been specified, the test was considered to have been successful. The production run of several hundred pumps experienced similar cracked bearings in service, and were later rebuilt at an extremely high cost.

- 4.5 Preparation For Delivery (Section 5): This section should include all necessary information on the packaging and packing of the component to assure safe delivery to the destination, and should take into consideration the duration and environment of the storage to which the product will be subjected prior to ultimate use. Particular attention should be given to the cleaning portion of a specification for fluid components to assure that the cleanliness requirements are realistic and that cleanliness standards can be achieved at a reasonable cost.
- 4.6 Notes (Section 6): This section is designed to include any information which does not readily fit into the other sections, and usually includes such information as intended use, ordering data, symbols, and definitions. The information related to intended use is of particular importance to a manufacturer, and inclusion of this information may eliminate many misunderstandings between the procuring agency and the producer.

5. SPECIFICATION LANGUAGE:

- 5.1 General: The success of a device or system is highly dependent upon the quality of the specification to which the item or system is constructed. The wording of a specification must be clear, concise, and non-conflicting.
- 5.2 Contractual Language: The word "shall" is used for all contractually binding requirements. The use of "will," "should," or "may" indicates recommended, desirable, or preferable, but non-mandatory requirements. When "shall" is used, the requirement is binding on either the contractor or the purchaser. The word "will" is used to express a declaration of purpose on the part of the purchaser.
- 5.3 Measurement Terminology: Dimensions, capacities, sizes, temperatures, accuracies, and tolerances should be specified in accordance with acceptable governmental or industrial practice. The use of percentage tolerances should be avoided when absolute values can be assigned. For instance, 95 to 105 volts would be preferable to 100 volts \pm 5 percent. The use of absolute values eliminates the need for unnecessary arithmetic. If there is a strong

5.3 Measurement Terminology (Cont'd.):

desire to indicate a nominal value, 100 ± 5 volts would be used. The specification of thickness or diameter by a gage number alone should not be used. If a gage number is indicated, the actual thickness or diameter should also be indicated.

5.4 Unenforceable Phraseology: A specification may have little value if it contains expressions and phrases which cannot be enforced contractually. A review of specifications will often reveal phrases similar to the following:

- (a) "In accordance with good commercial practice..."
This phrase is meaningless because good commercial practice may not be satisfactory, and even if commercial practice is satisfactory, the phrase does not refer to any industrial standard or code for performance standards, and therefore is unenforceable.
- (b) "The intent of this specification is to..."
This phrase appears frequently, and is usually ineffective because contracting personnel can only enforce the requirements of the contract, and may experience difficulty enforcing the "intent" of the specifications. A specification should contain the requirement rather than the intent of the purchaser.
- (c) "The relays shall be capable of closing when a 28-volt signal is applied..."
Whether the relay is capable of closing or not is unimportant. The important fact is whether or not the relay closed. The specification should have read... "The relay contacts shall close when a 28-volt signal is applied." The word "capable" is used only where some necessary condition of performance has not been stated. For example, "The pyrometer shall be capable of indicating ambient temperature with the range of 32 to 100 degrees Fahrenheit."
- (d) "As a design objective the..."
This phrase implies that it may be impossible to meet some objective or criterion, and that the contractor should at least try to approach the requirement. Phrases of this type cannot be administered or enforced. Wherever possible, a specification should contain firm, quantitative requirements which can be evaluated, rather than the unenforceable qualitative words illustrated in this

5.4 Unenforceable Phraseology (Cont'd.):

example. If such unenforceable phraseology is used, the specification should include elsewhere definite, required levels of the same parameters discussed under "Design objective".

- (e) "...consistent with good engineering practice..."
This phrase is of dubious value and implies that there is possibility of receiving bad engineering practice. Phrases of this type should refer to a specific engineering code or standard rather than generalities.
- (f) "...suitable for the purpose intended..."
This example contains two unenforceable phrases. Suitable for is an unenforceable generality, and purpose intended is a matter of judgement or interpretation. In many cases, the manufacturer has little or no knowledge of the detailed system into which a component will be assembled. For this reason, the component manufacturer may not be capable of determining suitability for a specific purpose.
- (g) "The equipment shall be suitably protected..."
Specifications should be definitive in requirements. The words suitably protected in a component specification might mean protection by means of anything from a plastic bag to a steel shipping container. The protection requirements should be detailed in specific terms rather than the vague phraseology used in this example.
- (h) "Only long life components shall be used..."
Vague performance requirements such as this example are meaningless. The number of operating cycles or mean time to failure should be specified, and tests to prove the life characteristics of the component should be included.

5.5 Use of "or equal":

There have been many legal cases involving the use of the phrase or equal in specifications; likewise, there is often considerable doubt in the minds of specification writers regarding its proper use. Regulations governing the use of or equal are contained in Armed Services Procurement Regulations, Section 1-1206.2, "Brand Name or Equal Purchase Descriptions." These regulations have been included by reference only in this subsection because

5.5 Use of "or equal" (Cont'd.):

they are in a constant state of flux. The current regulations require, under certain circumstances, that the contractor submit to the contracting officer certain data and information for evaluation.

These regulations assume that the contractor will give the pertinent data for comparison, and assume also that the contracting officer has equivalent data on the brand names specified and is technically capable of evaluating the comparative data. The current regulations appear to make the contracting officer responsible for determination of equality.

If vendors misrepresent the capabilities of their products in their standard published data and contracting officers do not have equivalent data on the specified brand names, the enforcement of an or equal clause is virtually impossible.

To evaluate quality properly, a specification should contain the critical performance requirements and tests to evaluate compliance with these requirements. The burden of proof of equality should be the responsibility of the contractor; he should be required to demonstrate compliance by test.

Any contractual arrangement which requires a comparative evaluation on any basis other than tests may result in the delivery of an inferior product.

6. APPLICABLE DOCUMENTS: Table 6 lists some of the applicable documents commonly cited in fluid component specifications. It should also be noted that the supplier should use diligence in seeking out other applicable documents.

Military specifications, standards, etc., are catalogued in the Department of Defense "Index of Specifications and Standards." Part I, Alphabetical Listing, and Part II, Numerical Listing. The "Index of Specifications and Standards" can be obtained from:

Commanding Officer
Naval Publications & Forms Center
Attention: NPFC 3064
5801 Tabor Avenue
Philadelphia, PA 19120

6. APPLICABLE DOCUMENTS (Cont'd.):

Military specifications (MIL), military standards (MS), Air Force-Navy Aeronautical specifications (AN) and standards (AN, AND), can be obtained by contractors or other qualified requestors from:

Commanding Officer
NPFC 3064
Naval Supply Depot
5801 Tabor Avenue
Philadelphia, PA 19120

TELEX 834295
Western Union: 710-670-1685
Telephone: 215/697-3321
Autovon: 442-3321

Society of Automotive Engineers (SAE): Aerospace Standards (AS), Aerospace Recommended Practices (ARP) and Aerospace Information Reports (AIR) can be obtained from:

SAE, Inc.
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Warrendale, PA 15096

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TABLE 4. SPECIFICATION CONTENT

Section 1 - Scope

- (a) Brief statement of coverage
- (b) Brief description of item
- (c) Type or class of item

Section 2 - Applicable Documents

- (a) Referenced specifications
- (b) Referenced standards
- (c) Referenced drawings
- (d) Referenced exhibits
- (e) Referenced publications

Section 3 - Requirements

3.1 Operational Requirements: (This is what the item has to do)

- (a) Service life
- (b) Leakage
- (c) Flow
- (d) Pressure drop
- (e) Cleanability
- (f) Electrical design requirements
- (g) Hydraulic design requirements
- (h) Other

3.2 Operational and Environmental Conditions: (These are the conditions under which the item shall meet the specified requirements)

- (a) Cycle
- (b) Operating fluids
- (c) Operating pressure
- (d) Proof pressure
- (e) Burst pressure
- (f) Operating temperature
- (g) Contamination
- (h) Storage requirements
- (i) Lubrication
- (j) Thermal shock
- (k) Acoustical noise
- (l) Vibration
- (m) Shock
- (n) Acceleration
- (o) Humidity
- (p) Fungus
- (q) Salt spray
- (r) Other

3.3 Construction Requirements: (How the item is to be built)

- (a) Envelope
- (b) Weight
- (c) Installation
- (d) Materials
- (e) Castings
- (f) Welding
- (g) Brazing
- (h) Joining methods
- (i) Threaded connections
- (j) Thread inserts
- (k) Self-locking nuts
- (l) Screw and bolt length
- (m) Snap rings
- (n) Electrical connections
- (o) Stress concentration
- (p) Finish
- (q) Identification & markings
- (r) Nameplate
- (s) Other markings
- (t) Maintainability
- (u) Standardization
- (v) Interchangeability
- (w) Design change control
- (x) Other

NOTE: Requirements listed under the above paragraphs may be either deleted or added to as required by the detail specification. For example, materials are frequently not specified in a model specification.

Section 4 - Quality Assurance Provisions

- (a) Test methods and procedures to support requirements stated in Section 3, including criteria for success:
 - Development
 - Design verification
 - Qualification
 - Production
 - Acceptance
- (b) Sampling requirements and procedures
- (c) Examinations and inspections

Section 5 - Preparation for Delivery

- (a) Cleaning
- (b) Painting
- (c) Packaging
- (d) Preserving
- (e) Marking
- (f) Identification

3.3 Construction Requirements (Cont'd.):

Section 6 - Notes

- (a) Safety
- (b) Intended use
- (c) Drawing and data requirements
- (d) Test reports
- (e) Ordering data
- (f) Maintenance data requirements
- (g) Special tools
- (h) Symbols
- (i) Definitions
- (j) Miscellaneous
- (k) Failure analysis reports

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TABLE 4.3 - PERFORMANCE PARAMETERS FOR TYPICAL FLUID COMPONENTS

	Shutoff Valves	Flow Control Valves	Pressure Regulators	Relief Valves	Servo-Valves	Explosive Valves	Multiple Passage Valves	Check Valves
WORKING FLUID(S)	X	X	X	X	X	X	X	X
PRESSURE CONSIDERATIONS:								
Burst Pressure	X	X	X	X	X	X	X	X
Proof Pressure	X	X	X	X	X	X	X	X
Operating Inlet Pressure	X	X	X	X	X	X	X	X
Operating Outlet Pressure	X	X	X	X	X	X	X	X
Differential Pressure at Rated Flow	X	X		X	X	X	X	X
Cracking Pressure				X				X
Reseat Pressure				X				X
Outlet Pressure Symmetry (multiple outlet ports)					X		X	
Lockup Pressure			X					
Lockup Differential Pressure			X					
Outlet Pressure Regulation Range		X	X		X			
Pressure (load) Droop			X					
Reference Pressure Sensing Considerations			X	X				
FLOW CONSIDERATIONS:								
Rated Flow (load and no-load as applicable)	X	X	X	X	X	X	X	X
Flow Range (throttleability)		X	X		X			
Flow Coefficient	X	X				X	X	
Flow Characteristics (linear, parabolic, etc)		X			X			
Load Flow - Pressure Characteristics					X			
Saturation Flow					X			
Outlet Flow Symmetry (multiple outlet ports)					X		X	
LEAKAGE CONSIDERATIONS:								
External Leakage	X	X	X	X	X	X	X	X
Internal Leakage	X	X	X	X	X	X	X	X
Null Leakage					X			
Quiescent Flow (leakage flow versus spool position, max at null)					X			
INPUT POWER OR FORCE CONSIDERATIONS:								
Actuation Force or Torque	X	X					X	
Actuation Power	X	X			X	X	X	
Pull-In Voltage	X						X	
Holding Voltage	X						X	
Drop-Out Voltage	X						X	
Coil Resistance and/or Impedance	X				X	X	X	
Rated Current	X				X	X	X	
Quiescent Current					X			
Null Bias Current					X			
Dither Current					X			
All-Fire Current						X		
No-Fire Current						X		
Phasing and/or Polarity	X				X		X	

TABLE 4.3 - (CONTINUED)

	Shutoff Valves	Flow Control Valves	Pressure Regulators	Relief Valves	Servo-Valves	Explosive Valves	Multiple Passage Valves	Check Valves
OUTPUT VERSUS INPUT CONSIDERATIONS:								
Time Response	X	X		X			X	
Deadband		X	X		X			
Linearity		X	X		X			
Hysteresis		X	X		X			
Resolution		X			X			
Gain (flow and/or pressure)		X			X			
Null Pressure Gain					X			
Hydraulic or Flow Null					X			
Null Shift (pressure and temperature effects)					X			
Transient (step) Response Time			X		X			
Overshoot Allowable and/or Settling Time From Step Input			X		X			
Frequency Response, Phase Lag, Amplitude Ratio (load and no-load)		X	X		X			
Feedback Considerations					X			
LIFE CONSIDERATIONS:								
Duty Cycle	X	X	X	X	X	X	X	X
Operating Cycle (total time and/or number of cycles)	X	X	X	X	X	X	X	X

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