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UNIFIED FACILITIES CRITERIA (UFC)

OPERATION AND MAINTENANCE: UNMANNED PRESSURE TEST FACILITIES SAFETY CERTIFICATION MANUAL

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OPERATION AND MAINTENANCE: UNMANNED PRESSURE TEST FACILITIES SAFETY CERTIFICATION MANUAL

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	Date	Location

This UFC supersedes Military Handbook 1039/2, dated 30 June 2000. The format of this document does not conform to UFC 1-300-01, however it will be rerformatted at the next revision.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request (CCR). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://dod.wbdg.org/.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

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CHAPTER 1

INTRODUCTION

1-1 **PURPOSE AND SCOPE**. This UFC is comprised of two sections. Chapter 1 introduces this UFC and provides alternate requirements of other Tri-Service agencies. Appendix A contains the full text copy of the previously released Military Handbook (MIL-HDBK) 1039/2. This UFC serves as criteria until such time as the full text UFC is developed from the MIL-HDBK and other sources.

1-2 **APPLICABILITY**. This UFC applies to all Navy service elements and Navy contractors; all other DoD agencies may use either document unless explicitly directed otherwise.

1-2.1 **Air Force Requirements**. Air Force pressure vessels must be inspected in accordance with AFI 32-1068, *Heating Systems and Unfired Pressure Vessels* as a minimum. Air Force Bases may adopt as an alternative to AFI 32-1068, procedures of this UFC for inspection and certification of unfired unmanned pressure vessels.

APPENDIX A

MILITARY HANDBOOK 1039/2
UNMANNED PRESSURE TEST FACILITIES SAFETY CERTIFICATION MANUAL

ABSTRACT

This document is approved for use by all departments and agencies of the Department of Defense (DOD).

Unmanned pressure test facilities have been in use by DOD personnel for centuries. To date there has not been a requirement to have these specialized facilities certified. Certification has been a standard requirement for all other classes of pressure vessel and certification standards and criteria has been developed for each class of pressure vessel. One such standard is MIL-HDBK-1152, Inspection and Certification of Boilers and Unfired Pressure Vessels. This document has been used by public works boiler and pressure vessels inspectors in an attempt to certify unmanned pressure test facilities. However, the criteria contained in MIL-HDBK-1152 are inappropriate for this type of pressure vessel. This document is written with the hopes of providing criteria and guidance for the certification and safe use of these specialized types of pressure vessels.

UNMANNED PRESSURE TEST FACILITIES
SAFETY CERTIFICATION MANUAL

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Section 1: INTRODUCTION

1.1 System Certification. This document provides specific certification guidelines for the design, construction, modification, repair, operation, and maintenance of Department of Defense unmanned pressure test facilities. Except as noted in par. 1.4, Department of Defense unmanned pressure test facilities include all pressure vessels used for testing and evaluating equipment or for unmanned medical or physiological experiments. System certification is a recommended prerequisite for all unmanned pressure test facilities used or operated by Department of Defense personnel, military or civilian. This prerequisite pertains to in-service systems built by the Department of Defense or private industry and privately owned systems that are under contract and operated by Department of Defense personnel. Exemptions from system certification may be granted through an operational waiver granted by the NAVFAC System Certification Authority (SCA).

1.1.1 Objective. The objective of system certification is to verify, by means of an independent technical review and evaluation, that when approved operating and maintenance procedures are followed, the pressure vessel system provides acceptable levels of safety to personnel and property throughout its specified operating range. This objective is accomplished by performing a detailed review of the material and procedural adequacy of the system.

1.1.2 Principal Participants. The principal participants in the system certification process are: (1) the system sponsor, (2) the system applicant, and (3) the SCA, NAVFACENGCOM.

1.1.2.1 System Sponsor. The system sponsor is normally the organizational unit responsible for funding the development, construction, repair, alteration, operation and/or maintenance of the unmanned pressure test facility. For systems already in existence and having achieved initial certification (see Section 3), the sponsor will normally be the parent command.

1.1.2.2 System Applicant. The applicant is normally the organizational unit responsible for the day-to-day operation and maintenance of the system. The applicant applies to the SCA for certification, and deals directly with the SCA in all certification related matters.

The sponsor and the applicant may be the same organizational unit, as in the case of an Acquisition Manager applying for initial certification of a newly developed system. Throughout the remainder of this document, only the term applicant is used when discussing the certification process. This does not, however, exclude the sponsor from participation in the process wherever appropriate.

1.1.2.3 SCA. The certification process is most effective and least complicated when:

a) The applicant designates a single, knowledgeable individual to serve as the point of contact for the certification effort.

b) The applicant has a clear understanding of the certification process.

c) The SCA has a clear understanding of the candidate system.

d) The SCA and the applicant communicate freely and frequently.

The importance of a continuing exchange of information between the applicant and the SCA cannot be overemphasized. Through open discussions and negotiation, the applicant and the SCA can establish a realistic balance between cost and time considerations and system certification objectives. Also, the SCA will gain a better knowledge and understanding of the candidate pressure vessel system through frequent contact with the applicant.

The ability of the system either to fulfill its mission or to meet program goals, other than safety, is not within the purview of the SCA.

1.2 Standard DOD Syntax Summary. This document utilizes standard DOD syntax regarding permissive, advisory, and mandatory language. Intended word meanings are as follows:

a) "Must" has been used only when application of a procedure is mandatory.

b) "Should" has been used only when application of a procedure is recommended.

c) "May" and "need not" have been used only when application of a procedure is discretionary.

d) "Will" has been used only to indicate futurity. It is never to indicate any degree of requirement for application of a procedure.

1.3 Purpose. The purpose of this document is to describe the system certification process and to provide guidance in implementing a certification program. Technical information and justification submitted by the applicant forms the basis for determining the material and procedural adequacy of each system to perform safely. This document describes the procedures and criteria used by the SCA that must be followed by the applicant.

Sections 2 through 5 provide detailed information about the certification process and the documentation required by the SCA. Appendices A and B provide technical requirements that must be met to successfully achieve certification. Appendix C provides guidance for the required documentation. Glossary contains a list of definitions. In hopes of achieving a more comprehensive understanding, readers are encouraged to review these definitions before proceeding with the remainder of the document.

1.4 Scope and Applicability. As stated previously, the scope of this document includes unmanned pressure test facilities used for testing and evaluation purposes or for unmanned medical or physiological experiments. It also includes the associated piping, mechanical, and electrical subsystems required to operate these pressure vessels. It further ensures the safety of operating personnel and the protection of property. Safety of the objects or subjects being tested is not within the scope of this document.

More specifically this document applies to pressure vessels of the classes described in Tables 1 and 2. Examples include, but are not limited to:

a) Pressure vessels used to subject test article(s) to a simulated Deep Ocean Environment using a liquid (incompressible) or gaseous (compressible) media
b) Pressure vessels that perform Medical Research using compressible test media (air, helium, helium/oxygen, hydrogen, hydrogen/oxygen, etc,)
c) Pressure vessels that perform helium soak (integrity) testing of components that will later be subjected to a Manned Hyperbaric Environment

Pressure vessels used for the storage of gases or liquids are covered by other standards such as MIL-HDBK-1152, American National Standards Institute (ANSI) NB-23, National Board Inspection Code, or Department of Transportation (DOT) specifications. Also, open tanks and towers used for testing equipment are not within the scope of this document.

1.4.1 Unmanned Pressure Test Facility Classification Criteria. Classification of the unmanned pressure test facility should be determined as follows:

a) First, choose the appropriate classification with regard to design pressure and size of the vessel in accordance with Table 1.

b) Secondly, review pressurization media of the test facility in accordance with Table 2. The most restrictive classification derived from the two tables should apply.

For further clarification of certification requirements for each pressure vessel class, see Table 3.

1.5 <u>System Certification Procedures</u>. The basis for system certification will be the evaluation of the OQE (refer to par. 2.5.2 for definition) submitted by or in the custody of the applicant and such on-site surveys and audits as are deemed necessary by the SCA. Where applicable, OQE should, encompass areas of:

a) Design

b) System drawings

c) Materials of construction

d) Construction, fabrication, and assembly

e) Quality assurance/control

f) Testing

g) Operability

h) Maintainability

Table 1
Unmanned Pressure Test Classification

	=< 6" I.D. Any Length	> 6" I.D. to 5 ft^3	> 5 ft^3 to 50 ft^3	> 50 ft^3
< 15 psig	Not Required	Not Required	Not Required	Class C
15 to 150 psig	Not Required	Class C	Class B	Class A
> 150 to 600 psig	Class C	Class B	Class A	Class A
> 600 psig	Class B	Class A	Class A	Class A

Table 2
Pressurization Media

	< 15 psig	15 to 150 psig	> 150 to 600 psig	> 600 psig
Pressure Media Liquid	Not Required	Class C	Class B	Class B
Pressure Media Gas	Not Required	Class B	Class A	Class A
Pressure Media Hazardous[1] (Gas or Liquid)	Class A	Class A	Class A	Class A

[1]Hazardous Media is defined as any gas or liquid that is flammable, toxic, or poisonous

1.5.1 New System. For a new system design, the applicant should present OQE documenting the above areas to the SCA during one or more formal design/construction reviews as appropriate. Preparation and presentation of this OQE must be specifically required by the terms of the contract or specifications and is the responsibility of the applicant. For a newly fabricated system which is an exact duplicate (e.g., design, material, depth limits, temperature, environment, etc.,) of a certified system, on-site surveys of the configuration, quality control, testing records, previous certification documents, and a demonstration of the system may provide sufficient OQE.

1.5.2 Existing System. For a system already in existence and possibly in service, the assembly of sufficient OQE might require considerable effort. If OQE is not retrievable, the information may have to be recreated. To recreate OQE, the applicant may have to resort to nondestructive and/or destructive testing, inspection, and design review analysis. The applicant should consult with the SCA for direction as to the required OQE necessary to certify the existing facility based on its intended use.

The criteria required by this document will not necessarily cause the system certification of current tenure to be suspended or terminated prior to normal expiration. However, all recertifications and continuances should be judged using the criteria established by this document.

It must be recognized that new information that may become available during the on-site survey, or subsequent to certification, may indicate the existence of an unsafe condition that previously had not been identified. In such cases, when the potential danger from the newly reported condition warrants, the SCA will direct a reevaluation of the system design. Suspension or termination of certification may result.

Section 2: THE SYSTEM CERTIFICATION PROCESS

2.1 Introduction. This section explains the major events during the system certification process and provides information for assisting the applicant in preparing the required documents (refer to Appendix C). Figure 1 represents the sequence of the major events and identifies whether the action is the responsibility of the SCA or the applicant. The Glossary defines the terms used throughout the certification process. These definitions should be reviewed before proceeding with the remainder of this document.

2.2 Application for System Certification. The certification process begins when the applicant submits a letter to the Commander, NAVFACENGCOM, in standard DOD format, requesting certification of his or her unmanned pressure test facility. The application should include the following items:

a) Identification of the applicant and a point of contact

b) General system description

c) Desired system use, type of intended testing

The SCA should respond to the application, making comments as appropriate, and request funding and request submission of the following documents:

a) Scope of Certification (SOC)

b) Milestone Event Schedule (MES)

c) System drawings

2.2.1 Scope of Certification (SOC). The applicant should submit a detailed list of all portions of the system and its ancillary equipment, which are expected to fall within the SOC as defined in the Glossary. The SOC boundaries will be approved or modified by the SCA.

As an aid in defining the SOC, especially for complex systems, the applicant is referred to the hazard analysis techniques described in the Hazard Analysis section of MIL-STD-882, System Safety Program Requirements. Additional guidance is provided by the hazard categories defined in par. 2.2.2 and Figure 2.

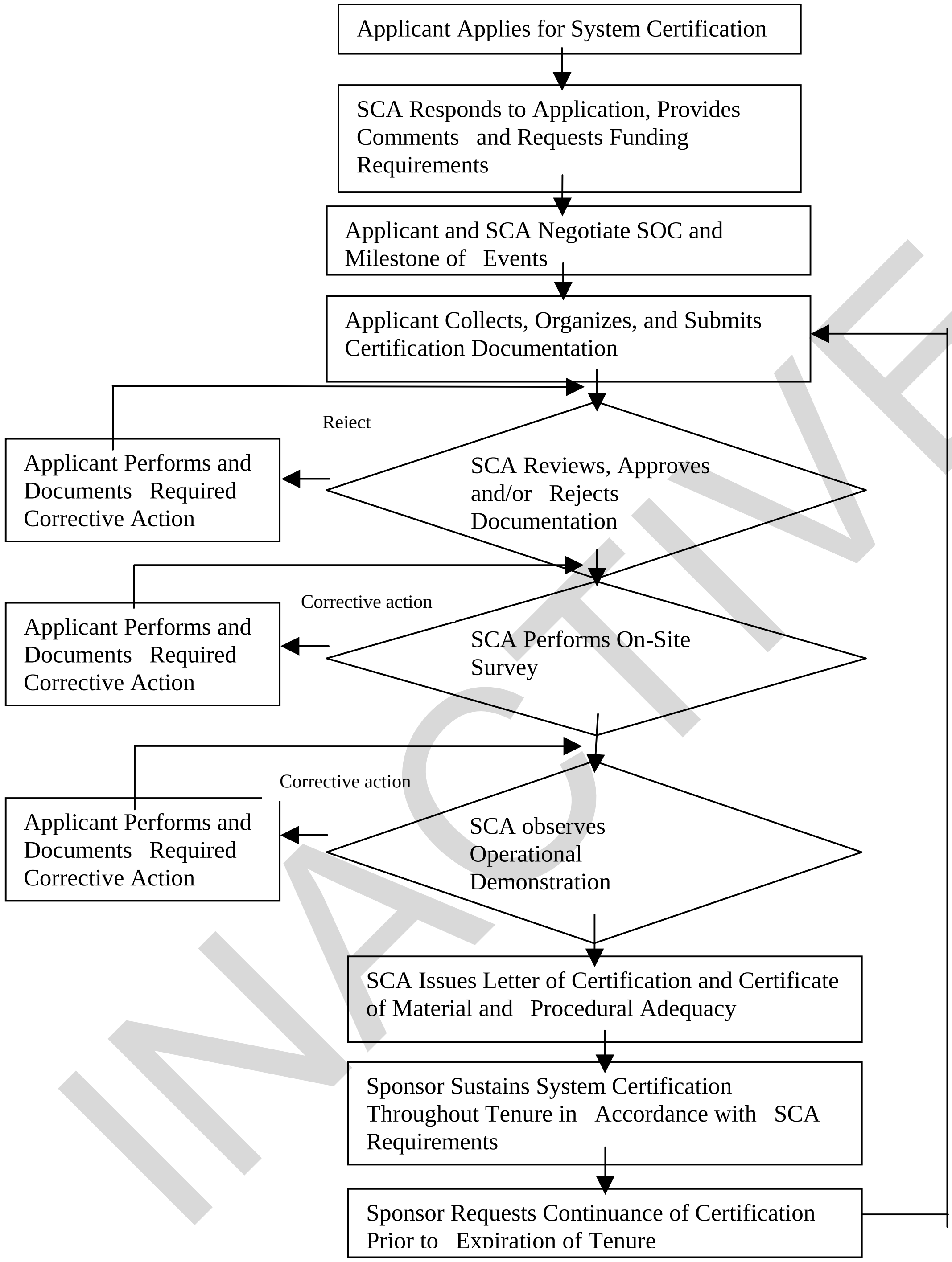

Figure 1
Certification Sequence of Events

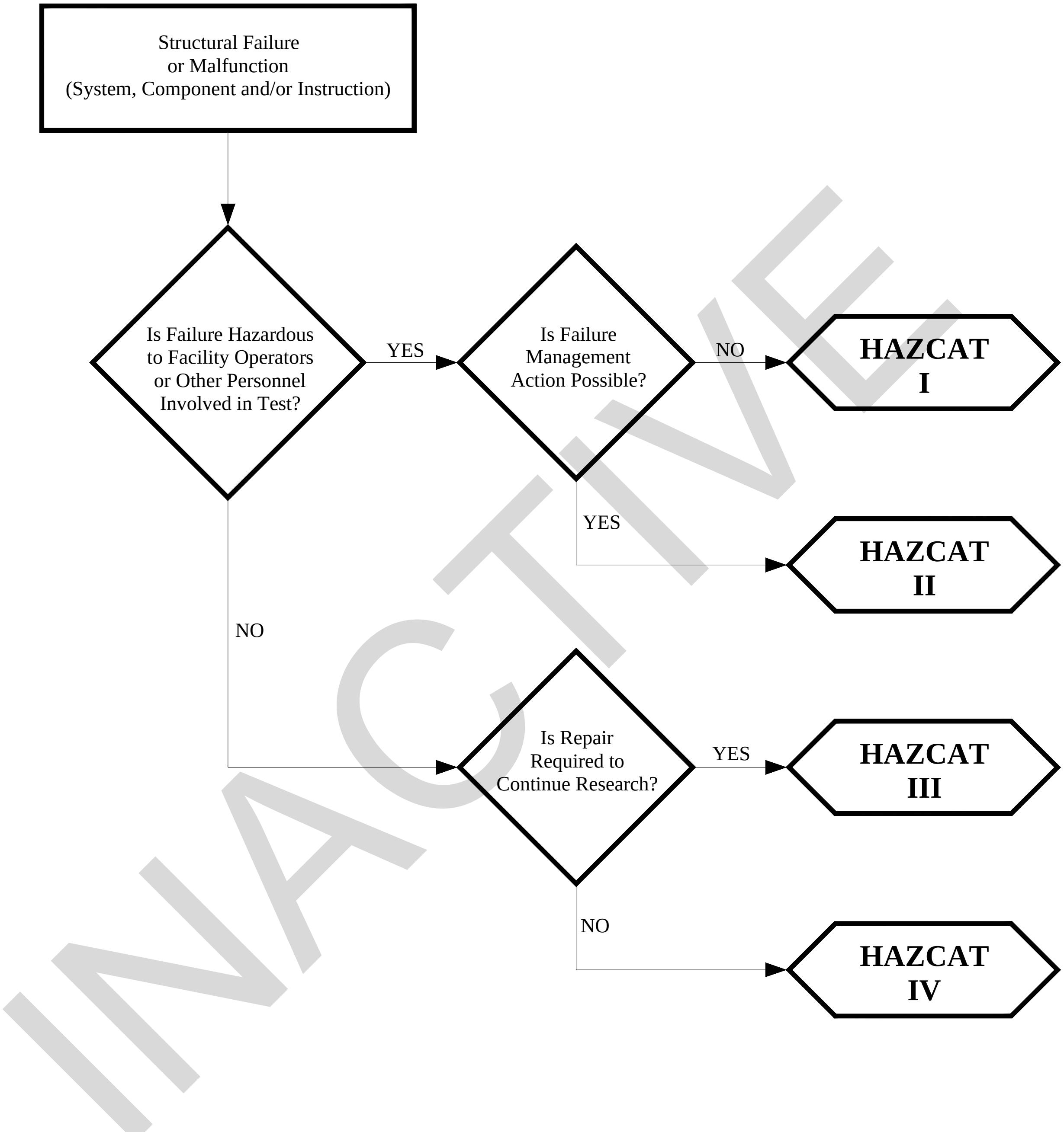

Figure 2
Hazard Category Identification

It is recognized that individual system designs will vary to such an extent that no single list can encompass the entire spectrum of SOC's. The following is a list of specific areas that generally require inclusion in the SOC. This list is provided for purposes of illustration and should not be considered as all inclusive or universally applicable:

a) Pressure hull, pressure vessels, hard structure, and appurtenances (penetrations, seals, etc.,).

b) Life support subsystems that provide an acceptable atmosphere for unmanned medical and physiological experiments.

c) Pressurization and depressurization systems including, but not limited to, piping systems and pressurized storage facilities.

d) Non-compensated equipment, subject to pressure, which may implode or explode.

e) Fire fighting devices or subsystems.

f) Electrical power subsystems that include internal and external electrical protective devices where failure could result in malfunction of a critical component or subsystem or create a shock hazard.

g) Subsystems and components that protect personnel directly or indirectly against the effects of accidents and hazards.

2.2.2 Hazard Category Criteria. In the analysis of a structural or functional failure of a system, equipment, or component, the following hazard category (HAZCAT) evaluation criteria are used (Figure 2 is used as a guide):

a) HAZCAT I. Catastrophic failure, which exposes operator/test personnel to hazards that would likely result in death, or severe injury (permanent total disability). Upon failure, operator action cannot be taken to manage or mitigate the hazards. Testing operations aborted.

b) HAZCAT II. Critical failure, which exposes operator/test personnel to hazards that would likely result in injury (permanent partial disability). Upon failure, operator action can be taken to manage or mitigate the hazards. Testing operations likely aborted.

c) HAZCAT III. Marginal failure, which would not likely expose operator/test personnel to any significant hazards. Upon failure, operator action is required to manage or repair the failure; otherwise testing operations must be aborted.

d) HAZCAT IV. Negligible failure, which would not likely expose operator/test personnel to any significant hazards. Testing operations may continue without management action.

Note – the above hazard categories do not contain a probability of mishap occurrence. These categories suggest a probability of end result associated with the hazard severity. HAZCAT I and HAZCAT II categories are acceptable only when the probability of mishap has been mitigated by design, testing, procedures, and inspection to improbable, as defined by MIL-STD-882.

2.2.2.1 HAZCAT Guidelines. Generally, most components within a specific system are all the same HAZCAT. Since HAZCAT I designation means a malfunction endangers the lives of operator/test personnel and no failure action is possible, stricter material selection and control; fabrication and installation procedures; and quality control testing is required on these items.

Likewise, HAZCAT II items have more stringent requirements than HAZCAT III and HAZCAT IV items. Additionally it is recognized that failure of a HAZCAT II item, such as a pressurized gage isolation valve, could result in operator death or severe injury. However, the probability that the severity would be as great as that encountered during failure of a HAZCAT I item (such as a pressure vessel) is considered improbable. Therefore, when determining HAZCAT boundaries, engineering judgment on a case basis, as well as consultation with the SCA, may be required.

The following guidelines are provided to assist in the determination of HAZCAT designations:

a) HAZCAT I items include the pressure boundary to which the operator/test personnel are exposed and the first pressure piping isolation valves connected to the pressure boundary. HAZCAT I items, dependent on design of the facility, may also include other system piping and components. For example, if hazardous gases or fluids exist, then all piping and components containing them would be HAZCAT I. Items include:

(1) Pressure vessel and hatches

(2) Pressure vessel view ports

(3) Pressure vessel penetrator fittings

b) HAZCAT II items include systems, equipment, and components which have sufficient isolation boundaries that injury can be precluded by securing the source of pressure, gas flow, fluid flow or electrical power. Items include:

(1) Ancillary piping, high pressure gages and instrumentation, and associated valves/components

(2) Electrical switch gear

c) HAZCAT III items include systems, equipment, and components that failure would compromise the research/test being conducted. Items include:

(1) Pumps

(2) Control valves

(3) Monitoring and control instrumentation

d) HAZCAT IV items include systems, equipment, and components that are not critical to the research or test evolution and can be repaired at a convenient time. Items include:

(1) Filtration equipment

(2) Building support systems

2.2.3 Milestone Event Schedule (MES). The certification MES should include a list of sequential events in the certification process with estimated dates of completion. The time required for documentation submissions, technical reviews and deficiency should be considered in the MES to ensure timely completion of the certification process prior to the desired system use date. Figure 3 is an MES for a typical system. It may be reproduced and filled in and submitted by the applicant. If it does not meet the needs of a particular system, the applicant may develop and submit one of original design. The initial MES may be submitted at the same time the initial SOC is submitted or may be submitted after the SOC has been approved by the SCA.

2.3 Submission of Supporting Documentation. Utilizing the approved SOC as a guide, the applicant should prepare and submit the following documentation in accordance with the MES:

a) Design review information.

(1) System drawings

(2) Design calculations

(3) Hazard analysis

b) Construction, fabrication, and assembly information

c) Quality program information

d) Test program information

e) Operating and emergency procedures

f) Maintenance procedures

g) Configuration management plan

Additional information may be required in the course of the certification process to fully justify any area that concerns the SCA.

2.4 Review and Approval of Supporting Documentation. All supporting documentation submitted should be reviewed by the SCA for technical adequacy and for conformance to the requirements of this document. When additional technical expertise is required, the SCA may obtain assistance from the headquarters technical staff or such other experts as may be appropriate. Design information should normally be reviewed during formal design reviews. Obtaining SCA concurrence with the design is strongly recommended prior to beginning construction.

2.5 On-Site Survey. As required, the SCA and his designated representative should conduct one or more on-site survey(s) of the system. The purpose of a survey is to verify that the "as-built" system has been fabricated in accordance with the approved documentation and that it can be operated safely and maintained effectively. Each survey should be officially requested in writing by the applicant and confirmed by the SCA. A request for a survey should be made to the SCA at least 90 days prior to the desired date of the survey. Normally, a survey should not be scheduled until after the system drawings and operating and emergency procedures have been approved.

2.5.1 Survey Team Personnel. The SCA will assemble a survey team to perform an on-site survey of the system. The type and complexity of the system will determine the size and make-up of the survey team. Typically, the areas of expertise of the survey team will include mechanical, electrical, hydraulic, ocean, and structural engineering. Quality assurance (QA) specialists may also frequently be included. For a relatively simple system, a single individual may represent the SCA.

2.5.2 Objective Quality Evidence (OQE). OQE is any statement of fact, either quantitative or qualitative, pertaining to verification of the quality of a product or service based on observations, measurements, or tests. Evidence will be expressed in terms of specific quality requirements or characteristics. These characteristics are identified in drawings, specifications, and other documents that describe the item, process, or procedure. One of the main objectives of the survey is to review the OQE to ensure that the system is actually built as designed and that it will perform safely to the limits for which certification is requested. Accordingly, the survey team will review OQE in sufficient detail and depth to support a conclusion as to the acceptability of the system. The applicant should ensure, prior to a survey, that necessary OQE not previously submitted to the SCA is readily available for the survey team. Appendix C provides additional guidance on OQE.

SYSTEM:__________________ INITIAL SUBMISSION DATE:________ SCA APPROVAL:_________
REVISION:___________DATE:___________

EVENT																						
Design Review Information																						
Scope of Certification (SOC)																						
Pre-Survey Outline Booklet (PSOB)																						
Summary Description of System																						
Design Parameters																						
Subsystem Descriptions																						
Design Analysis																						
System Drawings																						
Operability & Maintainability Procedures																						
Justification of Materials																						
Toxic & Flammable Materials Data																						
Atmosphere Analysis																						
Hazard Analysis																						
Fabrication Procedures																						
Work Procedures																						
Process Instructions																						
Welding Procedures																						
Brazing Procedures																						
Assembly Procedures																						
Cleaning procedures																						
Quality Assurance Procedures/Data																						
Design & Drawing Control Data																						
Material Control Data																						
Fabrication & Manufacturing Control Data																						
Cleaning Control																						
Testing & Inspection Control																						
Test Plan																						
Individual Test Procedures																						
Test Procedures Index																						
Test & Inspection Results																						
Re-Entry Control Data																						
Operating																						
Maintenance Records																						
Correct Discrepancies																						
On-Site Survey																						
Correct Discrepancies																						
Certification Dive																						
Receipt of Certification																						

Instructions: For each event applicable to the applicant's system, enter the date of completion in the appropriate box of the 24-month grid provided.

Figure 3
System Certification Milestone Event Schedule

2.5.3 Survey Coverage. The survey should include, but not be limited to, a review of the following items:

a) As-built drawings and documentation of the system

b) Drawing control procedures and records

c) QA procedures, results, and records

d) Non-destructive testing (NDT) qualifications and records

e) Construction, fabrication, assembly, and test procedures results, and records (e.g., welding/brazing procedures, records, and personnel qualifications)

f) System proof and performance test procedures and results

g) System cleaning procedures and results, including sampling points and pass/fail criteria

h) Accessibility to vital equipment and components

i) Quality of workmanship

j) System component identification and color coding

k) Gauge, instrument, and relief valve calibration data

l) Repair and maintenance procedures and records

m) Re-entry control procedures and records

n) Operating and emergency procedures (OPs and EPs)

o) A physical review of system hardware to determine general material condition

p) Operational demonstration of the system using the OPs and EPs

2.5.4 Preparation for Survey. The applicant is responsible to make every effort to prepare in advance for the on-site survey. All formally documented procedures requiring SCA review and approval should have been provided to the SCA prior to requesting the survey. The system should be operationally ready and all obvious deficiencies corrected prior to commencement of the survey. The supporting OQE discussed throughout this document should be available at the survey site in an organized fashion. It is essential that qualified personnel, knowledgeable in all aspects of the system (operation, design, testing, QA, maintenance, etc.,), be available and ready to assist the survey team. It is important to note that the applicant is responsible for the accuracy and completeness of documents presented regardless of their source. The applicant or designated representative should review all records and data supplied from industrial or support activities prior to the survey. Those that are incomplete or in error will be rejected and returned for correction. All documentation should be presented in an organized and audit ready form. The SCA should be able to quickly and easily trace the documentation to the hardware and vice versa.

2.5.5 Survey Guidelines. As in all safety related inspection programs, the intentional concealment of known deficiencies by either action or inaction is deliberate malpractice and could result in death or serious injury. Deficiencies that are known to the applicant and inadvertently overlooked by the survey team should be brought to the attention of the SCA and discussed. Certification survey cards should not be viewed as representative of either command or personal failure. Rather, cards should be viewed as the subjective findings of personnel, who are conscientious and responsible for ensuring the safety of the operators and the protection of property.

2.6 System Certification Survey Cards. Deficiencies noted during the survey and recommended corrective action will be documented in the form of System Certification Survey Cards (SCSCs). Survey cards are classified by the SCA as follows:

a) Category 1A. Corrective action must be accomplished prior to use of the system. For an unmanned pressure test facility that has already been certified, the issuance of a Category 1A SCSC should result in either the termination or suspension of the existing certification. Prior to further use of the system, full re-certification or removal of the suspension by the SCA is required.

b) Category 1B. Corrective action must be accomplished prior to system certification. The issuance of a Category 1B SCSC should permit use of the system for the purpose of operational demonstration pursuant to certification only.

c) Category 1C. Corrective action must be accomplished prior to the date or event specified on the card to sustain certification. Certification, sustaining certification or continuation of certification may be granted in the interim. Unless advance justification is provided, failure to correct the deficiency and notify the SCA officially in writing by the specified date or event should cause termination or suspension of certification.

d) Category 1D. Corrective action must be accomplished on specified component and SCSC cleared prior to its use, while the over all system retains it’s certification.

e) Category 2. Corrective action is desirable, but not mandatory. Category 2 deficiencies may be corrected at the applicant's option, but should be addressed by the applicant even if no action is taken.

Each card has space for the survey team to record its findings and recommendations. Separate space is provided for a statement of corrective action. Figure 4 is a sample SCSC. At the conclusion of the survey, a critique will be held. The survey team leader will review and discuss all survey cards and their recommended corrective actions with the system applicant or his designated representative. The critique is open to all interested parties. Frank discussion and free exchange of information are encouraged. Any disagreement by the applicant with the findings or with the categorization of any of the SCSCs should be discussed during the critique. Further, if the applicant has completed some or all of the corrective action for one or more of the deficiencies found, he should make this information known at the critique.

The survey team leader may, as a courtesy, leave preliminary copies of the survey cards. These copies are for discussion purposes only. Expenditure of resources should not be undertaken based on these unofficial cards as they are subject to change prior to official issue.

Upon completion of the survey, the SCA will forward the results of the survey team's evaluation of the system to the applicant for action, via the appropriate chain of command. The SCA will provide copies of the survey cards to other activities, when requested by the applicant. If many Category 1A or 1B survey cards are issued during a survey, a follow-on survey may be required. If a follow-on survey is necessary, the SCA will inform the applicant in writing. The SCA may revise a card or downgrade an SCSC category after its initial issuance. Reasons for revising an SCSC include:

a) A partial clearing of the deficiency.

b) A change in the nature of the deficiency based on additional information.

c) Discovery of a new deficiency closely related to deficiency already documented on an SCSC.

d) Splitting a single SCSC into multiple SCSCs for ease of tracking status by subsystem.

A SCSC may be downgraded if it can be shown that the lower category is more appropriate than the originally assigned category. SCSCs that include more than one recommended corrective action would not normally be revised based solely on the completion of one of the recommended corrective actions. SCSCs may be revised or downgraded either unilaterally, by the

SCA, or based on a request from the applicant.

When action identified by a specific card has been completed, a brief summary should be written on the card and the card signed by a senior representative of the applicant. Cards must then be returned to the SCA, via the chain of command, for clearing. Should the clearing of the card involve supporting documentation (e.g., re-entry control forms, test memos, NDT records, calibration data, etc.,), the documentation should be referenced on the card and copies returned with it. When the submitted corrective action is satisfactory to the SCA, two representatives of the SCA should sign the card and return it to the applicant. Normally, one of the signing individuals will be the one who wrote the card. Double signature by the SCA will clear the card. If the action taken by the applicant does not satisfy the finding, but instead alters the system mission so that personnel safety will no longer be an issue, the SCA may cancel the card. The applicant may, with supporting justification, request that an SCSC be canceled. The request to cancel a card should be documented by the applicant on the card with the technical justification attached to the card. A senior representative of the applicant and two representatives of the SCA must also sign canceled cards. The SCA will normally provide copies of officially cleared or canceled cards to the applicant for record purposes.

All Category 1A and 1B deficiencies must be cleared or canceled prior to certification. Category 1C deficiencies must be cleared or canceled prior to the date or event specified by the SCA to sustain certification. Category 1D cards must be cleared prior to use of the specified component. Category 2 deficiencies may be corrected at the applicant's option, but should be addressed by the applicant even if no action is taken. Following the granting of either initial certification or re-certification of an unmanned pressure test facility, there are two additional times when survey cards may be issued. These are:

a) During a survey performed within the tenure of certification to ensure that certification is being adequately sustained.

b) During a survey requested by the applicant to continue certification beyond the original tenure of certification.

CARD NO.: ________________
SER #: ________________

SYSTEM CERTIFICATION SURVEY CARD

ORGANIZATION:

SYSTEM:

ITEM:

CATEGORY OF DEFICIENCY:

TEAM MEMBER: SURVEY DATE: ___________

(A) FINDINGS:

(B) RECOMMENDATIONS:

(C) DATE CORRECTIVE ACTION MUST BE COMPLETED:

(D) CORRECTIVE ACTION:

(E) VERIFICATION OF CORRECTIVE ACTION:

I have reviewed the Corrective Action and consider it to fully correct the Findings

______________________________ ______________________
SENIOR SYSTEM REP DATE POSITION

(F) CORRECTIVE ACTION IS SATISFACTORY:

____________________________ ____________________________
SCA TEAM MEMBER DATE NAVFAC OOCE DATE

Figure 4
Sample System Certification Survey Card

2.7 Operational Demonstration. A satisfactory survey including correction of all Category 1A discrepancies may permit, with the concurrence of the SCA, the commencement of a certification operational demonstration to the depth or pressure limits stated in the certification application. The SCA or his appointed representative will participate in or observe the operational demonstration of the system. The SCA may elect not to observe an operational demonstration of an unmanned pressure test facility that has had a history of safe and satisfactory performance.

The SCA may certify or re-certify an unmanned pressure test facility for full certification depth based on operational demonstrations to a depth less than the full certification depth. This alternative can be exercised by the SCA for those systems that have a history of safe and satisfactory performance and pressurization to full depth is not possible or practical.

The certification operational demonstration may be conducted in conjunction with other DOD program requirements. Satisfactory completion of the certification operational demonstration and clearing of all open Category 1B SCSCs generally will justify the granting of system certification.

2.8 Issuance of Certificate. A certificate of Certification of System Adequacy may be issued by the SCA after the successful completion of the operational demonstration and the correction of deficiencies. The SCA should specifically state the operational limits, parameters and tenure for which the certification is granted. The SCA should also specify the terms and conditions of system certification and additional requirements as appropriate. The officer in charge of the facility is thereafter responsible for sustaining system certification and requesting continuation of system certification or re-certification.

2.9 Tenure of Certification. Tenure of certification is the length of time for which certification is granted. The tenure of certification for unmanned pressure test facilities should be determined by the guidelines provided in Table 3. The granting of system certification, by the SCA, does not automatically ensure that it will remain in effect for the full, stated period. System certification should not be granted for the entire design life of the system. The tenure of system certification may be negotiated to coincide with planned events such as overhaul or refurbishment.

Table 3
Unmanned Pressure Test Facility Certification Requirements

CLASS - A	CLASS – B	CLASS - C
3yr SCA Visit	6yr SCA Visit with 3yr documentation review	6yr Certification, No SCA Visit, submit documentation
-Initial Certification 1yr	-Initial Certification 1yr	-Initial Certification 1yr, no SCA visit
-Test Reliefs 1 time per Cert cycle (3yrs)	-Test Reliefs 1 time per Cert review (3yrs)	-Test Reliefs 2 times per Cert cycle (3yrs)
-Gauge Cal 24mos for critical gauges	-Gauge Cal 24mos for critical gauges	-Gauge Cal 24mos for critical gauges
-OQE/Documentation/ for new Cert, design modifications and maintenance	-OQE for new Cert and any design modifications	-OQE for new Cert and any design modifications
-Re-Entry Control Program, CWP, and Maintenance Manual	-Maintenance Log required	-Maintenance Log required
-OP/EP SCA Approval	-OP/EP Local Approval	OP/EP Local Approval

2.9.1 Termination or Suspension of System Certification

2.9.1.1 Termination of Certification. Termination of certification is a withdrawal of system certification. Once certification is terminated, the system cannot be re-certified without a complete SCA review of all work undertaken since the last certification survey.

2.9.1.2 Suspension of Certification. Suspension of certification is a temporary withdrawal of certification that remains in effect while one or more actual or potential violations of the terms of certification are investigated and corrected. Use of the system during the suspension is not authorized. Prior to reinstating system certification, an on-site review of the problem area(s) by the SCA may be required.

Once the deficiencies are corrected to the satisfaction of the SCA, the original system certification will be reinstated.

2.9.1.3 Conditions for Termination or Suspension. System certification may be terminated or suspended, at the discretion of the SCA, as a result of the following:

a) Violation of the limits or terms of the letter granting certification (e.g., pressure, time, temperature, etc.,).

b) Recognition of the existence of an unsafe condition.

c) Expiration of tenure of system certification.

d) Modifications to equipment or components within the SOC without the concurrence of the SCA.

e) Overhaul, repair, or alteration, as defined in Section 5.

f) Expiration of a lease contract.

g) Failure to correct Category 1C cards by specified date or event.

h) Issuance of a Category 1A or 1B survey card.

i) Casualty to the system pending the issuance of an investigative report dealing with the incident.

2.9.2 Sustaining System Certification. Sustaining system certification comprises those actions required of the applicant to ensure the SCA that the facility remains in the as-certified condition throughout the tenure of certification. As stated previously, granting system certification does not automatically ensure that system certification will remain in effect for the full certification period. The responsibility for sustaining system certification during the certification period rests with the officer-in-charge of the facility.

2.9.2.1 Design Changes and Alterations. SCA concurrence must be obtained for any design changes or proposed alterations to equipment within the SOC, or which could impact the SOC. Each proposed design change or alteration should contain an evaluation of the effects of the change to the safe operation, of the system, in accordance with the requirements of this document. Accomplishment of design changes and alterations within the SOC without SCA concurrence should result in termination or suspension of system certification.

2.9.2.2 Repairs and Maintenance. The facility should be maintained so that all systems, subsystems, and components within the SOC are functioning properly, in an as-certified condition, prior to each operational use.

All work and testing accomplished during routine repairs and maintenance should be in accordance with the requirements in Section 5. Only qualified personnel should perform repairs, maintenance, inspections and testing. Documentation requirements for repairs, non-routine maintenance, and testing should be recorded in accordance with the requirements of Appendix C.

2.9.2.3 System Certification Survey. A system certification survey, as described in par. 2.5, may be performed when deemed necessary by the SCA as a condition of sustaining or continuing system certification. Unsatisfactory survey results may result in termination or suspension of system certification.

2.9.2.4 Operating Limits. The system should be operated only within its certified operational limits. Operation outside of the authorized limits without a valid waiver is not allowed and may result in termination or suspension of system certification. Any violation should be immediately reported to the SCA, stating the cause or justification.

2.9.2.5 Unusual Situations. The SCA should be advised of any situation, which may prevent the system from maintaining its intended operational capability. These may include, but are not limited to, exceeding certified pressure, physical damage, fires, emergency pressure excursions, and casualties resulting in injury or death. Further, a report should be submitted containing an evaluation of the extent of damage, proposed repair methods, and probable cause of the emergency (e.g., personnel error, nature of the operations, system or component failures, etc.,). It is not intended that these emergency situations include failures that only temporarily interrupt the operational capability of the system and are corrected by routine repairs.

2.9.3 Continuation of System Certification. Continuation of system certification is an extension by the SCA of the certification period beyond that initially granted. This is normally done to permit continued use of a system that has had no changes to the basic design, SOC, or general operating characteristics and where the material condition of the system will support the continuation. During this continuation of system certification, all requirements noted in par. 2.9.2 should be observed. The applicant should arrange with the SCA for a continuation of certification and should submit a request for an on-site survey no less than 90 days prior to the desired certification date.

2.9.4 Re-certification. Re-certification is a new certification of a system where the existing certification has expired or has been terminated. To re-certify a system, the SCA should determine those requirements of this document that must be accomplished. Following a re-certification, all requirements noted in par. 2.9.2 should be observed.

2.9.5 Extension of Certification. The SCA may extend system certification for short duration in three cases:

a) When emergency operational commitments of the system prevent it from being available for an on-site survey at the time of the expiration of certification.

b) When the system is scheduled for overhaul within 90 days after expiration of the current certification.

c) When the SCA is unavailable due to prior commitments.

Extensions of certification will be granted only for systems that have required no more than routine maintenance and repairs during the original tenure of certification. Any non-routine work performed on the system should be reported to the SCA. The SCA requires equipment hydrostatic test dates, gage calibration dates and a statement that the system is operational prior to granting an extension of certification. If requested, the applicant should provide the SCA with a list of all work accomplished on the system during the tenure of certification and justification for the request for an extension.

2.10 Transfer of System Custody

2.10.1 Permanent Transfer. Unmanned pressure test facilities may be permanently transferred. The SCA should be kept apprised of all pending transfers. After authorization for a permanent transfer has been granted, the following action should be accomplished:

a) The custodial command should inform the recipient command of the operational condition of the system, including all operational and documentation deficiencies and outstanding SCSCs.

b) The custodial command should prepare a "turnover file" consisting of as-built system drawings, all re-entry control documentation, test records, technical manuals, operating and emergency procedures, a complete Preventive Maintenance System (PMS) package, and all certification survey documentation from previous surveys. The turnover file should accompany the system to the recipient command.

2.10.2 Recipient Command. After receipt of the system hardware and certification documentation, the recipient command should take the following action:

a) Establish a formal QA plan and re-entry control procedures.

b) Verify that system drawings, technical manuals, and operating and emergency procedures reflect the as-built condition of the system. All required drawings and operating and emergency procedure revisions should be submitted to the SCA for review and approval.

c) Initiate the preventive maintenance plan for the system.

d) Request an on-site survey of the system by the SCA.

Upon completion of a successful on-site survey, the SCA will grant the system a new certification. This procedure applies to all systems.

Section 3: INITIAL CERTIFICATION

3.1 Introduction. This chapter describes the criteria that must be met to obtain initial certification for an unmanned pressure test facility. Assembly of the necessary OQE and adherence to these criteria should coincide with the design and construction or fabrication of the new system. For a system designed, manufactured, and placed in service outside the purview of this document (i.e., a system built by and for private interests, placed in service, then purchased by DOD), the task of assembling the necessary documentation may be very difficult, if not impossible. In such cases, additional testing and analysis is generally required. The level of documentation complexity will vary according to the class of the facility. (See Tables 1 and 2.)

3.2 Design Review Information The applicant should submit the documentation and evidence described in the following paragraphs to the SCA for review and approval. During review of this evidence, the SCA may require the applicant to supply additional information. If, in the course of supplying information required by the SCA, it becomes necessary for the designer and or builder to disclose information he considers proprietary or classified, he should so identify it. The SCA should cooperate with the designer and builder in the protection of such information.

The design documentation submitted by the applicant for review and approval should include the following:

a) SOC

b) MES

c) Summary description of the system

d) Subsystem descriptions

e) Design parameters

f) Design analysis

(1) Design calculations

(2) Stress analysis

g) System drawings

h) Operability and maintainability criteria and procedures

i) Justification of materials

j) Flammable materials data

k) Hazard analysis

For new systems, the applicant should provide items (a) through (e) above to the SCA for review and/or approval prior to conducting formal design reviews.

Items (f) through (k) should be forwarded to the SCA by the applicant at least 60 days prior to convening each formal design review or as required by the MES. The number and scope of formal design reviews will be governed by the size and complexity of the system and can be negotiated between the applicant and the SCA.

3.2.1 System Scope of Certification and Milestone Event Schedule. The applicant should submit the SOC and MES (both described in Section 2) to the SCA for review and approval.

3.2.2 Summary Description of the System. To aid the SCA in performing a safety evaluation, the applicant should submit a summary description of the pressure vessel system including design and construction details. A written explanation of the features of the system, along with appropriate schematic drawings should be included. The content of the summary description should be commensurate with the complexity of the system. Simple systems need only brief summary descriptions; complex systems obviously require more detail.

3.2.3 Subsystem Descriptions. Each subsystem within the SOC should be described. These subsystems normally include fluid systems, electrical systems, compressed air and gas systems, and other significant mechanical, electrical, or structural features required for the complete operation of the facility.

Each subsystem design submitted must include both a written description and a function or flowchart diagram. The description should clearly delineate objectives of the design. Safety considerations should also be included. It should also include an analysis of the consequences of a failure or loss in the normal operating mode. The diagram should clearly show how the subsystem accomplishes its intended function. Sufficient information should be included to identify the specific components and their location, size, material, etc.

3.2.4 Design Parameters. Design parameters of the system must be identified. Design parameters provide the basis for evaluating system adequacy. Design parameters that the applicant must consider and which will be evaluated by the SCA include:

a) Design safety factors

b) Design life and service period (useful life, number of cycles, etc.,)

c) Effect of ambient operating conditions and the effect of mechanical shock and vibrations on design life

d) Depth and pressure limitations

e) Design temperature limits

f) Identification of anticipated hazards

g) Corrosion allowance and resistance requirements

h) Soil and foundation considerations where applicable

i) Floor loads including hydrostatic test weight

3.2.5 Design Analysis. A complete and thorough design analysis should be submitted for SCA review and concurrence. The design analysis should consist of formal design calculations and a complete stress analysis as explained below.

3.2.5.1 Design Calculations. Design calculations should be submitted for SCA review and concurrence to demonstrate the adequacy of design. All assumptions should be clearly stated. Calculations should show the effect of building to worst-case dimensions and tolerances. Potential effects of corrosion should be considered. Appropriate reference should be made to applicable test data or operating experience when either is used to support a calculation technique. Design calculations should clearly show the adequacy of the item analyzed in terms of the system design parameters. Information must be submitted in sufficient detail to permit independent analysis of the design. Documentation submitted by the applicant should be tabulated to ensure that the information completely covers the design.

3.2.5.2 Stress Analysis. Applicant should verify the adequacy of the design by performing detailed stress analyses and, when appropriate, by conducting the tests described herein. Applicable sections and provisions of pressure vessel and piping design codes should be applied. Test programs in support of system certification should consider all ramifications of the stress analyses. Stress analyses and test reports submitted by the applicant should also consider the most critical loading case which includes the cumulative detrimental effects of design allowances, dimensional variations, and tolerances. Applicant may request that specific designs utilizing standard materials or components be exempted from stress analysis, based on technical justification. In cases where the pressure boundary is a unique and complex shape, destructive testing may be required if the validity of a stress analysis is in question. The SCA will then make a determination of those materials and systems that do not require the stress analyses and will inform the applicant whether material may be exempted.

Examples of loads to be considered are:

a) Weight of water used for hydrostatic testing

b) Static loads imposed by the clamping or securing devices used to secure the system

c) Maximum operating pressure of the gas or fluid within the system

d) Thermal stresses due to the operating temperature range of the system

e) Reactions due to differential thermal expansion between the system and the structure to which it may be fixed or due to elastic expansion of the system caused by internal pressure

f) Shock, including accidental blows

g) Vertical and horizontal loads on foundations where applicable

h) Seismic requirements where applicable

i) Dynamic loads, such as those encountered from collapse of any non-pressure-compensated elements

j) Fatigue loads of the pressure resisting components and piping for a specified number of cycles

3.2.6 System Drawings. Certification of all unmanned pressure test facilities should require drawings meeting the requirements of MIL-DTL-31000, Technical Data Packages or acceptable commercial standards and which are adequate to support technical design reviews. The level of drawing detail should reflect the level of design maturity that has been attained at the time of each design review. The function and complexity of the subsystem being reviewed should determine the number and type of drawings required for an adequate technical design review. In addition to showing system and subsystem configuration, drawings normally required to support a technical design review must have adequate detail to show material, fabrication, cleaning, testing, and special assembly requirements. In most cases where mechanical or electrical systems are being reviewed, system schematic diagrams with the above information are acceptable. However, where critical equipment such as the pressure hull is being evaluated, actual assembly or fabrication drawings are required for the final design review. The applicant should submit up-to-date copies of drawings, signed by the appropriate technical agent, for each subsystem to be evaluated during a design review.

Each component that provides a control, sensing, or similar essential function that impacts the operation of the system (valves, gauges, pressure regulators, etc.,) should have a unique identifier made up of a system designation and a number. A table should be provided identifying system designations. These unique identifiers should be shown on the drawings and should be used in the operating and emergency procedures.

When the final system design has been approved, a complete set of product drawings should be produced and distributed as determined by the Acquisition Manager. Where appropriate, the drawings should specify any special material control requirements. The Acquisition Manager should confer with the SCA to determine which drawings will be required to maintain system certification and should ensure that those drawings are distributed to the activity that will operate the system after initial system certification has been achieved. The system operators will then continuously keep those drawings current by ensuring that they reflect as-built system configuration. This may be accomplished by "red-line" marking of the drawings. Red line drawings must be officially revised after each system overhaul or major configuration change, whichever comes first. All drawing revisions should be formally documented and the reason and authority for each revision should be explicitly stated on the drawing. Each component or item on the as-built drawings should be identified by the manufacturer's model or type number, part number, vendor identification, applicable military specification, federal specification or standard as appropriate.

3.2.7 Operability and Maintainability. The criteria and procedures for which operation and maintenance are based should be explained and supported by technical manuals and other documentation. Include emergency procedures.

3.2.7.1 Operating and Emergency Procedures. The applicant should develop and submit operating and emergency procedures that cover all foreseeable normal and emergency evolutions the system may be required to undergo. Refer to par. 3.6 for detailed requirements concerning operating and emergency procedures.

3.2.7.2 Maintenance Procedures. The applicant should provide the SCA with formal maintenance procedures for all systems, subsystems and components within the scope of certification. This requirement can be met using DOD PMS and pre- and post-operational procedures. These procedures will be considered in the certification process as they relate to safe operation of the system.

3.2.8 Justification of Materials. All materials and their applications, used in the design of an unmanned pressure test facility, should be justified. It is not the intent of this document to limit materials and their applications. New materials, or time-tested materials in new applications, may be used if sufficient data exists to ensure the material adequacy of the system. Justifying data must include the requirements for care, preservation and maintenance of new materials for the projected life cycle of the material. The less information and experience available concerning a given material for a specific application, the greater the burden upon the applicant to justify the proposed material for the application. For the purpose of system certification, types of materials and components are grouped into three categories that are defined in Appendix A.

3.2.8.1 Design Practices. When required by the SCA, material selection, design, and fabrication techniques should be justified in accordance with military and recognized commercial engineering practices. Proper consideration should be given to complex configurations and intersections, cyclic fatigue, and low temperature requirements. Examples of recognized engineering design practices are:

a) American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2

b) ASME PVHO-1, Safety Standard for Pressure Vessels for Human Occupancy

c) NAVFAC Design Manual (DM)-39, Hyperbaric Facilities

d) ASME B31.1, Power Piping Code

3.2.8.2 Design Criteria. For typical design criteria of unmanned pressure test facilities, the applicant should refer to the following appendices of this document:

a) Appendix A: Categorization of Scope of Certification Materials and Components

b) Appendix B: Design Parameters for Unmanned Pressure Test Facilities

c) Appendix C: Required Documentation

3.2.9 Flammable Materials Data. The applicant should submit, for review and approval, a list of all potentially flammable materials to be used during construction, or to be installed or used in the unmanned pressure test facility. Flammable materials are those which will ignite or explode from an electric spark or when heated and will continue burning in the presence of air or in any oxygen-enriched atmosphere. Flammable materials should be evaluated under both normal and emergency atmospheric conditions. As applicable, all material data should be submitted in standard

Material Safety Data Sheet (MSDS) format.

3.2.10 Hazard Analysis. As part of the design process, a hazard analysis must be performed to evaluate the effects of all possible failures. The hazard analysis must be performed assuming that only one failure occurs at a time, not multiple failures occurring at the same time. The applicant should submit the hazard analysis of the system for review and approval by the SCA. The hazard analysis should describe the possible effects of a mechanical failure or an operator error for each component or subsystem. Those failures that could affect personnel safety should clearly show what features, warnings or procedures have been incorporated into the design, operation, and maintenance of the system to preclude or minimize the probability of failure. It is the responsibility of the applicant to ensure that conditions identified as significant safety hazards are eliminated or reduced to the lowest practical level.

Mishaps are not always the result of equipment failure. Human error, when responding to a routine command, a minor problem, or operation of a control function at the wrong time can result in a catastrophe. Operating and emergency procedures must be specific, clear and concise to avoid confusion. The hazard analysis should show that this type of failure has been considered in the design of the system and that safeguards have been taken to reduce the likelihood of such an occurrence. MIL-STD-882 provides an acceptable set of guidelines for the conduct of a hazard analysis. The application and tailoring guidelines given in MIL-STD-882 should be carefully followed to make the hazard analysis no more complicated than is necessary to prove the safety of the design. Hazard Categories, as they pertain to unmanned pressure test facilities, are defined in Section 2.

3.3 Fabrication And Assembly Documentation is required to verify that fabrication and assembly procedures meet engineering standards necessary to deliver a safe, reliable system. Copies of all documentation must be submitted with the certification package or otherwise made available for SCA review in a manner negotiated between the SCA and the applicant. All written fabrication and assembly processes that may affect the designed performance of the system must be identified. Documentation must include fabrication drawings and specifications, as well as supplementary information, not necessarily specified on the drawings, but which affects the process. Information of importance includes, but is not limited to the following:

a) Fabrication/assembly procedures

b) Process instructions

c) Welding procedures

d) Brazing procedures

e) NDT procedures

f) Cleaning procedures

g) Quality assurance procedures and inspections

h) Personnel qualifications

i) Fabrication and assembly documentation

j) Any other processes, procedures, or instructions required for construction of the unmanned pressure test facility

Adequacy of these processes must be substantiated by a history of satisfactory use or by documented qualifications and tests.

3.3.1 Fabrication/Assembly Procedures. Fabrication/assembly procedures must define the scope of work and provide production personnel with step-by-step instructions on how the work is to be accomplished. When fabrication/assembly procedures are written to accomplish repairs, maintenance or modifications, they should state the specific reason for performing the work. These instructions are required wherever fabrication, assembly, cleaning and/or testing of components or systems, within the SOC boundaries, is to be performed during initial certification. Fabrication/assembly procedures should also provide all inspection and retest requirements and any warnings or cautions that must be observed while performing the work. Fabrication/assembly procedures should be generated prior to commencing work. Where work procedures already exist (e.g., technical manuals, standard process instructions, approved drawings, PMS, etc.,), the specific paragraphs from those documents should be called out in the fabrication/assembly procedure. The person responsible for the work, inspections and retest of the system or component should sign each work procedure. Any change to the scope of work being performed should cause a revision to the fabrication/assembly procedure to be issued. All fabrication/assembly procedures should be made available to the SCA for review during on-site surveys.

3.3.2 Process Instructions. Process instructions are those standardized procedures that have been developed by a production activity for work that they commonly perform. To be used in a fabrication/assembly procedure, the process instruction must provide step-by-step instructions for accomplishing the work. All process instructions that the production activity intends to use during fabrication or repair of an unmanned pressure test facility should be provided to the SCA for review. In some cases, (e.g., welding, brazing, NDT and cleaning), the SCA or his designated representative must approve process instructions prior to use.

3.3.3 Welding Procedures. All welding should be performed in accordance with written and approved welding procedures (see 3.3.2). Welding procedures must include requirements for documenting welder qualification and criteria for weld joint acceptance. The applicant must make available the written welding procedures and the welder qualification records, including any destructive/nondestructive test records required for proof-of-welder qualification on the specific material selected, for SCA review. Any repair involving heat or welding should be accomplished in accordance with approved written procedures and subjected to the tests and inspections specified for construction. All welded pipe joints must be documented and inspected in accordance with the P-1 requirements in NAVSEA S9074-AR-GIB-010/278 or ANSI/ASME B31.1, Power Piping, as supplemented by NAVFAC required inspections and documentation. The fabrication activity must provide traceability between the joint record and the actual welded joint for each welded pipe joint or structural weld joint.

The following procedures are typical of satisfactory welding practices:

NAVSEA S9074-AR-GIB-010/278, Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels

NAVSEA T9074-AD-GIB-010/1688, Requirements for Fabrication, Welding, and Inspection of Submarine Structure

MIL-STD-1689, Fabrication, Welding and Inspection of Ships Structure

ANSI/ASME B31.1, Power Piping (with additional NAVFAC inspection/ documentation)

The following procedures are typical of satisfactory welder qualification practices:

NAVSEA S9074-AQ-GIB-010/248, Requirements for Welding and Brazing Procedure and Performance Qualification

ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications

3.3.4 Brazing Procedures. In piping systems fabricated with brazed joints, all brazing should be performed in accordance with written and approved brazing procedures (see 3.3.2) which meet or exceed the requirements of Class P-3A, Special Category I, Table 3.1, described in NAVSEA 0900-LP-001-7000, Fabrication and Inspection of Brazed Piping Systems. Brazing procedures must include requirements for documenting brazier/brazing operator qualification and criteria for brazed joint acceptance. The applicant must make available the written brazing procedures and the brazier/brazing operator qualification records, including any destructive test records required for proof of brazier/brazing operator qualification, for SCA review. Any repair to joints involving heat or brazing should be accomplished in accordance with approved written requirements and subjected to, as a minimum, the tests and inspections specified for construction.

For all brazed piping systems, ultrasonic testing is required only for those brazed joints located between the chamber hull and the first manually operated stop valve external to the chamber hull. When ultrasonic testing or other nondestructive tests are required on brazed joints within the SOC, the test records should be made available to the SCA for review. All records should clearly indicate that each joint has met the specification requirements and must be signed by a qualified inspector.

3.3.5 Non-Destructive Testing. All nondestructive test (NDT) records of welds performed within the SOC should be made available to the SCA for review. All NDT records should clearly indicate that each joint has satisfactorily met or exceeded the specification requirements and must be signed by a qualified inspector.

3.3.6 Assembly Procedures. Special procedures for assembly of components and systems (e.g., torque specifications, lubrication requirements, etc.,) should normally be called out in technical manuals and on approved drawings. Where used, assembly procedures should be issued prior to the start of production and should be followed by personnel performing the work. All assembly procedures to be used should be called out in the fabrication/assembly procedure. When assembly procedures are provided as drawing notes or technical manuals, the fabrication/assembly procedure should call out the specific paragraphs that apply. Assembly procedures should be verified as completed by the person responsible for the work and these records should be available for SCA review during the on-site survey.

3.3.7 Cleaning Procedures. Where applicable, cleaning of piping systems should be performed in accordance with approved written cleaning procedures. Cleaning may be accomplished during fabrication/assembly, upon final completion of assembly, or in a combination of both, in accordance with the overall contamination control process developed by the production activity or invoked by the applicant. Cleaning procedures should include methods for sampling and criteria for acceptance. Quantitative analysis to verify system cleanliness must be performed prior to use of the system. Hydrocarbon contamination is of particular concern because hydrocarbons may be flammable. For guidance in cleaning and analysis, refer to Appendix B.

3.3.8 Quality Assurance Procedures and Inspections. Prior to any work on an unmanned pressure test facility, the applicant should prepare a formal Quality Assurance (QA) plan that lists the procedures to be followed and the inspections to be performed. In cases where costly or non-typical work is to be done, it is strongly recommended that the applicant submit the QA plan to the SCA for concurrence. Past experience has demonstrated that significant time, effort and cost savings can be realized when the SCA has reviewed and concurred with the proposed QA plan prior to commencing work.

3.3.9 Personnel Qualifications. Where required by specification or standard, personnel involved in critical fabrication and inspection procedures must be trained and qualified to perform such tasks. The qualification records of welders, braziers and NDT inspectors should be up to date and available for SCA review.

3.4 Quality Assurance Program. The QA program should be a planned and systematic pattern of all the actions necessary to provide adequate confidence that the facility conforms to established technical requirements. The applicant should ensure that QA provisions are maintained which demonstrate that a system meets these requirements. The quality assurance provisions should result in recorded data related to:

a) Configuration management and drawing control

b) Material control

c) Fabrication and manufacturing control

d) Cleanliness control

e) Testing and inspection control

f) Fabrication/assembly procedures

The vigorous enforcement of a comprehensive QA program for all parts of the system in which failure can result in a hazard to personnel will greatly decrease the chance that substandard workmanship practices or materials will degrade the safety of the system. QA provisions are more easily applied during construction of a system. However, it is the responsibility of the applicant to establish means by which the quality of an existing system may be evaluated. QA programs developed in accordance with ISO 9000, International Standards for Quality Management, or similar industry-developed standards are typical of satisfactory practices.

QA and personnel safety are inseparable. QA considerations are required in all areas that affect the safety of the system operators. These areas include, for example, initial forming, fabrication, assembly, cleaning, testing, inspection and preparation for delivery of all SOC items. The authority and responsibility of QA personnel in each of these areas should be clearly delineated. Manufacturing, fabrication, and assembly work conducted within the builder's plant, system maintenance facility or industrial activity should be carefully controlled. Such control should include a formal review and an engineering evaluation of all manufacturing processes, tolerances and deviations. An equally effective control over purchased materials and subcontracted work should be provided.

It is incumbent upon the applicant to conduct periodic internal QA audits during the course of production work. Internal audits often uncover deficiencies that, if left uncorrected, could cause extensive rework with associated cost and schedule overruns. The applicant should submit and retain copies of information relative to the quality provisions in sufficient depth, detail and organization to permit audit and evaluation by the SCA. QA documentation should be legible, accurate and complete. Each document should be dated and signed and should indicate, by the signature, that the work or procedure meets the requirements of the approved QA Plan. Such data is vital in the effort to sustain/continue certification. The applicant is responsible to make arrangements for the retention, storage and retrieval of all QA documents. The applicant should advise the SCA prior to disposing of such records.

3.4.1 Configuration Management and Drawing Control. The applicant is responsible for establishing configuration control of the unmanned pressure test facility design and documentation. The applicant must ensure that only current drawings are used and that obsolete drawings are removed from all points of issue and use. The applicant should maintain the technical data and drawings that reflect as-built conditions of the system.

3.4.2 Material Control. The applicant should show that the program for material control is effective for new construction and during overhaul or repair of existing systems. The program should ensure that materials used conform to the applicable technical requirements. A system of documenting the identity of tested and approved materials should be implemented. Controls should be established to prevent the inadvertent use of other than specified material. See Appendix C for material OQE requirements.

3.4.3 Fabrication and Manufacturing Control. The applicant should show how the QA program ensures that the system has been manufactured in accordance with the approved drawings, specifications and manufacturing processes. All production records required by the fabrication specifications and drawings should be completed, signed, dated, and made available, as appropriate, for review by the SCA.

The hazards associated with the performance requirements of an unmanned pressure test facility dictate that only the highest quality workmanship be acceptable. Consequently, the evaluation of the workmanship evident in the finished system is a significant factor in determining the acceptability of the individual system. Acceptance standards to verify high quality workmanship are available from both military and commercial sources that establish acceptance/rejection criteria.

3.4.4 Cleanliness Control. The applicant should show that the program for achieving and maintaining cleanliness of all piping systems is under the close control of the builder during and after system assembly.

The applicant should use only SCA approved cleaning procedures during and after system fabrication. Failure to keep these systems clean may cause serious injury or death to the system operators. Appendix B provides additional guidance concerning cleanliness control of unmanned pressure test facilities. Once a system is verified clean within acceptable limits, no re-entry is allowed into that system without strict adherence to re-entry controls. Any uncontrolled opening of an unmanned pressure test facility to the surrounding atmosphere may require re-cleaning of the entire system to re-establish system cleanliness.

The final levels of cleanliness should meet the requirements that have been specified and justified by the applicant and that have been accepted by the SCA. Records of the date, method and results of sampling should be kept and made available to the SCA for review. Documentation of system cleanliness should include cleaning sheets and sketches and should indicate that each component, section or subsection of a system has been satisfactorily cleaned and that the entire system is free of contamination.

3.4.5 Testing and Inspection Control. The applicant should show that there is an effective test and inspection system in place. The system must establish the inspections and tests necessary to substantiate that items within the SOC are in conformance with the specified requirements. All inspection and test requirements should be identified in the fabrication/assembly procedures. The inspection system should incorporate clear, complete, and current instructions for inspection and should include criteria for acceptance and rejection. Records of all inspections and tests should be maintained and should indicate the nature and number of observations made the number and type of deficiencies found and the nature of the corrective action taken. Where no deficiencies are found, the satisfactory condition should be noted. All test and inspection documents should clearly show the following as a minimum:

a) The testing activity.

b) The items, subsystems, and systems tested.

c) The procedure used, including minimum acceptance criteria (where applicable).

d) Test results that either meet or exceed requirements. Departures from test requirements must be justified, documented and approved by the cognizant technical authority.

e) The dated signatures of individuals responsible for testing and final evaluation of test data.

The inspection system should serve to verify that the latest applicable drawings, specifications and process controls, with all authorized changes incorporated, are used for fabrication, inspection and testing. The inspection system should describe the training and qualification of inspectors and should include demonstration of competency in techniques such as radiographic, ultrasonic, dye penetrant and magnetic particle inspection, as applicable. The inspection system should also provide for calibration of inspection equipment. In those areas where competence in technique must be demonstrated, it is imperative that the inspection be conducted by a qualified person other than the person performing the work to be inspected, unless specifically allowed by the inspection criteria; e.g. NAVSEA 0900-LP-001-7000, Fabrication and Inspection of Brazed Piping Systems. Test documents and data that fail to meet test criteria, are incomplete or are not technically evaluated and signed off as satisfactory by an authorized representative of the applicant will be rejected by the SCA. Additional guidance concerning test requirements is provided in Appendix C.

3.5 System Testing Program. The applicant should develop and implement a written test program. It should outline a comprehensive and integrated series of tests which fully demonstrates the adequacy of all systems and equipment within the SOC.

The test program should be approved by the SCA prior to execution and should be kept current by the applicant so that it can be utilized for future testing required to sustain certification. The test program should not be revised without prior approval by technical authority and the concurrence of the SCA.

The applicant must provide test results (data) to the SCA for review. Approval will be dependent upon satisfactory results and evaluation by an authorized representative of the applicant.

3.5.1 Test Categories. The test categories listed in items (a) through (d) below must verify that the candidate system operates safely as designed. Upon satisfactory completion of these tests, the applicant should request an on-site certification survey.

a) Factory acceptance tests (FAT). This category covers testing performed by an equipment or component manufacturer to ensure that the material functions in accordance with specified limits. FATs should be required on all material where operation is of such a critical nature that failure to perform within the specified limits would jeopardize the safety of the operators. Testing of this material at the factory is usually required in cases where material/component testing is of such a specialized nature that the unmanned pressure test facility fabricator may not have the necessary test apparatus. Acrylic for view ports is an example of material that requires a FAT.

b) Prototype/first article testing (PFT). This category of test may be required to prove the design of critical components or entire systems that are developmental in nature. Performance of materials, components and systems that are unique or untried in a similar environment and are within the Scope of Certification (SOC) must be demonstrated by such tests. PFTs will often incorporate life cycle testing to verify that a component or system will operate within design limits and will not fail prematurely.

c) Pre-installation and Pre-operational tests. Pre-installation tests (PIT) are those tests that are performed on components prior to installation in a system (often referred to as bench tests). Hydrostatic and bench seat tightness testing of valves are examples of PIT level testing. Pre-operational tests (POT) are those tests performed at the system level, but prior to operating the system. Insulation resistance and continuity tests and mechanical system tightness tests are examples of POT level testing. These tests should normally be conducted on each system produced.

d) System operational and system integration tests. System operational tests (SOT) are required to verify that separately each subsystem operates satisfactorily within its design parameters. System integration tests (SIT) are performed to verify that all subsystems can be operated concurrently, as designed. SITs are also used to verify that the system operating procedures can be used to operate the system safely prior to conducting operational testing.

3.5.2 General Requirements for Test Procedures. The applicant should submit an index of all FATs, PFTs, PITs, POTs, SOTs and SITs test procedures to the SCA, indicating those within the Scope of Certification. The design agent should approve all SOTs and SITs test procedures. Once the test procedures have been approved, the test director is authorized to modify them to suit conditions prevailing at the time of the test. For example, the test director may authorize the substitution of a piece of test equipment for one called out in the test procedure because of availability. However, only the design agent may authorize changes to a test parameter, such as a test pressure. Operational and system integration test procedures for systems within the SOC must be reviewed by the SCA. The format of the test procedures should provide both the test procedure and the data to be collected in a single document.

As each step in the test procedure that requires data to be recorded is satisfactorily completed, the witnessing representative of the builder's test or QA organization should so indicate by his dated signature. If the test requires that a particular parameter be within a specified range, both the range and the actual value must be recorded.

A test schedule should be provided to allow the SCA to schedule his presence at the test site for those tests he chooses to witness. The SCA reserves the right to require a rerun of any or all of the system operational and integration tests if results are not clear or are inconclusive. Upon completion of all system testing, an indexed documentation package containing all completed tests that were evaluated with satisfactory results should be provided to the SCA.

Specific component and system testing requirements are provided in applicable sections of Appendix B and C.

3.6 Operating And Emergency Procedures (OPs and EPs). The applicant should make normal and emergency operating procedures available for review by the SCA. For Class A Systems, all operating and emergency procedures should be approved in writing by the SCA. During the on-site survey, the SCA will verify the adequacy of and the operators' compliance with the OPs and EPs. Compliance with approved operating and emergency procedures is a requirement for sustaining system certification. Any changes to these procedures must have the approval of the SCA. For Class B and C Systems, OPs and EPs may be approved at the local level. Written operating and emergency procedures are required for the following purposes:

a. To ensure that the normal operation of the facility is within the range of conditions for which certification is granted

b) To ensure that there are adequate procedures to cope with emergencies

c) To ensure that there are checklists of prerequisites for various major evolutions (e.g., pre- and post-operational procedures)

d) To ensure that the duties of operating personnel are adequately defined

e) To ensure that up-to-date information is available for the training of operators and that it is consistent with safe operation of the facility

The procedures should be supplemented as necessary by diagrams, system alignment procedures, system shutdown procedures, pre- and post-operation procedures and other such procedures as they relate to normal and emergency operations. Component designation on all operating and emergency procedures must be consistent with the system drawings and as built conditions. Refer to Appendix C for a sample of an operating or emergency procedure form (Figure C.9).

Specific emergency procedures are dependent upon the type and complexity of the facility involved. Conditions typically covered by emergency procedures include rapid increase/decrease in pressure and fire in the building.

Additional emergency procedures may be required depending on the type and complexity of the system.

Operating and emergency procedures for systems within the SOC should be demonstrated during the on-site survey. This should include a demonstration of the accessibility to vital equipment or systems to ensure that personnel can safely operate the equipment and systems under normal and emergency conditions. Where an actual demonstration is not practical, the applicant may propose an alternate means of demonstrating acceptability of the procedures. In cases where it is found that a procedure cannot be performed in a satisfactory manner, the applicant must prepare an acceptable procedure for accomplishing the desired objective.

3.7 Maintenance Program. Sustaining system certification is predicated on maintaining the system in the "as certified" condition. The applicant must prepare a maintenance program that includes, as a minimum, the following elements:

a) Preventive maintenance procedures including calibration and alignment of instrumentation and servicing of other equipment in the facility

b) Corrective maintenance procedures that include repair and replacement of components and spare parts control

c) For Class A Systems, the applicant should ensure that a system of controlled work procedures (CWPs) and reentry control have been formally promulgated. For complex systems, the SCA may request that the CWP format be submitted for review. When a system has been cleaned and/or tested in accordance with certification requirements, no re-entry into that system should be accomplished without strict adherence to the CWPs. For further information, see Appendix C

The applicant should provide instructions for conducting periodic inspections and tests to ensure continued safe operation of the system. The instructions should include the scope of the inspections and tests and should provide pass/fail criteria. Maintenance should be conducted on all items of equipment within the SOC. NAVFAC MO-406, Hyperbaric Facilities Maintenance Manual may be used as guidance. For other systems covered by this document, the applicant should submit a formal preventive and corrective maintenance program to the SCA for concurrence. In addition to the above elements, this program should include personnel responsibilities and provide both record keeping requirements and detailed, step-by-step procedures.

3.8 Operating And Maintenance Manual. Depending on the complexity of the facility, operating and maintenance manuals may be required. These manuals should describe all equipment and all phases of system operation. The following sections should be included, as applicable:

a) System Description. This section should identify and describe the purpose and functional operation of all systems and subsystems. System drawings should also be

b) Component Description. Sufficient design information should be included to identify and describe all major system components and their functions. Component drawings showing internal parts should be included.

c) Instrumentation and Controls. This section should discuss the control philosophy used in the system design and provide a detailed description of the controls and instrumentation used.

d) Operating Procedures. This section should identify all normal system operations and evolutions that involve personnel. The approved operating procedures may be provided as part of this document or separately if desired.

e) Emergency Procedures. This section should identify conditions requiring emergency action and provide procedures to be followed in the event of their occurrence. Emergency action is defined as operation under conditions of system malfunction or failure such as component failure, physical damage, or fire. The approved emergency procedures may be provided as part of this document or separately if desired (See 3.6.).

f) System Limitations, Precautions, and Set points. In this section, the applicant should clearly identify all system operational limitations. This section should also state all precautions to be taken during normal operation to preclude potentially unsafe conditions. A list of system operation set points that represent the normal operation of the system should be included.

g) System Maintenance. This section should describe all required preventive maintenance and basic repair procedures for supporting the facility. All components that must be repaired by the manufacturer or depot level repair facility should be identified. While step-by-step detailed preventive maintenance procedures may be promulgated separately, the basic repair procedures should be included in this section.

h) System Storage and Start-up. This section should describe all disassembly and maintenance required to place the system in lay-up for an extended period of time. Additionally, instructions for system start-up, after extended storage, should be provided. These instructions should include all assembly, maintenance and testing required to bring the system out of storage and into an operationally ready condition.

i) System Troubleshooting. This section should provide guidance to be used to assess the symptoms, then locate and repair probable causes of a system malfunction. For the procedures used to repair failed components, this section may refer to the section on system maintenance.

3.9 <u>Granting Initial Certification</u>. The responsibility of the Acquisition Manager is defined in Section 4. It is the responsibility of the Acquisition Manager to ensure that the system is considered certifiable prior to its transfer to a user command. To be certifiable, the SCA must concur that all system design, fabrication and testing has been performed satisfactorily, in accordance with previously approved technical specifications. In addition, all system drawings, technical manuals, PMS and certification related documents should have been approved and issued. Custody of an unmanned pressure test facility will normally be transferred from the Acquisition Manager to the user command once the SCA deems the system certifiable but prior to granting initial system certification.

In addition, the Acquisition Manager should prepare a "turn-over file" consisting of as-built system drawings, fabrication records, test records, technical manuals, operating and emergency procedures and a complete Preventive Maintenance System (PMS) package. The turnover file should accompany the system to the user command.

After receipt of the system hardware and certification documentation, the user command should take the following action:

a) Establish a formal QA plan

b) Initiate the preventive maintenance plan for the system

c) Review and submit any necessary operating and emergency procedures to the SCA

d) Request an on-site survey of the system by the SCA

Upon completion of a successful on-site survey the SCA will grant the system "Initial Certification".

Section 4: RESPONSIBILITIES OF THE ACQUISITION MANAGER

4.1 Introduction. This section defines the responsibility of the Acquisition Manager in relation to certification requirements for unmanned pressure test facilities built for use by DOD personnel. The Department of Defense acquisition program is set forth in the DOD Federal Acquisition Regulations Supplement (DFARS). The management of acquisition programs is guided by DOD Directive 5000.1 A Defense Acquisition, and DOD Instruction 5000.2 Defense Acquisition Management Policies and Procedures. In addition, system safety certification procedures must be clearly defined and strictly followed in every phase of the procurement process. This is due to the life critical nature of unmanned pressure test facilities, with particular attention being applied in regards to safety to outside operators and other personnel in the vicinity of the unmanned pressure test facility. Therefore, the Acquisition Manager should establish the certification effort in the earliest conceptual phase of the program.

The Acquisition Manager is designated as the applicant for initial certification of a new facility until the new facility is delivered to the designated user activity. Early and frequent communication between the applicant and the SCA is essential to the efficient prosecution of the system certification process. This point cannot be overemphasized.

In all aspects of the certification process, the line of communication is between the SCA and the applicant and not between the SCA and the contractor, manufacturer or procurement agency hired or contracted by the Acquisition Manager to provide the unmanned pressure test facility. While discussions and conferences with these organizations are useful, the line of action and responsibility is between the SCA and the applicant.

During a major overhaul or repairs involving configuration changes to the system, the individual parent command should assume the responsibilities of the Acquisition Manager.

4.2 System Certification Requirements In Contracts. The Acquisition Manager who contracts for or otherwise arranges for the design, construction, testing and delivery of a new unmanned pressure test facility must translate system certification criteria and documentation requirements, clearly and concisely, into contract specifications. The use of this document as a contract reference document, which allows the contractor to interpret certification requirements, should be avoided. If a contractor anticipates lease or purchase by DOD of an unmanned pressure test facility, he is building, he should become familiar with the documentation requirements necessary to support the system certification process.

However, lease or purchase agreements entered into by DOD must be specific enough in content to preclude any interpretation of the requirements of this document by manufacturers or vendors. Areas of particular importance in the preparation of contract specifications are described in the following paragraphs.

4.2.1 Material Specifications. All materials used for the construction, fabrication and assembly of parts, components, subsystems and systems which are within the scope of certification must meet or exceed the specifications set forth in Appendix A. This material should also be provided with documented objective quality evidence (OQE) and test data verifying its acceptability, in accordance with Appendix C. The Acquisition Manager should ensure that contract specifications are complete and accurate in this respect and that deviations from these specifications are authorized only with the approval of the appropriate technical authority and the concurrence of the SCA.

4.2.2 Performance and Procedure Specifications. The Acquisition Manager should ensure that the performance and procedure specifications for the construction, fabrication and assembly of the facility are clearly and accurately described in contract documents.

4.2.3 Quality Assurance (QA). The Acquisition Manager should ensure that contract documents require the contractor to provide a Quality Assurance Program plan that specifically addresses the critical requirements of system certification. Contract documents should recommend the designation of a certification manager within the contractor's organization who will serve as a single point of contact between the contractor and the Acquisition Manager on matters concerning system certification.

4.3 Document Control. It is the responsibility of the Acquisition Manager to ensure that adequate document control procedures are developed and implemented in the earliest phase of the procurement process and that these procedures are strictly adhered to in every phase and at all levels of the procurement process. All documentation required by this document should be reviewed and evaluated by the Acquisition Manager, or his agent, prior to submission to the SCA. If an agent is used, the agent should not be affiliated with the fabricator.

4.4 Preparation Of Certification Application. The Acquisition Manager, as system applicant, should prepare and submit the application for system certification. The application for system certification should be prepared in accordance with the provisions of Section 2 of this document and should be submitted to the SCA with all required documentation attached.

4.5 Configuration Management Plan. The Acquisition Manager, as system applicant, should ensure that a configuration management plan is developed and prepared during the appropriate phase of the procurement process. DODINST 5000.2 provides policy and guidance for the preparation of configuration management plans.

4.6 Technical Design Reviews. The Acquisition Manager is required to conduct design reviews. The SCA should conduct independent technical review to assess the adequacy and safety of all systems associated with the facility.

This applies to both new systems and those systems that are undergoing significant modifications.

It is strongly recommended that the Acquisition Manager invite the SCA to participate in the normal system technical design review process. An understanding between the Acquisition Manager and the SCA should be reached early in the system design regarding technical design reviews. The number, timing and level of detail of the technical design reviews should be dependent upon the uniqueness and complexity of the system. These points should be negotiated between the Acquisition Manager and the SCA and promulgated in the certification Milestone Event Schedule.

The design review process is best served when the Acquisition Manager assembles additional technical personnel, not affiliated with the system designer, to review the system design. Sufficient technical expertise should be used in the design review process to ensure that electrical, structural, mechanical and piping systems are thoroughly evaluated.

The SCA recognizes that the level of detail provided in each design review will depend on how far along the actual subsystem design has progressed. Therefore, it is imperative that the design review team review all design documentation prior to conducting each formal review.

For complex systems, the Acquisition Manager should issue a design review check-off list for each subsystem to be reviewed. This check-off list should include verification that all the required design review information is available for technical review. The Acquisition Manager, technical design review team and SCA should complete the check-off list during the design review.

At the completion of each technical design review the Acquisition Manager should issue findings and recommendations regarding all system design deficiencies. The methods of issue of previous review findings should be discussed between the SCA and Acquisition Manager prior to each design review. Those deficiencies that are determined by the Acquisition Manager and SCA to be within the Scope of Certification should be identified as such.

All identified safety related design deficiencies must be resolved before the construction contract is awarded. Design deficiencies not resolved prior to the award of the construction contract will require a change order to the construction contract, which in most cases, causes additional costs and time delays to the Government.

The Acquisition Manager should avoid awarding the construction contract prior to resolution of all identified safety related design deficiencies.

4.7 Associated Documents. The Acquisition Manager, as system applicant, should ensure that all associated documents, such as technical manuals, preliminary design, final design, test memos, etc., are prepared and submitted in accordance with the Milestone Event Schedule during the acquisition process. The Acquisition Manager should ensure that all associated documents are submitted to the SCA in a timely manner and that there is adequate time allocated in the Milestone Event Schedule to allow the SCA to conduct a thorough review of the associated documents. The Acquisition Manager should review SCA comments and take appropriate action on safety related issues.

4.8 Construction Review Board. It is recommended that the Acquisition Manager conduct Construction Review Board (CRB) meetings during the period that the facility is being fabricated. The CRB should meet frequently at the construction facility, with frequency being dependent upon the complexity of the facility being built.

Section 5: REPAIR AND OVERHAUL

5.1 Introduction. Periodically, unmanned pressure test facilities require repair or overhaul wherein industrial work is performed within the certification boundary beyond that which is normally conducted during routine maintenance procedures. During such industrial periods, system certification should be terminated until the requirements for re-certification, specified in Section 2, have been satisfied.

During significant configuration changes, the responsibilities of the acquisition manager may shift from the user command to another command or program office. However, the user command to which the system is assigned should remain the applicant for system certification. Close coordination between the acquisition manager, the applicant and the SCA is crucial to ensure that the system certification process does not become disjointed and unmanageable.

In all instances, the number and extent of technical design reviews should be negotiated between the applicant and the SCA.

It is the responsibility of the system applicant to ensure that the requirements for re-certification are satisfied during repair or overhaul periods. As stated in Section 1, the line of communication concerning certification is between the SCA and the system applicant and not between the SCA and the activity responsible for the performance of the work. The applicant may designate an individual or organization to act as certification manager, who will be the single point of contact for liaison both with the overhaul organization and with the SCA on matters concerning certification.

5.2 Certification Status During Repair Or Overhaul. When the supporting building facilities undergo any major facility upgrade that would affect the performance or operational integrity of the unmanned pressure test facility, system certification is terminated.

Often, component or minor system repair is required between scheduled overhauls. Minor work on the facility that does not involve hot work (welding/brazing) and that does not modify the certified system configuration does not terminate system certification if the work and testing are documented under re-entry control. Though notification to the SCA is not required, all documentation of the minor work and testing will be reviewed at the next certification on-site survey. Examples of minor work that does not terminate or suspend system certification are:

a) Repairing leaking valves by replacing valve software

b) Replacing unmanned pressure test facility components (mechanical joints) with the same kind as specified by the system drawing

c) Re-qualifying system hoses, volume tanks, high pressure gas flasks, high pressure fluid tanks, filter housings or moisture separators by hydrostatic testing required by PMS

d. Calibrating gages and relief valves

e) Re-certifying DOT 3AA flasks/bottles

f) System configuration changes in support of mission testing documented on controlled work procedures

Should the scope of work exceed minor work (as described above), termination or suspension of system certification may be required. This applies whether the work is accomplished during scheduled maintenance, as day-to-day work, or to correct a casualty. The applicant should immediately notify the SCA when this work is required so the SCA can make a determination with respect to termination or suspension. Examples of significant work that may terminate or suspend system certification are:

a) Welding or brazing on the pressure boundary

b) Overhauling the unmanned pressure test facility.

5.3 Pre-Overhaul Requirements. Prior to the commencement of overhaul or repair of an unmanned pressure test facility, the applicant should submit the following to the SCA for review:

a) A detailed definition of the scope of the overhaul, including a list of repairs, alterations, modifications and significant components to be replaced, etc.,

b) The overhaul or repair work package should include, as appropriate, drawings, description of work, quality assurance provisions, tests and inspections to be accomplished. All procedures or processes to be followed must also be included.

c) A schedule showing major overhaul milestones.

Pre-Overhaul information should be submitted as early as possible to allow sufficient time for review by the SCA. The SCA, as early as possible, in conjunction with appropriate technical authorities, should review all work and procedures/processes that involve system certification.

In cases where the work package includes alterations, the Naval Facilities Engineering Command Hyperbaric Facilities Maintenance Manual, NAVFAC MO-406, may be used to provide guidance for the control of the alteration process. The timing of formal technical design reviews should be negotiated between the applicant and the SCA and should be dependent upon the complexity and uniqueness of the alteration.

5.4 Overhaul. All unmanned pressure test facilities should be overhauled, as described below. The length of time between overhauls of a particular facility should be determined by the activity, sponsor and SCA, but should not exceed 10 years. Should a facility be taken out of service (mothballed) for more than two years, an overhaul should be conducted prior to placing the facility back in service.

The overhaul of unmanned pressure test facilities should be accomplished in three phases as follows:

a) A pre-overhaul test and inspection of existing systems and components must be performed to determine the condition of the facility.

b) All systems and components that do not perform to specifications must be repaired or replaced to bring the facility into conformance.

c) The facility should undergo final system functional testing to verify the acceptability of the work performed.

Functional testing includes those tests that are performed upon completion of an overhaul. Functional testing is to be witnessed by a SCA representative and should include all systems of the facility.

The level of overhaul accomplished should be based on the criticality of the respective system.

5.4.1 Hazard Categories. All systems, equipment, components and procedures should be evaluated and assigned a hazard category (HAZCAT) as defined in Section 2. The HAZCAT is based upon the potential hazard to operators or other personnel involved in the test evolution, as well as systems associated with the loss of pressure boundary integrity and/or loss of functional operation. It is emphasized that the facility operators and test support personnel are the individuals to whom this HAZCAT analysis program is directed.

5.4.1.1 HAZCAT I Systems. All components that are a part of a HAZCAT I system should be evaluated and refurbished to the "as new" condition. The "as new" condition of a component is that condition which was acceptable in the original design, and/or meets the quality control requirements of the Commercial or Military Specification for that component. The "as new" condition includes, but is not limited to, the following:

a) complete internal/external visual inspection

b) replacement of all software

c) operational test

d) cleaning

In the event the component cannot be restored to "as new" condition, an in-kind replacement for the required component should be installed. The in-kind replacement must pass all the tests for the design requirements of the original component. General maintenance of all HAZCAT I components should be performed and documented. NAVFAC MO-406 may be used as a guide. In-kind replacement of a component is defined as replacement with an identical component if that component is still manufactured. In the event an identical component is no longer manufactured, the replacement component must meet all of the original component's design criteria. Should there be any doubt as to whether a component is an in-kind replacement, contact the SCA.

5.4.1.2 HAZCAT II Systems. All HAZCAT II systems should be envelope functionally tested to their complete design parameters. Envelope functional testing is defined as testing each component of the respective HAZCAT II system to its system design parameters (i.e., ball valves, completely shut off and fully open; needle valve, fine tuned and flow as required for original design; pressure gauges, accurately record tested parameters). In addition, Functional Testing, as performed originally when the system was installed, should be conducted for all HAZCAT II systems. HAZCAT II system components should not be removed or refurbished, unless the component does not perform or if a noticeable flaw is found during functional testing of the system. General maintenance of all HAZCAT II system components should be performed and documented, NAVFAC MO-406 may be used as a guide.

5.4.1.3 HAZCAT III and IV Systems. All HAZCAT III and IV systems should be demonstration tested to system design requirements. Demonstration testing is the functional testing level performed originally when the system was installed. HAZCAT III and IV system components should not be removed or refurbished unless the component does not perform, or if a noticeable flaw is found during demonstration testing of the system. General maintenance of all HAZCAT III and IV system components should be performed and documented, NAVFAC MO-406 may be used as a guide

5.5 Routine Maintenance. As defined in Section 2, all HAZCAT I, II, III AND IV system components should receive routine maintenance as required by facilities PMS or as required by the manufacturer of the respective component. General maintenance should include, but is not limited to: replacement of belts, pulleys, lubrication, filters, calibration, o-rings, calibration of gauges, periodic testing of relief devices, replacement of filter elements, calibration of sensors and indicators, etc.,

5.6 Document Control. The requirement for adequate document control during overhaul and repair is as essential to re-certification as it is in the initial certification process.

The applicant should ensure that all documentation required to support design, material selection, work procedures, tests and inspections are prepared and maintained in accordance with the requirements of Section 2 and Appendix C.

For major modifications due to system alterations, the Acquisition Manager should ensure that applicable fabrication and test documentation (i.e., drawings, technical manuals, test memoranda, etc.,) are revised and then reviewed by the SCA. For repairs, the responsibility for updating this documentation lies with the applicant.

5.7 <u>Procedures</u>. Those procedures required to perform work, inspection and testing should meet the requirements set forth in Section 3.3 and be so specified in contract documents. These procedures should be available for review and concurrence by the SCA during on-site surveys.

5.8 <u>Quality Assurance (QA)</u>. Quality assurance requirements during overhaul and repair should be the same as those specified in par. 3.3.8 of this document and should be specified in contract documents.

5.9 <u>Re-Entry Control</u>. Particular attention must be directed to the proper use of approved re-entry control procedures as described in Appendix C. Re-entry control forms must be accurately completed and must contain all required signatures prior to re-entry into a system that is within the scope of certification. Prior to use of the system, all re-entry control actions must be satisfactorily completed and signed or have an approval for a departure from specifications approved.

5.10 <u>Retest Requirements</u>. Repairs and modifications to systems require the same stringent testing requirements as newly designed systems. The following guidelines should be used to determine the level of testing required during systems overhaul periods:

a) Factory Acceptance Tests will not be required unless the replacement equipment is of such a specialized nature that the repair activity is unable to perform testing.

b) Pre-installation tests will be required only for replaced or repaired components.

c) Pre-operational tests will be required only when a subsystem is repaired or modified. These tests need to be performed to ensure that those sections of the system that were repaired or modified are properly reinstalled.

d) System operational tests should be conducted on all subsystems that have been repaired, modified or placed in lay-up when time permits and personnel are available. The extent of system operational testing may be negotiated with the SCA.

Additional information concerning test requirements is provided in Section 3.5 and in Appendix C.

5.11 Technical Requirements. The primary sources of technical requirements are the documents that the facility was designed to, such as:

a) ASME Section VIII Division 1 or Division 2, Boiler and Pressure Vessel Code

b) ANSI/ASME B31.1, Power Piping Code

c) NFPA 70 National Electric Code

Other documents that may be used for guidance are:

a) NAVFAC DM-39, Hyperbaric Facilities Design Manual

b) NAVFAC MO-406, Hyperbaric Facilities Maintenance Manual

c) NAVFAC MIL-HDBK-1152, Inspection and Certification of Boilers and Unfired Pressure Vessels

d) ANSI/NB-23, National Board Inspection Code

Section 6: NOTES

6.1 Subject Term (Key Word) Listing

American Society of Mechanical Engineers (ASME)
Boiler and Pressure Vessel Code (BPV)
Fatigue
Hatch
Hazard Category (HAZCAT)
High-pressure gas storage
Hyperbaric Facilities
Joint Tightness Test
Maximum System Pressure (MSP)
Milestone Event Schedule (MES)
Navy Occupational Safety and Health (NAVOSH)
Objective Quality Evidence (OQE)
Penetration
Pressure Media
Pressure Vessel
Re-certification
Re-entry control (REC)
Safety
Safety Standard for Pressure Vessels for Human Occupancy
Scope of Certification (SOC)
Seals
System Certification Authority (SCA)
System certification process
Unmanned Pressure Test Facility
View Port

APPENDIX A
CATEGORIZATION OF SCOPE OF CERTIFICATION MATERIALS AND COMPONENTS

A.1 INTRODUCTION

This appendix contains guidance for categorizing materials and components within the Scope of Certification (SOC). Categorization of a material or component is dependent upon its application and service experience. The proposed application, (configuration, joining techniques, etc.,) must be reviewed to determine the proper categorization for each material or component.

For the purpose of system certification, materials and components are grouped into three categories:

Category 1: Materials and components for which considerable operating experience in pressure vessel applications is available.

Category 2: Materials and components which are commonly used in a variety of military and commercial applications, but with little or no past experience for the proposed unmanned pressure test facility application. Generally, Category 2 material requires testing to verify that it will be acceptable for its intended use in the new application.

Category 3: Materials and components that may be developmental, or do not have a documented history of satisfactory use in pressure vessel applications.

These material and component categories are not to be confused with the hazard level categories of MIL-STD-882 and as defined in Section 2. Solely as an aid in assessing the reliability of materials and components in specific unmanned pressure test facility applications, the material and component categories described above were conceived. The applicant must justify the materials and their applications as used in the design of the pressure vessel system for the expected service environments. All materials considered to be within the SOC should be identified. Their relative location in the system should be described, and verification of material compatibility with the intended environment and with each other should be analyzed.

The applicant should justify the adequacy of the proposed material and its application. The less information and experience available regarding a proposed material or component for a particular application, the greater is the burden of proof for the acceptability of the material. This burden of proof is the responsibility of the applicant.

A.2 CATEGORY 1 - MATERIALS AND COMPONENTS

To be classified as a Category 1 material, the material must be manufactured to a commonly used commercial or federal specification. Additionally, extensive experience in fabrication of the specific component configuration (e.g., commercial off-the-shelf) and a history of operation in a specific environment must be presented to the SCA. For piping systems, compatibility with both the specific internal and external fluids/gases to which the piping will be exposed must be proven by previous usage.

Unusual configurations or applications of these materials and/or components with no documented history of use in the specific environment might, however, place them in Category 2.

All view ports made of acrylic plastic should comply with the requirements of ASME PVHO-1. View port materials other than acrylic plastic will be considered Category 3 materials

A.3 CATEGORY 2 - MATERIALS AND COMPONENTS

Materials manufactured to a recognized commercial or federal standard, but with no documented history of use in the specific pressure vessel environment, fall into this category. Materials used in standard commercial (or military) applications that are not commercial off-the-shelf are also in this category. The use of Category 2 materials and components requires justification by complete design analysis of material properties and operating stresses. Approval of a material or component for use in a specific application will be based on the supporting technical information provided by the applicant.

A.3.1 Structural Materials. For pressure vessels and hard structure, the applicant should submit information on material in accordance with Appendix B. For other structural components (i.e., foundations, weight handling strength members, etc.,) the applicant should submit the following information as justification for the use of each Category 2 material or component:

a) The commercial or federal specification and the chemical and physical properties of the base material in the condition it will be used. If the material is to be welded, brazed, cold worked, work hardened, etc., the acceptable material properties at the completion of fabrication should also be specified.

b) Proof of weldability and fabricability (if the fabrication process or possible future repairs include welding).

c) Fatigue data, preferably data in the high-stress, low-cycle range (below 10,000 cycles), which considers the effect of the environment (e.g., seawater, fresh water, oil, O_2, HeO_2 and hydrogen).

d) Data collected over a sufficient time period to justify the adequacy of the material with respect to general corrosion, susceptibility to stress-corrosion cracking, and compatibility with adjacent materials in its intended environment.

e) Nondestructive testing results on the material, the heat-affected zone (HAZ), and the weld joints, as appropriate.

A.3.2 Pressure Compensating and Hydraulic System Fluids. As a minimum, the applicant should submit the following:

a) A list of the applicable military, federal or commercial specifications

b) Information covering flammability, resistance to deterioration and compatibility with system component.

c) Information relating to possible toxicological hazards if used inside the unmanned pressure test facility

A.3.3 Electrical System Materials. All electrical system materials and components should, as a minimum, meet the requirements of Appendix B and the National Electric Code.

A.4 CATEGORY 3 - MATERIALS AND COMPONENTS

The basis for testing and the criteria for acceptance of new materials and components will not necessarily be the same as for those currently in use. The proof of the acceptability for the material or component and the justification of the acceptance criteria must be provided by the applicant. For example, the applicant should demonstrate the effect of defects and manufacturing variations on the reliability of the material or component by appropriate model and/or prototype testing in a simulated service environment. The applicant must establish that a design using the new material or component provides at least the same degree of safety as proven materials (Category 1) in a similar application. As such, this may result in a higher factor of safety being required for Category 3 materials.

Examples of Category 3 pressure vessel and other structural materials are those generally characterized by low ductility, such as ultra high-strength metals, glass, metallic composites, concrete and ceramic materials.

For pressure vessels and other structural materials, the applicant should submit the same information that is required for Category 2 material. In addition, as justification for the use of a Category 3 material, formal test data should be provided to the SCA covering, as a minimum, the following information:

a) Basic process to be used in producing the material. Sufficient information is required to demonstrate that the process results in reproducible material properties.

b) Effect of flaws, such as cracks, inclusions and porosity, on material performance.

c) Effects of temperature on material performance and on crack propagation rate.

d) Results of destructive tests of samples fabricated from the material and comparison of these results with the design basis predictions of the failure point.

e) Results of nondestructive test requirements applied to the base material and joints as appropriate.

f) Results of fatigue testing based on operating pressure differentials and external loading.

g) Hazards involved in fabrication or use of the material with respect to flammability.

h) Additional testing or information as required by the SCA.

Should the designer choose to use Category 3 materials for purposes other than as structural pressure vessel components, fully documented technical justification will be required. As a minimum, the applicant should submit the information required in paragraph A.3 plus additional information as may be required by the SCA to justify the use of Category 3 material or components.

APPENDIX B
DESIGN PARAMETERS FOR UNMANNED PRESSURE TEST FACILITIES

B.1 INTRODUCTION

This appendix provides guidance to the designer of an unmanned pressure test facility in the form of requirements, recommendations, information and preferred approaches pursuant to safety certification. It is not to be considered as all-inclusive. It is written to provide guidance in those areas of design where experience exists and design parameters have been established. The applicant must review the requirements for the specific facility for which he is seeking certification, then coordinate those requirements with the design guidance of this document. Established pressure vessel design guidance are provided in the following documents:

a) <u>NAVFAC DM 39, Hyperbaric Facilities</u>

b) <u>ASME/ANSI PVHO-1, Safety Standards for Pressure Vessels for Human Occupancy</u>

c) <u>ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and Division 2, Pressure Vessels</u>

d) <u>ASME B31.1, Power Piping</u>

The final responsibility for all aspects of a safe design lies ultimately with the applicant and cannot be assigned to any document or textbook.

B.2 STRUCTURAL DESIGN CONSIDERATIONS

The information provided herein may not be applicable to every design attribute for unique systems or systems used in unique environments. All unusual circumstances that may affect the system design should be brought to the attention of the SCA during the initial design phase. The designer should consider conditions such as the effects of shock, vibration, creep, thermal transients, implosions, material deterioration due to environmental effects, or any other condition that may be applicable to a specific design.

Pressure vessels are complex structures that may contain penetrations for piping, electrical cables, hatches, view ports or other appurtenances. These structures may also contain geometrical discontinuities, such as hemisphere-to-cylinder intersections and saddles for foundations. The physical properties of the materials from which these structures are fabricated, such as modulus of elasticity, yield strength, ultimate strength, fatigue strength and fracture toughness interact in a complex fashion. Thus, a rational design procedure, which accounts for fatigue, yield, fracture, buckling and all pertinent material properties, should be applied to ensure a safe structure. The burden of proof is upon the applicant to design a pressure vessel and demonstrate by use of analytical and/or experimental means that the structure will function as intended for its expected life.

B.2.1 Fatigue. A fatigue analysis should be submitted for all pressure vessels that do not comply with the requirements of the ASME Boiler and Pressure Vessel Code. This fatigue analysis may be based on specimen and/or model tests. Suitable fatigue strength reduction factors should be applied to the specimen or model test results to account for variations in properties, scatter in the test results and the uncertainties involved in applying specimen and model fatigue data to fabricated full-scale structures. The fatigue analysis must consider at least the following design parameters:

a) Magnitude and nature of peak stresses, stress concentration factors used in the calculation of peak stresses, should be based on experimental data on similar structures;

b) Material properties and method of fabrication;

c) Maximum deviation in material thickness, assembly techniques and allowable flaws;

d) Geometry of the structure and details of penetrations and attachments;

e) Previous fabrication and operating history of the material;

f) Effects of residual stresses, thermal stresses and strain rate;

g) Type and method of loading and environmental effects such as corrosion/erosion;

h) Maximum anticipated number of load cycles.

When pressure vessels are constructed of Category 3 material (see Appendix A), sufficient destructive fatigue tests of full-scale prototypes or models should be performed to determine the fatigue life of the design.

Pressure vessels designed to comply with the requirements of the <u>ASME Boiler and Pressure Vessel Code, Section VIII, Division 1</u>, may not require a fatigue analysis if SCA concurrence is obtained. Pressure vessels designed to comply with the requirements of the <u>ASME Boiler and Pressure Vessel Code, Section VIII, Division 2</u>, do not require a fatigue analysis if condition A or condition B of Article AD-160.2 are met.

B.2.2 Fracture Toughness. The applicant should ensure that the materials used to fabricate the pressure vessel, or any pressure boundary component exhibit adequate resistance to fracture. Specifically, the design analysis submitted to the SCA should demonstrate that brittle fracture is not a possible mode of failure by considering at least the following:

a) Magnitude, nature and rate of stresses (both applied and residual);

b) Temperature range to which the structure may be subjected in service;

c) Size, location and density of flaws initially present in the material and those that occur as a result of cyclic operations;

d) Environmental effects such as corrosion and/or erosion; Specifically, the environmental effects on crack initiation and propagation (e.g., stress-corrosion cracking) must be evaluated;

e) Effects of creep and strain rate on fracture toughness;

f) Localized effects due to penetrations, attachments and other vessel or component restraints (i.e., stress risers);

g) Effects of fabrication processes and heat treatments on the fracture characteristics of the material. In particular for welded construction, properties of the weld rod and base metal within the heat-affected zone and resultant induced internal stresses should be considered;

h) Material thickness

The material properties used in the fracture analysis should be based on appropriate tests such as tensile and compressive strength tests, K_{Ic} (fracture toughness) tests, K_{Iscc} (stress corrosion cracking) tests, Charpy V-notch impact tests, dynamic tear tests, drop-weight tests and explosion bulge tests as discussed in Appendix A. Where appropriate test data is not available, fracture mechanics type tests should be conducted. Further, the design analysis must consider possible variations in material properties and, in particular, the effect of material thickness on fracture characteristics. The structural design basis used by the applicant for the analysis of brittle fracture should be verified by destructive testing of the pressure hull and component models and structures, or, where possible, by reference to existing information and service experience. All plates, parts and components must demonstrate adequate strength and toughness over the range of design operating temperature. Toughness characteristics of ferrous materials should be referenced to the Nil Ductility Transition Temperature (NDTT).

B.3 DESIGN STRENGTH PARAMETERS OF INTERNALLY-LOADED PRESSURE VESSELS

In general, the applicant should demonstrate the structural integrity of the pressure vessel under loading conditions to be representative of those expected in service. Therefore, the designer must take into consideration the effects of temperature, cyclical loading, creep, ductility, corrosion rates and anisotropy. Examples of pertinent fabrication variables include material reproducibility, fabrication flaws and defects, vessel openings, intersections of different shells of revolution and attendant reinforcement(s), residual fabrication stresses and deviations from the nominal geometry.

B.3.1 Inelastic Stability (Yield). For stable pressure vessel structures (i.e., stiffened or un-stiffened shells which permit the level of load-induced membrane stresses to approach the material yield point), the ratio of the pressure that would produce yield to the design operating pressure should be justified. In determining the pressure at which yield occurs, all fabrication and design-induced restraint and geometric variables should be considered and their effect(s) included. This is because the strength of moderately stable vessels can be detrimentally affected by such variables (i.e., yield can occur at levels of membrane stress below calculated levels of yield stress).

B.3.2 Stress Analysis. The applicant should perform a complete stress analysis of the pressure vessel and demonstrate that all stresses are within the design criteria and that the vessel's fatigue life is adequate for its expected service life. For Category 1 and 2 materials, the allowable stresses under internal pressure should be justified to the SCA. The stress levels defined in paragraph B.3.3 may be used as guidelines; however, the applicant must demonstrate compliance with only B.3.3.c., maximum peak stress. The design requirements for Category 3 materials must be comprehensive, provide at least the same degree of conservatism as the design requirements for Category 1 and 2 materials and should be approved by the SCA.

B.3.3 Verification of System Design Pressure. For Category 1 and 2 materials, model testing or use of existing model test data must be used to verify the calculated system design pressure. There are three alternative methods of verification (SCA approval of the method chosen must be obtained prior to testing):

a) When comparable hull geometries and identical materials have been successfully tested to a pressure greater than the system design pressure of the vessel to be certified, the existing test data can be substituted for destructive model testing of the structure under review. Any geometric differences between the hull requiring verification and the comparable hull for which test data exists should be brought to the attention of the SCA.

b) For new designs that do not fall within the parameters described in paragraph (a) above, the calculated failure pressure may be verified by performing destructive model tests, either full or reduced scale. When such testing is performed, the structural model should be large enough to contain representative prototype geometries, material properties, and fabrication process restraints, tolerances and residual stresses.

c) Nondestructive pressure testing of the actual vessel to be put into service in accordance with applicable requirements of the ASME will be acceptable as verification of the calculations. All others will be non-destructively pressure tested to 1.5 times the maximum operating pressure. When this option is chosen, the calculated failure pressure must be greater than 1.5 times the maximum operating pressure by a factor of safety sufficient to preclude damaging the structure during the test. The SCA should approve the ratio of failure pressure to test pressure prior to testing. Clearly, use of this method requires that the decision be made very early in the design process because of the profound effect on the structural design.

For Category 3 materials, the above testing requirements may not be appropriate or adequate. The testing used must demonstrate the same degree of conservatism as the testing requirements for Category 1 and 2 materials. The factor of safety and all testing parameters should require SCA approval.

B.3.3.1 Testing Procedures/Test Instrumentation. For all vessels, a detailed test procedure should be developed and provided to the SCA for review and approval prior to testing. The test should be of sufficient duration to demonstrate that the combined stress/temperature/time loads do not produce permanent deformation or damage in the structure. If the tested structure is to be used in service, a complete set of instrumentation readings should be recorded at the maximum operating pressure (this may be accomplished during instrumented testing to 1.5 times the maximum operating pressure). The test procedure should include a detailed strain gage plan, which specifies the number, type and location of all gages. Strain gages should be placed at points of:

a) General stress level

b) Fatigue

c) Low quality analysis

d) Uncertain dimensions

e) Geometrical discontinuities

f) High stress between openings

The test procedure should duplicate the loading conditions expected in service and, where applicable, should be such that the mode of failure is identifiable. Upon completion of testing, the recorded strain gage data should be used to verify the calculated performance of the structure. The complete test report should be provided to the SCA for review and approval.

B.4 DESIGN OF PRESSURE VESSELS TO COMMERCIAL CODES

Pressure vessels, within the scope of certification, should be designed and fabricated in accordance with the ASME Boiler and Pressure Vessel (BPV) Code, Section VIII, an equivalent published design code, a standard approved by the SCA, or the design should meet the applicable criteria of Sections B.2 and B.3 herein. When designing to ASME BPV Code, Section VIII or other commercial codes, the allowable stress values given in that specific code are to be used. These allowable stress values reflect a factor of safety empirically determined for the material and application for each specific code.

B.4.1 Documentation Requirements for Pressure Vessels Built to Commercial Codes. When using commercial codes in designing and fabricating pressure vessels, the SCA requires documentation, as outlined in the following subsections, in addition to that which is specified in the commercial code.

B.4.1.1 Vessel Drawings. Drawings must completely identify the vessel and all the appurtenances (foundations, penetrations, attachments, etc). All welds should be detailed and fully located. All components should be fully specified on the Bill of Material and notes should fully explain or define processes, specifications, procedures and/or special instructions. Vessel weight, internal (floodable) volume and cycle life (when required) should be stated on the Top Assembly Drawing for each vessel.

B.4.1.2 Design Calculations. Design calculations should be provided showing worst-case dimensions and tolerances, and clearly stating all design assumptions and load conditions. The calculations should be in standard engineering data sheet format that clearly indicate that the design, as depicted in the drawings, is fully satisfactory and meets all design requirements of the ASME BPV Code, Section VIII Division 1 or 2 as appropriate. The design calculations should show that they meet the above requirements for the design life of the vessel, and be signed by the design engineer.

B.4.1.3 Manufacturer's Documentation. The Manufacturer's Data Report should be submitted for each vessel. Copies of the completed and signed ASME Manufacturer's Data Reports for Pressure Vessels (Form U-1/U-1A) should be submitted with applicable ASME Manufacturers Partial Data Reports (Form U-2).

A copy of the Certification of Authorization from the ASME Boiler and Pressure Vessel Committee, or the equivalent from other approved commercial code committees, authorizing the manufacturer to fabricate vessels of the designed class should be attached to the Manufacturer's Data Report.

B.4.2 Material Verification. All materials comprising the pressure vessel (pressure containing material) and all materials welded to the pressure vessel should be documented to verify compliance with the Bill of Materials and applicable specifications. This should also include welding rods used on the pressure boundary.

B.4.3 Welding Procedures. Copies of all welding procedures required for the fabrication of the pressure vessel and attachments should be provided to the SCA. In addition, documentation verifying approval of these procedures should also be provided.

B.4.3.1 Welder Qualifications. Documentation should be provided verifying that all welders that produce welds on the pressure vessel are qualified to the approved welding procedure for the type and position of each weld made. The document should clearly state that the welder is qualified to perform the procedure and his qualifications are current under applicable code requirements.

B.4.3.2 Weld Records and Maps. The weld records should consist of a chamber weldment joint identification drawing, or map, for each chamber pressure shell and piping system. All chamber joint weld locations should be shown and a joint identification number assigned to each weld. A chamber weldment record form for each welded joint, including non-pressure retaining joints and brackets, should be prepared. The weldment record form should contain the following information:

a) Joint Identification Number (JID) number

b) Joint design type

c) Base metal type with heat and lot number

d) Filler metal type with heat and lot number

e) Fit up and inspection results

f) Welding procedure number

g) Heat treatment if required

h) Welder or brazier number

i) Type of inspection and results

j) Disposition of joint (pass/fail)

k) Any repairs of joint

l) Inspection procedure number

m) NDT inspection number

n) Signature and date

B.4.3.3 NDT Records. Copies of all nondestructive testing (NDT) records should be provided. Qualification records of nondestructive test personnel should be maintained and provided to the SCA.

B.4.3.4 Dye Penetrant (PT) Inspection. Records of dye penetrant inspections should be maintained and should consist of:

a) Type(s) of dye penetrant tests

b) Identification of assembly, part, etc.,

c) Number of cracks

d) Type(s) of cracks

e) Signature and date of the assigned responsible individual verifying all specified PT inspection including PT of any required repairs has been accomplished and is satisfactory

B.4.3.5 Radiographic (RT) Inspection. Chambers are required to have full radiographic testing (RT) of all pressure retaining butt welds (joint efficiency of 1). Records of radiographic weld inspection should contain, as a minimum, the following:

a) Date of exposure of the radiograph

b) Positively identified location of weld radiographed

c) Type of material and material thickness

d) Type of weld joint

e) Approved procedure identification

f) Energy source (isotope type, intensity, kilo-voltage and focal spot size of x-ray machine)

g) Type of film, screens, source-to-film distance, and exposure time

h) Penetrameter designation

i) Image Quality Indicator (IQI) sensitivity reading

j) Applicable acceptance standards

k) Flaws (unacceptable slag, porosity, or other indications)

l) Acceptance or rejection

m) Date of interpretation and signature of film interpreter(s)

n) Interpreter's documented qualification level should be noted

o) Diagram (radiograph map) indicating the specific location of each radiograph coded to its unique number

Where required by contract, a copy of the actual radiographs should be provided to the government.

B.4.3.6 Ultrasonic (UT) Inspection. Records of ultrasonic inspection should contain, as a minimum, the following:

a) Date of the ultrasonic inspection

b) Description and unique item identification, weld location and joint identification

c) Type of material and material thickness

d) Type of weld joint and length of weld inspected

e) Approved procedure identification

f) Equipment used for inspection (instrument and search unit): manufacturer and model number, transducer size and type, search beam angle, test frequency, couplant

g) Calibration standard number

h) Applicable acceptance standard

i) Reference block identification

j) Discontinuities that exceed the DRL (Disregard Level)

k) Acceptance or rejection

l) Signature of inspection personnel and date

m) If supplemental ultrasonic inspection techniques are used that contribute to the final inspection results, they should be recorded

B.4.3.7 Heat Treatment Procedures and Records. Copies of the procedures and records of all heat treatments performed on the chamber should be attached to the Manufacturer's Data Report.

B.4.3.8 Charpy Impact Test Data. When Charpy Impact testing of materials is required by the applicable commercial code, a copy of the Charpy Impact Test data should be attached to the Manufacturer's Data Report.

B.4.3.9 Material Repair Report. A report on repairs of any defects in the materials used for the fabrication of chambers should be attached to the Manufacturer's Data Report.

B.4.3.10 Technical Manual. Each pressure vessel system should be supplied with all operating, maintenance, technical and parts manuals and instructions necessary for the safe operation of all devices or components supplied with or part of the pressure vessel system.

B.5 MATERIAL SELECTION

Selection of the proper materials to be used in the manufacture of pressure vessels is critical to ensuring system safety. The specific end use of each structural component must be evaluated on the basis of its operating environment, life expectancy and intended use. The use of inappropriate material in a pressure vessel may result in a catastrophic failure and cause fatal or critical injury to personnel and substantial damage to property.

B.5.1 Corrosion. Corrosion effects must be considered during the initial selection of the material and throughout the design process. The following list represents typical types of corrosion that must be considered:

a) Electrolytic corrosion - stray electrical currents that can accelerate corrosion.

b) Crevice corrosion - crevices in or between materials retard the formation of oxide film within these crevices.

The oxide film that forms on the surrounding surface will act as a cathode and the crevice will act as an anode that accelerates the corrosion within the crevice.

c) De-alloying corrosion - In some alloy compositions, corrosion will attack one or more of the components of the alloy, which will result in weakening of the material.

d) Galvanic corrosion - When two different metals are coupled in the marine environment, one will act as an anode and the other will act as a cathode depending on the relative positions of the metals within the galvanic series and the relative size of the exposed metal surfaces of each. This will accelerate corrosion. The applicant should consider this when choosing materials to use in the design of the system.

e) Stress corrosion - certain alloys are susceptible to stress corrosion cracking, which can only occur when the material is exposed to a corrosive environment while under tensile stress. In the case of some high strength steels and titanium alloys, this form of corrosion can be propagated at highly accelerated rates, depending on environmental conditions.

f) Pitting - pitting can be a serious problem in pressure vessels and components. Pitting is normally limited to alloys of steel and aluminum. Hatch and view port seating surfaces have been known to leak due to pitting.

Painting, anodizing and plating are all common and cost-effective methods of corrosion protection. These processes provide only a thin layer protection, however. When this surface protection is scratched, the exposed bare metal is subject to accelerated local corrosion.

B.5.2 Protective Finishes. Finishes applied to pressure containing and critical load bearing elements should not be of a type likely to permit the development of hidden pitting. The application of all protective finishes to surfaces in contact with breathing gases should be performed in accordance with written and approved procedures.

Metal applied as a surface finish, coating or cladding should be lower on the electrochemical scale than the metal to which it is applied. Clad welding is a process that deposits corrosion resistant metal over the area to be protected. This process can be used to protect critical hatch and view port seating surfaces and is effective in eliminating pitting and general corrosion. The applicant should justify that use of dissimilar metals in contact, where dissimilar metals are defined by MIL-STD-889, Dissimilar Metals, does not present an unacceptable corrosion potential.

B.5.3 Toxicity. As a precaution, the designer should consider the toxic effects of materials. Materials, such as paints, insulations, sealants, adhesives, plastics, fabrics, fittings, and other items and equipment containing material or components which may give off noxious fumes at any temperature below 200 degrees Fahrenheit or which could cause occupational illness, should not be installed or applied within the unmanned pressure test facility. For paints, sealants or adhesives, this requirement applies after drying or curing. The SCA may require Material Safety Data Sheets (MSDSs) for materials used inside pressure vessels and on other surfaces in contact with pressurization media.

Mercury, asbestos, cadmium, magnesium and beryllium are examples of materials that should not be used in an unmanned pressure test facility without adequate protection and justification.

B.5.4 Flammability. Every effort should be made to eliminate, or at least minimize, flammable material in the unmanned pressure test facility. It should be understood that materials that are nonflammable at atmospheric pressures might be highly flammable when subjected to increased oxygen concentrations and/or elevated pressure.

If aluminum paint is used inside an unmanned pressure test facility, precautions should be taken to ensure that it is not applied over rusted steel. A primer, not containing red lead or iron oxide, should be used under the aluminum paint.

Magnesium and alloys containing significant amounts of magnesium should not be used in the unmanned pressure test facility because of their high combustibility.

The applicant should provide sufficient information to permit an independent evaluation of the suitability and adequacy of the materials used.

B.6 DESIGN OF PENETRATIONS INTO AND THROUGH THE PRESSURE VESSEL

The applicant for the unmanned pressure test facility is responsible for the safe and adequate design of all openings or penetrations in the pressure envelope. When using the ASME pressure vessel code as a guide, the designer must carefully consider additional loads such as piping loads and make provision for them.

All possible modes of failure, including leakage, must be considered during the design phase of the system. Sufficient testing must be performed and documented to confirm the structural integrity and leak tightness of each penetration.

All vents, drains, exhausts, or other exits from the pressure envelope, should be equipped with a means of positively securing or locking against accidental opening or closing.

Penetrations with gasketed sealing areas should have corrosion protection provisions for these areas.

Alternative design methods may be approved by the SCA on a case-by-case basis.

B.6.1 Piping Penetrations. Pipe penetrations to the pressure envelope should be located and arranged so that, in the event of flooding, loss of atmosphere or similar emergency, a maximum amount of atmosphere will become entrapped in the unmanned pressure test facility. Emergency shutoff capability should be provided to protect the internal breathing atmosphere from exhaust, full flooding, or contamination.

B.6.2 Electrical Penetrations. The bodies of electrical penetrators and connectors that may be exposed to water or spray should be made of corrosion-resistant material. Electrical penetrations to the pressure envelope should be gas-/watertight, even when the connecting cables have been damaged. Pin-type connections or cable entrances into compensated enclosures are the preferred methods and should be used on all new design pressure vessels. Terminal tube entrances are acceptable on existing pressure vessels when evidence of compatibility of the cable jacket and insulation with the compensating medium is provided.

B.6.3 View Ports. The applicant should show that view port design is adequate for the system pressure and temperature range, environmental conditions and expected number of pressure cycles. The materials used must have adequate fatigue strength for the stress levels incurred over the expected life of the vessel. Resistance to the stresses applied continuously over long periods of time, as well as cyclic stresses, must be properly considered. Full specification must be made of the materials used; their composition; thermal, chemical, or physical treatment(s) required; dimensions and tolerances; and renewal or replacement criteria. Where necessary, view ports must be protected against accidental impact or other mechanical abuse. Although the use of various materials for view ports is not restricted, acrylic view ports have a demonstrated high level of success and are recommended above all other types when design parameters permit the use of acrylic. View port penetrators should be designed such that the view port seals against an integrally machined sealing surface when pressure is applied (i.e., the retaining ring should not be part of the primary sealing boundary when pressure is applied). Acrylic materials, view port designs and view port penetrators should conform to <u>ASME/ANSI PVHO-1, Safety Standards for Pressure Vessels for Human Occupancy</u> unless prior approval is obtained from the SCA.

In-service (i.e., used) view port defect criteria should be based on view port material, dimensions, and loading conditions, and must be determined separately for each view port design. SCA approval is required for used view port defect criteria. Crazing and cracks are not allowed in new or used view ports. Chips and scratches may be allowed in used view ports and the acceptable sizes of each, if permitted, will depend upon the view port design. The service life of a view port also depends on the view port design. For designs that are in accordance with ASME/ANSI PVHO-1, view port service lives are either 10 or 20 years, depending upon the view port design.

B.6.4 Hatches/Closures. For Category 1 or 2 materials, all pressure retaining closures, including hatches, doors, covers, and caps or plugs for openings should have a demonstrated (by hydrostatic test using strain gages) factor of safety of at least 1.5 times the maximum operating pressure. The mating flanges of all hatches and doors should be integral to the pressure vessel shell.

For Category 3 materials, the criteria stated for Category 1 and 2 materials may not be appropriate or adequate. Therefore, the criteria used must demonstrate the same degree of conservatism as the criteria for Category 1 and 2 materials and require SCA approval.

The ease and speed with which a closure can be opened or closed, and whether tools are required to do so, should be a design consideration. In all cases when these factors are important, SCA approval of the closure design should be obtained.

B.6.5 Seals. Sealing materials and techniques must be shown to be adequate for the range of pressures, temperatures, pressurizing media, vibrations, lubricants, and atmospheric environments specified for the system. Seals should not be subject to failure due to the effects of a non-lethal extinguishable fire inside or outside the system, attack by the fire extinguishing agent(s) used by the system, or by thermal shock caused by the application of the extinguishing agent(s). The effects of ultraviolet light, pressure cycling, stress concentrations, differential thermal expansion, differences in moduli of elasticity, tolerances and aging should be considered when designing seals.

In systems that may contain elevated oxygen concentrations, only oxygen compatible materials should be used.

B.7 FABRICATION DESIGN CRITERIA

Prior to the start of fabrication, the applicant should demonstrate to the SCA that accepted commercial or military guidelines are being used during the system fabrication process. In cases where the applicant desires to use fabrication procedures developed to commercial specifications, recorded data, in addition to that required by the commercial specification, may be required to provide the SCA with assurance that those procedures have been followed.

B.7.1 Welding and Brazing. All welded and brazed pressure-retaining construction should be performed in accordance with written and approved procedures, as discussed in Section 3, Sections 3.3.3 and 3.3.4. Welding and brazing of structural members may require the use of approved procedures depending on the application. The applicant is responsible for the integrity of the joint design and the proper choice of filler material.

B.7.2 Threaded Fasteners. The design of all critical threaded fasteners, including bolts, studs and nuts, should meet the requirements of the Screw-Thread Standards for Federal Services, FED-STD-H28, Screw-Thread Standards for Federal Service. Studs and bolts should be of sufficient length so that, when nuts are tightened to their appropriate torque values, at least 1 thread is exposed. Where practicable, the number of threads exposed should not exceed 5; however, in no case should the thread exposure exceed 10 threads. Any fastener design not covered in FED-STD-H28 or ASTM A325, Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength must be brought to the attention of the SCA for approval.

B.7.3 Locking Devices for Critical Mechanical Fasteners. The need for locking devices on mechanical fasteners should be evaluated by the applicant. In cases where the loss of a fastener would cause a critical failure, locking devices should be used. Generally, a locking device should provide a positive locking action, be simple to install and should lend itself to easy inspection without disturbing the locking feature.

If the locking device does not meet the above guidance, or is unique in design, the applicant should bring this device to the attention of the SCA, with sufficient information to justify the safety and integrity of the device. The justification should include recommended inspection procedures and acceptance standards.

If locking devices are not practical, critical fasteners should be marked with a "torque stripe" which identifies the relative locations of parts when properly torqued.

B.8 DESIGN OF PIPING SYSTEMS

When designing piping systems, the applicant should employ the design requirements of established military or commercial standards where a substantial body of service experience exists in similar applications.

Maximum System Pressure (MSP) is the highest pressure that can exist anywhere in a system or subsystem during any condition (i.e., uncontrolled pressure excursion). MSP is generally understood to be the relief valve set pressure and must include the effect of static head pressure. Pressure ratings for all piping and components should be equal to or greater than the MSP of the system or line of which they form a part. Piping subject to external pressure should be designed for the maximum differential pressure that can exist in either direction during operating, shutdown or test conditions; otherwise suitable over pressure protection should be provided.

Maximum Operating Pressure (MOP) is the highest pressure that can exist in a system or subsystem under normal operating conditions. All piping components must undergo a hydrostatic strength test based on the MOP, with no external leakage or permanent distortion permitted. Additional information concerning testing requirements can be found in Appendix C.

B.8.1 Piping. Consideration should be given to material type, wall thickness, minimum bend radius, back-wall thinning allowance and inner radius wrinkling when specifying the method of piping system fabrication.

B.8.1.1 Structural Considerations. The applicant should consider the structural adequacy and fatigue life of the piping system for all anticipated in-service conditions. Some in-service conditions include the following:

a) Weight of pipe fittings, valves and other components including cleaning or testing fluids

b) Internal or external pressure, both static and cyclic

c) Restraint of hangers and supports

d) Thermal expansion and contraction

e) Shock, impact, vibration and water hammer

f) Mechanical loads caused by operation of the system

g) Effects of the corrosion

Piping which, if ruptured, would depressurize the unmanned pressure test facility should be protected against damage. Suitable routing, shielding, etc., may accomplish this. Piping connections should be designed and arranged so that it is physically impossible to inadvertently connect a system of one pressure or service to a system of a different pressure or service. If gas reservoirs, such as cylinders, are included in a system, a readily-accessible valve should be provided to stop gas flow from the reservoir.

B.8.1.2 Pipe Hangers. Arrangement and design of pipe hangers should be carefully considered as a basic element of the piping design. Piping support spacing should be IAW Table B.1 and ASME B31.1, Power Piping.

Piping and tubing should be supported as close to bends as possible. Piping alone should not be used as the sole support for relatively heavy components (e.g., large valves, moisture separators or filter housings). Components should be supported so that the force required to operate them (or other normal operational loads) does not cause visible deflection, rotation or vibration. One line should not be used to support another, although clamp blocks may be used to support two or more adjacent lines as long as the blocks are attached to non-piping structural members.

B.8.1.3 Piping Flexibility. Piping should be designed to have sufficient flexibility to prevent failures resulting from the conditions listed in Section B.8.1.1.

In certain cases piping flexibility calculations are required by the SCA as a further measure of assurance prior to system fabrication. Detailed sketches of piping under examination may be required with the calculation report. Where required, calculations should show maximum stresses and their location in each section of piping under examination. Calculations should be submitted in a detailed form that will permit their review without difficulty and should include a statement delineating the following:

a) Theoretical basis of the calculations

b) Method of performing the calculations

c) Simplifying assumptions

d) Sign and symbol conventions

e) Assumed material and dimensional data

f) Other pertinent information such as hull deflections

The piping flexibility analysis should also consider the flexibility of piping components. The applicant's piping flexibility analysis should include calculations of the bending moments, twisting moments, and reaction forces imposed on each critical component in the piping system. Flexibility analysis is not required for pipe up to and including 3/8 inch IPS or for tubing up to and including 1/2 inch OD. Additional information on the flexibility analysis can be found in <u>ASME B-31.1</u>.

Table B.1
Pipe Support Spacing

PIPE SUPPORT SPACING		
Nominal Pipe Size (Inches)	Span (Inches)	
	Gas Service	Liquid Service
1/8	24-28	18-24

1/4	38-44	30-36
3/8	50-60	40-46
1/2	60-70	50-56
3/4	85-95	65-75
1	95-100	85-100
1-1/4	120-140	110-120
1-1/2	120-140	110-120
2	120-140	110-120
2-1/2	120-140	110-120
3	120-140	110-120
TUBING SUPPORT SPACING		
Nominal Tubing Size O.D. (Inches)	Span (Inches)	
	Gas and Liquid Service	
1/8	18-24	
1/4	24-30	
5/16	30-40	
3/8	40-50	
1/2	50-60	
3/4	60-70	
1	70-80	

B.8.1.4 Materials. In general, piping materials should be in accordance with MIL-STD-777, Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships. However, materials called out in ASME B-31.1 may be used with prior SCA approval. Consideration should be given to eliminate contact between dissimilar metals where galvanic effects of corrosion may occur. Specific approval must be obtained from the SCA for the use of non-metallic piping and piping components. Refer to Appendix A for additional information on material categories.

B.8.1.5 Pipe Joints. Only pipe joint designs that are fabricated, assembled and tested to accepted military or commercial standards may be used (typically; butt welds, socket welds, bolted flange connections and O-ring faced fittings). Other joint designs (typically; bite type, flared, compression fittings and threaded joints) must be justified to the SCA. Brazed joints, while considered standard practice in shipboard pipe systems, should be justified for portable and shore based systems.

The number of pipe joints should be kept to a minimum. Wherever possible, bending of the pipe should be considered. MIL-STD-1627, Bending of Pipe or Tube for Ship Piping Systems provides specific requirements and limitations for bending pipe or tube. All pipe and tube fittings should be used only at temperatures and pressures not exceeding ratings recommended by the manufacturer.

Lines, which must be connected and disconnected during system operation, should be equipped with appropriate pressure venting capabilities. Lines which are required to be disconnected during set-up and take-down of the unmanned pressure test facility must be provided with suitable caps or plugs to maintain cleanliness and prevent damage to threads. Both male and female connections should be so protected. Caps, which introduce moisture, and tapes, that leave adhesive deposits, should not be used for this purpose. Closure devices, when not in use, should be stored in a way that prevents contamination.

B.8.1.5.1 Welded Pipe Joints. Welded pipe joints are the preferred method of joining pipe that will not require disassembly for system repair or maintenance. The welding process melts the base metal to form a joint that is often as strong as the surrounding piping and resists cracking due to piping flexure. Welded pipe joints must meet the requirements of ASME B31.1 and supplemental requirements of the SCA.

B.8.1.5.2 Brazed Pipe Joints. Brazed pipe joints are used to permanently join piping material that is not weldable (i.e., copper and copper-nickel). Brazed joints are not as strong as welded joints because the process only melts a soft filler metal, not the base metal. Brazing of austenitic stainless steels should not be performed without express permission of the SCA. All unmanned pressure test facility brazed pipe joints should meet the requirements of NAVSEA 0900-LP-001-7000, Category P-3a, Special Category (I) and should be performed in accordance with NAVSEA/NAVFAC-approved procedures.

B.8.1.5.3 O-Ring and Flanged Pipe Joints. Mechanical piping unions and flanges include a wide variety of designs that rely on a mechanical action (i.e., torquing of bolts or nuts) to compress a soft seal. Flange fittings are most often used in designs for large diameter shore-based liquid or steam system piping. The use of face seal o-ring unions are recommended over bolted flanges. MS boss fittings, with o-ring seals, are preferred over threaded pipe joints because galling of the threads is less likely and the threads are not relied upon to form the seal. Additional design requirements for bolted flanges and blanks and all alignment and assembly requirements for mechanical joints should be in accordance with Navy Ships Technical Manual (NSTM), Chapter 505 and ASME B-31.1.

B.8.1.5.4 Threaded Pipe Joints. Experience has shown that these connections are susceptible to corrosion, shock and vibration damage, and leakage. Consideration must be given to pressure limitations due to a reduction in wall thickness of the pipe at the tapered threads. Should a component only be procurable with threaded end fittings, a means must be provided upstream and downstream of the component to permit its removal without disturbing the threaded joints. Any compound (e.g., antiseize thread tape) or lubricant used in threaded joints should be suitable for the service conditions and should not react unfavorably with the service fluid or piping materials.

B.8.1.5.5 Flared Pipe Fittings. Flared pipe fittings and their joints should conform to the range of wall thicknesses and method of assembly recommended by the manufacturer. Care should be taken with cutting and flaring tools so as to not induce work hardening of the tube end, which can make the material more susceptible to brittle fracture. Flared fittings should not be used without specific NAVFAC approval.

B.8.1.5.6 Flareless Pipe Fittings. Flareless, mechanical friction or bite-type connections should not be used on piping components where failure could cause uncontrolled depressurization or flooding of pressure vessels, mission support systems, electrical assemblies or other mission components. The use of such fittings in control and monitoring systems may be permitted only if:

a) they can be quickly isolated from the rest of the system in case of failure and,

b) a redundant means of providing the control and monitoring functions is available

Flareless and non-standard fittings, including proprietary fittings, should not be used without specific NAVFAC approval. Approval for joint design should be based on past experience and/or tests that demonstrate that the joint is safe for the operating conditions.

B.8.1.6 Flexible Hoses/Flexible Pipe. In most applications and for permanent installations, flexible hose is a poor substitute for rigid pipe or tubing. The use of flexible hose should be limited to applications where excessive flexing or vibration of rigid piping dictates its use. When hose is to be subjected to considerable vibration or flexing, sufficient slack should be provided to avoid mechanical loading. Sharp bends or twisting should be avoided. Bend radii should not be less than the manufacturer's recommended minimum bend radius. All hoses should have a rated working pressure equal to or greater than the system design pressure for the system in which they are used. A pressure safety factor of four times the hose rated working pressure to burst pressure should be the minimum used for flexible hose. Flexible hose material should be compatible with the intended service. Cleaning solutions must be compatible with the hose materials and must be able to clean the hose to the same level as the system in which it is used.

When hoses and connectors are used in applications where they may be subjected to mechanical loading, they should be provided with strain relief devices. These devices should be designed to prevent damage to the hoses and connectors as well as to prevent accidental disconnection of the hoses if they are pulled. Provisions should be made to connect the strain relief device to a nearby structural member. The most common form of strain relief is a small diameter wire cable with eyes at each end for shackles. The cable is attached to the hose by marlin at regular intervals. All high-pressure hoses are required to have this strain relief device except those that are permanently installed.

The safe useful life for each flexible hose in the unmanned pressure test facility should be specified and inspection requirements and criteria should be established. Periodic replacement of rubber hoses should be anticipated. Rubber hoses used in critical applications should be replaced every five and one-half years from date of manufacture. Rubber hoses used in non-critical applications should be replaced at least every 12 years. Metal, PTFE and thermoplastic hoses have no predetermined life but require annual inspection and testing. In all cases, hose inspection and replacement criteria should be in accordance with approved PMS.

All flexible hoses that are not permanently installed should be provided with suitable end caps that protect the hose end fittings from mechanical damage and prevent contamination when not connected for use.

The applicant should maintain a hose log for recording the inspection and test records and the life history of each flexible hose in the system.

Quick disconnect fittings used on flexible hoses should be readily accessible and capable of being disconnected under pressure in an emergency. Provision should be made to prevent accidental disconnection, i.e., a positive locking mechanism requiring more than one mechanical action to disconnect.

B.8.2 Piping Components. Care must be exercised when installing piping components in the system to ensure that gas or liquid flow is in the proper direction through the component. Most components have a designed direction for flow and this should be observed. Where components permit bi-directional flow, they should be installed to take best advantage of the design. For example, valves that serve as both inlet and outlet on high-pressure flasks should be installed so that when they are closed the flask pressure acts from below the seat and not on the valve stem packing. Piping components should always be installed in accordance with the manufacturers' recommendations, unless deviation is approved by NAVFAC.

All manually operated piping system components should be readily accessible and easily operable under normal and emergency conditions.

All piping system components should be selected for flow that is adequate for the most demanding mission conditions expected for the unmanned pressure test facility. These conditions should be specified when justifying the selection of a component.

Unmanned pressure vessels are of two types, those pressurized using a gas and those pressurized using fluid. Because of the differences in the pressurizing medium, selection of components of the different systems should be given different considerations.

B.8.2.1 Components of Gas Pressurized Systems. Only seamless piping or tubing is authorized in DOD unmanned pressure test facilities.

B.8.2.1.1 Compressors. Required features include pressure gages for each stage of compression, running hour meter, high-pressure shutdown, high temperature shutdown/alarm and low oil pressure shutdown/alarm. It is recommended that automatic condensate drains be installed on compressors. Consideration must be given to the location of the compressor inlet in regards to possible contamination from machinery exhaust fumes or other airborne contaminants. Proper inlet filtration should be provided. A dry type, non-shedding inlet filter is recommended.

B.8.2.1.1.1 Coolers. High temperatures associated with high-pressure air compressors may cause compressor lubricants to break down. Therefore, compressor inter-stage coolers and after coolers may be required to bring the discharge temperatures down to an acceptable level.

B.8.2.1.2 Moisture Separators. All high-pressure air compressors require moisture separators to remove liquid contaminants from the compressed air. The moisture separator capacity is selected according to compressor output flow rate and temperature and the anticipated environment that the compressor will be used in.

Separators should be located downstream of any after coolers to trap the condensation resulting from the air cooling process and compressor oil which may enter the outlet gas stream. All separators must be provided with drain valves to remove collected liquid. For maximum efficiency, moisture separators should be installed in a straight length of pipe at least 10 pipe diameters downstream of the nearest valve or fitting and should be drained regularly during operation. All moisture separators should be visually and hydrostatically tested. The periodicity for hydrostatically testing the moisture should be negotiated with the SCA.

B.8.2.1.3 Back Pressure Regulators. High-pressure air compressors should be equipped with a backpressure regulator located downstream of the moisture separator. Backpressure regulators should be designed to maintain a specified minimum operating pressure (normally 1000 psig or greater in accordance with the compressor manufacturer's requirements) at the compressor outlet. The backpressure regulator is used to seat the compressor piston rings and prevent excessive compressor lubricating oil from entering the system piping.

B.8.2.1.4 Filters. Compressor outlet filters are to be located downstream of the moisture separator and backpressure regulator and upstream of the rest of the system. All installed filter housings (except compressor inlet housings) should be hydrostatically tested. The periodicity for hydrostatic testing should be negotiated with the SCA. Depending on system design, additional particulate filters may be required to protect sensitive system components.

Components should have a working pressure that is greater than the maximum system pressure and the purification chambers should conform to ASME Code for unfired pressure vessels, Section VIII, Division 1.

B.8.2.1.5 Valves. For guidance on the selection of valves for a particular application refer to MIL-STD-777, NSTM Chapter 505, ASME B31.1 or NAVFAC DM-39.

Valves utilizing a soft seat design are preferable to those employing a metal-to-metal seat design.

Periodic inspection and maintenance should be performed in accordance with PMS. Pressure boundary hydrostatic and seat tightness testing of valves should be in accordance with NSTM Chapter 505.

B.8.2.1.6 Receivers and Volume Tanks. All air systems that are supplied air from a compressor should incorporate medium or low-pressure receivers or volume tanks. These components help to eliminate pulsations in the compressor discharge, and act as storage tanks, allowing the compressor to shut down during periods of light load. Receivers and volume tanks should be fabricated using approved specifications for pressure vessels described in Section B-5.1. In general, receivers and volume tanks are fabricated in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. All receivers and volume tanks should be equipped with pressure gages, drain valves and relief valves. Receivers and volume tanks should be inspected in accordance with MIL-HDBK-1152, Inspection and Certification of Boilers and Unfired Pressure Vessels. More information on receivers and volume tanks can be found in NSTM Chapter 551.

B.8.2.1.7 Flasks. If high-pressure gas cylinders or flasks are installed, they should be designed and fabricated in accordance with DOD-approved specifications such as MIL-F-22606, Flask Compressed Gas and End Plugs for Air, Oxygen and Nitrogen or standards of DOT or ASME. Each gas flask should have a readily accessible isolation valve to stop gas flow to the system. The flask isolation valve must be able to withstand full flask pressure. Each air flask should incorporate a method for periodically draining moisture from its interior (i.e., drain valve, dip tube). MIL-F-22606 system air/gas flasks should be periodically inspected and undergo either nondestructive testing or hydrostatic testing. DOT and ASME flasks should be inspected and hydrostatically tested in accordance with DOT or ASME requirements.

B.8.2.1.8 System Pressure Gages. The need for accurate, reliable, readable pressure gages in unmanned pressure test facilities cannot be overstated. Sufficient gages should be located throughout the system so that operators are able to monitor pressures at all times. Location of gages at the following points in a system is essential:

a) Gas manifolds

b) Volume tanks

c) H.P. bank manifold

d) Upstream and downstream of reducing valves

e) On each compressor stage and at outlet

The prudent designer will locate pressure gages at other locations throughout the system as operating needs, configuration or layout may require. Gage operating ranges should be selected so that system minimum and maximum operating pressure fall between one-fourth and three-fourths of full scale. Pressure gages in the system should be accurate to within "1% of full scale.

Unless specifically exempted by the SCA, each gage should be provided with a gage isolation valve that is readily accessible and may be closed to isolate a defective gage from the system. Valves that act as both isolation valve and calibration connection port are recommended.

All gages must be securely mounted in a location that permits easy reading of the dial and access for removal. Gages must be protected from mechanical vibration, shock and inadvertent mechanical damage. Care must be taken when mounting gages not to obstruct or block the operation of the "blow-out" plug.

When a gage is calibrated, a calibration data sheet should be prepared and retained as part of the certification documentation. A calibration sticker showing the date of calibration and the next calibration due date should be affixed to the gage dial or housing. Calibration should be accomplished only by a qualified calibration activity. The accuracy of helical-type Bourdon-tube gages may be verified by performing a comparison check with a gage that has been calibrated to a national standard. Gage comparison checks may be performed by qualified personnel within the command, however, those gages requiring adjustments must be forwarded to a qualified calibration activity. The dates and results of comparison checks should be documented and retained. All gage calibration and comparison should be performed in accordance with approved system PMS.

B.8.2.1.9 Special Considerations for Oxygen Systems. The applicant should give special consideration and analysis to the use of oxygen in the specific unmanned pressure test facility design. Oxygen leaks are extreme fire hazards. Every attempt should be made to design oxygen-piping systems to eliminate the possibility of leaks. Use of seamless stainless steel piping/tubing is permitted in oxygen systems. Wherever possible, high-pressure portions of the oxygen system should be welded, vice using mechanical fittings. Quick-opening valves should not be used in high-pressure oxygen systems.

For further guidance on designing oxygen systems refer to ASTM G88, Standard Guide for Designing Systems for Oxygen Service; NFPA 53M, Manual on Fire Hazards in Oxygen Enriched Atmosphere and CGA G-4, Oxygen. Deviation from any of the above criteria requires technical justification and approval from the SCA.

B.8.2.1.10 Special Considerations for Hydrogen Systems. The applicant should give special consideration to the use of hydrogen in a UPTF. Dialog with the SCA early in the planning and design process is strongly recommended. The primary emphasis of the design is to prevent a flammable mixture of hydrogen and air or oxygen from forming. This can be broken down into two areas;

1. hydrogen gas leaking from the vessel, component or piping

2. flammable mixtures of hydrogen, oxygen or air within the piping system or vessel.

In the design of hydrogen piping systems special consideration should be given to the choice of piping joints, type of components and location of ancillary equipment. Special safety features and operating procedures should be considered to prevent the inadvertent forming of a flammable mix within piping or the pressure vessel.

Consideration should be given to monitoring equipment to alert operators of hydrogen gas leaks or hydrogen flames that may be undetectable to the naked eye.

The following additional references should be considered when designing a UPTF utilizing hydrogen as a pressurization media:

a) Flame Arresters in Piping Systems. API Publication 2028, Second Edition, American Petroleum Institute, December 1991.

b) Hydrogen as a Diving Gas. UHMS Publication number 69(WS-HYD), Undersea and Hyperbaric Medical Society, February 1987.

c) McCarty, R.D. Hydrogen: Its Technology and Implications. CRC Press, Inc., 1975.

d) NASA Hydrogen Safety Handbook.

e) Standard for Purged Enclosures for Electrical Equipment in Hazardous (Classified) Areas. NFPA 496, National Fire Protection Association, 1989.

f) Standard for Gaseous Hydrogen Systems at Consumer Sites. NFPA 50A, National Fire Protection Association, 1989.

B.8.2.2 Components of Fluids Pressurized Systems.

B.8.2.2.1 Pumps. Pump selection should be based upon the system fluid, the operating pressure and the flow capacity that is required. Once these operating parameters have been determined, pump selection is determined by an overlay of system and pump curves. Pumps should be located to maximize the net positive suction head and to minimize air entrainment into the system.

Pumps should be equipped with one pressure relief valve per each stage. Each stage of a pump should be provided with a temperature gauge for monitoring bearing temperature and with a pressure gauge. When pumping potentially contaminated fluids, a filter should be provided upstream of the pump to remove debris that could cause pump/system inefficiencies (e.g., cracked impeller, build-up in suction and discharge piping). The filter should be placed in an easily accessible location for ease of maintenance.

When installing pumps, consideration should be given to minimizing the effects of vibrations when choosing foundation mountings and piping connections. Consult with the manufacturer's recommendations for installation.

When high flow and low-pressure conditions are needed, centrifugal pumps should be considered for use. If these pumps are used in series, ensure that each pump is rated for the proper inlet pressure (i.e., the inlet pressure will increase for each consecutive pump).

When low flow and high-pressure conditions are needed, positive displacement pumps should be considered for use. This type of pump should also be considered when pumping high viscous fluids (i.e., if the viscosity is the same as or greater than SAE-30 motor oil (at room temperature)). Positive displacement pumps may also be used for metering flow. Some examples are external gear pumps and sliding vane pumps.

B.8.2.2.2 Valves. Valves should be selected based upon the system fluid, operating pressure and flow capacity that are required. Valves produced to a commercial or military standard are acceptable as long as the design pressure of the valve meets or exceeds the system operating pressure. The soft goods (e.g. O-rings, gaskets) contained in the valves should be compatible with the system fluid.

Consult manufacturer's literature for recommendation on routine maintenance.

Ball Valves should be used in "on/off" applications and should not be used for throttling.

Globe/Plug Valves should be used in locations where throttling is necessary.

Needle Valves should be used in by-pass applications and where precise control is needed.

B.8.2.3 Piping Component Testing. All piping system components should be subjected to adequate strength and leak tests to ensure that the system is safe. The requirements for material OQE and component testing are given in Appendix C. All test results must be formally documented and available for SCA review during on-site surveys.

B.8.3 General Considerations for Piping Systems. It is essential that all seals, gaskets and o-rings in unmanned pressure test facilities be fabricated from the proper material. Gaskets containing asbestos material should not be used without approval of the SCA.

B.8.3.1 Identification and Labeling. All piping and components including fittings should be identified in sufficient detail on the system drawings (i.e., description, material, part number, pressure rating) to prevent replacement with an unsuitable part. Unless specifically exempted by the SCA, all hoses, valves, pressure vessels, gages, filters, etc., must be marked or labeled to indicate function and content.

Unless authorized by the SCA, all piping and piping system components used for the transmission or monitoring of liquid or gas within a system should be marked and color-coded to identify the specific gas or liquid contained and the direction of flow. Where piping is located behind a panel, an accurate schematic should appear on the panel. Color-coding of piping systems not identified in Table B.2 should be negotiated with the SCA. A labeling system should be used to identify each component by type of gas or liquid, by color and by word or letter symbol.

Table B.2.
Suggested Color Code And Component Designation
For Unmanned Pressure Test Facilities

Gas System	Designation	Color Code

Helium	HE	Buff
Oxygen	OX	Green
Helium-Oxygen mix	HE-OX	Buff & Green
Nitrogen	NIT	Light Gray
Exhaust	EXH	Silver
Air (low pressure)	ALP	Black
Air (high pressure)	AHP	Black
Chilled Water	CW	Blue & White
Hot Water	HW	Red & White
Potable Water	PW	Blue
Fire Fighting Material	FP	Red

Piping system components must have a standardized labeling scheme throughout, with unique component identifiers that match the system drawings and system operating and emergency procedures. Such standardization is important for approval of operating and emergency procedures, continuity of system manuals and personnel training.

B.8.3.2 Cleaning and Testing. All cleaning and testing of piping for unmanned pressure test facilities should be in accordance with NAVFAC approved procedures. Cleaning of oxygen, helium, HEOX and NITROX piping systems should meet the requirements of MIL-STD-1330, Precision Cleaning and Testing of Shipboard Oxygen, Helium, Helium-Oxygen, and Nitrogen Systems.

All pressure retaining components of the piping system must be hydrostatically tested for strength and porosity after completion of the installation and/or after welding or brazing. Individual components (e.g., valves, pressure regulators, volume tanks, etc.,) may be tested prior to installation in the system. In gas systems, pressure-measuring devices, such as gages and sensors, should not be hydrostatically tested due to the possibility of component damage.

Additional tests must also be performed to ensure system tightness and proper operation of components. General testing requirements are provided in Section 3. Appendix C provides specific component testing requirements for installation and repair of components.

Protection devices such as caps, plugs and plastic bags should be used to prevent entrance of foreign materials whenever the system integrity is broken and to protect the sealing surfaces of the components. Both male and female connections should be protected. Caps, plugs and plastic bags that introduce particulate contamination from shedding, moisture and tapes that leave adhesive deposits should not be used for this purpose. Caps and plugs should be cleaned to the acceptable level of system cleanliness before each use in accordance with approved cleaning procedures. When not in use, protection devices should be stored in a way that prevents their contamination.

B.9 DESIGN OF ELECTRICAL SYSTEMS

Consideration must be given to the electrical requirements for all unmanned pressure test facilities and supporting equipment. This covers a wide range of equipment from heavy machinery such as pumps, compressors and handling equipment to precise instrumentation for monitoring, control, communications and data acquisition.

Although they cannot always be eliminated, electrical components exposed to high oxygen concentrations inside an unmanned pressure test facility pressure hull are potentially hazardous. The applicant should justify their use and should show their potential for creating a fire hazard in a hazard analysis. Electrical systems must be designed to the requirements of NFPA-70.

B.9.1 Power Requirements. The applicant should provide an estimate of he power requirements, both normal and emergency, to support the unmanned pressure test facility. The applicant should show how much power is required from the support facility and how much of the unmanned pressure test facility is self-supporting.

B.9.2 Electrical Connectors and Penetrators. The bodies of pressure vessel electrical penetrators and connectors exposed to water should be made of corrosion resistant material. Connector pins and sockets should be corrosion resistant or plated to prevent corrosion and electrical discontinuities. Provisions should be made to protect the pressure vessel from corrosion in the gasketed areas of the penetrators. Electrical connectors and individual hull penetrator designs should be technically justified for their intended applications.

B.9.3 Electrical Connectors. Connector design should permit the operator to readily disconnect the cable assembly and any other electrical conductor without receiving an electrical shock. System design or operating procedures should not allow disconnecting connectors when the circuit is energized.

Electrical connectors must be designed to prevent incorrect connection and accidental disconnection. This may be accomplished by size selection, key fitting, or other means. Color-coding or other visual identification alone is usually insufficient.

B.9.4 Electrical Penetrators. Pin-type connections for cable entrances into compensated enclosures are preferred; however, terminal tube entrances are acceptable provided evidence of compatibility of the cable jacket and insulation with the compensating medium is provided.

The electrical hull penetrator is part of the primary pressure boundary. Therefore, pressure test data should be provided to ensure that its hydraulic life is defined in relation to the design life of the hull and thermal shock to the connector.

B.9.5 Lighting Systems. If lighting is required, it is preferred that light sources be located external to the unmanned pressure test facility and provided internally through ports, light pipes, or other suitable means. In this case, infrared filters or other means may be required to dissipate heat from the port.

When lights are installed inside an unmanned pressure test facility chamber or capsule, the housings must be adequately designed so as not to explode or implode, and the wiring to the fixture must be sufficiently rugged to withstand inadvertent impact and mechanical loads without causing a fire or shock hazard.

B.9.6 Instrumentation. Instrumentation must be electrically isolated from the unmanned pressure test facility personnel, but not located in a manner that might subject it to erroneous readout. Electrical failure of one instrument must not impair the use of another. All instrumentation must be compatible with its intended environment and must not create a fire, electrical or toxic hazard.

B.10 ENVIRONMENTAL CONDITIONING COMPONENTS

Hyperbaric chamber heating/cooling systems may be required where environmental conditions dictate. The electrical components of heating/cooling systems should be located outside the pressure hull whenever possible. Heated/cooled gas or water may flow through the pressure hull, or the hull itself may be heated/cooled. If the hull is to be heated or cooled by an electrical device, the applicant should provide verification that no electrical current may pass through the hull.

B.11 OPERABILITY AND MAINTAINABILITY

The applicant should demonstrate the operability and maintainability of the facility. The facility must perform reliably under worst-case conditions. Mean time between failures must be longer than the longest mission duration. A comprehensive operation and maintenance technical manual, including troubleshooting instructions, should be developed and submitted for review.

B.12 REMOTE CONTROL SYSTEMS

The designer should furnish detailed design information for all remote control systems and components. Information provided to the SCA must clearly discuss the capability of the system to function in the intended environment (i.e., temperature, pressure, humidity). Descriptions must be furnished for all remote control systems. The descriptions should include an analysis of the consequences of a failure or loss of normal mode, and describe automatic and manual backup control features available for emergency recovery or surfacing procedures. Test data in support of system and component reliability for the intended service must also be provided. Design information and test data must be in sufficient detail to permit an independent evaluation of the adequacy of the controls in their environment, under all normal and emergency operating conditions.

B.12.1 Remote Control Power Supply. Remote control power supplies may be manual, mechanical, pneumatic, hydraulic, or electrical. The choice should be based on reliability in the environment in which the power supply must function. The designer should furnish information that substantiates the reliability of the power supply in the intended environment. This information may be based either on previous use of the power supply or on tests.

All critical remote controls must have two independent sources of power. Failure of one of the power sources should not hinder the use of the other power source.

B.12.2 Remote Control Monitoring. Remote control systems should require devices that monitor system status and responses. Indication of malfunction or failure in a control actuator must be provided to the operator. The applicant should define the level of monitoring required based on the criticality of the system. The monitoring system design should be submitted to the SCA for concurrence.

B.12.3 Remote Control Actuators. A remote control actuator is any device or group of devices used to accomplish a desired control function. The design should be such that the control actuator is not subject to false alarms or extraneous signals that produce undesired responses. Switches and controls that are used to manually energize a control actuator must be located so that they are not inadvertently energized.

Remote control actuators should be designed to be fail-safe. Individual remote control actuators should be capable of being isolated from other remote control actuators that share a common power supply. For electrical remote control actuators, this requires either fuses or circuit breakers on all lines connecting each remote control actuator to the power supply. For hydraulic or pneumatic remote control actuators, this requires appropriate check valves or isolation valves on all lines connecting the power supply to the remote control actuator.

Where a remote control actuator normally operates automatically, provision should be made to allow the operator to manually override the automatic control. The manual control should bypass as much of the automatic control system as is practical.

APPENDIX C

REQUIRED DOCUMENTATION

C.1 MAINTENANCE AND REPAIRS

Work within the Scope of Certification (SOC) must be done in a controlled fashion to ensure certification is not voided. All work within the SOC on class-A chambers, should either be done in accordance with a controlled work procedure (CWP) or a re-entry control (REC) package. For Class-B and Class-C chambers, a maintenance log sheet should be filled out for all work within the Scope of Certification. An example of a Maintenance Log Outline Sheet is provided as Figure C.1.

C.1.1 Controlled Work Procedure (CWP). Work that is of a repetitive nature such as maintenance, equipment set-ups and alterations in support of testing may be accomplished using a CWP. All controlled work procedures should state:

a) Facility/Title

b) Safety Procedures
   - tag out/isolation, depressurization, etc.,

c) Material required for installation
   - penetrators by serial number
   - soft goods
   - test set-ups

d) Detailed work procedures
   - list work steps in order
   - list special work instructions

e) Testing required
   - list test set-up requirements
   - pressure, time, pass/fail criteria

f) Signature of person performing work and testing

CWPs may be pre-printed in a fill-in-the-blank format and used on an as needed basis. Controlled work procedures for each application should have individual numbers and be retained on file until the next certification audit. An example of an acceptable controlled Work Procedure is provided in Figure C.2.

Note: Deviation from the certified design within the Scope of Certification requires SCA Approval.

Facility ___________________________ Date __________

_____ Maintenance _____ Repair _____ Design Change (requires Cert Board approval)

Caution: Verify system is NOT pressurized/powered prior to starting work and that the system CAN NOT be pressurized/electrified during work!

Short description of why work was performed:

List parts repaired/replaced:

State tests performed (type of test, item tested, pressures and result):

Craftsman performing work ___________________Sign/date: __________

Supervisor's approval of work _______________Sign/date: __________

Figure C.1
Maintenance Log Outline

C.1.2 Re-Entry Control (REC). REC is a system for maintaining positive control of work performed within the certification boundaries of the unmanned pressure test facility. The system provides for monitoring and documenting the following:

a) What system worked on

b) Why work was required

c) What work was accomplished, including safety precautions, materials and components used, re-test requirements, test data and supporting documentation

d) Who did what work (Craftsman)

e) Who authorized and accepted the work (Facility Manager or his designated representative.

f) Who maintains documentation (REC Supervisor)

When any maintenance or work is performed which breaches the certification boundaries of the UPTF the REC supervisor must first initiate a REC. This is accomplished by filling out the REC log, completing a REC sheet obtaining authorization from the facility manager (or designated representative). The necessary work or maintenance can now be performed on the facility. Upon successful test completion, the REC sheet is completed and all applicable maintenance check-off sheets, inspection records, testing records, and fabrication records are attached to the REC sheet. Once the closure complete signature is obtained from the Facility Manager, the REC can then be closed out by the REC supervisor by placing the REC package on file and completing the REC log entry.

Under Normal circumstances the unmanned pressure test facility should not be operated with an open REC. However, if the system or Sub-system affected by the REC can be isolated to ensure the safety of operators, craftsmen, and property, the Facility Manager may authorize operation of the Unmanned Pressure Test Facility.

C.1.2.1 Exceptions to Re-Entry Control. Certain UPTF require frequent entry into the certified boundary for routine operations or maintenance actions to enable mission accomplishment. Any operational controls believed to be adequate in lieu of re-entry control or controlled work procedures should be submitted to the SCA for approval. Examples of actions not requiring a REC are:

a) Normal operation of access hatches, pressure boundary doors or similar operations covered by an operating procedure (OP).

b) Removal of portable gas flasks for charging.

c) Gauge calibration, reference or sampling line changes where the ID of the line is 0.25 inches or smaller and the pressurization medium is considered non-flammable.

Note: No exceptions from re-entry control other than those listed above are authorized. Recommendations for exception from re-entry control will be considered on a case-by-case basis by the SCA. When entering systems under a REC exemption normal caution must be observed in protecting the system integrity and cleanliness.

C.1.2.2 Energy Control (Lockout/Tag-Out). Lockout/Tag-out procedures are used to identify equipment and components which are (1) in need of maintenance or repair, or (2) define REC boundaries and are not to be operated while the REC is open (i.e., work in progress). Commands must develop suitable lockout/tag-out procedures to control energy during maintenance or servicing of equipment that meet the following requirements (Navy plans must be in accordance with OPNAVINST 5100.23, Navy Occupational Safety and Health (NAVOSH) Program Manual or USACE EM-385-1-1, Safety and Health Requirements Manual for contractor personnel):

a) Command instruction that clearly defines Lockout/Tag-out procedures to be used for the unmanned pressure test facility

b) Both Lockout/Tag-Out devices shall indicate the identity of the employee applying the device, cognizant shop of code, telephone number where the employee can be reached during working hours, his/her supervisor, date applied, and the machine, equipment or system component that is deenergized.

C.1.2.3 Supporting Documentation/Objective Quality Evidence. Objective quality evidence (OQE) is supporting documentation that enables verification of installed components and raises confidence in the installation. For UPTFs the major area of concern is the primary pressure boundary. Pressure vessels, hull penetrators, fittings and piping up to and including the hull isolation valve, soft goods and repair kits, are examples of components requiring OQE. OQE ranges from ASME code documentation, level of cleanliness documentation, soft goods packaging, and certificates of conformance (COC) from manufacturers verifying part or kit numbers.

C.1.2.4 Re-Entry Control Log Instructions (FIG C.2).

Block (1) Enter name or designation of the subject Unmanned Pressure Test Facility.

Block (2) Enter REC number (example 6003; 6 is the year group 1996, 003 is the third REC of that year).

Block (3) Enter the revision, for the initial issue REC and alphabetical letters for each revision thereafter.

Block (4) Enter the name of the system Re-Entered.

Block (5) Enter the name of the REC supervisor.

Block (6) Enter dates for when REC number is issued, when work is started and when the REC is completed.

Block (7) Enter any remarks or associated REC numbers.

APPENDIX C (Continued)

(1) FACILITY

(2) REC NO.	(3) REV	(4) SYSTEM RE-ENTERED	(5) REC SUP (Print Name)	(6) DATES			(7) REMARKS (Include associated RECs)
				ISSUE	START	COMPLETE	

Figure C.2
Re-Entry Manned Pressure Test Facility Control Log

C.1.2.5 Re-Entry Control Form Instructions for Figure C.3.

Block (1) The assigned technician should identify the system or components being re-entered. Only one system can be entered on one REC. Where more than one system is involved, separate associated RECs must be written.

Block (2) Obtain the appropriate sequential serial number from the REC log and enter it on the Re-entry Control form (an example of a REC Log can be found in figure C.2. Revision should be entered on the initial version of all RECs. If a revision is made, prepare a new REC form with the original number, plus the next revision letter, obtained from the REC log. Attach the revised REC to the front of the original and make the required entries in the log.

Block (3) Enter the applicable reason for the REC. When other is checked, state the reason in the space provided.

Block (4) Enter the number of pages in the REC.

Block (5) Enter the applicable drawing and revision or reference numbers for the systems identified in Block 1. Where specific plans/drawings do not exist, system drawings may be referenced or sketches can be prepared and approved by the appropriate technical authority.

Block (6) Enter the valve, circuit breaker or device numbers that have been tagged out.

Block (7) List by name all other systems affected by this REC, included non-certified systems.

Block (8) Describe in brief detail the work to be accomplished. List steps to be performed, including special actions required to retain certification of the balance of the system. Provide enough detail for craftsman to complete the removal, repair, testing and reinstallation. The boundaries of the re-entry should be detailed in specific terms, a simple sketch may be attached to the REC for clarity. The identity of all joints to be affected by this work must be clearly indicated and any new material to be installed must be listed Other supporting OQE should be attached to the REC Form. The craftsman's signature indicates that the work was performed as documented.

Block (9) List steps to prevent contamination of the system being re-entered.

Block (10) Mark the recertification requirements that will be supported with documentation in the REC package. The SCA may be contacted when questions about recertification requirements arise.

Block (11) Facility Manager should review the REC for completeness and clarity, signature authorizes work to commence.

Block (12) Facility Manager, or representative, should review the completed REC package for its compliance with documentation requirements. Upon satisfactory review the supervisor or his representative should sign the REC and file the package for future SCA review.

C.1.2.5.1 Test Line-Up. A test line-up (TLU) or approved operating procedure (OP) should be initiated by the REC supervisor and will be included as part of all Re-Entry control packages as Objective Quality Evidence (OQE) of the valve line up used for testing. The TLU will include a simple line drawing, or photocopy of an existing drawing, of the portion of or entire system being tested. The drawing should be marked to indicate valve positions (open/closed) during the test. A key should be included to define any symbols or colors used. This drawing may also be used to show the valves that were tagged out during the work procedure. The Test Director may, if preferred, list the valves in the system on the TLU and indicate the open or closed position and any special instructions to describe the sequence of the test procedure.

C.1.2.5.2 Test Line-Up Instructions (FIG C.4).

Block (1) Enter the system or component being tested and enter the REC number the test supports.

Block (2) Enter the gas or fluid used for the test (He, O_2, N_2, air, water, etc.).

Block (3) Enter the intended test pressure in psig.

Block (4) A sketch, copy of an existing drawing, or valve list should be included for the system undergoing testing and indicating the valve positions used for the test.

Block (5) The test director should sign stating the test line-up was completed per documented instructions. Note: Any variation from documented test method will be annotated and signed.

Block (6) A witness should sign stating the line-up was completed as documented.

(1) SYSTEM RE-ENTERED:	(2) REC # REV:
(3) REASON FOR REC: Alteration ☐ Repair ☐ Maintenance ☐ Trouble Shooting ☐ Retest ☐ Other (state)☐ ---	(4) PAGE ________ OF ______
	(5) DRAWING OR REF. NO.
(6) SYSTEM ISOLATION (List Vlv #’s):	(7) OTHER SYSTEMS AFFECTED BY THIS REC:
(8) WORK DESCRIPTION (USE REVERSE SIDE OR OTHER SHEET IF REQUIRED): ________________________________ ______________ CRAFTSMAN DATE	
(9) STEPS TO BE TAKEN TO PRECLUDE CONTAMINATION OF ANY PORTION OF THE SYSTEM BEING ENTERED:	
(10) TESTING/RECERTIFICATION SUPPORTING DOCUMENTATION: NDT DOCUMENTATION ☐ SKETCHES OR DRAWINGS ☐ CLEANING DOCUMENTATION☐ TEST LINE UP ☐ STRENGTH TEST ☐ SEAT TIGHTNESS TEST ☐ JOINT TIGHTNESS TEST ☐ DROP TEST ☐	
(11) WORK AUTHORITY APPROVAL: ____________ ________ Signature Date	(12) CLOSURE COMPLETE ____________ ________ Signature Date

NOTE: Local Re-entry formats may be generated, but require SCA approval.

Figure C.3
Unmanned Pressure Test Facility Re-Entry Control Form

(1)SYSTEM/REC: ______________________	(2) TEST MEDIA ____________________	(3) TEST PRESSURE (psig) ______________
(4) SIMPLE DIAGRAMMATIC DRAWING OF SYSTEM TEST LINE-UP		
(5) TEST DIRECTOR DATE	(6) WITNESSED: DATE	

Figure C.4
Unmanned Pressure Test Facility Test Line-Up Sheet

C.1.2.6 Joint Tightness Test. A joint tightness test subjects mechanically joined pressure containing boundaries of pipe and piping components to an internal pressure equal to 100% of maximum operating pressure. It is used after joint assembly to help identify leakage in mechanically joined pipe and piping components. Unless otherwise specified, test pressure tolerance should be maintained within + or - 3% (but no greater than 100 psig) of the specified test pressure. The duration for the joint tightness test is to be not less than 15 minutes (not less than 5 minutes if the test is conducted in a shop or a bench test) soak time plus sufficient time for inspection. All joints, when possible, should be checked for leakage using a leak detection solution. A sonic leak detector may be used in conjunction with the leak detection solution to help find leaks. System fluid is the preferred test medium for joint tightness testing, however, for O_2 systems, nitrogen may be used due to safety concerns. Requests for other fluid substitutions should be directed to the SCA.

C.1.2.6.1 Acceptance Criteria. Acceptance criteria for joint tightness testing of all systems, except those tested with helium or hydrogen, should be zero leakage. For systems using helium or hydrogen as the test medium, the acceptance criteria should be zero leakage except at valve stem seals where a leakage rate of 0.6cc/min for each stem seal is permitted. This is identified by only small bubbles forming in the solution like foam but no bubbles large enough to be identified as an individual bubble with the naked eye.

C.1.2.6.2 Joint Tightness Test Instructions (FIG C.5).

Block (1) Enter the name of the command at which the work is being performed.

Block (2) Enter the REC number that this test is associated with.

Block (3) Enter the system or component that is being tested.

Block (4) Enter a short description of the item being tested.

Block (5) Enter the required test pressure (100% of operational pressure).

Block (6) Enter the time the test was started and the time the test was completed.

Block (7) The facility Manager (or designated representative) should review the REC including the proposed test. Signature in this block allows testing to begin.

Block (8) Enter the joint numbers tested. Joint numbers may be assigned at the time of the test by including a sketch identifying the location and orientation of each joint.

Block (9) Enter the results of each joint test (sat or unsat). If a joint is unsatisfactory it must be repaired and retested with the appropriate documentation being added to the REC package.

Block (10) If required, make a sketch to show the joint configuration clearly marking the joint numbers.

Block (11) The test technician should sign stating the test was completed as documented.

C.1.2.7 System Tightness Test. A system tightness test is performed when the scope of work exceeds the complexity at which a joint tightness test can be performed. When a system is applying for initial certification or has undergone an extensive overhaul a system tightness test should be run. This test is used to identify long-term leakage of an entire system. The system is gradually pressurized to 100% of maximum operating pressure. Data is then taken to measure the change in pressure, corrected for temperature, over an extended period of time. System tightness tests, unless otherwise specified by the SCA, should be at least 6 hours in duration. The test pressure tolerance used to perform this test should be within + or - 3% (but not greater than 100 psig) of the specified test pressure.

Step 1 Pressurize the entire system to its maximum operational pressure with the appropriate pressurization medium.

Step 2 Ensure accurate temperature monitoring throughout the system being tested.

Step 3 Allow approximately two (2) hours for the temperature to stabilize and repressurize if necessary.

Step 4 Log the test pressure and temperature hourly. Monitor the tightness of the installed using A and B below.

a) For gas filled systems, apply leak detecting soap solution to all joints (mechanical, welded, brazed, etc.,) within the test boundaries. Solution should be applied at least hourly. For liquid filled systems, look for physical evidence of leaks.

b) Verify installation of a calibrated pressure gage for monitoring pressure within the system undergoing test. Observation of the test pressure is required to ensure that the test pressure is maintained throughout the test duration and that no piping leakage goes undetected due to piping porosity that may not be detected by the leak detecting solution. For systems with small volumes, acceptable tightness of the system based on the pressure drop method may be indeterminate. Therefore, step A should be an integral part of all tightness tests.

C.1.2.7.1 Acceptance Criteria.

a) Leak detecting solution method: For systems tested with Helium or Hydrogen, mechanical joints (such as union connections) shall have no detectable leakage. Only leakage allowed is 0.6 cc/min for each valve system seal. This rate is identified by the formation of only foam like bubbles, no large bubbles. Systems pressurized with other media should exhibit no leakage.

b) Pressure drop method: Calculate the corrected pressure as specified below. The pressure drop is considered acceptable if it is less than 1% of the test pressure (test pressure divided by 100). If the leakage exceeds 1% the source must be found, leak repaired and test repeated until acceptable.

The system corrected pressure (Pc) is found by the following formula:

$$Pc = [(Pf+14.7 \text{ psig}) \times [(Ti+460°F)/(Tf+460°F)]] - 14.7 \text{ psig}$$

$$\Delta P = Pi-Pc$$

Where:
- Pi = pressure as read at start of test (psig)
- Ti = temperature as read at start of test(°F)
- Tf = temperature taken hourly for pressure correction (°F)
- Pf = pressure taken hourly, to be corrected (psig)
- Pc = corrected pressure (psig)
- ΔP = pressure drop (psi)

1. COMMAND/UNIT		2. REC NO.
3. SYSTEM/COMPONENT		4. DESCRIPTION OF ITEM
5. REQUIRED TEST PRESSURE		6. DURATION OF TEST
7. TEST AUTHORIZATION		DATE
8. JOINT NUMBER	9. SAT / UNSAT	10. SKETCH (If Required)
11. TECHNICIAN		DATE

Figure C.5
Unmanned Pressure Test Facility Joint Tightness Test

C.1.2.7.2 System Tightness Test Instructions (FIG C.6).

Block (1) Enter the system or component that is being tested.

Block (2) Enter the test media used (air, O_2.He, water, etc,).

Block (3) Enter the required test pressure.

Block (4) Enter the date the test started.

Block (5) Enter the time the test was started.

Block (6) Enter the time the test completed.

Block (7) Enter the REC number with which this test is associated.

Block (8) Enter the pressure (Pi) and temperature (Ti) readings at the start of the test.

Block (9) The facility Manager (or designated representative) should review the REC including the proposed test. Signature in this block authorizes testing to begin.

Block (10)Each hour enter, the time the readings were recorded, system pressure (Pf), system temperature (Tf), corrected pressure (Pc) using above formula, and pressure drop.

Block (11)Enter any comments, observations, or changes made during the test

Block (12)The test director should sign stating that the test was performed as documented.

(1) SYSTEM:	(2) TEST MEDIA (gas)	(3) TEST PRESSURE (psig)	
(4) TEST DATE	(5) TEST START TIME	6)TEST COMP TIME	(7)REC

(8)INITIAL READINGS AT START OF TEST

INITIAL PRESSURE P_i _______ Psig INITIAL TEMPERATURE T_i _________ ^oF

(9) TEST AUTHORIZATION DATE

(10) TIME	(P_f) SYSTEM PRESSURE	(T_f) SYSTEM TEMPERATURE	(P_c)CORRECTED PRESSURE	$\Delta P = P_I - P2$
1	Psig	^oF	psig	psig
2	Psig	^oF	psig	psig
3	Psig	^oF	psig	psig
4	Psig	^oF	psig	psig
5	Psig	^oF	psig	psig
6	Psig	^oF	psig	psig

(11) COMMENTS:

(12) TEST DIRECTOR DATE

Figure C.6
Unmanned Pressure Test Facility System Tightness Test

C.1.2.7.3 Hydrostatic/Pneumatic Test Instructions (FIG C.7).

Block (1) Enter the command or unit where the facility is located.

Block (2) Enter the REC number with which the test is associated or the Job Control Number (JCN).

Block (3) Enter the system or component this test supports.

Block (4) Enter a description of the item being tested.

Block (5) Enter any references for the test (drawings, manuals, etc,.).

Block (6) Enter any required test and inspection points.

Block (7) Make a diagram of the test area.

Block (8) Enter the required test pressure.

Block (9) The facility supervisor (or designated representative) should review the proposed test, signature in this block authorizes testing to begin.

Block (10) Enter the actual test pressure obtained during the test.

Block (11) Mark the test result (SAT or UNSAT).

Block (12) Record any remarks or observations.

Block (13) The test technician should sign stating the test was completed as documented.

C.1.2.8 Hose Log (FIG C.8). A hose log must be maintained for all flexible hoses. Hose logs may be divided into facilities that the hoses support but must be maintained in an auditable fashion. Locally generated forms may be used with the SCA's concurrence.

C.1.2.9 Operation Log. The operation log is the official chronological record of procedures and events that occur during each pressurization of the test facility. The operation log must be retained by the command and available for SCA review. The minimum data items in the operation log include:

a) Date of test facility pressurization

b) Purpose of test

c) Maximum test pressure

d) Identification of operator(s)

e) Note(s) on unusual events during operation or with equipment

f) Signature of operator(s)

1. COMMAND/UNIT	2. REC NO./JCN
3. SYSTEM/COMPONENT	4. DESCRIPTION OF ITEM
5. TEST REFERENCE	6. REQUIRED TEST & INSPECTION POINTS
7. DIAGRAM OF TEST AREA INCLUDING GAGS, BLANKS INSTALLED AND VALVE POSITIONS	
8. REQUIRED TEST PRESSURE (psig)	9. TEST AUTHORIZATION DATE
10. ACTUAL TEST PRESSURE (psig)	11. TEST RESULTS ( ) SAT ( ) UNSAT
12. REMARKS:	
13. TECHNICIAN	DATE

Figure C.7
Unmanned Pressure Test Facility hydrostatic/Pneumatic Test

HOSE NO. ______	
LOCATION ______	
WORKING PRESSURE	
MANUFACTURE	
SIZE / TYPE	
PART NUMBER	
END FITTINGS	
RECEIVED DATE	
* * * * * * * RECORD OF HYDROSTATIC TEST * * * * * * *	
HYDRO DATE	DATE DUE

Figure C.8
Unmanned Pressure Test Facility Hose Log

DATE: ______________

NOTE

TO LINE UP XXXXX FOR PRESSURIZATION:

PROCEDURE	INIT	NOTE

COMPONENT	DESCRIPTION	LOCATION	PROCEDURE	INIT	NOTES

Figure C.9
Unmanned Pressure Test Facility Sample Operating Procedure
Form XXXXX LINE UP

BIBLIOGRAPHY

The publications listed below are representative of those that may be useful to the sponsor in preparing for certification of an unmanned pressure test facility. The most recent issue or revision of each should be used.

ANSI/ASME B57.1, Compressed Gas Cylinder Valve Outlet and Inlet Connections

API Publication 2028, Flame Arrestors in Piping Systems

ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examinations

ASTM E1742, Standard Practice for Radiographic Examination

Compressed Gas Association Pamphlet C-5, Cylinder Service Life

Compressed Gas Association Pamphlet C-6.1, Standards for Visual Inspection of Compressed Gas Cylinders

Compressed Gas Association Pamphlet G-4, Oxygen

Compressed Gas Association Pamphlet G-4.2, Standard for Bulk Oxygen Systems at Consumer Sites

Compressed Gas Association Pamphlet G-4.4, Industrial Practices for Oxygen Transmission Systems and Distribution Piping

Compressed Gas Association Pamphlet P-1, Safe Handling of Compressed Gas

Compressed Gas Association Pamphlet P-9, Inert Gases Argon, Nitrogen, Helium

EM 385-1-1, Safety and Health Requirements Manual

IEST-STD-CC1246, Production Cleanliness Levels and Contamination Control Program

ISO 9000, International Standards for Quality Management

MIL-STD-101, Color Code for Pipelines and for Compressed-Gas Cylinders

MIL-STD-777, Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships

MIL-STD-889, Dissimilar Metals

MIL-STD-1411, Inspection and Maintenance of Compressed Gas Cylinders

MIL-STD-1689, Fabrication, Welding and Inspection of Ships Structure

NASA Hydrogen Safety Handbook

National Fire Protection Association, 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites

National Fire Protection Association, 53M, Manual on Fire Hazards in Oxygen Enriched Atmosphere

National Fire Protection Association, 70, National Electric Code

National Fire Protection Association, 99, Health Care Facilities

National Fire Protection Association, 496, Standard for Purged Enclosures for Electrical Equipment in Hazardous (Classified) Areas

NAVFAC DM 3.5, Compressed Air and Vacuum Systems

NAVFAC MIL-HDBK-1002/2A, Structural Engineering – Loads

NAVFAC MIL-HDBK-1004/2A, Power Distribution Systems

NAVFAC MIL-HDBK-1004/3, Switchgear and Relaying

NAVFAC MIL-HDBK-1004/4, Electrical Distribution Systems

NAVFAC MO 406, Hyperbaric Facilities Maintenance Manual

NAVFACINST 11012.128,Design and Fabrication of High Pressure Gaseous Oxygen and Nitrogen Piping Systems

NAVSEAINST 6260.1, Occupational Noise Control and Hearing Conservation

NAVSEA 0900-LP-001-7000, Fabrication and Inspection of Brazed Piping Systems

NAVSEA S9074-AQ-GIB-010/248, Requirements for Welding and Brazing Procedure and Performance Qualification

NAVSEA S9074-AR-GIB-010/278, Requirements for Fabrication Welding and Inspection, and Casting Inspection, and Repair for Machinery, Piping, and Pressure Vessels

NAVSEA T9074-AD-GIB-010/1688, Requirements for Fabrication, Welding, and Inspection of Submarine Structure

NAVSEA T9074-AS-GIB-010/271, Non-Destructive Testing Methods

OPNAVINST 5100.23, Navy Occupational Safety and Health (NAVOSH) Program Manual

OPNAVINST 6260.2, Occupational Noise Control and Hearing Conservation

UFC 3-310-01, Design: Load Assumptions for Buildings

UFC 3-600-01, Design: Fire Protection Engineering For Facilities

UHMS Pub. No. 69(WS-HYD), Hydrogen as a Diving Gas

REFERENCES

NOTE: THE FOLLOWING REFERENCED DOCUMENTS FORM A PART OF THIS DOCUMENT TO THE EXTENT SPECIFIED HEREIN. USERS OF THIS DOCUMENT SHOULD REFER TO THE LATEST REVISIONS OF CITED DOCUMENTS UNLESS OTHERWISE DIRECTED.

FEDERAL/MILITARY SPECIFICATIONS, STANDARDS AND HANDBOOKS:

Unless otherwise indicated, copies are available from the Naval Publishing and Printing Services Office (NPPSO), Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

STANDARDS

FED-STD-H28	Screw-Thread Standards for Federal Services
MIL-STD-882	System Safety Program Requirements
MIL-STD-1330	Precision Cleaning and Testing of Shipboard Oxygen, Helium, Helium-Oxygen, and Nitrogen Systems
MIL-STD-1627	Bending of Pipe or Tube for Ship Piping Systems

HANDBOOKS

MIL-HDBK-1152	Inspection And Certification Of Boilers and Unfired Pressure Vessels

SPECIFICATIONS

MIL-DTL-31000	Technical Data Packages
MIL-F-22606	Flask Compressed Gas and End Plugs for Air, Oxygen and Nitrogen

OTHER GOVERNMENT DOCUMENTS AND PUBLICATIONS:

DODD 5000.1A	Defense Acquisition
DODI 5000.2	Defense Acquisition Management Policies and Procedures
NAVFAC DM 39	Hyperbaric Facilities
NAVSEA NSTM	Naval Ships Technical Manual

(Unless otherwise indicated, copies are available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia PA 19120.)

NON-GOVERNMENT PUBLICATIONS:

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI NB-23	National Board Inspection Code
ANSI/ASME B31.1	Power Piping
ANSI/ASME PVHO-1	Safety Standards for Pressure Vessels for Human Occupancy

(Unless otherwise indicated, copies are available from American National Standards Institute (ANSI), 11 W 42nd St., 13th Floor, New York, NY 10036.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME Boiler and Pressure Vessel Code	Section VIII, Division 1, Unfired Pressure Vessels, and Division 2, Alternative Rules for Pressure Vessels ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications

(Unless otherwise indicated, copies are available from American Society of Mechanical Engineers (ASME), 3 Park Ave, New York, NY 10017.)

ASTM INTERNATIONAL

ASTM G88	Standard Guide for Designing Systems for Oxygen Service
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength

(Unless otherwise indicated, copies are available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

GLOSSARY

For purposes of this document, the following words or phrases are as defined.

Accessibility to vital equipment	The ability to reach, read, and/or operate vital equipment and devices.
Accident	A happening that is not expected, foreseen, or intended under normal circumstances.
Alteration	A change from the as-certified design, material, configuration, or performance.
Appurtenance	An accessory added to a major component (e.g., view ports hatches, support rails, connectors, piping, etc.,).
Builder	Contractor or agency that constructs the unmanned pressure test facility.
Casualty	An incident which causes damage or interruption of the normal operation of the unmanned pressure test facility and which may result in physical injury to personnel.
Catastrophe	Any extreme or sudden disastrous malfunction which jeopardizes the safety of the facility operators or causes major damage to the facility.
Certifiable	See System certification.
Certificate	The document attesting to the system certification granted by the SCA.
Certification	See System certification.
Certification Scope	See Scope of certification.
Emergency	A sudden, unexpected malfunction or other set of circumstances in the System operation which requires immediate attention.
Explodable items	Any item containing a non-compensated volume that has the potential for failure under internal

pressure.

Fail Safe	Material or equipment designed or arranged so that failure or malfunction renders it harmless or inert.
Fire resistant	A material that will immediately self extinguish when the source of ignition is removed, when tested in an atmosphere representative of its intended use environment.
Foundation	The permanently installed part of a pressure vessel system which serves exclusively to support the Pressure vessel system.
Hard structure	Pressure resistant structures, including reinforced openings and penetrations, but other than the pressure vessels, which may experience high differential pressure and that are designed to the same criteria as the pressure vessel.
Heat resistant	A material that does not give off noxious fumes at its operating temperature or at any temperature below 200° F and which is not degraded in respect to performing its intended function when exposed to a temperature of 400°F for 5 minutes.
Implodable item	Any item containing a non-compensated compressible volume that has the potential for failure under external pressure.
Material adequacy	Designed and constructed of proper materials and (materially adequate) performance tested in accordance with accepted engineering principles to provide for safety of the pressure vessel system personnel.
Maximum operating pressure	The highest pressure that can exist in a system or subsystem during any condition.
Maximum System Pressure	The maximum pressure that the system can experience.
Milestone event	A list of sequential events in the certification schedule process with estimated completion dates.

Operator(s)	1. The organization, agency, or firm having responsibility for the operation, repair, and maintenance of the pressure vessel system. 2. The personnel who physically control the operating parameters of the pressure vessel system.
Penetration	The assembly, component shaft packing gland, seal, or other device which penetrates the pressure resistant structure (e.g., pressure vessel or hard structure).
Pressure vessel	See definition of Unmanned Pressure Test Facility.
Procedural adequacy	The procedures used in the operation and maintenance of the pressure vessel system, suitable and sufficient to provide for the safety of the occupants and operators of the system, before, during, or after any credible operational or emergency evolution.
Procedures	Instructions, checklists, and maintenance guides, prepared in a manner that provides the occupants and operators a detailed, safe sequence of operations of the pressure vessel system in all of its various normal and emergency operating modes.
Re-certification	A new certification for system adequacy of a pressure vessel system fabricated, assembled, and performance tested in accordance with acceptable engineering principles.
Repair	A restoration to the original condition or replacement that does not change the original material, configuration, or performance, using procedures previously approved.
Replacement-in-kind	Replacement with parts or components meeting original specification requirements.
Scope of Certification (SOC)	A list defining those systems, subsystems, components, portions of the pressure vessel system,

	maintenance, and operational procedures which are needed to preserve the physical well being of the pressure vessel system personnel.
Sponsor	The agency/organization that is making application for system certification or re-certification of a pressure vessel system. For the pressure vessel System being developed, the sponsor will normally be that agency or organization tasked with development of the capability provided by the pressure vessel system. For existing pressure vessel systems, the sponsor will normally be that element within the organizational chain responsible for operational readiness and deployment of the specific pressure vessel system.
Survey	To examine, inspect, and review in detail all items falling within the scope of certification to determine their material and procedural adequacy.
Survey team	The personnel representing the System Certification Authority to perform the on site verification of the pressure vessel system survey.
Suspension of certification	The temporary revocation of certification that does not require full re-certification. Manned use of the system during suspension is not authorized.
Sustaining system certification	Actions required of the sponsor to ensure the SCA that the pressure vessel system remains in the as-certified condition for the tenure of certification.
System certification	The procedure including application, independent technical review, survey, and approval to ensure the adequacy of the pressure vessel system to safely perform over its operational/emergency spectrum. System certification is a combination of two major areas of review: material adequacy and procedural adequacy. This replaces the old term "material certification".

System Certification Authority (SCA) — The code within NAVFAC that has been delegated, through the Navy chain of command, the responsibility to conduct the Certification process.

System design pressure — The pressure used in the calculation of piping and piping components minimum section thicknesses.

Tenure — Tenure of Certification is the length of time for which certification is granted.

Termination of certification — The cancellation of system certification, requiring full system review to re-certify.

ACRONYMS

ANSI. American National Standards Institute

ASME. American Society of Mechanical Engineers

DOD. Department of Defense

DOT. Department of Transportation

EP. Emergency procedure

HAZCAT. Hazardous Category

MES. Milestone Event Schedule

MSDS. Material Safety Data Sheet

NAVFACENGCOM. Naval Facilities Engineering Command

NDT. Non-destructive Testing

OP. Operating procedure

OQE. Objective Quality Evidence

PMS. Preventive Maintenance System

PSOB. Pre-Survey Outline Booklet

QA. Quality Assurance

SCA. System Certification Authority

SCSC. System Certification Survey Card

SOC. Scope of Certification