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RECORD OF REVISIONS

Rev.	Date	Description	POC	RM
0	9/22/2023	Initial issue as section PS-GUIDE. Some content was in previous sections (ADMIN and others) while other content is new.	Ari Ben Swartz, *ES-FE*	Dan Tepley, *ES-DO*

Contact the Standards point of contact (POC) for upkeep, interpretation, and variance issues.

Chapter 17	Pressure Safety POC

This document is online at https://engstandards.lanl.gov

1.0 INTRODUCTION

This section provides guidance and precautionary considerations relating to pressure system design. These are not Code or LANL-imposed requirements but should be considered if applicable to the engineering design.

2.0 OVERPRESSURE PROTECTION EVALUATIONS

Guidance for performing overpressure protection evaluations is provided in Attachment GUIDE-1, *Overpressure Protection Evaluation Guide*.

3.0 MATERIAL COMPATIBILITY

A. Corrosion

1. For systems with active corrosion (e.g., carbon steel and water), corrosion inhibitors should be utilized to reduce the corrosion rate.

2. Corrosion rates should be evaluated prior to selecting materials for fluid service at temperature and pressure. The manufacturer's compatibility information may be used or a general guide like the National Association of Corrosion Engineers (NACE) "Corrosion Data Survey" ISBN 0-915567-07-5. *Note: At time of writing, the ES-UI Gas System Engineer was a NACE member and standards committee author. Contact ES-UI if assistance is needed on using this ISBN.*

3. Passive Corrosion

    a. Systems that utilize passive corrosion (passivation) as a means of self-protecting the system from further corrosion (e.g., aluminum oxide, fluorine systems) should not be disturbed. Care should be taken to re-establish the passive corrosion layer if ever removed.

    b. Fluorine systems should be passivated (see Ultrapure Gas Delivery "Preparing a gas delivery system for excimer lasers with fluorine passivation of 316L stainless steel" by Eugene, J. Karwacki Jr., Kerry R. Berger, Ronald M. Pearlstein, and Robert J. Haney Air Products and Chemicals).

4. The Designer should consider the potential for galvanic corrosion when specifying dissimilar metal connections for electrolytic liquid fluid service (e.g., water, deionized water, etc.).

5. The Designer should consider potential corrosion effects for the fluid service and the temperature and pressure of the fluid service, such as the following:

    a. The susceptibility of the piping material to crevice corrosion under backing rings, in threaded joints, in socket welded joints, and in other stagnant, confined areas,

    b. The possibility of adverse electrolytic effects if the metal is subject to contact with a dissimilar metal (i.e., galvanic corrosion),

    c. The effect of stress corrosion,

d. The effect of intergranular corrosion (e.g., austenitic stainless steel carbide precipitation and chromium depletion),

e. The effect of hydrogen embrittlement,

f. The effect of pitting corrosion,

g. The effect of Microbiologically Influenced Corrosion,

h. The possible corrosion under insulation effect,

i. The effect of erosion corrosion and/or flow-accelerated corrosion,

j. The effect of environmental cracking,

k. The effect of selective corrosion attack on structural constituents,

l. The effect of exfoliation corrosion, and

m. The effect of interfacial corrosion.

6. Stress Corrosion Cracking (SCC)

a. Stress corrosion cracking is induced from the combined influence of tensile stress, elevated temperature, and a corrosive environment. The impact of SCC on a material usually falls between dry cracking and the fatigue threshold of that material. The required tensile stresses may be in the form of directly applied stresses or in the form of residual stresses. The problem itself can be quite complex. The situation with buried pipelines is a good example of such complexity.

b. Cold deformation and forming, welding, heat treatment, machining, and grinding can introduce residual stresses. The magnitude and importance of such stresses is often underestimated. The residual stresses set up because of welding operations tend to approach the yield strength. The build-up of corrosion products in confined spaces can also generate significant stresses and should not be overlooked. SCC usually occurs in certain specific alloy-environment-stress combinations.

c. Usually, most of the surface remains unharmed, but with fine cracks penetrating the material. In the microstructure, these cracks can have an intergranular or a transgranular morphology. Macroscopically, SCC fractures have a brittle appearance. SCC is classified as a catastrophic form of corrosion, as the detection of such fine cracks can be very difficult, and the damage not easily predicted. Experimental SCC data is notorious for a wide range of scatter. A disastrous failure may occur unexpectedly, with minimal overall material loss.

7. Chloride Stress Corrosion Cracking (CSCC)

a. CSCC is a localized corrosion mechanism like pitting and crevice corrosion. Chloride stress corrosion is a type of intergranular corrosion that involves selective attack of the metal along grain boundaries. The three conditions that should be present for chloride stress corrosion to occur include the following:

- Chloride ions are present in the environment,
- Dissolved oxygen is present in the environment, and
- Metal is under tensile stress.

b. Austenitic stainless steel is a non-magnetic stainless-steel grade consisting of iron, chromium, and nickel, with a low carbon content. This alloy is highly corrosion resistant and has desirable mechanical properties. Chloride stress corrosion can attack austenitic stainless steel. During stainless steel formation, a chromium-rich carbide precipitates at the grain boundaries leaving these areas low in protective chromium, and thereby, susceptible to attack. It has been found that this is closely associated with certain heat treatments resulting from welding. The potential for CSCC can be minimized considerably by utilizing proper annealing processes.

c. This form of corrosion is controlled by maintaining low chloride ion and oxygen content in the environment and using low carbon steels. Environments containing dissolved oxygen and chloride ions can readily be created in auxiliary water systems. Temperature plays an important role in CSCC, with a maximum effect at around 180°F.

B. Organic Material (Soft Goods) and Flexible Hose Selection

1. Organic materials that are part of the pressure boundary (e.g., O-ring, valve seats, flange gaskets) typically have more stringent compatibility requirements and need to be selected with careful consideration, primarily temperature and chemical compatibility.

2. Manufacturer's compatibility information should be reviewed prior to selection of material for the system's fluid service at the design temperature and pressure. For general use, the Parker Hannifin Corporation O-Ring Division "Parker O-Ring Handbook" ORD 5700 may be used to evaluate the materials.

3. Consider material compatibility per NFPA 30, NFPA 45, or similar when selecting flexible hoses.

C. Radiological Service

1. Review the guidance of ESM Chapter 6, Mechanical, Section D20 Plumbing/Piping/Vessels, D2090 Other Plumbing and Piping Systems (R&D, PROG, & FAC) paragraph 5.0 RADIOACTIVE SERVICE GENERAL GUIDANCE.

   a. DOE-HDBK-1132-99 (reaffirmed 2014), *Design Considerations*

   b. ESM Ch. 6, Section D20, Table D2090-1, *Relative Stability of Plastics*.

2. Tritium system design should consider DOE-HDBK-1129, *Tritium Handling and Safe Storage*, if applicable.

4.0 FLANGE GASKETS

A. Gaskets should be selected so that the required seating load is compatible with the flange rating and facing, the strength of the flange, and its bolting. See ASME B16.20 (metallic) and B16.21 (non-metallic) for information on gaskets. See ASME B16.5 5.3 and 5.4 for guidance on flange bolting and flange gaskets.

B. Gaskets should be made of material which is compatible with the fluid service and should be capable of withstanding the pressures and temperatures to which they will be subjected in service.

5.0 FLEXIBLE ELASTOMERIC SEALED JOINTS (EXPANSION JOINTS)

A. When possible, specify expansion joints that meet Expansion Joint Manufacturers Association (EJMA) Standards.

B. Assembly of flexible elastomeric sealed joints should be in accordance with the manufacturer's recommendations.

C. Any solvents or lubricant used to facilitate joint assembly should be compatible with the joint components and the intended service.

D. Flammable vapors should be purged prior to hot work.

6.0 OXYGEN AND OTHER OXIDIZER SYSTEMS

A. Pressure system design guidance for the use of oxygen or other oxidizer system fluids is provided in Attachment GUIDE-2, *Oxygen System Design Guide*.

B. GUIDE-2 serves as a detailed design guide that will aid the designer in assessing the hazard level of the oxygen/oxidizer system and should generally relax the requirements given in the previous revision of ESM Chapter 17.

7.0 ACETYLENE

A. In all cases, copper, silver, and mercury must be excluded from contact with acetylene in transmission and control systems; copper content of 65% may be used if the designer specifies the specific item.

B. Acetylene can react explosively with fluorine or chlorine when exposed to sunlight and caution should be exercised to avoid this interaction.

C. Aluminum should be avoided, since it may become corroded by exposure to calcium hydroxide formed in the production of acetylene from calcium carbide.

D. The common nonmetallic materials that have been found satisfactory for use with acetylene include polytetrafluoroethylene (PTFE), polychlorotrifuoroethylene (PCTFE), polyamide (PA), natural and synthetic rubbers, and leather.

E. Use of semi-steel that may be exposed to the pressure effects of an acetylene deflagration or detonation is not recommended.

F. For additional guidance, refer to CGA G-1, *Acetylene*, and CGA G1.3, *Acetylene Transmission for Chemical Synthesis (Recommended Minimum Safe Practices for Piping Systems*).

8.0 CLEANING

A. When potential contamination could impact the pressure system, the engineering design should specify cleaning requirements. The purpose of cleaning is to remove harmful deposits from all parts of the system that encounter the fluid during operation. All foreign materials, fatty acids, oils and grease, loose mill scale, rust, paint, and similar materials should be removed. Any solution employed should be a good cleaning agent for these purposes and should be compatible with the materials of construction.

B. Standard Cleaning

1. The need for and degree of cleanliness of pressure systems is dictated by the system requirements, the degree to which the system can be cleaned after installation, and the need for removal of contaminants deposited during fabrication.

2. Unless otherwise specified by the customer, cleaning will consist of removing all non-adhering material such as loose scale, sand, weld spatter particles, rust, cutting chips, grinding residue, etc. from the inside of the piping assembly by suitable means. This level of cleaning will allow the presence of mill scale, surface rust, and tightly adhered weld spatter.

3. Externally the piping should be free of weld slag, flux, and weld spatter.

C. Additional Cleaning

1. Additional cleaning if required will be specified by the customer. These methods include but are not limited to brushing, grinding, blasting, degreasing, and pickling and passivation.

D. Precision cleaning of contamination may be required by the customer. Precision cleaning includes but is not limited to particulate contamination, chemical surface contamination, non-volatile surface residue (greases and oils), and biological clean (sterile).

E. Cleaning should consider different types of contamination as applicable to the system, for example:

1. Particulate contamination

2. Chemical surface contamination

3. Non-volatile surface residue (greases and oils)

4. Biological clean (sterile)

F. Particulate contamination (dirt and fibers) chemical cleaning is conducted with solvent solution primarily for the purpose of removing mill scale and products of corrosion. The solvent solution may be acidic or basic, or successive solutions of differing character may be employed. The effect of the cleaning agent on the substrate should be evaluated.[1]

G. Purging, flushing, or blowing down unwanted dirt, debris, and residual fluid from the inside of a piping system should be performed with caution and control. It is left to the discretion, knowledge, and responsibility of the Owner or Designer as to the degree of caution and control necessary for a safe work environment. The fluid selected for the purpose of purging, flushing, or blowing down should preferably be inert. However, for cases in which the use of a flammable or toxic fluid is unavoidable, e.g., when displacing residual testing or flushing fluid with the service fluid, the implementation of additional precautionary considerations may be necessary. Those precautionary considerations should include the following items:

1. The discharge of liquids to a safe collection point,

2. The discharge of flammable liquids away from ignition sources and personnel,

[1] Because of the chemical control required to ensure a successful cleaning, to avoid damage to both ferrous and nonferrous materials through improper use of the solvent and because of the potential dangers involved in dealing with corrosive solutions and possibly explosive and toxic products of the cleaning process.

3. Venting of gases to a safe outdoor location,
4. Venting of flammable gases away from ignition sources and personnel,
5. Further protection of personnel via controlled access of the work area, including perimeter warning signs for personnel not involved in the purging process, and
6. For precautionary requirements and recommendations regarding the displacement of flushing and testing fluids using a flammable gas, refer to ANSI Z223.1/NFPA 54, National Fuel Gas Code.

9.0 INSTALLATION

A. Plastic and nonmetallic tubing is discouraged where the tubing is hidden from sight.

B. Wire brushes used on pipe or tube can cause corrosion if the wire brush material is dissimilar to the pipe or tube material. The use of proper wire brushes should be communicated in the work documents.

10.0 VESSEL INSPECTION DURING INSTALLATION OR SERVICE CHANGES

A. The Designer may require vessel inspection during installation or service changes in accordance with American Petroleum Institute (API) 510, *Pressure Vessel Inspection Code*, Section 6.2.1.

11.0 HOSE ASSEMBLY AND PRESSURE REGULATOR INSPECTION

Maintenance guidance for inspecting flexible hose and pressure regulators is provided in P101-34, Attachment B, *Maintenance Guidance for Hose Assembly Inspections and Pressure Regulators.*

12.0 ATTACHMENTS

GUIDE-1, *Overpressure Protection Evaluation Guide*

GUIDE-2, *Oxygen System Design Guide*