Performance Assurance System for the Design, Procurement, and Acceptance of LANL Confinement Vessels Designated as Safety Class

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Table of Contents

1 Foreword - LANL Confinement Vessel Document Preamble

Los Alamos National Laboratory uses confinement vessels in explosives testing programs to contain the energy and debris from the detonations of high explosive (HE) assemblies. The purpose of this document is to provide a framework for construction activities (design, fabrication/manufacturing, inspections, and Vessel Qualification) that will assure that the vessel meets the requirements of operational safety. Operations within the LANL confinement vessel are beyond the scope of this document. This document applies to LANL Safety Class vessels used for this service.

Prudent engineering practices, years of program experience, and the appropriate use of national codes and standards have been included in the development of this document. This includes standards sponsored by the American Society for Testing and Materials (ASTM), the American Welding Society (AWS), and the American Society of Mechanical Engineers (ASME). The ASME Boiler and Pressure Vessel Code (the "Code"), which is recognized as the international standard for pressure vessels, was an initial input.

Confinement vessels will be subject to a single, rapid event driven by a HE detonation. This event induces significant shock loading (microsecond duration), which is the principal design consideration. Additional design considerations include shrapnel impacts and, to a lesser extent, residual pressure. The confinement vessels will be used only once in the experimental configuration.

It is appropriate to compare and contrast the intended use of the confinement vessels with the intended use of vessels designed and built per the Code for commercial purposes. The current Code addresses pressure vessels that are intended for relatively slow transient and steady state design loads, and are often subjected to many operating cycles. The Code does not address fragment loads or shock loads of extremely short (microsecond) duration, which must be considered for the LANL confinement vessel. Therefore, the Code is minimally applicable for use and alternative techniques must be used for design, dynamic analysis, and empirical verification of the vessel performance.

This document and the Code share a common philosophy of identifying and designing for all loads that the respective vessels must accommodate. The design path set forth in this document addresses all applicable vessel loads, and satisfies the intent of the Code regarding these loadings.

The Code also has provisions related to the procurement and fabrication of vessels, including materials, quality assurance, testing, inspections, and acceptance criteria. In general, these specific provisions of the Code are applicable to the LANL vessel and are satisfied by this document.

The use of non-Code materials and of design considerations beyond those utilized in the Code differentiates the confinement vessel for this application. For this document,

alternative specifications, requirements, and acceptance criteria parallel the comparable Code requirements, specifications, and acceptance criteria.

Three potential confinement vessel structural failure modes have been identified. These include ductile rupture due to gross overload, brittle fracture, and perforation by a fragment.

Different approaches are used to mitigate these potential failures. Ductile rupture and brittle fracture are addressed in the design process and for each vessel design an adequate safety margin is demonstrated through an explosive Overtest. Fragment perforation is addressed by the conduct of a dry run test for each experimental setup.

Confinement vessels incorporating the same basic design features have successfully been manufactured and used for thirty (30) years. That experience, coupled with the use of modern analytical capabilities, appropriate fabrication and NDE technologies, the use of appropriate steels, quality controls, and the use of this document, ensures that the confinement vessels will be safe when used within their design bases.

2 Scope

The scope of this document includes construction activities (design, fabrication/manufacturing, inspections, and Vessel Qualification) for confinement vessels designated as Safety Class. Operations within the LANL confinement vessel are beyond the scope of this document.

See Figure 1. The vessel construction process begins with Design Inputs and requirements received from the end users. The construction process ends where the vessel passes from design, fabrication/manufacturing, inspections, and Vessel Qualification to use; from the developers and designers to the end-users.

3 Purpose

The purpose of this document is to provide a framework for construction activities and processes (design, fabrication/manufacturing, inspections, and Vessel Qualification) that will assure that the LANL confinement vessel meets the requirements of operational safety. It also provides users an understanding of the underlying principles for these activities. With this understanding, the users will be able to determine the specific design, fabrication/manufacturing, inspections, and testing activity requirements applicable to their unique project. In this way, the document is flexible, while ensuring that safety goals are met.

4 Applicability

This document defines Safety Class requirements for confinement vessels used at the Department of Energy's Los Alamos National Laboratory.