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# ENGINEERING DESIGN PACKAGE

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# Silos 1 and 2 Dome Seal Repair 40740

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FERNALD
Environmental Management Project

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# SILOS 1 AND 2
# DOME SEAL REPAIR

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# 1.0 INTRODUCTION

This Engineering Design Package (EDP) provides the engineering basis required to support the Silos 1 and 2 Dome Seal Repair Scope of Work, contained in Appendix A. This EDP will serve as a basis for design and repair actions. Project related documents that may use this EDP as a source document include the Safety Assessment and Performance Grade Evaluation, Occupational and Environmental ALARA Analyses, Quality Assurance Job Specific Plan, Human Factors Evaluation Document, Labor Standard Review Committee Project Transmittal (labor determination), Maintenance Work Orders, Maintenance Work Instruction(s), and other project related documentation.

This EDP satisfies requirements noted in the Site Procedures, Functional Areas 1, Configuration Management, and 2, Engineering Design, for a "Hazard Category 4" project. Thou this activity takes place in a Hazard Category 3 Facility, it has been determined that it is a Standard Industrial Hazard and such a PG-4 rating has been assigned (See Appendix E). The development of this EDP included design review sessions to present conceptual design details to support/interfacing Functional Areas and organizational personnel (as required in ED-12-4002, Conceptual Design Report). Specific criteria (ED-12-4003, Design Criteria Package) required to support this design are called out in Section 2 of this package. Finally, this EDP is maintained by engineering to facilitate the design, implementation planning, ALARA, safety and health, property management, and all closeout issues (ED-12-4004, Design Package).

## 1.1 Background

There has been an upward trend of radon concentration at the exclusion zone of Silos 1 and 2 (See Figure 1). Silos Engineering, Safety and Health, Project Management, along with other key organizations evaluated alternative solutions to effectively mitigate the radon releases (See Appendix B). Alternatives identified included a new Radon Control System, rehydrating the bentonite, resealing the dome with foam, and headspace pressure control. The alternative chosen was to first identify "hot spots" of radon release for both Silos 1 and 2. Leak paths of radon were determined in a survey of the silos utilizing direct alpha survey data (See Appendix C). Alpha count rates varied from 500 to 200,000 CPM for the areas identified.

Leak paths identified include:

1) Plywood covers used to seal penetrations made in the steel and plywood center cap to facilitate 1993 NDT testing (7 each silo);
2) A 2 foot by 4 foot access port cut in the plywood over the center manway (1 each silo);
3) Flange gaskets of the peripheral manways (4 each silo);
4) Some 2" sounding ports (4 total);

Similarities exist for all the leak points in that they are engineered penetrations, are localized, and are currently not encapsulated by the foam applied in 1987 (Reference 1).

Silos 1 and 2 domes received an exterior application of foam in the fall of 1987. The foaming consisted of applying a three-inch layer of rigid polyurethane foam to the outer dome surface and a 1.5-inch layer to the steel and plywood dome cap. This was followed by a 45 mil waterproof, ultra-violet resistant, urethane finish coating.

The benefits derived from the external foam application included:

1) Weather protection of the K-65 silo domes;

2) Insulation of the silo domes;

3) Reduction of radon emissions

Based on the results of the survey data, the decision was made to seal the identified leaking areas with an application of foam. In some cases this is a repair to foam damaged or removed since 1987, in others it is a new application.

**1.2 Purpose**

The purpose of this engineering design package is to provide an engineering basis and design necessary for application of the selected foam materials to Silos 1 and 2.

# 2.0 BASIS FOR DESIGN

This document presents baseline functional design requirements as specified in ED-12-4001, Functional Requirements Document, for the dome seal repair activity.

## 2.1 Functional Requirements

The following functional requirements apply to Silos 1 and 2 Dome Seal Repair:

- Foam materials selected shall be compatible with those applied in 1987.
- Foam material selected shall provide as good or better results relative to weather protection, insulation of the domes, and reduction of radon emissions than those applied in 1987.
- Application shall utilize standard industrial equipment.
- Waste and debris from operations shall be collected in a pre-approved container for management by Waste Planning and Integration.
- Silo containment or steel/plywood cap shall not be breached at any time.
- Observe the limiting conditions for operation (LCO-1) as listed in the Technical Safety Requirements Document and the Hazard Analysis Report for OU4 (Reference 3). They are summarized as follows:
  - Restrict the placement of loads on the domes of Silos 1 or 2 so that no live load greater than 700 pounds (including up to three persons), other than snow, is applied to the dome and/or the protective plywood and steel frame protective dome covers;
  - Equipment live loads shall be distributed over the largest area practical. In no case shall equipment be distributed over an area smaller than that of a 3 foot diameter circle. Under routine circumstances, personnel accessing the dome are not expected to occupy areas less than described above;
  - The load to be placed on the silos dome surface shall be measured or estimated by calculation (as appropriate) prior to activities on a silo dome; and
  - Fall protection will be utilized to protect personnel when accessing the dome.
- Weight of encasement material will not compromise structural integrity of the silo domes (See Appendix D).

## 2.2 Assumptions

- A silo radon control system will not be in place during this activity.

- Secondary containment will not be required for operations on Silos 1 and 2.
- Cables and turnbuckles currently in place on the domes will be removed/repositioned so as not to interfere with foam application.
- Appropriate PPE with respirators/breathing air shall be supplied as required by FDF Work Permits.

## 2.3 Safety Basis

Various safety aspects were evaluated for the Silos 1 and 2 Dome Seal Repair Project. First, a structural evaluation was performed to ensure worker and facility safety. Next, an ALARA evaluation was performed to ensure that the work can be performed in accordance with ALARA guidelines. Then, a performance grade determination was performed to determine the safety significance of the project.

### 2.3.1 Structural Evaluation

A structural evaluation was performed (Appendix D) determining that the additional weight of the encasement systems from the proposed repair is well within the allowables determined during the original dome foaming in 1987. A review was also made of the most recent evaluation of the physical condition of the silos (Reference 2). The conclusion from this review is that the additional weight from the repair will not affect the referenced report.

### 2.3.2 ALARA Evaluation

An ALARA evaluation (Appendix J) for this activity determined the major radiological hazards are internal exposures due to radon/radon progency and whole-body deep dose penetrating radiation. Based upon data, past practices and respiratory protection (as required), no internal exposure is anticipated to be assigned to any personnel as a result of this project. The whole-body deep dose equivalent is estimated to be .975 person-rem, while the highest individual whole-body deep dose equivalent is estimated to be 88 mrem. By implementing the ALARA requirements generated in Radiological Work Permits and Work Plans, exposures will be ALARA.

### 2.3.3 Performance Grade Determination

A performance grade determination was performed (Appendix F) determining that application of the encasement system is Performance Grade 4, Standard Industrial Hazard. As support for this determination, a simplified programmatic risk analysis was performed (Appendix I) to qualitatively evaluate the mission importance and the programmatic risk associated with this activity. Based on this analysis, the performance grade remained PG-4.

# 3.0 ENCASEMENT SYSTEM

## 3.1 Defined

The encasement system is a combination of products that will safely seal the identified areas to provide a long term protection jacket that is airtight, seamless, waterproof and impact resistant. The most suitable encasement system for this application was determined based on review of available alternatives and conversations with technical representatives. Materials selected are shown in Section 3.2 below.

## 3.2 General Application Procedure

The surfaces to be covered shall be prepared per manufacturers recommendations.

NOTE: The center portion of the existing herculite over the center manway (Items 8 and 28) that is not adhered to the foam underneath, is to be removed prior to application of the encasement material.

The encapsulant material is applied in three steps. Technical data and specific application instructions for each of these products in supplied in Appendix E.

1.) Penetrating Epoxy Sealer- To penetrate and seal the concrete, wood, and other surfaces prior to application of foam material.

2.) Polyurethane Spray Foam System - For sealing air leaks.

3.) Coating System - A permanently flexible "breathing" membrane that protects foam from general weathering, aging and ultraviolet exposure.

1) PENETRATING EPOXY SEALER
UNITED COATINGS; "UNI-TILE SEALER"

Obtain sealer with black colorant for absorption of heat and to enhance effectiveness of polyurethane foam.

NOTE: Sealer is not to be applied to metal surfaces such as the sounding ports, manways or flashing. If some sealer is inadvertently applied to a metal surface, do not attempt to remove, leave as is.

Sealer is a two-component material that is mixed in equal amounts. Application is by brush, roller or spray. One coat should be sufficient. Extend sealer a minimum two inches out from the foam application area as described in Section 4.0 "Application Area".

Sealer is to be cured according to manufacturers specifications prior to applying foam.

2) POLYURETHANE SPRAY FOAM SYSTEM
FOAM ENTERPRISES, INC. "FE303-2.5HC"

Foam is to be applied over the sealer after it has sufficiently dried and cured. Plans should be made to apply the foam within 24 hours of sealer application. At no time should the foam be applied after 48 hours following sealer application.

Foam is to be applied in areas and levels as shown in Section 4.0 " Application Area". Apply in passes of ½" to 1" thickness, or according to manufacturers specifications..

COATING SYSTEM
UNITED COATINGS, "ELASTUFF 101/102"

Elastuff 101 and 102 are single component materials that are best applied by airless spray equipment but brush or roller can be used. Elastuff 101 is a polyurethane basecoat applied directly to the foam. It must be applied within 72 hours, or as determined by the manufacturer, of foam application. Material can be applied in one or two coats with minimum total dry thickness of 14 mils or as determined by the manufacturer. Material is to be applied so it completely covers the foam and sealer.

Note: Each coat of 101 or 102 shall be applied in a direction perpendicular to the previous coat.

Elastuff 102 is a UV-resistant polyurethane topcoat. Elastuff 102 shall be applied within a 48 hour period of following application of Elastuff 101. Elastuff 102 can be applied in 1 or 2 coats with minimum total dry thickness of 10 mils, or as determined by the manufacturer.

Material is to completely cover Elastuff 101. Total thickness for 101 and 102 is minimum 24 mils, or as determined by the manufacturer

## 4.0 FOAM APPLICATION AREAS

The sealer, foam, and coating systems are to be applied to the areas shown in Figures 2 and 3 for Silos 1 and 2 domes, respectively. Figures 4,5,6, and 7 show generalized application cross sections for the four items being encased. Field conditions at each specific item will dictate actual application of material.

Additional areas, not observed at the time of initial inspection, may require application of encasement material. Based on field conditions, one of the four generalized application cross sections or similar technique that provides equivalent coverage are to be used for these new areas.

Sequence of application relative to items and /or Silos 1 and 2 is to be determined during work planning sessions.