Chapter 6 – Engineered Safety Features

ATOMIC ALCHEMY INC.

Non-Proprietary

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TERMS

ABBREVIATIONS AND ACRONYMS

Common acronyms, abbreviations, and units of measurements may not be included here as it is assumed the reader is familiar with their meaning.

AAI	Atomic Alchemy Inc.
ESF	engineered safety feature
MHA	Maximum Hypothetical Accident
SSCs	systems, structures, and components
VIPR	Versatile Isotope Production Reactor

6 ENGINEERED SAFETY FEATURES

6.0 INTRODUCTION

This chapter describes the engineered safety features (ESFs) for the non-power Versatile Isotope Production Reactor (VIPR). ESFs are active or passive features designed to mitigate the consequences of accidents and to keep radiological exposures to the public, the facility staff, and the environment within acceptable values. The concept of ESFs evolved from the defense-in-depth philosophy of multiple layers of design features to prevent or mitigate the release of radioactive materials to the environment during accident conditions.

6.1 SUMMARY DESCRIPTION

The ESFs of the Meitner-1 facility are those systems designed to mitigate the consequences of postulated accidents, although these postulated accidents are unlikely. The structures, systems, and components (SSCs) within the facility that provide this functionality is the confinement structure and its associated confinement systems.

No emergency core cooling system is required for the VIPR to prevent or mitigate consequences of an accident as shown in Chapter 13, Section 13.3.4. Decay heat removal during accident scenarios is provided passively by natural convection within the light water pool. Additional information on natural convection is found in Chapter 5.

6.1.1 <u>Confinement</u>

The confinement structure primarily consists of concrete tilt-up construction that provides active and passive protection against the potential release of radioactive material to the environment during normal operations and postulated abnormal conditions. The confinement systems provide for active isolation of piping and heating, ventilation, and air conditioning systems penetrating confinement boundaries in certain post-accident conditions. There are no SSCs which change state or mode of operation in response to credible accidents. Specifically, in their inactive states, the confinement SSCs provide the credited release control described in the Maximum Hypothetical Accident (MHA); this bounds all credited release cases.

The confinement system as designed accommodates both the postulated design basis accidents and the MHA with its associated release as discussed in Chapter 13. The results of Chapter 13 analyses confirm that the release of fission products is improbable, while the amounts involved, if released, would be well within the limits established by appropriate regulations consistent with 10 CFR Part 20 and a 1 rem accident criterion detailed in 10 CFR 50.34(a)(i).

6.2 DETAILED DESCRIPTION

6.2.1 <u>Confinement and Subsystems</u>

The confinement structure protects against is the uncontrolled release of radioactive material to the surrounding environment from damaged fuel. Chapter 13 shows that the VIPR confinement structure mitigates the consequences of the most limiting accident scenario (the MHA) to acceptable levels below both occupational and public dose limits. Accordingly, a more extensive containment facility is not required and, therefore, not included as part of the ESFs. Any further analysis of the ESFs mitigative effects of potential radiological exposures to the facility staff and the public, with and without the confinement ESFs, will be provided in the FSAR:

The analysis may show airflow rates, reduction in quantities of airborne radioactive material by filter systems, system isolation, and other parameters that quantify the effectiveness of the confinement system beyond the safety analysis in this PSAR. While the ventilation system is assumed to be operational but inactive during the MHA it provides a controlled means by which to disperse and dilute radioactive effluent to safe levels. Securing the ventilation system simply holds all of the effluent within the reactor confinement area and any releases are constrained to a leak rate (if any) through the confinement structure. The design of the confinement structure to accommodate the extremely unlikely MHA ensures that spurious fuel pin or irradiation capsule failures have inconsequential impacts and do not affect the continued operation of the facility.

The reactor confinement area contains the quad-reactor bay, the transfer canal and its systems (canal target transfer system, canal water system), and the used fuel pool and its auxiliary systems as shown in Figure 6-1Figure 6-1. The bay door, personnel door, and equipment room access door are the confinement doors. These doors will be constructed of steel, gasketed, equipped with double locks, and have security devices attached. Any additional access points that may be added in the final design of the facility will have these same characteristics. The reactor confinement walls are poured reinforced concrete with a painted surface. All penetrations of the reactor building are sealed to minimize leakage and the possibility of releasing contamination to the environment. Penetrations are sealed in the following manner:

1) All pipes and ducts passing through the walls are sealed to the wall.
2) Electrical conduits are sealed to the walls and the wires are sealed to the inside of the conduit.
3) Major process pipes and ducts have isolation valves or dampers.
4) All doors leading into the reactor building are gasketed. They are also self-closing and self-latching.
5) All spare pipes and conduits are plugged or capped.

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Figure 6-1: The Meitner-1 confinement boundaries

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Figure 6-2: Meitner-1 confinement systems boundaries, interfaces, and ventilation pathways

The confinement structure, as a low-leakage solid barrier, controls the release of radioactive material by forcing the ventilation system to be the sole release point for contaminated air. By controlling the movement of air through the ventilation system, contaminated air can be filtered, and therefore the concentration of released radionuclides reduced, prior to release from the stack. The routing of air through the filter train is not a safety function and is actuated automatically based on detector readings or manually via the control room. The confinement structure's systems are shown in Figure 6-2. Additional information on the ventilation and monitoring system is described in Chapter 9, Section 9.1. Information on the instrumentation and controls related to the confinement SSCs is covered in Chapter 7.

Confinement system requirements such as setpoints, tests, and inspections will be specified in the technical specifications in Chapter 14 in the FSAR.

6.3 REFERENCES

Nuclear Regulatory Commission. 1991. 10 CFR Part 20, “Standards for Protection Against Radiation.”

Nuclear Regulatory Commission. 1996. NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content.”