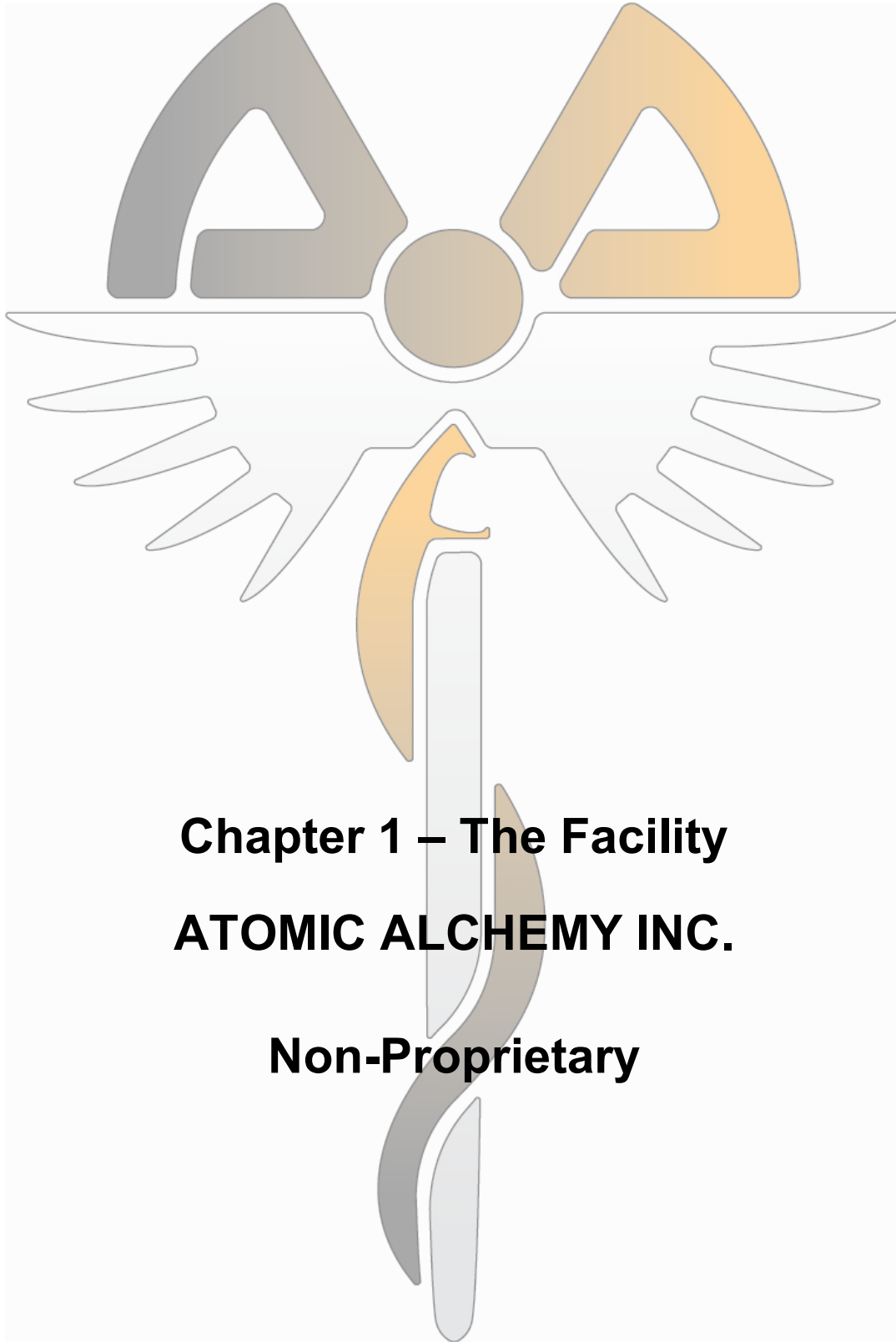




Chapter 1 – The Facility
ATOMIC ALCHEMY INC.
Non-Proprietary

Document Number	Revision	Approved By	Template
AAI-PSAR-01 (NP)	0		TEM-003 Rev 2 (05/14/2025)



TABLE OF CONTENTS

Terms	1-3
Acronyms and Abbreviations	1-3
1 The Facility	1-4
1.1 Introduction.....	1-4
1.2 Summary and Conclusions on Principal Safety Considerations	1-5
1.2.1 Consequences from the Operation and Use of the Facility.....	1-5
1.2.2 Safety Considerations	1-5
1.2.3 Inherent and Passive Safety Features.....	1-6
1.2.4 Design Features and Design Bases.....	1-6
1.2.5 Potential Accidents at the Facility	1-7
1.3 General Description of the Facility.....	1-7
1.3.1 Facility Location	1-13
1.3.2 Principal Characteristics of the Site	1-13
1.3.3 Principal Design Criteria, Operating Characteristics, and Safety Systems.....	1-14
1.3.3.1 Principal Design Criteria	1-14
1.3.3.2 Operating Characteristics	1-14
1.3.3.3 Safety Systems.....	1-15
1.3.4 Engineered Safety Features	1-15
1.3.5 Instrumentation, Control, and Electrical Systems	1-15
1.3.6 Reactor Coolant and Other Auxiliary Systems.....	1-16
1.3.7 Radioactive Waste Management and Radiation Protection	1-16
1.4 Shared Facilities and Equipment.....	1-17
1.5 Comparison with Similar Facility Designs.....	1-17
1.5.1 Comparison of Reactor Design	1-17
1.5.1.1 Fuel System Design.....	1-17
1.5.1.2 Reactor Safety Systems	1-18
1.5.1.3 Engineered Safety Features.....	1-18
1.5.1.4 Instrumentation and Control Systems	1-18
1.5.1.5 Conduct of Experiments	1-18
1.6 Summary of Operations	1-18
1.7 Compliance with the Nuclear Waste Policy Act of 1982.....	1-19



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)
Rev 0

Page 1-2

1.8	Facility Modifications and History	1-19
1.9	References.....	1-19
1.10	Appendices	1-20
Appendix A: Confirmation of Active and Good Faith Negotiations for Disposal Contract for Meitner-1		1-21

LIST OF FIGURES

Figure 1-1: General arrangement of facility	1-9
Figure 1-2: Meitner-1 elevation drawing showing the control room.....	1-10
Figure 1-3: Meitner-1 elevation drawing showing the reactor and used fuel pools.....	1-11
Figure 1-4: Meitner-1 preliminary site plan.....	1-12
Figure 1-5: Meitner-1 preliminary architectural rendering.....	1-13

LIST OF TABLES

Table 1-1: AAI comparison with similar facilities (reactor).....	1-17
--	------



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-3

TERMS

ACRONYMS AND ABBREVIATIONS

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.
ALARA	as low as reasonably achievable
CFR	<i>Code of Federal Regulations</i>
ESF	engineered safety features
I&C	Instrumentation and Control
INL	Idaho National Laboratory
ISG	Interim Staff Guide
MFC	Materials and Fuels Complex
MHA	Maximum Hypothetical Accident
NPUF	Non-power Production and Utilization Facility
PDC	principal design criteria
PWR	pressurized-water reactor
RPF	Radioisotope Production Facility
SSCs	systems, structures, and components
TEDE	total effective dose equivalent
VIPR	Versatile Isotope Production Reactor



1 THE FACILITY

1.1 INTRODUCTION

This Preliminary Safety Analysis Report (PSAR) was prepared in accordance with the provisions of Title 10 of the *Code of Federal Regulations* (CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities.” The PSAR generally follows the content and organization of NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content,” as augmented by the Final Interim Staff Guidance (ISG) Augmenting NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for Licensing Non-Power Reactors: Format and Content for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors,” October 17, 2012.

By conforming to the content and formatting guidelines of NUREG-1537, the PSAR fulfills the technical information requirements of 10 CFR 50.34(a) “Contents of applications; technical information” of the construction permit submittal.

This construction permit submittal comprises four construction permits combined via 10 CFR 50.52. The first and primary construction permit covers the entire facility as detailed in this SAR excluding three VIPR cores. The three subsequent construction permits authorize the assembly of the components comprising the three additional reactor cores. These components will be constructed within the pool tanks previously installed in accordance with the primary construction permit. Collectively, all the structures and systems that make up the facility are referred to as a Non-power Production and Utilization Facility (NPUF). The NPUF is referred to as “Meitner-1” or informally as “the Facility” throughout this SAR.

The construction permits are intended to be converted into a Class 103 operating license and shall cover a period of 40 years from the date of issuance. An additional license pursuant to 10 CFR 70, “Domestic Licensing of Special Nuclear Material” for a specific portion of the facility covering activities related to fabrication activities involving special nuclear material will be submitted with the FSAR. These licenses will be combined via 10 CFR 50.52, “Combining licenses” with issuance of the operating license.

AAI was founded for the purpose of designing, constructing, and operating the facility described in this PSAR. The purpose of the facility is to produce radioisotopes for medical, industrial, space, defense and research applications. This facility will contain the world’s first commercial radioisotope production reactors since the decommissioning of the Cintichem facility in the early 1990s (LaGuardia and Carignan 2021) and will be capable of producing over 40 different high value radioisotopes.

Meitner-1 is designed to maximize the use of proven, commercial, off-the-shelf reactor and hot cell technologies. This approach has led to the development of the Versatile Isotope Production Reactor (VIPR), a 15 MWth pool-type, non-power reactor using traditional low enriched uranium fuel.

VIPR is walk-away safe with many inherent and passive safety features. These are described in Subsection 1.2.3.



The facility will be located on the Idaho National Laboratory (INL) desert site located in Bingham County, Idaho. The AAI site and details regarding the geographical location and the surrounding areas are presented in Chapter 2.

1.2 SUMMARY AND CONCLUSIONS ON PRINCIPAL SAFETY CONSIDERATIONS

1.2.1 Consequences from the Operation and Use of the Facility

The main consequence of the operation and use of the facility is the securing of a North American supply of several dozen radioisotopes, ensuring that millions of doses of diagnostics and therapeutics are available to promote human health and welfare.

Another consequence is the promotion of national security. Not only is this achieved by creating a domestic source of these extremely valuable materials which are largely imported but also provides a means to eliminate the need for the US and other countries to procure these materials from state-owned enterprises in unstable, authoritarian regimes. For example, at the time of the submittal of this SAR, the United States relies on the Russian Federation for dozens of critical stable and radioactive isotopes (House Committee on Energy and Commerce, 2024).

The final— albeit not least significant —impact of operating the Meitner-1 facility lies in its potential to advance human progress. A stable supply of medical radioisotopes enables the development, testing, and large-scale production of innovative cancer treatments. A reliable source of radioisotopes for heat generation supports the use of top-tier materials to power spacecraft and rovers, will fuel the ongoing renaissance of commercial space ventures and exploration. Additionally, the broader industrial availability of radioisotopes will facilitate the expansion of powerful non-destructive techniques such as radiography and food sterilization, both of which have significant public health benefits and the potential for greater cost efficiency.

The primary, potential negative consequences resulting from the operation of the Meitner-1 facility are radiological. As the facility is dedicated to the production of radionuclides, the staff receives occupational exposures. Members of the public may receive inconsequential exposure from the release of radiological noble gasses during normal operations or potential exposures from inadvertent releases and shipments of the produced materials. The positive consequences greatly outweigh the negative. Methods used to ensure the safety of the reactor and mitigate potential negative consequences are introduced in the subsequent sections of this chapter.

1.2.2 Safety Considerations

Low-power, small-source-term, pool-type research reactors have safely operated in the center of population-dense areas across the United States for decades. As the VIPR is a low-power reactor with a small source term (the entire core inventory is comparable to a single fuel assembly [^{PROP,ECI}]), there are no safety considerations nor special factors which have influenced the selection of the facility site.

While unlikely, the effects of postulated events involving the release of radiological material have been considered and engineered safety features are integrated into the facility design to mitigate potential consequences. The low-power design, low reactor core inventory, and location all contribute to large



margins with respect to the 1 rem (0.01 Sv) total effective dose equivalent (TEDE) accident dose criterion specified in 10 CFR 50.34(a)(i) for non-power utilization facilities. Facility design, engineered controls, and administrative procedures all contribute to minimizing exposures to radiation workers, the public, and the environment.

1.2.3 Inherent and Passive Safety Features

The VIPR is designed to be completely passively safe, requiring only minimal nuclear safety systems. Key passively safe features within the facility include

- the ability of the reactor(s) to maintain effective cooling through natural convection while in a shutdown state,
- the inability of the reactor pool to completely drain ensuring the reactor always maintains water coverage in the unlikely scenario of a primary coolant pipe failure,
- the ability to maintain safe shutdown of all processes in the event of a loss of normal and backup power,
- the negative reactivity coefficients associated with the fuel and moderator temperatures, mitigating the consequences of any reactivity excursion and promoting self-regulation of the reactor,
- the control rods held in place by electromagnets fail safe via gravity, and
- the location of the facility which allows for the dilution of any effluents, intentional or accidental.

1.2.4 Design Features and Design Bases

The design features and design bases of AAI facility systems, structures, and components (SSCs) important to safe operation and shutdown include:

Reactor Control System: The reactor control system consists of both shim/control rods and a regulating rod. The former are used to attain criticality, to compensate for fission product poisoning and fuel depletion, and to accomplish major changes of reactor power. The latter is used for the fine adjustment of reactor power. The four shim rods are connected to drive mechanisms by electromagnets. On a loss of electricity, all rods drop into the core under the influence of gravity. The reactor control system restricts reactivity insertion by permitting only one shim rod to be withdrawn at a time. All four rods can be driven in simultaneously to shut the reactor down. In an emergency, all four can be simultaneously dropped into the core.

Reflector Drain Capability: The contents of the heavy water reflector can be pumped to a holding tank. Loss of the reflector shuts the reactor down, so this capability is a backup shutdown mechanism.

Reactor Protection System: The reactor protection system consists of the nuclear safety systems. It monitors parameters that are important to safety including reactor power and duration, coolant outlet temperature and flow, and the core tank level. The system uses a one-out-of-two logic. Actuation of the protection system causes the shim rods electromagnets to de-energize, thereby dropping the four shim rods into the core.



Confinement: By virtue of a low-leakage building housing the reactors, any release of hazardous material is controlled. During normal operation, air is released through the ventilation and a stack. During abnormal operations or shutdown conditions, the confinement can be sealed regardless of the operability of the ventilation system.

AAI facility SSCs related to safe operation and shutdown of the facility are further addressed in Chapter 3, Section 3.5.

As part of this construction permit application, AAI is not requesting the NRC to approve of any specific design feature or specification per 50.35(b).

1.2.5 Potential Accidents at the Facility

Potential design basis accidents at the Meitner-1 facility were identified by the application of hazard analysis methodologies to evaluate the preliminary design of the facility and processes for potential hazards, initiating events, scenarios, and associated controls.

The following accident categories and initiating events are addressed for the VIPR:

- Insertion of excess reactivity
- Loss of coolant
- Loss of coolant flow
- Mishandling or malfunction of fuel
- Experiment malfunction
- Loss of normal electrical power
- External events
- Mishandling or malfunction of equipment

These credible events define the design bases that the Meitner-1 SSCs are designed and qualified to handle. These design bases are elaborated on in Chapter 3. SSCs which mitigate any potential release of radiological material as the result of a design basis accidents are discussed in Chapter 6.

The Maximum Hypothetical Accident (MHA) is a beyond design basis accident which bounds all of the credible design basis accidents listed above. For the VIPR, the MHA is a fuel assembly at a conservatively high burnup completely shearing in half. Both credible and incredible accidents are addressed in Chapter 13.

1.3 GENERAL DESCRIPTION OF THE FACILITY

This section includes a general discussion of the objectives, design criteria, operating characteristics, and safety considerations for the Meitner-1 facility and provides a general overview of the facility site and general facility arrangement. **Figure 1-1** shows the general arrangement of the reactor hall with the sizing of the main structures and details such as the locations of reactor pools, canal, control room, and major auxiliary equipment area. **Figure 1-2** and **Figure 1-3** provide elevation views. **Figure 1-4** shows the preliminary facility site plan. **Figure 1-5** is a preliminary architectural rendering of Meitner-1.

As there are no safety-related SSCs located outside of the area marked “50.51(a) construction” in **Figure 1-4**, AAI will be constructing those portions of the facility separately from the reactor area,



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-8

which, while integrated into the larger facility, does reside on its own foundation and structurally is a separate building.

The AAI construction permit application may mention activities involving byproduct material or special nuclear material as it pertains to reactor safety or how it interfaces with the reactor, however such details are limited. Specifically, “B” chapters as discussed in NUREG 1537 are not included at this time because AAI intends to submit information with respect to potential Part 70 activities, such as target production for Mo-99 generation, with the FSAR. While AAI is choosing to subsume this scope in the Part 50 License, the Part 70 activities are expected to involve less than critical mass of special nuclear materials; the exact processes and quantities will be provided in the FSAR.

In addition, AAI has engaged NRC Region IV to obtain a Part 30 material possession license for an existing facility and will conduct numerous material handling activities in the years leading up to the utilization facility commissioning. AAI anticipates extending this Part 30 license to parts of the Meitner facility not subject to the VIPR-specific SAR (Part 50 and 70). Accordingly, portions of the facility dedicated to material possession and isotope production as they pertain to Part 30, will not be subsumed in the Part 50 license. Consequently, activities pertaining to Part 30 are not mixed with activities pertaining to Part 70; by-products that fall under special nuclear material (SNM) category, are processed under Part 70.

As mentioned previously, this SAR covers four construction permits of different scope. The scope of these permit applications is outlined in **Figure 1-1**, highlighting the aforementioned initial license for the entire structure, all shared systems, and one reactor; the subsequent three reactors and their specific support systems will fall under their own respective licenses.



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-9



[

] SEC, ECI

Figure 1-1: General arrangement of facility



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-10

[

]SEC,ECI

Figure 1-2: Meitner-1 elevation drawing showing the control room



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-11

[

] SEC, ECI

Figure 1-3: Meitner-1 elevation drawing showing the reactor and used fuel pools



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-12

[

]SEC,ECI

Figure 1-4: Meitner-1 preliminary site plan



Figure 1-5: Meitner-1 preliminary architectural rendering

1.3.1 Facility Location

The Meitner-1 facility is proposed to be located in Bingham County, Idaho, at approximately

[

] ^{PROP}.

The INL was originally named the National Reactor Testing Station and has been home to dozens of prototypic, testing, and research reactors. AAI's proposed Meitner-1 site is approximately [

] ^{PROP} northwest of Highway 20. DOE-ID and AAI have a memorandum of understanding ([

] ^{PROP}) to cooperate on siting Meitner-1. The proposed site will be finalized with a land lease after the NRC concludes its environmental review. Post-lease, AAI will have authority over the site for access control, the regulatory jurisdiction will solely be with the NRC for all activities within the leased property.

1.3.2 Principal Characteristics of the Site

The proposed site for the Meitner-1 facility is on a 172-acre plot located in the southeast area of the INL desert site, just over 48 km (30 miles) west of Idaho Falls. The INL site is located in the Eastern Snake River Plain in southeastern Idaho. It extends 63 km (39 miles) from north to south and, at its broadest section, about 58 km (36 miles) from east to west. The INL Site is located along the northwestern edge of the Eastern Snake River Plain Physiographic Province. The landscape consists of relatively flat open plains interrupted by prominent volcanic buttes rising from the plains and surface



basalt flows near the southern boundary. Pastures, foothills, and farmlands border much of the INL Site, with agricultural activity concentrated in areas to the northeast. The Bitterroot, Lemhi, and Lost River Mountain ranges border the INL Site to the north and west. Approximately 94 percent of INL remains open and undeveloped. There are no residential dwellings on INL property.

Extensive information about the proposed Meitner-1 site near MFC on the INL is described in Chapter 2 of this SAR.

1.3.3 Principal Design Criteria, Operating Characteristics, and Safety Systems

1.3.3.1 Principal Design Criteria

10 CFR 50.34(a)(i) requires a facility design that provides reasonable assurance that any radiological release results in a dose less than 1 rem TEDE to an individual in an unrestricted area. This is typically accounted for via the facility design criteria. The design criteria for Meitner-1 and the methodology used to develop them are addressed in Chapter 3, Section 3.1. AAI's principal design criteria (PDC) are derived from the International Atomic Energy Agency's fundamental safety objective, which is to ultimately control the release of radionuclides to minimize the risk of ionizing radiation to the public and the environment. Individual criteria were built from the ground up, rather than derived from the General Design Criteria applicable to large power reactors, to ensure that they were commensurate with the simplicity, utilized technology, and inherent safety of the facility.

The four encompassing PDC for the Meitner-1 facility, for compliance with 10 CFR 50.34(a)(3)(i), are as follows:

1. Control of Reactivity
2. Removal of Heat
3. Confinement
4. Fire Protection

These PDC are detailed in Chapter 3, Section 3.1.1. The design bases of SSCs which prevent or mitigate accidents per each PDC are located in Chapter 3, Section 3.5.

1.3.3.2 Operating Characteristics

The VIPR has a highly compact core, comprised of []^{PROP,ECI} which roughly equals the effective fuel mass of a single []^{PROP,ECI} fuel assembly in a large power reactor. The fuel is enriched to []^{PROP,ECI} with a total of []^{PROP,ECI} of U-235 (heavy metal) per core, which is comparable to other, similarly small research reactors such as the PULSTAR or a FLIP TRIGA. Additionally, the VIPR fuel assemblies only undergo a modest average burnup of []^{PROP,ECI} compared to the average of 45 GWd/MTU that large power reactors undergo.

The VIPR will operate on a two-cycle shuffle, like that of a power reactor, whereby the half of the fuel in the core that has gone through a prior operating cycle will be positioned in the most reactive fuel positions in the core, or the "inner" positions. Fresh fuel will be placed in the corner grid positions of the reactor from where the once-burned fuel had been shuffled. The fuel in the center positions which



have gone through two operating cycles are discharged to the used fuel pool and is described in Chapter 9.

The average reactor operating cycle is approximately []^{PROP}, though this will vary based on materials placed in the core and reflector. A detailed description of the VIPR can be found in Chapter 4.

1.3.3.3 Safety Systems

Due to the robust design of the VIPR, very few active safety systems are required. These SSCs include (1) the reactor protection system, which is used to monitor both core neutronic performance and the status of the various process systems especially those associated with heat removal and (2) the reflector drain system, which acts as a backup for maintaining subcriticality in the event that additional negative reactivity is required to maintain a safe shutdown state during the VIPR's initial, all-fresh fueled operating cycle.

1.3.4 Engineered Safety Features

Engineered safety features (ESFs) are SSCs of the facility designed to mitigate the consequences of design basis accidents and are addressed in Chapter 6. The sole ESF incorporated into the design is the reactor confinement structure and its associated confinement systems.

Confinement systems refer to the low-leakage barriers and associated ventilation systems that contain radioactive materials released during normal operating and accident conditions. The principal design and safety objective of the confinement systems is to protect on-site personnel, the public, and the environment. The second design objective is to minimize reliance on administrative or complex active engineering controls to provide a confinement system that is as simple and fail-safe as reasonably possible.

The confinement systems are designed to localize release of radioactive material to controlled areas in normal operational states and mitigate the consequences of design basis accidents. Radiation protection control features such as adequate shielding and confinement ventilation minimize hazards associated with radioactive materials. The structure itself acts as a final confinement barrier. It is designed as a low-leakage structure to keep any contaminants that may be present in the building's atmosphere, ensuring it is first passed through the ventilation system.

The fuel cladding serves as the first barrier to the release of fission products. In the event of a cladding breach and subsequent radiological release, the reactor pool (including both the biological shield and the water) acts as the second barrier, passively retaining fission products and providing radiation shielding. The ventilation system filters serve as the third barrier, capturing airborne particulates and radioactive iodine. To address radioactive noble gases not retained by the pool or filters, effluents are discharged at high velocity through an exhaust stack to promote atmospheric dispersion.

1.3.5 Instrumentation, Control, and Electrical Systems

Instrumentation and Control (I&C) SSCs are designed to monitor and regulate variables and systems across the expected ranges for normal operations, anticipated operational occurrences, and accident conditions to ensure adequate safety. These variables and systems include those that influence the



fission process, protect the integrity of the reactor core, and support radioactivity confinement and its associated systems. Appropriate controls are provided to maintain these parameters within their prescribed operating limits.

The highest safety objective of the I&C architecture design is to protect against uncontrolled radiation release from unsafe reactor operation. I&C systems initiate protective actions to mitigate the consequences of design basis events via qualified SSCs. Such systems include, but are not limited to, the reactor protection system and the radiation monitoring and alarm system.

Inside Meitner-1, up to four VIPRs interface with multiple I&C systems which provide primary operator interfaces in the control room with secondary, backup interfaces throughout the facility. The control room operator interfaces provide a mix of analog displays and digital displays of facility process variables. The controls in the control room primarily allow the operator to manually control reactivity and scram the reactor(s). A description of the I&C system can be found in Chapter 7.

Meitner-1 has one common normal electrical supply system, which provides power to the reactors, material processing, auxiliary systems, and other support buildings. Power service is intended to be provided by Idaho Power.

Emergency electrical power for Meitner-1 is provided by a common emergency power system. An uninterruptible electrical power supply system is provided for the facility. This system consists of two independent trains, each consisting of a 250 volts-direct current battery system with associated charger, inverter, and distribution system. A standby diesel generator provides power for asset protection to selected loads in the event of a loss of off-site power. Emergency electrical power is not required for nuclear accident prevention, plays no role in nuclear safety, and is provided in the facility design for asset protection and continuity of operations. Electrical systems are described in Chapter 8.

1.3.6 Reactor Coolant and Other Auxiliary Systems

The reactor coolant system is comprised of a simple primary and secondary loop, connected via a heat exchanger. The primary loop consists of the reactor pool, a pump, and associated piping to form the loop. The secondary loop consists of a pump, industrial chiller, and a heat exchanger which interfaces with cooling towers on the roof of the auxiliary area of the facility. Systems which interface with the reactor coolant system include water purification and makeup, and a nitrogen-16 suppression system. The coolant system is described in Chapter 5.

1.3.7 Radioactive Waste Management and Radiation Protection

AAI will develop and implement a radiation protection program and a radioactive waste management program to protect the radiological health and safety of its workers, the public, and the environment. The program will comply with the regulatory requirements of 10 CFR Parts 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," 20, "Standards for Protection Against Radiation," and 70, "Domestic Licensing of Special Nuclear Material."

These programs include the elements of an as low as reasonably achievable (ALARA) program, radiation monitoring and surveying, exposure control, dosimetry, contamination control, environmental monitoring, radioactive waste management, and respiratory protection. These



programs are addressed in Chapter 11. SSCs used to implement these programs are described in Chapter 9.

1.4 SHARED FACILITIES AND EQUIPMENT

The Meitner-1 facility does not share any systems or equipment with facilities not covered by this SAR.

There are several SSCs, such as the facility-wide electrical system and the canal structure, which interface with multiple VIPRs and are shared. None of these systems play a role in nuclear safety, nor can cause a reactor accident in the event of failure. Conversely, an abnormal event within a VIPR cannot affect these shared systems nor propagate to other VIPRs.

1.5 COMPARISON WITH SIMILAR FACILITY DESIGNS

1.5.1 Comparison of Reactor Design

The VIPR design is most comparable to the North Carolina State University PULSTAR and the now-decommissioned Buffalo PULSTAR, which are both pool-type reactors and have a very similar fuel form. The reliable operation of the PULSTAR reactor confirms the proven inherent safety of this technology and design and supports the conclusion that no additional research or developmental testing will be required for the VIPR design. See **Table 1-1** for a side-by-side comparison of reactor parameters.

The information in Chapter 4 and Chapter 5 supports the FSAR Chapter 13 accident analysis and the ability of the AAI facility to ensure that fuel design limits are not exceeded in any postulated event and that a hypothesized fission product release does not exceed regulatory requirements for public doses.

Table 1-1: AAI comparison with similar facilities (reactor)

Parameter	VIPR	Buffalo ^(a)	PULSTAR ^(b)
Core Power (MWth)	15	5	1
Number of Fuel Assemblies	[] ^{PROP,ECI}	25	25
Number of Control Assemblies	4	3	3
Reactor (primary) Coolant Flow (gpm)	2662	2500	1000
Enrichment	[] ^{PROP,ECI}	6%	4%/6%

(a) IRM, 1993; (b) NC State University, 2019

1.5.1.1 Fuel System Design

The VIPR fuel assemblies are [

] ^{PROP,ECI} Their design considers effects such as fuel density changes, fission gas release, clad creep, and other physical properties which vary with burnup. As such, the VIPR uses a uranium dioxide, zircaloy-clad fuel assembly. The VIPR fuel assemblies are [

] ^{PROP,ECI} that have decades of operational experience over many plants. Atomic Alchemy takes a



similar approach to NuScale in this regard, []^{PROP,ECI} meet its operational requirements and leveraging well established engineering and licensing bases.

1.5.1.2 Reactor Safety Systems

The reactor protection system employed is similar to what is employed at research reactors of comparable power. A variety of redundant sensors and detectors are used to determine if the reactor is approaching an unsafe condition and preemptively shut down the reactor when certain setpoints are exceeded. The reactor protection system is the only system necessary to prevent core damage.

1.5.1.3 Engineered Safety Features

The ESFs of the reactor hall are similar to most other university research reactors. Confinement is the main barrier to uncontrolled release of radiological materials in an accident scenario, with the VIPRs located inside a confinement structure and all effluents forced to exit this structure through a stack.

The VIPR utilizes a large pool which allows for natural convection cooling in the event of a loss of power, or a large decontamination factor in the event of a fission product release.

1.5.1.4 Instrumentation and Control Systems

Instrumentation and control are conventional in nature and will be procured from commercial suppliers. In general, there are no unique features that warrant further discussion in this chapter. These systems are discussed primarily in Chapter 7 of this report.

1.5.1.5 Conduct of Experiments

Numerous NRC-licensed academic institutions and laboratories around the country have programs in place for the irradiation of experiments or the production of a wide range of radioisotopes. The AAI experiment program will be most comparable to the Missouri University Research Reactor (MURR), which routinely produces radioisotopes on a commercial basis and processes them within their own hot cell facility. AAI intends to have a similar type of program in place, with additional provisions to designate an additional class of irradiation targets for routine production as to differentiate them from experiments. The experimental program and additional concepts around routine production are described in Chapter 10.

1.6 SUMMARY OF OPERATIONS

As stated previously, the primary mission of the reactor is the production of radioisotopes which are used for the benefit of human life and technology advancement. The reactor(s) are intended to operate continuously with the exception of refueling. The material processing facility (not covered by this SAR) will manufacture a wide range of refined byproduct material. Activities within the reactor confinement hall do not constitute a production facility per the 10 CFR 50.2 definition.



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-19

Major operations to be performed in the Meitner-1 facility are as follows:

- Irradiation target fabrication
- Irradiation of targets in the VIPR(s)
- Transfer of irradiated targets through the reactor hall canal into the material processing facility
- Processing or isotope extraction from irradiated targets
- Recycling or disposal of leftover or processed material
- Packaging and shipment of isotope products

There are over 40 radionuclides with immediate commercial value that are able to be produced in the VIPR. AAI will employ a rigorous evaluation process per 10 CFR 50.59, “Changes, tests, and experiments” to review all new radioisotope production activities to ensure they are bounded by the FSAR or will be addressed as applicable by FSAR changes in accordance with regulatory requirements for such. Radioactive material handled in, and radioactive effluents that will be released from the Meitner-1 facility will meet applicable requirements of 10 CFR Part 20.

1.7 COMPLIANCE WITH THE NUCLEAR WASTE POLICY ACT OF 1982

Section 302(b)(1)(B) of the Nuclear Waste Policy Act of 1982 states that the NRC may require, as a precondition to issuing or renewing an operating license for a research or test reactor, that the applicant shall have entered into an agreement with DOE for the disposal of high-level radioactive wastes and spent nuclear fuel.

AAI is currently in the process of engaging in good faith negotiations with DOE to show compliance with Section 302(b)(1)(B) of the Nuclear Waste Policy Act of 1982. Proof of negotiations is submitted as Chapter 1, Appendix A and a formal agreement with the DOE will be provided in the FSAR.

1.8 FACILITY MODIFICATIONS AND HISTORY

This section is not applicable. This preliminary safety analysis report is part of the initial construction application for the Meitner-1 facility. As there are no existing facilities, there have been no modifications, and there is no history to report.

1.9 REFERENCES

House Committee on Energy and Commerce. 2024. “Bipartisan E & C Leaders Call on GAO to Review the DOE Isotope Program’s Work to Reduce Reliance on Russia.” Press release. October 2024. <https://energycommerce.house.gov/posts/bipartisan-e-and-c-leaders-call-on-gao-to-review-the-doe-isotope-program-s-work-to-reduce-reliance-on-russia>

Institute for Resource Management (IRM), Inc. 1993. “PULSTAR Fuel, Low Enrichment, Long Lifetime, Economical, Proven.”

LaGuardia, Thomas S., and Joseph E. Carignan. 2021. “Cintichem’s Research Reactor and Hot Cell Facility Decommissioning,” *Nuclear News*. (November 12) American Nuclear Society.



CHAPTER 1 THE FACILITY

AAI-PSAR-01 (NP)

Rev 0

Page 1-20

North Carolina State University. 2019. "PULSTAR Reactor Updated Safety Analysis Report," ADAMS Package Accession No. ML19221B601. (August 9) <https://www.nrc.gov/docs/ML1922/ML19221B601.pdf>

Nuclear Waste Policy Act of 1982 (NWPA), Pub. L. No. 97-425, 96 Stat. 2201.

University of Missouri. 2006. Missouri University Research Reactor (MURR), "License Renewal Application Safety Analysis Report," License No. R-103, Docket No. 50-186,(August 16) Columbia, MO.

1.10 APPENDICES

Chapter 1, Appendix A: Confirmation of Active and Good Faith Negotiations for Disposal Contracts for Meitner-1



**CHAPTER 1, APPENDIX A
CONFIRMATION OF ACTIVE AND GOOD FAITH
NEGOTIATIONS FOR DISPOSAL CONTRACT FOR
MEITNER-1**

**AAI-PSAR-01 (NP)
Rev 0**

Page 1-21

**APPENDIX A: CONFIRMATION OF ACTIVE
AND GOOD FAITH NEGOTIATIONS
FOR DISPOSAL CONTRACT FOR MEITNER-1**



CHAPTER 1, APPENDIX A
CONFIRMATION OF ACTIVE AND GOOD FAITH
NEGOTIATIONS FOR DISPOSAL CONTRACT FOR
MEITNER-1

AAI-PSAR-01 (NP)

Rev 0

Page 1-22



Department of Energy

Washington, DC 20585

November 20, 2023

VIA ELECTRONIC MAIL

Thomas Eiden
Founder & CEO
Atomic Alchemy, Inc.
855 N. Capital Ave., Ste #3
Idaho Falls, ID 83402-3405
thomas.eiden@atomicalchemy.us

Re: Confirmation of Active and Good Faith Negotiations for Disposal Contract for Meitner-1

Dear Mr. Eiden:

I am writing to affirm that Atomic Alchemy is actively and in good faith negotiating with the Secretary of Energy for a contract for the Meitner-1 reactor under section 302(b) of the Nuclear Waste Policy Act of 1982, as amended ("NWP").

Although section 302(b)(1)(A)(ii) of the NWP assigns to the Secretary of Energy the function of making the above affirmation, section 304(b) of the NWP further provides that the director of the Office of Civilian Radioactive Waste Management (OCRWM) "shall be responsible for carrying out the functions of the Secretary under [the NWP], subject to the general supervision of the Secretary." In 2010, OCRWM was closed and the functions relating to the Standard Contract were assigned to the Office of the General Counsel. Those functions were later assigned by the General Counsel to my office.

DOE is reviewing the issue of the appropriate contract mechanism and will be in contact for further discussions.

Sincerely,

/s/ Constance A. Barton

Constance A. Barton
Contracting Officer, Director
Office of Standard Contract Management
Office of the General Counsel