Enclosure 2 to AAL-2021-009

AA0-VIPR-PDC-01 (NP)

Atomic Alchemy Inc. Topical Report:

Atomic Alchemy NPUF Principal Design Criteria

Revision 1

Dated October 25, 2021

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ATOMIC ALCHEMY SYSTEM ACRONYM LIST

ACRONYM	SYSTEM DESCRIPTION
ASM	Administration and Service Module Building
CAS	Plant Compressed Air System
CGM	Combustible Gas Monitoring System
CHW	Chiller Evaporator Water System
CIS	Compressed Instrument Air System
CRD	Control Rod Drive Mechanism System
CRE	Control Room Emergency Habitability System
CRF	Control Room Emergency Ventilation and Filtration System
CRV	Control Room HVAC System
CRX	Control Room Re-Circulating Sensible Cooling/Heating System
CSA	Safety-related Compressed Instrument Air System
CVC	Chemical Volume and Control System and Subsystems
CWS	Chiller Condenser Water System
DGM	Diesel Generator Module Building
DHR	Reactor Decay Heat Removal System
EFS	Communication and Data Systems
EOM	Emergency Operations Center Module Building (offsite)
ERW	Rad-Worker Radiation Permit System (Dosimetry Control)
FDS	Equipment and Floor Drainage System (Non-Radioactive)
FHR	Fuel Handling and Refueling System
FPW	Fire Protection Water System
FSR	Fuel Storage Racks System
HCF	Miscellaneous Hot Cell Air Filtration Systems and Subsystems
IAM	Continuous Air Monitoring System
ICA	Criticality Area Detection and Alarm System
ICC	Hot Cell Criticality Detection System
ICR	Control Rod Drive Management System
IDA	Diverse Actuation System
IDD	Data Display and Processing System
IES	Engineered Safety Features System
IFP	Fire Protection System (Instrumentation)

IIC	In-Core Instrumentation System
IMS	Protection and Safety Monitoring System
IOC	Operation and Control System
IPA	Post-Accident Monitoring and Sampling System
IPC	Plant Control System
IQD	Qualified Data Processing System
IRM	Radiation Monitoring and Alarm System
IRP	Reactor Protection System
IRT	Reactor Trip System
ISM	Seismic Monitoring System
ISP	Safety Parameter Display System
LWP	Light-Water Pool System
MCF	$Molybdenum^{99}$ Hot Cell Air Filtration Systems
MHS	Material Handling System
MTM	$Molybdenum^{99}$ Target, Fabrication and Purification Module Building
NSS	NO_x Treatment System
PAS	Post Accident Sampling System
PCF	Pneumatic Capsule Room Air Filtration System
PMF	Radioisotope Production Process Module Air Filtration Systems
PPM	Radioisotope Production Process Module Building
PWS	Potable Water System
RAE	Reactor Auxiliary Module Cascade Exhaust System
RAM	Reactor Auxiliary Module Building
RAV	Reactor Auxiliary Module HVAC System
RCF	Reactor Confinement Air Filtration System
RCM	Reactor Confinement Module Building
RCS	Reactor Coolant System
RCV	Reactor Confinement Module HVAC System
RCX	Reactor Confinement Module Re-Circulating Sensible Cooling/Heating System
RGW	Radioactive Gaseous Waste Collection System and Sub-systems
RLC	Reactor Coolant/Light-Water Pool Leak Collection System
RLD	Reactor Coolant Piping Leak Monitoring and Detection System
RLW	Radioactive Liquid Waste Collection System
RSW	Radioactive Solid Waste Collection & Packaging System

RWM	Radwaste Processing & Handling Module Building
SFP	Spent Fuel Pool Cooling Water System
SSD	Sanitary Sewer Drain System
SWS	Service Water System
TPF	$Molybdenum^{99}$ Target Production & Processing Module Air Filtration System
TTW	$Molybdenum^{99}$ Target Transfer Light-Water Canal System
UPF	Class 1E DC and UPS Rooms Emergency Ventilation and Filtration Systems
VIPR	Versatile Isotope Production Reactor
WHF	Radwaste Processing & Handling Module Air Filtration system
WHV	Radwaste Processing & Handling Module HVAC System
ZAC	Main AC Power System
ZDC	DC and UPS System (non 1E)
ZIE	Class 1E Power Systems
ZOS	Onsite Stand-by AC Power System (non-safety diesel generators)

ABBREVIATION LIST

ABBREVIATION	DEFINITION
AOO	anticipated operational occurrence
ASME	American Society of Mechanical Engineers
BDC	Baseline Design Criteria (or Criterion, as applicable)
BPVC	boiler pressure vessel code
BTP	branch technical position
BWR	boiling water reactor
CFR	Code of Federal Regulations
DBE	design basis event
ECCS	emergency core cooling system
ESF	engineered safety feature
FSAR	Final Safety Analysis Report
GDC	General Design Criteria (or Criterion, as applicable)

IAEA	International Atomic Energy Agency
IAW	In accordance with
ISI/IST	inservice inspection/inservice testing
LCO	limiting condition for operation
LOLA	loss of large area
LOOP	loss of offsite Power
LWR	light-water reactor
MCR	Main Control Room
PDC	Principle Design Criteria (or Criterion, as applicable)
NRC	Nuclear Regulatory Commission
NPR	non-power reactor
NPUF	Non-power Production and Utilization Facility
PSAR	Preliminary Safety Analysis Report
PWR	pressurized water reactor
NFPA	National Fire Protection Association
QAPD	Quality Assurance Program Document
RG	regulatory guide
SAFDL	Specified Acceptable Fuel Design Limit
SAR	Safety Analysis Report
SER	Safety Evaluation Report
SREC	standard radiological effluent controls
SSC	structures, systems, and components
TMI	Three Mile Island
TR	topical report
UFSAR	Updated Final Safety Analysis Report
UPS	uninterruptible power supply
VIPR	Versatile Isotope Production Reactor

WCAP	Westinghouse Commercial Atomic Power
WG	water gauge

1.0 INTRODUCTION TO THE TOPICAL REPORT

Atomic Alchemy is pursuing the design, licensing, and construction of a Non-power Production and Utilization Facility (NPUF). Nuclear Regulatory Commission (NRC) Title 10 regulation 10 CFR 50.34(a)(3)(i) requires applicants for a construction permit to develop and include its Principal Design Criteria (PDC) in its application. Title 10, Part 50, Appendix A, provides the General Design Criteria (GDC) that establishes the minimum requirements for PDC for nuclear power light-water reactors (LWRs). NUREG-1537 Part 2, Section 3.5b, states that meeting the minimum requirements for PDC of 10 CFR 70.64 would be acceptable for radioisotope production facilities under a 10 CFR Part 50 license. The staff, however, has not established minimum requirements for PDC for a Non-Power Reactor (NPR) of a NPUF.

The primary objective of this Topical Report (TR) is to describe the Atomic Alchemy PDC for safety-related structures, systems, and components (SSC) for its entire NPUF as well as the preliminary design approach to Atomic Alchemy's implementation and compliance of the PDC requirements. The demonstration that Atomic Alchemy design satisfies these PDC will be provided with either the construction and/or operating license application documents as required to be submitted under 10 CFR 50.

Another objective of this Topical Report is to provide the NRC with another component of Atomic Alchemy's preliminary regulatory GAP analysis[1] with respect to 10 CFR 50 Appendix A General Design Criterion. Atomic Alchemy is presently performing a detailed review of existing LWR-based regulations and guidance for applicability and technical relevance to the Atomic Alchemy's NPR/NPUF plant design. The overall purpose of the GAP analysis is to identify existing LWR-based regulations and guidance that are not technically relevant and thus would be inappropriate to apply to the Atomic Alchemy NPUF design specifically due to design characteristics, functions, and capabilities unique to the Atomic Alchemy facility.

2.0 ATOMIC ALCHEMY PDC DEVELOPMENT METHODOLOGY

The starting point for the Atomic Alchemy development of its PDC was both the 10 CFR Part 50 Appendix A GDC, and the 10 CFR Part 70.64 Baseline Design Criteria (BDC). The 10 CFR Part 50 Appendix A GDC presents an established basis and has served as a key regulatory element that has provided the NRC with reasonable assurance of the safety of the design of light-water power reactors for decades.

Atomic Alchemy conducted a thorough analysis of the 10 CFR Part 50 Appendix A GDC as part of a regulatory GAP analysis and to establish guidance in developing the basis of the Atomic Alchemy PDC because of the numerous similarities in LWR technology. Similarly, an analysis of the 10 CFR Part 70.64 BDC was also conducted as part of the regulatory GAP analysis and to augment the radioisotope production process portion for the facility's PDC. Some of the Atomic Alchemy NPUF reactor design features are deemed to be significantly different in specific areas from those general design features considered when the 10 CFR Part 50, Appendix A GDC for nuclear power plants were formulated.

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[1] The final Atomic Alchemy Gap Analysis results will be subdivided into Appendices in FSAR Chapter 1 and Chapter 3, with an overall summary in Chapter 1 Appendix G, there will be separate appendices for NUREG-0800, NUREG-1537 Part 2, NUREG-0737, NUREG-0933, and 10 CFR 50 Appendix A.

Additionally, the strict adherence to the light-water nuclear power plant criteria is not warranted and should not be considered necessary by the staff in conforming to NUREG-1537 requirements. Less stringent and less prescriptive measures will still provide equivalent protection to the health and safety of the public due to the lower level of risk presented by an NPR.

While every 10 CFR Part 50 Appendix A criterion may not be directly applicable to the key design features of an NPUF, the 10 CFR Part 50 Appendix A criteria can serve as the referenced framework for the NPUF design. Therefore, it can provide the same reasonable safety assurances to the NRC for the health and safety of the public for the Atomic Alchemy NPUF while also demonstrating compliance to applicable Title 10 regulations.

A conservative engineering judgement was made to determine which 10 CFR Part 50 Appendix A GDC could be adopted directly and which require modifications, either due to the nature of the Atomic Alchemy NPR design variation from a power reactor design or because the difference in the level of risk and challenges to the NPR system and its respective components' safety limits are significantly less than would be encountered for either a PWR or BWR design.

Atomic Alchemy used the 10 CFR Part 50 Appendix A GDC as guidance in developing the basis for establishing its NPUF PDC to meet the regulatory requirements of 10 CFR 50.34(a)(3) as incorporated by reference in NUREG-1537 Part 1, Appendix A.

Atomic Alchemy contends that the design criterion requirements for its radioisotope production process portions of its facility (as promulgated in 10 CFR Part 70.64 BDC) can essentially be bounded by the 10 CFR Part 50 Appendix A GDC. In instances where they are not directly bounded, Atomic Alchemy modifies the 10 CFR Part 50 Appendix A GDC to include the scope of the missing elements of 10 CFR Part 70.64 BDC. Likewise, the 10 CFR Part 50 Appendix A GDC have also been applied (and the scope subsequently expanded or modified as necessary) to encompass the applicable design features and characteristics of the radioisotope production process, target fabrication process, and radwaste processes as determined by the Atomic Alchemy engineering review.

2.1 SUMMARY OF THE COMPARATIVE ANALYSIS

A comprehensive review was conducted to ensure that all design basis[2] features and characteristics of the Atomic Alchemy facility were addressed in the development of its PDC.

Atomic Alchemy has determined to adopt eleven of the 10 CFR Part 50, Appendix A GDC directly as written into their PDC. Another thirty-nine of the 10 CFR Part 50, Appendix A GDC have been modified to either:

a. better suit the distinctive design features and characteristics of the NPUF;
b. incorporate additional 10 CFR Part 70 BDC elements;
c. expand the scope of the GDC requirements to be applicable to elements of the design basis features and characteristics of the radioisotope-related systems and processes; or

[2] The Atomic Alchemy NPUF design basis is derived from the Atomic Alchemy Facility Requirements Document (FRD) (similar in concept to a power reactor's Utilities Requirements Document (URD)) which initially develops high level key design centric, technology centric, and mission centric attributes for systems and components along with establishing design objectives, performance requirements, regulatory/statutory requirements, design constraints, and design interfaces. Conceptual system and component functional attributes are then further refined into design and licensing basis input documents which provide traceability between regulatory requirements and physical system and component designs.

d. reduce the restrictiveness of the scope of the GDC language due to reduced levels of risk and challenges to NPUF system and components' safety limits.

The modified GDC sections are considered a departure from the original GDC. Three of the 10 CFR Part 50, Appendix A GDC were determined not to be applicable to any of the NPUF design characteristics as those systems and components do not exist in the NPUF design and therefore were not included in the Atomic Alchemy PDC.

2.2 ADDITIONAL PDC DEVELOPMENT

Since the Atomic Alchemy reactors are of a light-water design, any principal design features and characteristics have been presumed to be captured under the 10 CFR Part 50 Appendix A, GDC. The comparative analysis performed by Atomic Alchemy engineering confirmed that there are no current design attributes in the VIPR design or Radioisotope Production Processes' design that have not been addressed by the selected set of PDC that are based on both the 10 CFR Part 50, Appendix A, GDC and 10 CFR Part 70 BDC. As detailed design proceeds, should fundamental changes occur to key design features or characteristics that are not bounded by the present Atomic Alchemy PDC or should new or revised NRC regulations be established in NUREG-1537 that might affect the PDC for the Atomic Alchemy facility, such changes would be resolved and addressed in the construction license application. To re-emphasize, there are some design features and characteristics of the radioisotope production process, target fabrication process, and radwaste process that have been determined to be included in the Atomic Alchemy PDC that were derived from original 10 CFR Part 50 Appendix A Criterion.

2.3 CONCLUSIONS

Atomic Alchemy performed a methodical review of its NPUF design. The design includes four non-power reactors constructed in phases on a single NPUF site, along with two Radioisotope Production Process facilities and their respective supporting modular buildings. Both 10 CFR 50 Appendix A, and 10 CFR 70.64 were comparatively reviewed against this NPUF design. Subsequently, a set of 50 PDC were developed to meet the safety objectives of 10 CFR 50.34(a)(3)(i). The Atomic Alchemy PDC are summarized in Table 2.3-01. They are presented in this table in sections that are consistent with formatting of 10 CFR Part 50 Appendix A.

3.0 ATOMIC ALCHEMY TOPICAL REPORT FORMAT DESCRIPTION

The Atomic Alchemy PDC are based on Title 10, Part 50, Appendix A. As presented in Appendix A of this TR, the Atomic Alchemy Principal Design Criterion is first quoted and then the means of Atomic Alchemy intended compliance is discussed. Notation is made where the 10 CFR Part 50 Appendix A criterion has been conservatively determined to bound the respective criterion of a comparable 10 CFR Part 70 BDC.

In instances where Atomic Alchemy does not directly adopt the specific language of 10 CFR Part 50 Appendix A GDC "as is" and has determined a modification to the language or less stringent language is warranted due to the nature of a NPUF design feature, the Atomic Alchemy departure version of the Atomic Alchemy PDC language is presented directly below the original 10 CFR Part 50 Appendix A GDC language. Justification[3] for the departure follows with a discussion of the means of intended compliance for the departure version.

Where additional information may be needed for a complete discussion, the appropriate corresponding SAR sections or compliance with relevant applicable Regulatory Guides are also referenced.

[3] The justification also includes the evaluation and determination component of the regulatory GAP analysis.

Table 2.3-1 Atomic Alchemy Principal Design Criteria Categorization

ATOMIC ALCHEMY PRINCIPAL DESIGN CRITERIA		
I. Overall Requirements	Quality Standards and Records	Criterion 1
	Design Bases for Protection Against Natural Phenomena	Criterion 2
	Fire Protection	Criterion 3
	Environmental and Dynamic Effects Design Bases	Criterion 4
	Sharing of Structures, Systems, and Components	Criterion 5
II. Protection by Multiple Fission Product Barriers	Reactor Design	Criterion 10
	Reactor inherent Protection	Criterion 11
	Suppression of Reactor Power Oscillations	Criterion 12
	Instrumentation and Control	Criterion 13
	Reactor Coolant Boundary	Criterion 14
	Reactor Coolant System Design	Criterion 15
	Confinement Design	Criterion 16
	Electric Power Systems	Criterion 17
	Inspection and Testing of Electric Power Systems	Criterion 18
	Control Room	Criterion 19
	Protection System Functions	Criterion 20
	Protection System Reliability and Testability	Criterion 21

III. Protection and Reactivity Control Systems	Protection System Independence	Criterion 22
	Protection System Failure Modes	Criterion 23
	Separation of Protection and Control Systems	Criterion 24
	Protection System Requirements for Reactivity Control Malfunctions	Criterion 25
	Reactivity Control System Redundancy and Capability	Criterion 26
	Reactivity Control System Capability	Criterion 27
	Reactivity Limits	Criterion 28
	Protection Against Anticipated Operational Occurrences	Criterion 29
IV. Fluid Systems	Quality of Reactor Coolant Boundary	Criterion 30
	Fracture Prevention of Reactor Coolant Boundary	Criterion 31
	Inspection of Reactor Coolant Boundary	Criterion 32
	Reactor Coolant Makeup	Criterion 33
	Residual Heat Removal	Criterion 34
	Decay Heat Removal Cooling	Criterion 35
	Inspection of Decay Heat Removal Cooling System	Criterion 36
	Testing of Decay Heat Removal Cooling System	Criterion 37
	Confinement Heat Removal	Criterion 38
	Inspection of Confinement Heat Removal System	Criterion 39

	Testing of Confinement Heat Removal System	Criterion 40
	Confinement Module Atmosphere Cleanup	Criterion 41
	Inspection of Confinement Module Atmosphere Cleanup Systems	Criterion 42
	Testing of Confinement Module Atmosphere Cleanup Systems	Criterion 43
V. Reactor and Radioisotope Production Confinement	Confinement Design Basis	Criterion 50
	Fracture Prevention of Confinement Boundary	Criterion 51
	Capability for Confinement Leakage Rate Testing	Criterion 52
	Provisions for Confinement Testing and Inspection	Criterion 53
	Systems Penetrating Reactor Confinement	Criterion 54
	Reactor Coolant Boundary Penetrating Reactor Confinement	Criterion 55
	Reactor Confinement Isolation	Criterion 56
	Closed Systems Isolation Valves	Criterion 57
VI. Fuel, SNM, and Radioactivity Control	Control of Releases of Radioactive Materials to the Environment	Criterion 60
	Fuel Storage and Handling and Radioactivity Control	Criterion 61
	Prevention of Criticality in the NPUF Facility	Criterion 62
	Monitoring Fuel, SNM and Waste Storage	Criterion 63
	Monitoring Radioactivity Releases	Criterion 64

APPENDIX A – THE ATOMIC ALCHEMY PRINCIPAL DESIGN CRITERIA[4]

A-1.0 GDC CRITERION 1 – QUALITY STANDARDS AND RECORDS

Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified, as necessary, to assure a quality product, in keeping with the required safety function.

A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

A-1.1 PDC CRITERION 1 DEPARTURE – QUALITY STANDARDS AND RECORDS

Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified, as necessary, to assure a quality product, in keeping with the required safety function.

A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the NPUF facility licensee throughout the life of the facility.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 1 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy modifies the distinction between nuclear power and nuclear non-power facilities.

Atomic Alchemy Compliance

The Quality Assurance Program for the Atomic Alchemy facility provides confidence that safety-related items and services are designed, procured, fabricated, inspected, and tested to quality standards commensurate with the safety-related functions to be performed. Design, procurement, fabrication,

[4] A modified version of this Topical Report Appendix A will be included in the SAR in Chapter 3 as Appendix F. The departure justifications will comprise the regulatory GAP analysis component.

inspection, and testing are performed according to recognized codes, standards, and design criteria that comply with the requirements of 10 CFR 50.55a.

The Atomic Alchemy Versatile Isotope Production Reactor (VIPR) modular design features four non-power VIPRs, each located in their own respective light-water cooled pool and operate at ambient atmospheric pressure. In the passively safe, modular Atomic Alchemy VIPR design, systems necessary to provide the reactor coolant boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, and the capability to prevent or mitigate the consequences of transients that could result in potential offsite exposures comparable to the guideline exposures of 10 CFR 50.34, are designated as safety systems. Additionally, for simplicity, items relied on for safety (IROFS) as defined in 10 CFR 70.65(b)(4), 10 CFR 70.61(b) and 10 CFR 70.61(c) are also identified as "safety-related" and covered by Atomic Alchemy's Quality Assurance Program Description (QAPD).

Appropriate records documenting that design, procurement, fabrication, inspection, and testing comply with the applicable codes, standards, and design criteria are maintained according to appropriate, applicable laws and NRC regulations. Atomic Alchemy Technical Specification (TS) Section 5.8 will describe the records showing that the design was properly accomplished. It will also include not only the final design output and revisions to the final design output but will also include the important design steps (e.g., calculations, tests, inspections, materials, qualifications, analyses, design basis inputs, and computer programs), and the sources of input that support the final output.

Atomic Alchemy FSAR Chapter 3, Section 2 will describe the PDC, design bases, codes, and standards applied to the facility.

The Atomic Alchemy QAPD was submitted as Topical Report (TR) AA0-VIPR-20-QAPD(P) Rev. 0 to the NRC in Atomic Alchemy letter number AAL-2020-003 Agencywide Documents Access and Management System (ADAMS) Accession No. ML20290A978) dated October 16, 2020. The Atomic Alchemy QAPD conforms to ASME NQA-1-2017, ASME NEQ-1-2017, and ASME BPVC Section III, 2017.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(1).

A-2.0 PDC CRITERION 2 – DESIGN BASES FOR PROTECTION AGAINST NATURAL PHENOMENA

Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without the loss of the capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed.

Atomic Alchemy Position

Atomic Alchemy adopts the language of the 10 CFR 50 Appendix A GDC 2 with no modifications.

Atomic Alchemy Compliance

The safety-related SSC that are vital to mitigating effects of transients and providing shutdown capability to the reactor and to the radioisotope production processes, are designed to withstand the maximum probable natural phenomena at the Atomic Alchemy NPUF site without loss of the capability to perform their safety-related functions. Seismic and quality group classifications are conservatively applied to SSC related to safety. Atomic Alchemy's FSAR Chapter 15 will identify the coincident, conservative site conditions for each postulated transient. Appropriate combinations of structural loadings from transients, normal operation, and environmental phenomena are accounted for in the facility design.

FSAR Chapter 1, Appendix B, Section 2 will describe Atomic Alchemy's compliance with Site Characteristics.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(2).

A-3.0 GDC CRITERION 3 – FIRE PROTECTION

Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat-resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.

A-3.1 PDC CRITERION 3 DEPARTURE – FIRE PROTECTION

Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat-resistant materials shall be used wherever practical throughout the NPUF Facility, particularly in locations such as the reactor confinement modules and control room. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the capability of these safety-related structures, systems, and components.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 3 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for departure from 10 CFR 50 Appendix A GDC 3 criterion with respect to re-defining the containment boundary, is addressed in PDC 16.

Atomic Alchemy Compliance

The safety-related structures, systems, and components are designed to minimize the probability and effect of fires and explosions. Noncombustible and fire-resistant materials are used on components of safety-related systems, and elsewhere in the facility where fire is a potential risk to safety-related systems. Firefighting systems are designed such that their rupture or inadvertent operation will not prevent any safety-related systems from performing their design functions.

Atomic Alchemy will perform a Fire Hazards Analysis of each area within the facility. FSAR Chapter 9, Appendix A will describe Atomic Alchemy's fire protection program and fire hazards analysis. The Atomic Alchemy Fire Protection Program will comply with BTP CMEB 9.5-1 and the following industry guidance:

a. NFPA 4 – "Organization for Fire Services"
b. NFPA 4A – "Organization of a Fire Department"
c. NFPA 6 – "Industrial Fire Loss Prevention"
d. NFPA 7 – "Management of Fire Emergencies"
e. NFPA 8 – "Management Responsibilities for Effects of Fire on Operations"
f. NFPA 27 – "Private Fire Brigades"
g. NFPA 101,"Life Safety Code."
h. NFPA 802 – "Recommended Fire Protection Practice for Nuclear Reactors."
i. NFPA 801 – "Standard for Fire Protection for Facilities Handling Radioactive Materials"

The Fire Hazard Analysis will be provided in FSAR Chapter 9, Appendix A. It will also evaluate the loss of large area (LOLA) of the facility due to fires or explosions.

Fires will also be analyzed in FSAR Chapter 15 and in FSAR Chapter 1, Appendix F, "Non-power Reactors on Multi-unit Sites", for related fire hazards caused by construction activities.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.78, 1.101, 1.120, 1.189, and Regulatory Guide1.205.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(3).

A-4.0 GDC CRITERION 4 – ENVIRONMENTAL AND MISSILE DESIGN BASES

Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

A-4.1 PDC CRITERION 4 DEPARTURE– ENVIRONMENTAL AND MISSILE DESIGN BASES

Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated transients, including loss-of-coolant transients. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the NPUF. However, dynamic effects associated with postulated pipe ruptures in NPUF facilities may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 4 as presented in this PDC Departure.

Atomic Alchemy Departure

As a conservatism, Atomic Alchemy will apply PDC 4 to the radioisotope production process module, target fabrication module, and radwaste module buildings as they each may present a potential for a release of radioactive products to the environment following postulated environmental, equipment and/or piping missile transients described in the FSAR Chapter 15 accident analysis.

The Atomic Alchemy Versatile Isotope Production Reactor (VIPR) is a design akin to a university research/test reactor and differs greatly from that of a power reactor. For example, internal missiles generated from turbine blades do not exist in the design basis event analysis of a non-power reactor. Because the reactors are located within light-water pools open to the atmosphere the probability of fluid systems piping over pressurization and rupture of the RCS system is also not credible design basis event scenarios.

Atomic Alchemy will adopt into its PDC 4, the NRC’s position promulgated in GDC 4 with respect to allowing the use of analyses to eliminate from the design basis the dynamic effects of pipe ruptures.

Atomic Alchemy Compliance

Safety-related structures, systems, and components are designed to accommodate the effects of both interior and exterior generated missiles. Protection from external missiles, including those generated by natural phenomena, is provided by the external walls and roof of the Seismic Category I module building structures. Details of the design features and construction of these structures, systems, and components to protect against these effects are described in FSAR Chapter 3, Section 6, and Section 8. The analysis of the postulated events is discussed in FSAR Chapter 15, Section 6 Reactor Accidents and Section 8, Radioisotope Production Process Accidents.

The dynamic effects of postulated pipe ruptures and pipe whip are minimized based on the application of the leak-before-break approach to safety-related ASME Class 1 and 2 piping.

Atomic Alchemy high energy and moderate energy piping located outside of the reactor confinement module building will also be analyzed for breaks. A pipe break hazards evaluation will be part of the

Atomic Alchemy piping design. The evaluation will be performed for high and moderate energy piping to confirm the protection of SSC which are required to be functional during and following a design basis event.

The NPUF reactor modules will be constructed in phases. In FSAR Chapter 1, Appendix F, "Non-power Reactors on Multi-unit Sites", missiles created from on-going construction activities or from environmental conditions that could impact construction activities will also be analyzed.

The Atomic Alchemy VIPR has been designed to be passively safe; it will have the capability to be shut down and maintain a safe shutdown condition and the capability to prevent or mitigate the consequences of transients that could result in potential offsite exposures comparable to the guideline exposures of 10 CFR 50.34 without the use of any active systems.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.76, 1.115, 1.117, and Regulatory Guide 1.221.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(4).

A-5.0 GDC CRITERION 5 – SHARING OF STRUCTURES, SYSTEMS, AND COMPONENTS

Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit.

A-5.1 PDC CRITERION 5 DEPARTURE – SHARING OF STRUCTURES, SYSTEMS, AND COMPONENTS

Structures, systems, and components important to safety shall not be shared among the nuclear non-power reactor units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of a transient in the NPUF facility, an orderly shutdown and cooldown of the remaining non-power reactor units as well as an orderly shutdown of the remaining radioisotope related processes as deemed necessary by control room operators.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 5 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy does not interpret the 10 CFR Part 50, Appendix A criterion 5 to be applicable to non-reactor structures, systems, and components. This is in line with the guidance Section 7.1 of IEEE Std. 308-2001[5].

[5] The NRC does not endorse this IEEE standard for the sharing of DC power in multi-unit sites in Regulatory Guides 1.32 and 1.81. However, it is Atomic Alchemy's position this non-endorsement of the standard is only applicable to sharing of DC power for the safe shutdown of reactors and not to systems required to safely shutdown non-reactor radioisotope processes.

Atomic Alchemy does not intend to apply the 10 CFR 50 Appendix A, GDC 5 criterion to the radioisotope production process related SSCs (e.g., the SSCs located in the radioisotope production process module, radwaste module, or target fabrication module) all of which may share additional SSC's that perform safety-related functions. These shared systems will be designed with conservative assumptions in considering the potential for radioactive releases and include redundancy and isolation design features for out of service and testing, which will prevent the uncontrolled release of radioactivity to the environment.

Atomic Alchemy expands the scope of the PDC 5 language to include the capability of shutting down both non-power reactors and radioisotope related processes following a significant transient in either.

Atomic Alchemy Compliance

The VIPR light-water pool (which also contains each reactor's spent fuel) shares a common light-water radioisotope transfer canal (TTW) system with one other VIPR light-water pool. The TTW system has been conservatively design (though this function has been preliminarily determined to not be necessary) to also functions as an "emergency core cooling" type of system, identified as the reactor decay heat removal system (DHR) which is an additional source of water for the reactor light-water pools. The sharing of this DHR makeup water does not impair the capability of either reactor safety-related systems to perform their intended safety functions.

The volume of water stored in the light-water transfer canal pool will be sufficient for the decay heat removal for each of the two (2) reactor pools it serves, for 72 hours should it ever be necessary. After 72 hours the volume of water remaining in the two (2) reactor light-water pools are capable of dissipating decay heat of both the reactor and the spent fuel located within the light-water pool for 30 days. Even without the DHR system the light-water pools are alone, capable of dissipating decay heat from the core during the first 72 hours following a postulated transient, and subsequently 30 days afterwards.

The Atomic Alchemy facility shares the 1E DC UPS systems between radioisotope, target fabrication, and radwaste processes (See GDC 17, and Atomic Alchemy compliance with Regulatory Guide 1.81 position C.3 in FSAR Chapter 1, Appendix A). Each reactor has its own dedicated 1E DC UPS system.

With this one exception (the Light-water Radioisotope Transfer Canal), only non-safety-related systems may be shared between the reactors, and their respective module buildings. Although non-safety-related, the shared systems will be designed for operational reliability and availability to minimize restrictions on VIPR operating configurations during normal modes of operation. The non-safety-related shared systems will include design features such as redundancy, spare capacity, isolation, and consideration of system interfaces. These features minimize the effects of reactor out-of-service and testing configurations in order to allow continued full-power operation of the other reactors.

Atomic Alchemy will determine which non-safety-related shared VIPR structures, systems and components should fall within the scope of its 10 CFR 50.65(b) program.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy compliance with Regulatory Guides 1.26, 1.27 and 1.81.

A-10.0 PDC CRITERION 10 – REACTOR DESIGN

The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

Atomic Alchemy Position

Atomic Alchemy adopts the language of the 10 CFR 50 Appendix A GDC 10 with no modifications.

Atomic Alchemy Compliance

The information in FSAR Chapters 4a and Chapter 5 will support the FSAR Chapter 15 accident analysis and the ability of the Atomic Alchemy facility to ensure that fuel design limits are not exceeded during Condition I and II events[6], to safely provide adequate cooling for Condition III events, and that the core remains intact with acceptable heat transfer geometry following condition IV events. The reactor protection system will be designed to actuate a reactor trip whenever necessary to prevent exceeding the fuel design limits.

Specified Acceptable Fuel Design Limits (SAFDL) will be provided in Atomic Alchemy FSAR Chapter 15, Table 15.7-03.

FSAR Chapter 4a, Reactor Description, will describe the design of the mechanical components of the reactor and reactor core, including the fuel rods and fuel assemblies, the mechanical design, nuclear design, and the thermal hydraulic design.

FSAR Chapter 5, Reactor Coolant System, will describe the design of the mechanical components of the coolant system.

FSAR Chapter 7 Instrument and Control Systems, will describe the safe shutdown methods as follows:

a. Safe shutdown using safety-related systems.
b. Safe shutdown using safety-related and non-safety-related systems.
c. Safe shutdown using non-safety-related systems.
d. Safe shutdown from outside the main control room, (e.g., remote shutdown room), controls at other locations (e.g., MCC, electrical switchgear rooms, and technical support center workstation).

FSAR Chapter 15, Section 2 will provide a description of anticipated operational occurrences that will be considered in the accident analysis for the VIPRs.

FSAR Chapter 1, Appendix A, Atomic Alchemy compliance with Regulatory Guides 1.53, 1.68, 1.77, 1.83, 1.93, 1.97, 1.105, 1.126, 1.157, 1.195, and 1.196.

[6] ANSI 18.2 "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants" was superseded by ANS 51.1, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants" which was subsequently withdrawn. Atomic Alchemy, however, continues to use the standard to define Condition I, II, III, and IV transients throughout the SAR per Regulatory Guide 1.70.

A-11.0 PDC CRITERION 11 – REACTOR INHERENT PROTECTION

The reactor core and associated coolant systems shall be designed so that in the power-operating range the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity.

Atomic Alchemy Position

Atomic Alchemy adopts the language of the 10 CFR 50 Appendix A GDC 11 with no modifications.

Atomic Alchemy Compliance

The negative fuel temperature reactivity effects provide prompt reactivity feedback to compensate for a rapid, uncontrolled reactivity excursion. The negative Doppler coefficient of reactivity is provided by the use of a low-enrichment fuel design. This Doppler feedback is the primary reactivity feedback mechanism to provide the inherent core reactivity protection during rapid core reactivity excursions. FSAR Chapter 4a, Section 2, “Reactor Core and Fuel Design,” will describe the Atomic Alchemy VIPR core design.

A-12.0 PDC CRITERION 12 – SUPPRESSION OF REACTOR POWER OSCILLATIONS

The reactor core and associated coolant, control, and protection systems shall be designed to assure that power oscillations which can result in conditions exceeding specified acceptable fuel design limits are not possible or can be reliably and readily detected and suppressed.

Atomic Alchemy Position

Atomic Alchemy adopts the language of the 10 CFR 50 Appendix A GDC 12 with no modifications.

Atomic Alchemy Compliance

Oscillations of the total power output of the core, from whatever cause, are readily detected by the nuclear instrumentation. The Atomic Alchemy reactor core is small enough so that oscillations due to spatial xenon effects are not credible transients. The monitoring system processes information provided by the fixed in-core detectors and in-core thermocouples. A reactor trip occurs if power increases unacceptably, thereby preserving the design margins to fuel design limits.

Confidence that fuel design limits are not exceeded is provided by reactor protection system overpower and overtemperature trip functions. FSAR Chapter 4a, Section 2, “Reactor Core and Fuel Design,” will describe the Atomic Alchemy VIPR design. Details of the instrumentation design and logic will be described in FSAR Chapter 7, Sections 4, 5, and 6 (“Reactor Power Control”, “Reactor Protection System” and “Reactor Trip System” respectively).

A-13.0 GDC CRITERION 13 – INSTRUMENTATION AND CONTROL

Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

A-13.1 PDC CRITERION 13 DEPARTURE – INSTRUMENTATION AND CONTROL

Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the reactor and radioisotope-related processes, the integrity of the reactor core, the spent fuel, the reactor coolant boundary, and the confinement boundaries and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 13 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the reactor coolant pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to re-defining a pressure boundary is addressed in PDC 14.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy expands the scope of the applicability of PDC 13 to all applicable safety-related processes of its NPUF.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements' phases of the I&C Design Process. As of the time of this TR issuance, Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design conformance with respect to GDC 13.

The Westinghouse Common Qualified (Common Q) platform modified[7] for an NPUF is planned to be the basis of the Atomic Alchemy I&C Architecture. The standard Common Q platform is defined in Topical Report WCAP-16097, which was approved by the NRC. Instrumentation and controls are provided to monitor and/or control such parameters as: neutron flux (source, intermediate, power), neutron flux differences, thermal power, reactor coolant pump bearing water temperature, water level

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[7] Atomic Alchemy intends to base its I&C architecture on the Westinghouse Common Qualified (Common Q) platform. It is a computer system consisting of a set of commercial-grade hardware and previously developed software components dedicated and safety-related qualified for use in nuclear power plants. Since the number of safety-related systems in a non-power, <20 MW reactor are substantially less than those required in a 1500 MW power reactor, and since the challenges to these systems are also not as severe, the overall Atomic Alchemy Common Q I&C architecture will be modified to suit these differences while maintaining the same NRC approved system design elements.

The Westinghouse Common Q Platform consists of the following Class 1E major building blocks that can be used to design any specific safety-related system: Advant Controller 160 (AC160) with PM646 Processor Module, S600 Input and Output Modules, Flat Panel Display System for human-machine interface consisting of the MTP, Safety/QDPS display and Operators Module, Component Interface Module (CIM), Termination Units, and Cabinets.

in the confinement pool, reactor coolant flow, speed of either reactor coolant pump, cold leg temperature (T-cold), hot leg temperature (T-hot), status of each manual reactor trip control, reactor core cooling, core pool inventory, radioisotope transfer pool inventory, core pool temperature, transfer canal pool temperature, N16 quantity and levels, etc. to maintain the VIPR in a safe mode of operation.

Following the standard Common Q Platform I&C architectural design, Atomic Alchemy provides a similar Protection and Safety Monitoring System (IMS) which consists of four redundant divisions, designated A, B, C, and D. The Atomic Alchemy IMS system will be based on a modified for NPUF Common Q design I&C architecture similar to what was submitted to the NRC as WCAP-16675-NP, “AP1000 Protection and Safety Monitoring System Architecture Technical Report”. The Atomic Alchemy IMS performs the necessary safety-related signal acquisition, calculations, setpoint comparison, coincidence logic, automatic reactor trip/ESF actuation functions, and automatic component control functions to achieve and maintain the facility in a safe shutdown condition. The IMS provides signal conditioning, communications, and display functions for Regulatory Guide 1.97 Category I variables and for Category 2 variables that are energized from Class 1E power supply systems. The Atomic Alchemy Protection and Safety Monitoring System (IMS) is actuated when safety system setpoints are reached for selected reactor parameters.

In the event of a postulated common mode failure of the IMS system, certain ESF functions can be actuated though diverse means. Following the standard Common Q I&C architectural design, Atomic Alchemy employs a similar Diverse Actuation System, (IDA). The IDA is a defense-in-depth, non-safety-related system, providing a backup to the reactor protection system. The diverse actuation system functional requirements are based on a deterministic assessment of the protection system instrumentation common mode failures combined with the event failures.

The IMS implements data flows between safety and non-safety equipment using division separated unidirectional gateways and individual digital signals.

The IMS uses the standard Common Q type High Speed Links (HSL) to transfer ESF system-level actuations and related status information calculated in the Local Coincident Logic (LCL) controllers to Integrated Logic Processor (ILP) that control the safety components.

The portion of the Atomic Alchemy Operation and Control System (IOC) that is dedicated to the safety-related display function is referred to as the “Qualified Data Processing Subsystem” (IQD). The Atomic Alchemy IQD provides safety-related display of selected parameters in the control room, safe shutdown panel room and at the technical support center workstation. The IQD consists of a redundant configuration of sensors, QDPS hardware, and qualified displays.

Safety-related display instrumentation provides the operator with information to determine the effect of automatic and manual actions taken following reactor trip due to a Condition II, III, or IV event which will be defined in the Atomic Alchemy FSAR Chapter 15 accident analysis.

In FSAR Chapter 7, each Atomic Alchemy I&C safety-related system will describe, at a minimum, their respective independence, diversity, single failure criteria, separation between monitoring and controls, trip functions and trip conformance.

Atomic Alchemy systems required for safe shutdown of the reactor and/or the radioisotope production processes will be provided in FSAR Chapter 7, Section 12, and Section 13, respectively.

The Atomic Alchemy's Engineered Safety Features (ESF) system will be described in FSAR Chapter 7, Section 11 which includes descriptions of ESF Monitoring Parameters, ESF Blocks, Permissives and Bypasses, ESF Signal Selector Algorithm ESF Coincidence Logic, and ESF Component Testing and Inspections.

FSAR Chapter 15.0 will provide a description of the fifteen anticipated operational occurrences that have been considered in the accident analysis for the VIPR.

Criteria regarding the Atomic Alchemy human factors engineering program will be found in FSAR Chapter 18. The human system interface includes the design of the Operation and Control System (IOC) and each of the human system interface resources. The operation and control system includes the main control room, the technical support center, the remote shutdown room, emergency operations facility, and associated workstations for each of these centers.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(10).

A-14.0 GDC CRITERION 14 – REACTOR COOLANT PRESSURE BOUNDARY

The reactor coolant pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

A-14.1 PDC CRITERION 14 DEPARTURE– REACTOR COOLANT BOUNDARY

The reactor coolant boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 14 as presented in this PDC Departure.

Atomic Alchemy Departure

The Atomic Alchemy facility does not use a nuclear reactor pressurized vessel in its VIPR design. The Atomic Alchemy reactor coolant piping system is designed as an "open piping system," that discharges directly into an open-to-atmosphere light-water pool located within the Reactor Confinement Module (RCM) building. Therefore, ASME Code III pressure relief devices are not required in the piping system design. The only pressurization of the RCS system is created by the RCS pump head (to this extent there is a maintainable "pressurized piping boundary" but that is not comparable to the much higher pressures experienced in a PWR or BWR reactor coolant pressure boundary design).

The Atomic Alchemy VIPR reactor coolant piping boundary is designed to accommodate the system pressures (pump head) and temperatures attained under the expected modes of the VIPR operation, including FSAR Chapter 15 design basis event transients, while maintaining stresses within applicable limits, including loadings under both normal and abnormal operating conditions (including seismic).

With respect to this PDC (the 10 CFR 50.2 definition, and any other applicable code requirements or references) the RCS pressure boundary, will be re-defined as just an RCS boundary. Atomic Alchemy specifically defines this RCS boundary as follows:

a. The RCS piping maintains a fission products barrier.
b. The RCS piping extends up to the connection to the light-water pool, from the RCS pump to the primary coolant loop (tube side) of the RCS Heat Exchanger.
c. All connections to the RCS system are considered part of this boundary up to and including:
    1. The outermost confinement valve capable of an automatic design isolation function in the RCS system piping that is located inside of the boundary of the primary reactor confinement building module or,
    2. The second of two valves capable of an automatic design isolation function during normal reactor operation in the RCS system piping that is located immediately outside the primary reactor confinement building module, or,
    3. The second of two valves normally closed during normal reactor operation connected to the RCS system piping that does not penetrate primary reactor confinement building module.

Atomic Alchemy Compliance

The RCS design incorporates piping bends instead of welded fittings, thus reducing the overall number of welds and potential pipe break locations.

The RCS pumps and heat exchanger are in a separate module (Reactor Auxiliary Module (RAM)) building. The reactor coolant piping passes between the RCM and RAM routed in a piping chase, the RCS piping system does not utilize any motorized control, isolation, or locked closed valves.

The VIPR reactor coolant system design will incorporate pipe-break criteria (leak-before-break) to reduce or eliminate the need to consider the dynamic effects of pipe breaks. The design layout configuration and materials of the reactor coolant system have been selected such that the pipe stresses meet the leak-before-break criteria.

The qualification program for valves that are part of the reactor coolant boundary shall include testing or analysis that demonstrate that these valves will not experience leakage beyond the design criteria when subjected to all design loading.

The Atomic Alchemy design does not utilize any pressure relieving devices in the primary reactor coolant system.

The portions of the Chemical and Volume Control System (CVC) that is defined as reactor coolant boundary is Seismic Class C-II, safety-related. This portion of the system is capable of being automatically isolated by the activation of passive safety-related valves.

The Atomic Alchemy reactor coolant piping design includes compliance with the requirements of the Atomic Alchemy QAPD “ISI/IST design for inspectability program” (this will be described in FSAR Chapter 13, Appendix A).

A-15.0 GDC CRITERION 15 – REACTOR COOLANT SYSTEM DESIGN

The reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during normal operation, including anticipated operational occurrences.

A-15.1 PDC CRITERION 15 DEPARTURE– REACTOR COOLANT SYSTEM DESIGN

The reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant boundary are not exceeded during normal operation, including anticipated operational occurrences.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 15 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to the definition of pressure boundary is addressed in PDC 14.

Some of the typical PWR or BWR reactor coolant anticipated operational occurrences are either not applicable to the VIPR design or pose a substantially reduced risk to impacting the safe operation of the reactor. For example, the Atomic Alchemy RCS, CVC and DHR systems are boron-free, therefore increases in RCS inventory only poses a potential temperature decrease risk which is bounded by other transients in FSAR Chapter 15.

Atomic Alchemy Compliance

Protection and control setpoints are based on accident analyses in FSAR Chapter 15, Section 7, Table 15.7-04, which ensures that the RCS does not exceed design basis conditions during operations and anticipated operational occurrences.

See FSAR Chapter 15.0 for a description of the fifteen anticipated operational occurrences that have been considered in the accident analysis for the VIPR (There are five non-reactor AOO's considered in the accident analysis).

The use of mechanistic pipe break criteria permits the elimination of the evaluation of dynamic effects of sudden circumferential and longitudinal pipe breaks in the design basis analysis of structures, systems, and components. General Design Criterion 4 of Appendix A, 10 CFR Part 50 allows the use of analyses to eliminate from the design basis the dynamic effects of pipe ruptures. While Atomic Alchemy modifies GDC 4, for its PDC 4, it nevertheless adopts the language of the GDC as applicable to its pipe break criteria.

An RCS piping hazard analysis and leak before break analysis will be performed, see FSAR Chapter 3, Section 6.

A-16.0 GDC CRITERION 16 – CONTAINMENT DESIGN

The reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

A-16.1 PDC CRITERION 16 DEPARTURE – CONFINEMENT DESIGN

The reactor confinement and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of significant amounts of radioactivity to the environment and to assure that the confinement design conditions important to safety are not exceeded for as long as postulated transient conditions require.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 16 as presented in this PDC departure.

Atomic Alchemy Departure

The Atomic Alchemy facility does not use a pressurized containment vessel in the VIPR design. The Atomic Alchemy reactors' module building design does not include a secondary steel containment structure. The reactors are located within open to atmosphere light-water pools inside a reactor confinement module building. There are no cylindrical or other shaped steel containment structures containing the light-water pool. Therefore, any applicable principal design criteria or references to a "containment design" will be re-defined as a "confinement design" by Atomic Alchemy as follows:

a. The outermost steel and concrete structure of the NPUF's Reactor Confinement Module Building, a seismic Category C-I structure.
b. Atomic Alchemy expands the definition of a "confinement" structure in the PDC to also include those module buildings that could also potentially release radioactivity to the environment. Therefore, the outermost steel and concrete structures of the Radioisotope Production Process Module, Radwaste Module and Target Fabrication Module Buildings, are included and are also seismic Category C-I structures.
c. The NPUF's Reactor Confinement Module Filtration System (RCF) of the Reactor Confinement Module Building, the Reactor Auxiliary Module Cascade Exhaust System (RAE) of the Reactor Auxiliary Module Building, the Radioisotope Production Process Module Air Filtration Systems (PMF), the Rad Waste Handling Module Air Filtration System (WHF), and the Mo-99 Target, Production, Processing Module Air Filtration System (TPF).

Atomic Alchemy Compliance

The light-water pool, which houses both the reactor core, and the spent fuel is the safety-related ultimate heat sink for the removal of the reactor coolant system sensible heat, core decay heat, spent fuel heat and stored energy.

The location (situated between other buildings) and design of the NPUF confinement module building protects against postulated missiles from external sources as well as missiles produced by internal equipment failures.

The reactor confinement building module is capable of maintaining a negative pressure in relation to the atmosphere during normal operation and have a measurable leakage rate less than 5% over 24 hours.

The design of the confinement module building, and ventilation systems prevents the rapid, uncontrolled release of radioactive material to the environment. The Atomic Alchemy reactor confinement module and process module buildings establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the design conditions important to safety are not exceeded for as long as postulated transient conditions require.

The Atomic Alchemy design incorporates a significant reduction (from what is typical in PWR and BWR designs) in the number of penetrations between the reactor confinement module building and the reactor auxiliary module building and radioisotope production module building, respectively.

A-17.0 GDC CRITERION 17 – ELECTRICAL POWER SYSTEMS

An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming that the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled, and containment integrity and other vital functions are maintained in the event of postulated accidents.

The onsite electric power supplies, including the batteries, and the onsite electric distribution system shall have sufficient independence, redundancy, and testability to perform their safety functions, assuming a single failure.

Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights-of-way) designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time, following a loss of all onsite alternating current power supplies and other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss of coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

A-17.1 PDC CRITERION 17 DEPARTURE – ELECTRICAL POWER SYSTEMS

An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety during normal modes of operation. The onsite electric power system shall be provided capable to permit functioning of structures, systems, and components important to safety during all modes of operation. The safety function for each onsite electrical power system shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant boundary are not exceeded as a result of anticipated operational occurrences and (2) the core and spent fuel is cooled, the reactor confinement integrity and other vital confinement functions of the radioisotope processes are maintained in the event of postulated transient events.

The onsite electric power supplies, including the batteries, and the onsite electric distribution system shall have sufficient independence, redundancy, and testability to perform their safety functions, assuming a single failure.

Electric power from the onsite networks to the onsite electrical distribution system for each of the reactor confinement modules shall be supplied by two physically independent circuits designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated transient and environmental conditions. Each of these circuits shall be designed to be available in sufficient time, following a loss of all onsite alternating current power supplies and other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss of coolant transient to assure that core cooling, confinement integrity, and other vital safety functions are maintained.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 17 as presented in this PDC Departure.

Atomic Alchemy Departure

The Atomic Alchemy facility departs from the conditions of 10 CFR 50 Appendix A General Design Criterion 17 with respect to safety-related onsite and offsite AC power availability and the sharing of 1E DC UPS systems. The Atomic Alchemy design does not require safety-related offsite AC power. Atomic Alchemy takes a specific exception to the sharing of 1E DC UPS systems between multiple non-reactor, radioisotope related processes (Regulatory Guide 1.81 position C.3) as described in its departure PDC 5. Atomic Alchemy's position is that the 10 CFR 50 Appendix A GDC 5 criteria, with respect to sharing of safety-related systems is not applicable to any of the non-reactor systems.

Each VIPR will have its own dedicated DC 1E UPS system located in the reactor auxiliary module building of each reactor. Offsite AC power has no safety-related function due to the passively safe design of the Atomic Alchemy VIPR. The VIPR is designed to maintain light-water pool cooling for both the reactor core and spent fuel and reactor confinement module building integrity independent of a safety-related AC power source indefinitely.

Atomic Alchemy Compliance

The Atomic Alchemy DC 1E UPS system for the radioisotope production processes includes augmented design provisions for sharing 1E power across radioisotope and radwaste processes that prevents adverse interactions and the introduction of other failures of systems that are required to ensure a safe shutdown of any radioisotope, target fabrication or radwaste ongoing process.

The Atomic Alchemy facility is designed with reliable, non-safety-related offsite and onsite AC power that are normally expected to be available for important facility functions. Non-safety-related AC power is not relied upon to maintain the core and spent fuel cooling, confinement module integrity, radioisotope module integrity or radwaste module integrity. Although not relied on for facility safety-related functions, the AC power systems are designed with reliability considerations, including independence, redundancy, and testability.

The onsite power system is comprised of the main AC power system and the DC power system. The main AC onsite power system is a non-Class 1E system, AC power is supplied by the non-safety related diesel generators. The DC onsite power system consists of Class 1E and non-Class 1E DC power systems. Each DC system consists of ungrounded batteries, DC distribution equipment, and a UPS. The Class 1E DC and UPS system are the only safety-related power sources required to monitor and actuate the safety-related passive systems in multiple reactors and for radioisotope related processes.

The Class 1E DC and UPS systems for each reactor are located in their respective Reactor Auxiliary Module building. Each reactor has four independent, Class 1E DC divisions, A, B, C, and D. Divisions A and D each are comprised of one battery bank, one switchboard, and one battery charger. The battery bank is connected to Class 1E DC switchboard through a set of fuses and a disconnect switch. Divisions B and C each are composed of two battery banks, two switchboards, and two battery chargers. The first battery bank in all four divisions is designated as 24-hour battery bank, it provides power to the safety-related loads for their respective VIPRs required for the first 24 hours following an event of loss of all AC power sources concurrent with any postulated DBE. The second battery bank in divisions B and C are designated as 72-hour battery bank and is used for those potential loads requiring safety-related power for 72 hours following the same event and for the same multiple systems and components.

(The 1E DC and UPS systems for the radioisotope production process, target fabrication and radwaste module buildings will also feature several independent Class 1E DC divisions to be designed similar to the reactor confinement modules for diversity and redundancy.)

The Class 1E DC and UPS system is designed to accommodate component failures, such as the loss of a battery charger, a battery, or an inverter, without the loss of power to either the DC bus or the AC instrumentation and control power bus. The Class 1E DC power systems include a spare Class 1E battery bank with a spare battery, battery charger, and permanently installed cable connections that allow the spare bank to be connected to the affected bus by operator actions.

Both the Class 1E and non-Class 1E inverters and battery chargers are located in a controlled environment within the reactor auxiliary module buildings, similarly, the shared radioisotope production related Class 1E and non-Class 1E will be located within controlled environments. The UPS equipment is rated for continuous operation at an ambient temperature of 104°F. In addition, the temperature-sensitive components such as capacitors, transformers, and semiconductors, used in the UPS equipment are designed to continuously withstand higher temperatures of 158° F. All Class 1E electrical components are environmentally qualified in accordance with the Atomic Alchemy EEQ program.

In the event of a Loss of Offsite Power (LOOP) AC power to the battery chargers is provided from the non-Class 1E onsite standby diesel generators. Preassigned loads and equipment are automatically loaded on the diesel-generators in a predetermined sequence.

Additional loads can be manually added to the standby diesel generators as required. The onsite standby diesel generator power system is not required for safe shutdown of any reactor, or any radioisotope or radwaste process.

The Class 1E battery chargers and Class 1E regulating transformers are designed to limit the input AC current to an acceptable value under faulted conditions on the output side. Circuit breakers exist at the input and output sides for protection and isolation. The circuit breakers are coordinated and periodically tested to verify their current-limiting characteristics.

Atomic Alchemy will determine which non-safety-related AC electrical SSCs should fall within the scope of its 10 CFR 50.65(b) program.

The NPUF will be constructed in phases. In FSAR Chapter 1, Appendix F, "Non-power Reactors on Multi-unit Sites" the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Work control processes and procedures will ensure proper considerations for electrical power system interfaces and continued safe operations of the existing reactors and radioisotope production processes. In some instances, existing reactor or radioisotope operations and processes may be required to be temporarily halted for short periods of time to permit some electrical AC or DC power construction or testing activities.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.6, 1.9, 1.32, 1.47, 1.75 and 1.81.

FSAR Chapter 1, Appendix D, "Compliance with Generic Safety Issues" (NUREG-0933) will address generic issues and operational experience relevant to the design of the Atomic Alchemy electrical power systems (A24, A25, B35, B44, B53, B56).

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(7).

A-18.0 GDC CRITERION 18 – INSPECTION AND TESTING OF ELECTRIC POWER SYSTEMS

Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

A-18.1 PDC CRITERION 18 DEPARTURE – INSPECTION AND TESTING OF ELECTRIC POWER SYSTEMS

Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical including the transfer between offsite site power and the onsite power systems.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 18 as presented in this PDC Departure.

Atomic Alchemy Departure

The Atomic Alchemy facility departs from the language of 10 CFR 50 Appendix A GDC 18 with respect to some of the inspection and testing conditions of General Design Criterion 18 requirements with respect to AC power. The Atomic Alchemy facility is designed with reliable non-safety-related offsite and onsite AC power that are normally expected to be available for important facility functions, but non-safety-related AC power is not relied upon to maintain the reactor core or spent fuel cooling or the confinement integrity of the RCM, RAM, PPM, or RWM buildings.

Offsite and onsite AC power has no safety-related function due to the passively safe design of the Atomic Alchemy VIPR. The VIPR is designed to maintain core cooling and confinement integrity independent of a non-safety-related ac power source indefinitely. Transfer of safety-related electric power does not occur in any of the reactor units. The only reactor unit safety related power is the 1E DC and UPS.

Testing simulating the total loss of electrical power to safety-related systems is not performed under facility operating conditions since this type of testing could adversely affect continued facility operation because the safety-related components fail to their safeguards actuation position for a loss of electric power. The unnecessary actuation of the safety-related components can adversely affect facility operation and facility safety. Therefore, testing of the 1E DC and UPS will be performed as close to design conditions as reasonably practical without significantly challenging operations.

Atomic Alchemy Compliance

In the Atomic Alchemy electric power design basis, only the Class 1E DC and UPS system is required to actuate the systems necessary for initiating safe shutdown of the VIPR (or any radioisotope or radwaste process), maintaining VIPR core cooling, spent fuel cooling, and confinement integrity. The Atomic Alchemy safety-related DC power system design complies with PDC 18.

Atomic Alchemy will comply with IEEE-603-1991, and the latest revisions of IEEE-308, IEEE-323, IEEE-344, IEEE-450, IEEE-484, IEEE-485, and IEEE-535. Some of the latest versions are not endorsed by a regulatory guide, but its use should not result in deviations from the design philosophy otherwise stated in any regulatory guides.

Atomic Alchemy will determine which non-safety-related AC electrical SSCs should fall within the scope of its 10 CFR 50.65(b) program.

The surveillance testing of the Class 1E DC UPS systems will be performed as required by Technical Specification. Atomic Alchemy Technical Specification LCO 3.8.1, 3.8.2 and 3.8.5 will be provided for this purpose.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.22, 1.30, 1.32, 1.41, 1.75, 1.81, 1.93, 1.118, 1.131, 1.158, 1.160, and 1.218.

FSAR Chapter 1, Appendix D, will describe Atomic Alchemy's compliance with NUREG-0933, Section 1, TMI Action Plans Task I.G, Section 2, Task Action Plans Item A-25, Item A-30, and Item B-70, Section 3, New Generic Issues, Issue 17, Issue 47, Issue 128, and Issue 168.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(8).

A-19.0 GDC CRITERION 19 – CONTROL ROOM

A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss of coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent, to any part of the body, for the duration of the accident.

Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

A-19.1 PDC CRITERION 19 DEPARTURE – CONTROL ROOM

A control room shall be provided from which actions can be taken to operate all of the nuclear reactor units safely under normal conditions and to maintain them in a safe condition under transient conditions, including loss of coolant transients. A control room shall also be able to monitor selected radioisotope related processes and take actions to operate the radioisotope systems necessary to maintain the radioisotope related processes and related areas in a safe condition under transient conditions.

Adequate radiation protection shall be provided to permit access to and occupancy of the control room under all postulated transient conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent, to any part of the body, for the duration of the transient.

Controls at appropriate safe locations outside the control room shall also be provided with a design capability for prompt shutdown of all the reactor units and applicable radioisotope processes, including the necessary instrumentation and controls to maintain the facility in a safe shutdown condition indefinitely.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 19 as presented in this PDC Departure.

Atomic Alchemy Departure

Operating up to 4 reactors from a single main control room is a configuration that is not presently regulated in 10 CFR 50.54(m). While the 10 CFR 50 Appendix A GDC 19 specifically mentions “power” reactors, control room operators at NPRs are also licensed under Title 10, Part 55. Because the potential hazards identified by 10 CFR 50.54(m) can occur among the new non-power reactor designs, Atomic Alchemy acknowledges that this Title 10 regulation can be applicable to the non-power reactor category.

The Atomic Alchemy NPUF design includes the monitoring and controlling of up to 4 NPRs from a single main reactor control room. Staffing can be reduced, and human errors minimized by utilizing Human Factors Engineering (HFE) good practices and increased digital software automation.

Atomic Alchemy will take an alternative approach to staffing the reactor control room and will request an exemption for the reactor control room staffing requirements identified in 10 CFR 50.54(m). This approach is similar to the design approach taken by NuScale in their Standard Plant Design Certification Application (DCA). The approach involves use of applicable NRC guidance contained in NUREG-0711, Revision 3 “Human Factors Engineering Program Review Model”, NUREG-1791, “Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)” and NUREG/CR-6838, “Technical Basis for Regulatory Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)”.

Atomic Alchemy Compliance

At this point in the preliminary design phase, Atomic Alchemy intends to provide a separate control room for monitoring and controlling non-reactor radioisotope evolutions and hot cell processes directly adjacent to the reactor main control room. For the purpose of this TR, they will be referred to as a single control room. There are no regulatory requirements for the staffing of this type of radioisotope process control room. Maintaining a separate control room for radioisotope processes allows the MCR operators to focus on just the control and operations of the 4 reactors. An in depth systematic HFE analysis and a functional requirements analysis of the control room design processes and operations for assuring the safe operation of the facility will be conducted later in the design phase to determine the conservative staffing requirements and whether or not to use a single control room to control both the reactors and radioisotope processes.

The Atomic Alchemy main control room provides the instrumentation and controls required to operate the facility safely under normal conditions and to safely shutdown the VIPRs and any radioisotope or radwaste processes under transient conditions. Passive safety-related system designs are provided that do not rely upon control room operator action to maintain core or spent fuel pool cooling for design basis events.

Conservative assumptions have been made in considering design basis event radioactive releases from the VIPR confinement module, target fabrication module, radwaste module and radioisotope production process module buildings to permit access to and continued occupancy of the main control room.

The beyond design basis severe events (as identified in FSAR Chapter 19) dictates the shielding requirements for the main control room. Consideration is given to shielding provided by the Reactor module and Radioisotope production process module building concrete and steel structures. Shielding combined with other engineered safety features is provided to permit access to and continued occupancy of the control room following a postulated beyond design basis severe event, so that radiation doses are limited to 5 rem whole body from contributing modes of exposure for the duration of the transient, in accordance with PDC 19.

The control room is centrally located in the Administrative/Service Module building and is shielded from direct gamma radiation and inhalation doses resulting from the postulated release of fission products from any of the reactor confinement module buildings or from any radioisotope production process related module buildings.

The functional design and layout of control room ventilation systems are designed in accordance with ASME Code AG-1 including the AG-1a Addenda with single failure criteria applied to the safety-related systems.

If AC power is unavailable for more than 10 minutes or if "high-high" particulate is detected, or if iodine radioactivity is detected in the main control room supply air duct (CRV system), which would lead to exceeding PDC 19 operator dose limits, the Protection and Safety Monitoring System (IMS system) automatically shuts down the four VIPRs and isolates the main control room. Operator habitability requirements are then met by the Control Room Emergency Habitability System (CRE system). The control room emergency habitability system also allows access to and occupancy of the main control room under these transient conditions. The control room emergency habitability system is designed to satisfy seismic Cat-I requirements.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F, “Non-Power Reactors on Multi-Unit Sites,” Atomic Alchemy will analyze and evaluate potential hazardous radioactive releases created by transients involving on-going construction activities that might challenge the continued occupancy of the main control room.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy’s compliance with Regulatory Guides 1.195, 1.196, and 1.197.

A-20.0 PDC CRITERION 20 – PROTECTION SYSTEM FUNCTIONS

The protection system shall be designed (1) to initiate automatically the operation of appropriate systems, including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 20 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 20.

The Atomic Alchemy radioisotope production processes (including radwaste and target fabrication) facility will share I&C systems and subsystems as well as interfacing with each other and the reactor protection systems. The Protection and Safety Monitoring System (IMS) interfaces with both the Reactor Protection System (IRP) and the Reactor Trip System (IRT). All three provide detection of off-nominal conditions and actuation of appropriate safety-related functions necessary to achieve and maintain the facility in a safe shutdown condition. The protection and safety monitoring system initiates a reactor trip whenever a condition monitored by the system reaches a preset level. The protection and safety monitoring system monitors key variables indicated in the main control room, as well as equipment mechanical limitations in both the reactor and in selected radioisotope and radwaste processes' components. The reactor trip portion (IRT system) of the protection system includes four independent, redundant, physically separated, and electrically isolated divisions.

FSAR Chapter 15.0 will provide a description of anticipated operational occurrences that have been considered in the accident analysis for the VIPR and the radioisotope production processes.

FSAR Chapter 7, sections 7.3, 7.5, and 7.6 will provide a description of the IMS, IRP and IRT systems, respectively.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F, "Non-power Reactors on Multi-unit Sites" the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Future reactor and process module I&C SSCs with connections to existing operating components will be isolated or partitioned at locations outside of the operating modules. Work control processes and procedures will ensure proper considerations for construction system interfaces and continued safe operations of existing reactors. In some instances, existing reactor or radioisotope operations may be required to be temporarily halted for short periods of time to permit future component connections and testing of new interfaces.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.53.

A-21.0 PDC CRITERION 21 – PROTECTION SYSTEM RELIABILITY AND TESTABILITY

The protection system shall be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) no single failure results in the loss of the protection function and (2) removal from service of any component or channel does not result in the loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 21 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 21.

The VIPR protection systems are design to be reliable and tested while in service. The design employs redundant logic trains and component diversity.

The automatic actuation processors, in each of the two redundant automatic subsystems of the IMS system are provided with the capability for channel calibration and testing while the facility is operating. The protection system, including the engineered safety features are tested at power to the greatest extent practical.

The Atomic Alchemy instrumentation architecture will conform to NUREG/CR-6303 and meets IEEE-603-1991, and the latest revision of IEEE-379, IEEE-497, 338 standards. Some of the latest versions are not endorsed by a Regulatory Guide, but its use should not result in deviations from the design philosophy otherwise stated in any of the Regulatory Guides.

Control functions, reactor trip functions, engineered safety features functions, and monitoring & indication functions are divided into three levels containing: non-safety systems, safety systems, and non-safety diverse systems.

During testing or maintenance, protection system functions will be provided to bypass a channel monitoring a variable for reactor trip. Although no setpoints need to be changed for bypassing, the coincidence logic is automatically adjusted.

A test simulating the total loss of instrument air to safety-related systems will not be performed since this type of testing would adversely affect continued facility operation since the safety-related air-operated components fail to their safeguards actuation position on a loss of air. The unnecessary actuation of the safety-related components can adversely affect the facility operation and facility safety.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F, “Non-power Reactors on Multi-unit Sites” the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Future reactor and process module reactor protection I&C SSC’s with connections to existing operating components will be isolated or partitioned at locations outside of the operating modules. Work control processes and procedures will ensure proper considerations for construction of new system interfaces and continued safe operations of the existing reactor units. In some instances, existing reactor or radioisotope operations may be required to be temporarily halted for short periods of time to permit future component connections and testing of new interfaces.

FSAR Chapter 7, Section 7.3 will provide a description of the reliability and testing of the IMS system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.22, 1.45, 1.53, 1.100, and 1.118.

A-22.0 PDC CRITERION 22 – PROTECTION SYSTEM INDEPENDENCE

The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in the loss of the protection function or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principals of operation, shall be used to the extent practical to prevent loss of the protection function.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 22 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 22.

A modified[8] version of the Westinghouse Common Qualified, or Common Q™, safety-grade instrumentation and control (I&C) platform is planned to be the basis of the Atomic Alchemy I&C Architecture. Safety-related instrumentation & control (I&C) systems based on the application of Common Q platforms are designed to provide protection against unsafe reactor operation during steady state and transient power operations. They also initiate selected protective functions to mitigate the consequences of design-basis events and transients, and to safely shut down the facility by either automatic means or manual actions. The standard Common Q platform is defined in Topical Report WCAP-16097, which was approved by the NRC.

The VIPR protection system (IRP) will be designed with sufficient functional diversity and redundancy for a variety of postulated transients. Redundancy provides confidence that reactor trips are generated on demand, even when the protection system is degraded by a single failure. Reactor trips are four-way redundant. The single failure criterion is met even if one channel is bypassed. Diverse and redundant protection functions automatically serve to mitigate the consequences of a postulated transients. FSAR Chapter 15 will describe the extent to which the IRP functions for each event. In FSAR Chapter 7, Section 5, the IRP system will be described, including independence, diversity, single failure criteria, and separation between monitoring and controls.

[8] Atomic Alchemy intends to base its I&C architecture on the Westinghouse Common Qualified (Common Q) platform. It is a computer system consisting of a set of commercial-grade hardware and previously developed software components dedicated and safety-related qualified for use in nuclear power plants. Since the number of safety-related systems in a non-power, <20 MW reactor are substantially less than those required in a 1500 MW power reactor, and since the challenges to these systems are also not as severe, the overall Atomic Alchemy Common Q I&C architecture will be modified to suit these differences while maintaining the same NRC approved system design elements. The Westinghouse Common Q Platform consists of the following Class 1E major building blocks that can be used to design any specific safety-related system: Advant Controller 160 (AC160) with PM646 Processor Module, S600 Input and Output Modules, Flat Panel Display System for human-machine interface consisting of the MTP, Safety/QDPS display and Operators Module, Component Interface Module (CIM), Termination Units, and Cabinets.

Sufficient redundancy and independence will be designed into the protection systems so that no single failure or removal from service of any component or channel of a system results in loss of that protection function. Functional diversity and location diversity will be designed into the Atomic Alchemy system. High-quality components, conservative design and quality control, inspection, calibration, and tests will be used to guard against common-mode failure.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F, “Non-power Reactors on Multi-unit Sites” the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Future reactor and process module protection system I&C SSC’s with connections to existing operating components will be isolated and/or partitioned at locations outside of the operating modules. Potential challenges caused by construction activities of the remaining reactors to the independence of the reactor protection system is addressed in the FSAR Chapter 1, Appendix F. Work control processes and procedures will ensure proper considerations for system interfaces and continued safe operations of the existing reactor units. In some instances, existing reactor or radioisotope operations and processes may be required to be temporarily halted for short periods of time to permit some I&C construction or testing activities.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy’s compliance with Regulatory Guide 1.75 and 1.100.

A-23.0 PDC CRITERION 23 – PROTECTION SYSTEM FAILURE MODES

The protection system shall be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air) or postulated adverse environments (e.g., extreme heat or cold, fire, pressure, steam, water, and radiation) are experienced.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 23 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 23.

The Atomic Alchemy Protection system and components will be designed, tested, and qualified for operation in the postulated Design Basis Event (DBE) environment in which the components are required to function. The most conservative failure modes are considered under various transients and the components are designed to fail to that determined conservative functional state.

Branch Technical Position (BTP) 7-19, "Guidance for Evaluation of Diversity and Defense-In Depth in Digital Computer-Based Instrumentation and Control Systems," identifies criteria for defense against common-mode and common cause failures. The Atomic Alchemy I&C architecture will comply with this guidance. The Staff has previously stated it considers defense-in-depth, and diversity to be key elements in a protection system design against failure modes.

Atomic Alchemy I&C architecture will conform with the intent of the latest requirements of IEEE Std 379, "Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems" as applicable to DC safety-related power systems.

The Atomic Alchemy protection systems will contain sufficient redundancy and independence in the protection systems so that no single failure or removal from service of any component or channel of a system results in loss of the protection function.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F, "Non-power Reactors on Multi-unit Sites" the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Interactions or transients caused by construction activities are also considered when determining the failure mode functional state of protection system SSCs. In some instances, existing reactor or radioisotope operations and processes may be required to be temporarily halted for short periods of time to permit some I&C construction or testing activities.

FSAR Chapter 7, section 11, will provide a description of the diversity of the engineered safety features (ESF).

FSAR Chapter 7, Section 2, will provide a description of the I&C Systems Reliability and Availability.

A-24.0 PDC CRITERION 24 – SEPARATION OF PROTECTION AND CONTROL SYSTEMS

The protection system shall be separated from the control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems, leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 24 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 24.

The Atomic Alchemy protection system (IMS) will be separate and distinct from the control systems. Control systems are dependent on the protection system for control signals that are derived from protection system measurements, where applicable. These signals are transferred to the control system by isolation devices classified as protection components.

The Atomic Alchemy Protection system and components will be designed, tested, and qualified for operation in the Design Basis Event environment in which the components are required to function. The protection systems are separate and distinct from the control systems.

The adequacy of system separation will be verified by pre-operational testing. The failure of a single control system component or channel, or the failure or removal from service of a single protection system component or channel common to the control and protection system, does not adversely impact the protective system from continuing to be able to perform its intended design basis safety-related functions. The removal of a protection division from service is allowed during testing of that division.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F "Non-power Reactors on Multi-unit Sites" the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. Separation of protection and control systems of newly added reactor components were also considered when determining the overall I&C architecture to maintain separation of functions. In some instances, existing reactor or radioisotope operations and processes may be required to be temporarily halted for short periods of time to permit some I&C construction or testing activities.

FSAR Chapter 7, Section 7.4, will provide a description of the I&C Systems instrumentation separation criteria.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.75.

A-25.0 PDC CRITERION 25 – PROTECTION SYSTEM REQUIREMENTS FOR REACTIVITY CONTROL MALFUNCTIONS

The protection system shall be designed to assure that specified acceptable fuel design limits are not exceeded for any single malfunction of the reactivity control systems, such as accidental withdrawal (not ejection or dropout) of the control rods.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 25 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 25.

The Atomic Alchemy Reactor Trip system is independent of the control functions. Trip functions will interrupt power to the control rod mechanism's independent of control signals. Any trip demand signal from neutron flux, temperature, pressure, level, or flow signals will be generated independently of the control signals.

The VIPRs will be constructed in phases. In FSAR Chapter 1, Appendix F "Non-power Reactors on Multi-unit Sites" the analysis of construction work impact to existing reactor and radioisotope production process operations will be provided. The impact of construction activities on reactivity control components for malfunctions were also considered when determining the overall I&C architecture to maintain separation of reactor protection functions. In some instances, existing reactor or radioisotope operations and processes may be required to be temporarily halted for some I&C construction or testing activities.

FSAR Chapter 4a, Section 4, and FSAR Chapter 7, Section 6 will describe reactor trip functions.

FSAR Chapter 15, Section 7, will provide a description of transients involving reactivity control.

A-26.0 PDC CRITERION 26 – REACTIVITY CONTROL SYSTEM REDUNDANCY AND CAPABILITY

Two independent reactivity control systems of different design principals shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure that the acceptable fuel design limits are not exceeded. One of the systems shall be capable of holding the reactor core subcritical under cold conditions.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 26 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process, at the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 26.

The Atomic Alchemy design features two different design principles for reactivity control: 1) coarse-step control rods and a fine-step regulating rod and 2) burnable poison in the form of gadolinium ($Gd2O3$) that is introduced as an additive to some of the fuel rods in a zoned manner. The control rod clusters and regulating rod assembly are inserted into the VIPR core by the force of gravity. While the Atomic Alchemy VIPRs are non-power reactors, the design is consistent with PWR industry practices in taking burnup credit for assembly designs with burnable poisons. This satisfies the intent of PDC 26.

FSAR Chapter 15, Section 1 will provide the reactor characteristics, reactivity coefficients, assumptions, and analysis. The safety analysis assumes the most restrictive time in the core operating cycle.

FSAR Chapter 7, Section 19 (reactor) and Section 20 (radioisotope production processes) will provide the Reactor I&C System Permissive and Interlock Descriptions.

FSAR Chapter 15, Section 2 will describe the anticipated operational occurrences that have been considered in the accident analysis for the VIPR.

A-27.0 GDC CRITERION 27 – COMBINED REACTIVITY CONTROL SYSTEMS CAPABILITY

The reactivity control systems shall be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.

A-27.1 PDC CRITERION 27 DEPARTURE – REACTIVITY CONTROL SYSTEM CAPABILITY

The reactivity control systems shall be designed to reliably control reactivity changes to assure that under postulated transient conditions and with appropriate margin for stuck rods the capability to cool the core and spent fuel is maintained.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 27 as presented in this PDC Departure.

Atomic Alchemy Departure

Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 27.

Atomic Alchemy departs from the language of the 10 CFR 50 Appendix A General Design Criterion 27 requirement for a poison addition by an emergency core cooling system (Atomic Alchemy's equivalent is the DHR system). The Atomic Alchemy VIPR is a non-power reactor. The reactivity control design (utilizing control rods and a burnable poison in some fuel rods) provides sufficient means of making and holding the reactor core subcritical under any anticipated transient conditions and within an appropriate margin for contingencies without the necessity to add a soluble neutron poison. Likewise, configuration alone is sufficient to ensure reactivity control of the spent fuel at the far end of the light-water pool.

Atomic Alchemy Compliance

The single failure of the highest worth control rod assembly is assumed to be stuck in the fully withdrawn position for this determination. Even in this "N-1" configuration, light-water pool cooling for both the reactor core and spent fuel is maintained by the overall passive cooling design of the light-water pool and if necessary, additional water can be provided by the reactor core decay heat removal (DHR) system. This satisfies the intent of GDC 27.

FSAR Chapter 7, Sections 3, 4, 5, and 6 will describe the In-core Instrumentation System (IIC), Reactor Power Control (IRC), Reactor Protection System (IRP), and Reactor Trip System (IRT) respectively.

Technical Specifications LCO 3.1, for Reactivity Control Systems (IRC, ICX), LCO 3.2, for Power Distribution (IRC, ICX) and LCO 3.3 for Instrumentation will be provided.

FSAR Chapter 15, Section 3 will describe reactor characteristics, reactivity coefficients, assumptions, and analysis.

FSAR Chapter 4a, Section 2, will provide a summary description of principal reactor design criteria, and FSAR Chapter 4a, Section 3 and 4 will describe the reactor core and fuel design criteria.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.79.

A-28.0 GDC CRITERION 28 – REACTIVITY LIMITS

The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold-water addition.

A-28.1 PDC CRITERION 28 DEPARTURE – REACTIVITY LIMITS

The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity transients can neither (1) result in damage to the reactor coolant boundary greater than limited local yielding nor (2) sufficiently disturb the core, the spent fuel, their respective support structures, or other reactor light-water pool internals to impair significantly the capability to cool the core and the spent fuel. These postulated reactivity transients shall include consideration rod dropout, changes in reactor coolant temperature, and cold-water addition.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 28 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal, Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 28.

The Atomic Alchemy departs from the language of 10 CFR 50 Appendix A GDC 28, VIPRs are non-power reactors, therefore, some of the postulated transients that could potentially impact reactivity limits identified in GDC 28 are not applicable because they are not credible transients in the FSAR Chapter 15 analysis (i.e., reactor coolant pressure variants, rod ejection accidents (REA), steam line ruptures, etc.)

Because the spent fuel is located in the same light-water pool as the reactor core, Atomic Alchemy extends PDC 28 criteria to include the potential adverse effects to the spent fuel area of the light-water pool.

Atomic Alchemy Compliance

FSAR Chapter 15, Section 7 will describe the postulated reactor accidents including cold water addition (from several sources), changes in RCS temperature, and control rod malfunctions.

Maximum rates of reactivity increase are limited by design and operating procedures. The Atomic Alchemy Technical Specifications will explicitly state the requirements for control rod bank alignment (T/S 3.1.4), and insertion limits (T/S 3.1.5) in addition to the shutdown margin (T/S 3.1.1) reactivity requirements. The control rod reactivity addition rate is determined by the allowable rod control system withdrawal speed, in conjunction with the control rod worth, which varies throughout the operating cycle.

Reactor core (as well as the spent fuel) light-water pool cooling capability following any of the postulated reactivity transients is maintained by the overall passive design methodology of the light-water pool decay heat removal system and if necessary, additional water from the reactor Decay Heat Removal System (DHR). This departure satisfies the intent of PDC 28 with respect to reactivity limits.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.77, and 1.236.

A-29.0 PDC CRITERION 29 – PROTECTION AGAINST ANTICIPATED OPERATIONAL OCCURRENCES

The protection and reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 29 with no modifications.

Atomic Alchemy Compliance

Atomic Alchemy has completed the conceptual and requirements phases of the I&C Design Process. At the time of this Topical Report (TR) submittal Atomic Alchemy is working to complete the hardware and software developmental phases. This TR section therefore identifies and describes the design features and component requirements that will comprise the Atomic Alchemy I&C design with respect to PDC 29.

The Atomic Alchemy instrumentation architecture will conform to NUREG/CR-6303. Control functions, reactor trip functions, engineered safety features functions, and monitoring & indication functions are divided into three levels containing: non-safety systems, safety systems, and non-safety diverse systems. The protection and safety monitoring system monitors key variables related to equipment mechanical limitations in both the reactor and in selected radioisotope and radwaste processes' components.

The reactor trip portion (IRT system) of the protection system will include independent, redundant, physically separated, electrically isolated divisions.

This defense in depth design approach will ensure that the Atomic Alchemy I&C reactor protection systems maintain a high certainty of performing their intended safety-related functions in the event of operational occurrences.

FSAR Chapter 7, Section 4 will describe the safety criteria for instrument redundancy, separation, and diversity.

FSAR Chapter 15.0 will describe the fifteen (15) reactor anticipated operational occurrences (AOO) and the five (5) non-reactor (radioisotope processes) AOO's that have been considered in the accident analysis for the NPUF.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.97.

A-30.0 GDC CRITERION 30 – QUALITY OF REACTOR COOLANT PRESSURE BOUNDARY

Components which are part of the reactor coolant pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.

A-30.1 PDC CRITERION 30 DEPARTURE – QUALITY OF REACTOR COOLANT BOUNDARY

Components which are part of the reactor coolant boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 30 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the reactor coolant pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to defining the reactor boundary is addressed in PDC 14.

Atomic Alchemy Compliance

The components in the Reactor Coolant System (RCS) are Atomic Alchemy Equipment Class A (equivalent to ANS Safety Class 1), Quality Group A, and are designed and fabricated according to ASME Code Section III, Class 1.

The qualification program for valves that are part of the reactor coolant boundary shall include testing or analysis that demonstrate that these valves will not experience leakage beyond the design criteria when subjected to design loading.

The reactor coolant piping boundary leakage detection monitoring provides a means of detecting and to the extent practical, identifying the source and quantifying the reactor coolant leakage. The detection monitors perform the detection and monitoring function in conformance with the recommendations of Regulatory Guide 1.45. Leakage from the reactor coolant boundary may result in an increase in the radioactivity levels inside either the Reactor Confinement Module or the Reactor Auxiliary Module buildings. The area's atmosphere is continuously monitored for airborne particulate radioactivity.

Substantial intersystem leakage from the reactor coolant piping boundary to other piping systems is not expected. However, possible leakage points across passive barriers or valves are considered in the Atomic Alchemy design. A piping rupture hazards analysis will be performed on high and medium energy secondary sub-systems attached to the RCS system. Sub-systems connected to the reactor coolant boundary incorporate design and administrative provisions that limit leakage.

Leakage detection monitoring is also maintained in support of the use of leak-before-break criteria.

FSAR Chapter 3, Section 6 will describe the application of leak-before-break criteria.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.45, and 1.100.

A-31.0 GDC CRITERION 31 – FRACTURE PREVENTION OF REACTOR COOLANT PRESSURE BOUNDARY

The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state, and transient stresses, and (4) size of flaws.

A-31.1 PDC CRITERION 31 DEPARTURE – FRACTURE PREVENTION OF REACTOR COOLANT BOUNDARY

The reactor coolant boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated transient conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated transient conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state, and transient stresses, and (4) size of flaws.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 31 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the reactor coolant pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to defining the pressure boundary is addressed in PDC 14.

Atomic Alchemy Compliance

Atomic Alchemy RCS reactor coolant system piping is designed and fabricated in accordance with ASME BPVC Section III and meets the requirements of fracture toughness of ferritic materials in Section III of the ASME Code. The reactor coolant boundary piping materials exposed to the coolant are corrosion resistant. Allowable pressure-temperature relationships for reactor heat-up and cooldown rates are calculated using methods derived from the ASME Code, Section III, Appendix G. The VIPR does not have a reactor vessel; therefore, any other fracture toughness requirements of 10 CFR Part 50 Appendix G and 10 CFR Part 50 Appendix H do not apply to the VIPR RCS boundary. The reactor core is located in an open-to-atmosphere light-water pool that has an aluminum liner.

Similar material surveillance type programs will be described in FSAR Chapter 13, Appendix A and QAPD for Atomic Alchemy's "Material Control and Accountability Program", Reactor Light-water Pool Liner Inspection", and the "Reactor Coolant Piping Material Inspection Program".

FSAR Chapter 5, Section 3 will describe the functional design of the RCS components that comprise the RCS boundary.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.26.

A-32.0 GDC CRITERION 32 – INSPECTION OF REACTOR COOLANT PRESSURE BOUNDARY

Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leak-tight integrity and (2) an appropriate material surveillance program for the reactor pressure vessel.

A-32.1 PDC CRITERION 32 DEPARTURE – INSPECTION OF REACTOR COOLANT BOUNDARY

Components which are part of the reactor coolant boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leak-tight integrity and (2) an appropriate light-water pool liner surveillance program.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 32 as presented in this PDC Departure.

Atomic Alchemy Departure

Per 10 CFR 50.2, the reactor coolant pressure boundary includes all pressure-retaining components such as pressure vessels, piping, pumps, and valves, which are part of the RCS, or connected to the RCS. The VIPR does not have a reactor vessel; therefore, the fracture toughness surveillance requirements of Part 50 Appendix H do not apply to the RCS boundary.

As an NPUF, Atomic Alchemy re-defines the reactor coolant pressure boundary for the VIPR as described in PDC 14. The basis for the departure for this PDC with respect to the definition of reactor coolant boundary is addressed in PDC 14. Since there is no pressurized vessel to inspect, Atomic Alchemy will develop a biological barrier inspection of the light-water pool liner to be performed periodically.

Atomic Alchemy Compliance

The examination requirements of ASME Section XI, Subsection IWB, apply to all Class 1 pressure retaining components and their welded attachments. Atomic Alchemy (or its subcontractors) maintain control over material selection and fabrication for the reactor coolant boundary components so that the boundary behaves in a nonbrittle manner.

Atomic Alchemy will develop and perform inspections on the light-water pool liner.

Piping bends are used in lieu of pipe fittings to minimize the number of welded connections. RCS piping is routed through concrete pipe chases which have adequate removable HELB hatches for ASME Section XI inspections. The connection of the RCS piping to the reactor core light-water pool is also accessible for inspection in this manner.

FSAR Chapter 5, Section 3 will describe the functional design of RCS Piping Boundary Integrity.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.45.

A-33.0 GDC CRITERION 33 – REACTOR COOLANT MAKEUP

A system to supply reactor coolant makeup for protection against small breaks in the reactor coolant pressure boundary shall be provided. The system safety function shall be to assure that specified acceptable fuel design limits are not exceeded as a result of reactor coolant loss due to leakage from the reactor coolant pressure boundary and rupture of small piping or other small components which are part of the boundary. The system shall be designed to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished using the piping, pumps, and valves used to maintain coolant inventory during normal reactor operation.

A-33.1 PDC CRITERION 33 DEPARTURE – REACTOR COOLANT MAKEUP

A system to supply reactor coolant makeup for protection against small breaks in the reactor coolant boundary shall be provided. The system safety function shall be to assure that specified acceptable fuel design limits are not exceeded as a result of reactor coolant loss due to leakage from the reactor coolant boundary and rupture of small piping or other small components which are part of the boundary during normal and AOO operations.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 33 as presented in this PDC Departure.

Atomic Alchemy Departure

The reactor coolant makeup system is the Chemical Volume and Control System (CVC). Atomic Alchemy departs from the language of the requirements of 10 CFR 50 Appendix A GDC 33 in that it is not entirely applicable, the Atomic Alchemy CVC system does not perform any post-accident safety-related function and it is not powered by safety-related onsite or offsite power. The only safety function of the CVC system is to provide makeup RCS water during normal and AOO operations.

The CVC system is not seismically designed since no breaks are postulated for piping with a nominal diameter of 1-1/2 inches or less.

The VIPR does not use a pressure vessel for the reactor core. The VIPR coolant piping system is designed so that it discharges directly into an open-to-atmosphere reactor light-water pool.

The CVC system does not introduce any chemical additives to mitigate any reactivity design basis transient events.

Atomic Alchemy Compliance

Atomic Alchemy uses a "leak before break" analysis of ASME Section III piping (RCS). A piping rupture hazards analysis is also performed on high and medium energy secondary systems that connect to the RCS system. The Atomic Alchemy technical specifications will establish conservative limits on the total volume of acceptable light-water pool and RCS piping leakage.

Nozzle connections to the RCS piping provide for purification flow and makeup flow from the safety-related Chemical and Volume Control (CVC) System (Non-Category Seismic I piping attached to Category Seismic I systems satisfy the NUREG-0800 SRP 3.9.2 guidelines[9]) to the reactor coolant system.

The safety-related chemical and volume control system automatically provides inventory control to accommodate minor leakage from the reactor coolant system, any potential expansion during heat-up from cold shutdown, and any potential contraction during cooldown during normal and AOO operations. While the CVC system is not powered from a safety-related AC power source, it can also be powered by an alternative non-safety-related diesel generator AC system when offsite AC power is unavailable during normal operations.

The passive nature of the design of the light-water pool ensures fuel design limits are not exceeded as a result of loss of reactor coolant inventory due to RCS boundary leakage or rupture of components that comprise the RCS boundary.

FSAR Chapter 5, Section 4 will describe the RCS makeup water system.

A-34.0 GDC CRITERION 34 – RESIDUAL HEAT REMOVAL

A system to remove residual heat shall be provided. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded.

Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

A-34.1 PDC CRITERION 34 DEPARTURE – RESIDUAL HEAT REMOVAL

A system to remove residual heat from the light-water pool shall be provided. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core and spent fuel at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant boundary are not exceeded.

[9] While not explicitly stated in NUREG-1537, Part 2, SRP Sections 3.1 and 3.4, the intent of these NUREG-1537 sections is to provide a reasonable assurance that significant damages due to seismic transients to safety-related functions remains unlikely, Atomic Alchemy applies the design approach of NUREG-0800 SRP 3.9.2 to ensure this.

Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided. The system safety function can be accomplished assuming a single failure.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 34 as presented in this PDC Departure.

Atomic Alchemy Departure

The Atomic Alchemy VIPR core and spent fuel light-water pool do not require any post-accident forced cooling or cooling that relies on AC power; it relies on passive convection cooling for residual heat removal.

The Atomic Alchemy design satisfies the intent of the 10 CFR 50 Appendix A General Design Criterion for its PDC by further reducing any potential risk associated with loss of the decay heat removal function through a combination of safety-related passive systems and non-safety-related active systems. The VIPR design therefore does not rely on a safety-related Residual Heat Removal system to maintain reactor fuel design limits or the RCS boundary.

Atomic Alchemy Compliance

The VIPR core is located on top of a reactor coolant supply (RCS) distribution plenum, located at the bottom of an open-to-atmosphere reactor light-water confinement pool (which also houses the spent fuel in a lower cavity opposite to the core).

In the event that the primary reactor coolant flow is interrupted, numerous re-circulation slots located on each side of the RCS supply plenum will open passively on loss of forced flow and provide a path for natural convection cooling to be established within the light-water pool. In order to prevent any potential debris from obstructing the slotted openings, recirculation screens are provided.

Additionally, the screens are protected from any obstructing debris by protective plates that are located above the top of and extend past the of sides of the screens. The plate dimensions are relative to the portion of the screens where water flow enters the screen openings. Slot openings are sized such that any postulated reactor pool debris would not prevent the light-water-cooling convection function.

A nozzle connection from the safety-related CVC pumps (that can be powered from the non-safety-related diesel generators) to the RCS piping can also be utilized to assist in creating a small nominal minimum flow across the core in the light-water pool to further enhance convection cooling.

However, the design of the light-water pool is such that natural convection cooling is all that is necessary to maintain acceptable fuel design limits and the RCS boundary.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.29, 1.82, and 1.139.

A-35.0 GDC CRITERION 35 – EMERGENCY CORE COOLING

A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that

(1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

A-35.1 PDC CRITERION 35 DEPARTURE – DECAY HEAT REMOVAL COOLING

A system to provide abundant additional core cooling to the light-water pool shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant in the light-water pool at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and confinement capabilities shall be provided to assure the system safety function can be accomplished, assuming a single failure.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 35 as presented in this PDC Departure.

Atomic Alchemy Departure

The VIPR core and spent fuel located in the light-water pool does not require any additional post-accident active systems for cooling; it relies on convection cooling for decay heat and/or residual heat removal. The Atomic Alchemy design satisfies the intent of the 10 CFR 50 Appendix A General Design Criterion 35 by further conservatively reducing any potential risk associated with loss of the decay heat removal function through the addition of a safety-related passive design system. This system, however, is not necessary to meet any post DBE transient cooling requirements and is strictly provided as a conservatism in the design.

Atomic Alchemy Compliance

The Atomic Alchemy design will provide an additional Reactor Decay Heat Removal (DHR) safety-related system that meets the intent of the PDC 35, and functions independent of onsite or offsite AC power supplies, assuming single active failures. This Atomic Alchemy reactor decay heat removal system also does not rely on the non-safety-related diesel-generators or the 1E DC and UPS power system for electrical power to either actuate or operate the various passive DHR system components.

The Atomic Alchemy Facility utilizes the volume of light-water contained in the molybdenum^{99} target transfer light-water canal system (TTW) as an “emergency core cooling” (ECC) type of safety related system. Components of the TTW system that provide this function are separately designated as a DHR system component. DHR system components are Safety Class A, Quality Class A, and Seismic Cat-I.

Each pair of VIPR light-water pools share one common light-water target transfer canal (TTW). The sharing of this backup makeup water source does not impair the capability of either VIPR safety-related systems to perform intended safety functions. The volume of water stored in the TTW system transfer canal pool is sufficiently sized for decay heat removal for two reactor pools on loss of coolant transients in the other (or both) light-water pools if needed.

Additionally, the TTW system also includes a manually activated non-safety-related makeup water storage tank located within the radioisotope production process module building with the capacity to refill the transfer canal if needed.

Even without an ECC system activation, a postulated DBE LOCA transient in the Atomic Alchemy FSAR Chapter 15 analysis does not cause the reactor core to become uncovered, therefore, even in the low-level water state of a LOCA the reactor light-water pools alone are capable of dissipating decay heat of both the VIPR core and the spent fuel for 30 days by convection cooling alone.

During a loss of coolant transient, in-series swing check valves whose function is to open on a change in the pressure differential between the Light-water Pool and the TTW canal pool (located below the canal water level) in the water/air lock dikes automatically open allowing the volume of the canal water (TTW system) to refill the VIPR pool by the force of gravity alone.

FSAR Chapter 6, Section 3 will describe the Reactor Decay Heat Removal system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27, and 1.157.

A-36.0 GDC CRITERION 36 – INSPECTION OF EMERGENCY CORE COOLING SYSTEM

The emergency core cooling system shall be designed to permit appropriate periodic inspection of important components, such as spray rings in the reactor pressure vessel, water injection nozzles, and piping, to assure the integrity and capability of the system.

A-36.1 PDC CRITERION 36 DEPARTURE – INSPECTION OF DECAY HEAT REMOVAL COOLING SYSTEM

The decay heat removal cooling system shall be designed to permit appropriate periodic inspection of important components to assure the integrity and capability of the system.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 36 as presented in this PDC Departure.

Atomic Alchemy Departure

The VIPR core and spent fuel located in the light-water pool does not require any additional post-accident active systems for cooling; it relies on convection cooling for decay heat and/or residual heat removal. The Atomic Alchemy design satisfies the intent PDC 35 by further conservatively reducing any potential risk associated with loss of the decay heat removal function through the addition of a safety-related passive system.

Since the system is a passive design, the amount of necessary inspections are significantly reduced. The only active component (as defined by the IAEA Safety Glossary) in the Atomic Alchemy DHR system are the in-series check valves whose function is to open on reversal of pressure differential between the light-water pool and the TTW canal pool.

Atomic Alchemy Compliance

The Atomic Alchemy utilizes the molybdenum target transfer light-water canal system (TTW) as its only designated safety-related "emergency core cooling" type of system. The components of the TTW system that function in this capacity are designated as reactor decay heat removal (DHR) system components and are Safety Class A, Quality Class A, and Seismic Cat-I. This a passive system that does not utilize any components that require any onsite or offsite AC power.

Additionally, the TTW system also includes a manual activated non-safety-related makeup water storage tank located within the radioisotope production process module building with the capacity to refill the transfer canal if needed.

The system piping and components are designed to permit access for periodic inspection of equipment, according to the ASME Code and technical specification requirements, to provide confidence in the integrity and capability of the systems.

FSAR Chapter 6, Section 6 will describe the Inservice Testing and Inspection of Quality Class Components.

Technical Specifications LCO 3.5 will describe the Reactor Decay Heat Removal limited conditions of operation and surveillances.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.116, 1.178 and 1.192.

A-37.0 GDC CRITERION 37 – TESTING OF EMERGENCY CORE COOLING SYSTEM

The emergency core cooling system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole and under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.

A-37.1 PDC CRITERION 37 DEPARTURE – TESTING OF DECAY HEAT REMOVAL COOLING SYSTEM

The decay heat removal cooling system shall be designed to permit appropriate periodic functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active components of the system.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 37 as presented in this PDC Departure.

Atomic Alchemy Departure

The VIPR core and spent fuel located in the light-water pool does not require any additional post-accident active systems for cooling; it relies on convection cooling for decay heat and/or residual heat removal. The DHR system does not require any electrical power to operate, it is passive design system that functions by gravity. Because of these passive design features, Atomic Alchemy departs from this general design criterion requirement for full operational periodic functional testing of active components under design conditions.

Operability of the system as a whole, under design operational conditions is not feasible because it would require the light-water pool to be partially drained while the reactor core is loaded with nuclear fuel. Elimination of the requirement to perform these types of periodic full operational sequence tests is acceptable since the level of risk and challenges to the light-water pool systems' safety limits are significantly less by the design.

The only active component (as defined by the IAEA Safety Glossary) in the Atomic Alchemy DHR system are the in-series check valves whose function is to open on reversal of pressure differential between the Light-water Pool and the TTW canal pool.

Atomic Alchemy Compliance

The Atomic Alchemy utilizes the molybdenum^{99} target transfer light-water canal system (TTW) as its only designated safety-related "emergency core cooling" type of system. The components of the TTW system that function as DHR components are Safety Class A, Quality Class A, and Seismic Cat-I. The DHR system is a passive system that does not utilize any components that require any onsite or offsite AC power.

The DHR system components are designed to permit access for periodic testing according to the ASME Section XI Code and technical specification requirements, to provide confidence in the integrity and capability of the system. Atomic Alchemy will determine the acceptance criteria within certain ASME OM Code-defined expectations including bi-directional testing when it establishes an IST acceptance criterion for these type A and/or type C check valves.

Initial verification of the water transfer capability and functional operation of the reactor decay heat removal system under design conditions is performed by conducting a natural circulation flow test. This test will be conducted during hot functional testing of the reactor coolant system which will include testing the DHR check valves under a drain down of the light-water pool before fuel load.

The Decay Heat Removal System (a subsystem of the TTW) design has significantly reduced the number of I&C support systems required for system operation. Atomic Alchemy will determine which non-safety-related TTW SSCs should fall within the scope of its 10 CFR 50.65(b) program.

Based on the above design elements, the Atomic Alchemy design conforms with the intent of PDC 37.

Technical Specifications LCO 3.5 will describe the Reactor Decay Heat Removal limited conditions of operations and surveillances.

FSAR Chapter 6, Section 3 will describe the pre-operational and periodic testing requirements of the emergency core cooling system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.22, 1.68.2, 1.79, 1.116, 1.171, 1.192, and Regulatory Guide 3.22.

A-38.0 GDC CRITERION 38 – CONTAINMENT HEAT REMOVAL SYSTEM

A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss of coolant accident and maintain them at acceptably low levels.

Suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

A-38.1 PDC CRITERION 38 DEPARTURE – CONFINEMENT HEAT REMOVAL SYSTEM

A system to remove heat from the reactor confinement module building environment shall be provided. The system safety function shall be to reduce, consistent with the functioning of other associated systems, the confinement module building temperature as needed, following any loss of coolant DBE transient and maintain it at acceptably levels.

Suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and confinement capabilities shall be provided to assure the system safety function can be accomplished, assuming a single failure.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 38 as presented in this PDC Departure.

Atomic Alchemy Departure

An over pressurization failure of the confinement module building by a LOCA is not a credible transient in the Atomic Alchemy FSAR, Chapter 15 accident analysis. Therefore, a rapid reduction of heat, or reliance on electrical power is immaterial to the functionality of the Atomic Alchemy confinement system. As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to the re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The Atomic Alchemy design only uses passive systems for post loss of coolant transient heat removal in the reactor confinement module building. The reactor light-water pool, which houses both the reactor core and the spent fuel assemblies, is the safety-related ultimate heat sink for the removal of the reactor coolant system sensible heat, core decay heat, spent fuel decay heat and stored energy.

Following the loss of the operation of the reactor coolant system, the reactor will be scrammed, and should the Reactor Decay Heat Removal system (DHR) also suffer a catastrophic failure, the confinement module atmosphere will continue to cool down by natural convection alone, maintaining the module building structure's internal pressure and temperature at an acceptable level.

Heat generated from the light-water pool is transferred to the confinement module atmosphere which is then transferred to the confinement module building structure by natural convection and condensation.

The Reactor Confinement Module HVAC System (RCV) and the Reactor Confinement Module Re-Circulating Sensible Cooling/Heating System (RCX) are redundant non-safety-related systems that perform cooling/heating functions during normal operations. Both systems can also be powered from the non-safety-related Diesel Generators.

Atomic Alchemy will determine which non-safety-related ventilation cooling systems and respective components will fall within the scope of the Atomic Alchemy 10 CFR 50.65(b) program.

Based on the above design features, Atomic Alchemy meets the intent of PDC 38, in being able to maintain atmospheric environmental conditions (within the reactor confinement module building) within appropriate safety margins following a DBE.

Technical Requirements Manual Section 3.6 will describe for Confinement Module HVAC systems availability requirements.

See FSAR Chapter 6, Section 2, and Section 7 for a description of the passive reactor confinement module building heat removal system.

FSAR Chapter 1, Appendix A, which will describe Atomic Alchemy's compliance with Regulatory Guide 1.7, 1.27, and Regulatory Guide 1.157.

A-39.0 GDC CRITERION 39 – INSPECTION OF CONTAINMENT HEAT REMOVAL SYSTEM

The containment heat removal system shall be designed to permit appropriate periodic inspection of important components, such as the torus, sumps, spray nozzles and piping, to assure the integrity and capability of the system.

A-39.1 PDC CRITERION 39 DEPARTURE – INSPECTION OF CONFINEMENT HEAT REMOVAL SYSTEM

The confinement heat removal system shall be designed to permit appropriate periodic inspection of important components to assure the integrity and capability of the system.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 39 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy departs from the language of the 10 CFR 50 Appendix A General Design Criterion 39 requirement of a periodic inspection since in the NPUF design, the confinement heat removal system is a passively designed system.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to the re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The Atomic Alchemy design uses a passive system for post loss of coolant DBE transient heat removal from the atmosphere of the confinement module building as described in its PDC 38. The system components are designed to permit access for periodic inspection of equipment, according to the ASME Code and technical specification requirements to provide confidence in the integrity and capability of the system.

FSAR Chapter 6, Section 7 will describe the inspection of components that comprise the reactor confinement module building passive heat removal system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27.

A-40.0 GDC CRITERION 40 – TESTING OF CONTAINMENT HEAT REMOVAL SYSTEM

The containment heat removal system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak tight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole, and, under conditions as close to the design as practical the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.

A-40.1 PDC CRITERION 40 DEPARTURE – TESTING OF CONFINEMENT HEAT REMOVAL SYSTEM

The confinement environmental heat removal system shall be designed to permit appropriate periodic functional testing to assure (1) the structural and leak tight integrity of its components, and (2) the operability and performance of the active components of the system.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 40 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy departs from the language of General Design Criterion 40 periodic functional testing requirements of the confinement heat removal systems since these are passively designed systems in the Atomic Alchemy NPUF.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The Atomic Alchemy design uses a passive system for post loss of coolant DBE transient heat removal in the confinement module building as described in Atomic Alchemy's PDC 38. The system relies upon natural convection and condensation to occur within the confinement module building to reduce internal pressure of the building. Initial testing verification of the heat transfer capability of the passive confinement heat removal system is performed by conducting a natural air-flow circulation test. This test is conducted during hot functional testing of the RCS system.

FSAR Chapter 6, Section 7 will describe the inspection of components that comprise the confinement module building heat removal system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27.

A-41.0 GDC CRITERION 41 – CONTAINMENT ATMOSPHERE CLEANUP

Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided, as necessary, to reduce, consistent with the functioning of other associated systems, the concentration and quantity of fission products released to the environment following postulated accidents and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Each system shall have suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure.

A-41.1 PDC CRITERION 41 DEPARTURE – CONFINEMENT MODULES ATMOSPHERE CLEANUP

Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor confinement, radioisotope related processes, and radwaste module buildings shall be provided, as necessary, to reduce, consistent with the functioning of other associated systems, the concentration and quantity of fission products released to the environment following postulated DBE transients and to control the concentration of hydrogen or oxygen and other combustible substances in these modules' atmosphere following postulated transients to assure that module's building integrity is maintained.

Each system shall have suitable redundancy in components and features and suitable interconnections, leak detection, isolation, and confinement capabilities to assure that its safety function can be accomplished, assuming a single failure.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 41 as presented in this PDC Departure.

Atomic Alchemy Departure

The atmosphere cleanup systems of the Atomic Alchemy NPUF have no safety-related post-accident cleanup functions. Atomic Alchemy re-defines the containment boundary for the VIPRs as a "confinement boundary". This is described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

As a further conservatism, Atomic Alchemy will apply its PDC 41, PDC 42 and PDC 43 criterion to the radioisotope production process module, target fabrication module and radwaste module buildings as they each may present a potential for a release of radioactive products to the environment following postulated transients described in the FSAR Chapter 15 accident analysis.

Atomic Alchemy Compliance

The Atomic Alchemy's atmosphere fission products control strategy does not require onsite or offsite AC power and does not depend on active systems to remove airborne particulates or elemental iodine from the confinement atmospheres of the Reactor Module, Radioisotope Production Process Module, Target Fabrication Module, or Radwaste Module following a postulated transient in any of these building modules. Atomic Alchemy fission product control is provided via natural removal processes such as deposition and sedimentation within the reactor confinement module, the radioisotope production process module, and radwaste module buildings and by limiting the module building's leakage. These naturally occurring removal processes provide significant removal capability such that airborne elemental iodine is reduced to very low levels within a few hours and the airborne particulates are reduced to extremely low levels within 12 hours following a postulated DBE in any module.

The Atomic Alchemy Reactor Confinement Module, Radioisotope Production Process Module, Target Fabrication Module, and Radwaste Module buildings do not require engineered safety feature (ESF) atmosphere cleanup systems to meet limits on doses offsite or onsite. The reactor Confinement Air Filtration System (RCF), Radioisotope Production Process Module Air Filtration Systems (PMF), Mo-99 Target Fabrication Module Air Filtration system (TPF), and the Radwaste Module Air Filtration system (WHF) are non-safety-related systems. The purpose of these filter ventilation systems is to control normal operating releases. These systems may also be powered by the non-safety-related Diesel Generators. The RCF, PMF, TPF, and WHF systems are not required for any post-accident scenarios.

The generation of hydrogen in the reactor confinement module or within the radioisotope production process modules under post-accident conditions has been preliminarily evaluated. The Atomic Alchemy combustible atmosphere product control strategy also does not require onsite or offsite AC power and does not depend on active systems to remove combustible gases. The concentration of uniformly distributed hydrogen produced by the equivalent of a 75 percent active fuel-clad metal water reaction should not exceed 13% by volume during and following any postulated degraded core event. Similarly, there is no credible transient that can occur within the radioisotope production related processes (i.e., battery charging rooms) that could produce a significant amount of combustible gases. At this point in the preliminary design, the potential for hydrogen or combustible gas buildup greater than 10% will not be a credible transient in the Atomic Alchemy FSAR Chapter 15 accident analysis. However, for the purposes of conservatism, and good business practice, at this preliminary design phase, a safety-related combustion gas monitoring system is employed. The non-safety-related fire protection smoke exhaust system can be utilized to purge any combustible gases, and natural convection will minimize any accumulation of combustible gases inside the confinement module, radioisotope production process module, or radwaste module buildings.

FSAR Chapter 15, Appendix B- "Removal of Airborne Activity from the Reactor Confinement Module Atmosphere Following a Design Basis Event", and FSAR Chapter 15, Appendix C - "Removal of Airborne Activity from the Radioisotope Production Process Module, Radioisotope Target Fabrication Module and Radwaste Processing Module Atmosphere Following a Design Basis Event" will describe the Atomic Alchemy atmosphere cleanup methodology in detail.

FSAR Chapter 9, Section 4 will describe the components that comprise the reactor confinement module, reactor auxiliary module, radioisotope production process module and radwaste module building air filtration systems.

For hydrogen related issues, FSAR Chapter 1, Appendix D, will describe Atomic Alchemy's compliance with Generic Safety Issues, Section 2.0 - Task Action Plan Items, and Section 3.0 – New Generic Issues

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.7, and 1.52.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(6).

A-42.0 GDC CRITERION 42 – INSPECTION OF CONTAINMENT ATMOSPHERE CLEANUP SYSTEM

The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components such as filter frames, ducts, and piping, to assure the integrity and capability of the systems.

A-42.1 PDC CRITERION 42 DEPARTURE – INSPECTION OF CONFINEMENT MODULES ATMOSPHERE CLEANUP SYSTEMS

The confinement atmosphere cleanup systems of each confinement module shall be designed to permit appropriate periodic inspection of important components and to assure the integrity and capability of the systems.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 42 as presented in this PDC Departure.

Atomic Alchemy Departure

As previously described in the Atomic Alchemy's PDC 41, the atmosphere cleanup systems have no safety-related post-accident cleanup functions. Atomic Alchemy therefore departs from the language of 10 CFR 50 Appendix A General Design Criterion 42 requirement on the basis that it is not applicable.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining containment is addressed in PDC 16.

As a further conservatism, Atomic Alchemy will apply its PDC 41, PDC 42 and PDC 43 criterion to the Radioisotope Production Process module, Target Fabrication Module and Radwaste module buildings as they each may present a potential for a release of radioactive products to the environment following postulated DBE transients described in the FSAR Chapter 15 accident analysis.

Atomic Alchemy Compliance

Dose mitigation is passively provided by the confinement module, radioisotope module, target fabrication, and radwaste module building isolation and integrity, natural removal processes, and limited module building leakage.

For conservatism, and good business practice, however Atomic Alchemy intends to perform inspections for component integrity, availability of active components, availability of these systems (RCF, PMF, TPF and WHF) as a whole, and performance of the sequence that brings the system into operation as permittable. Further, Atomic Alchemy will determine which non-safety-related filtration systems and components will fall within the scope of the Atomic Alchemy 10 CFR 50.65(b) program.

FSAR Chapter 9, Section 4 will describe the periodic inspection of the components that comprise the confinement, radioisotope production process module, and radwaste module building air filtration systems.

FSAR Chapter 13, Appendix A, will describe the Atomic Alchemy Maintenance Rule program.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.7, and 1.52.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(8).

A-43.0 GDC CRITERION 43 – TESTING OF CONTAINMENT ATMOSPHERE CLEANUP SYSTEMS

The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves, and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems.

A-43.1 PDC CRITERION 43 DEPARTURE – TESTING OF CONFINEMENT MODULES ATMOSPHERE CLEANUP SYSTEMS

The confinement atmosphere cleanup systems of each confinement module shall be designed to permit appropriate periodic functional testing to assure (1) the structural and leak-tight integrity of its components, and (2) the operability and performance of the active components of the systems.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 43 as presented in this PDC Departure.

Atomic Alchemy Departure

As previously described in the Atomic Alchemy's PDC 41, the atmosphere cleanup systems have no safety-related post-accident cleanup functions.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure with respect to re-defining containment for this PDC is addressed in PDC 16.

As a further conservatism, Atomic Alchemy will apply its PDC 41, PDC 42 and PDC 43 criterion to the Radioisotope Production Process module, Target Fabrication Module and Radwaste module buildings as they each may present a potential for a release of radioactive products to the environment following postulated DBE transients described in the FSAR Chapter 15 accident analysis.

Atomic Alchemy Compliance

Dose mitigation is passively provided by the Reactor Confinement module, Radioisotope module, Target Fabrication module, and Radwaste module building isolation and integrity, natural removal processes, and limited module building leakage.

However Atomic Alchemy intends to perform functional testing for component integrity, availability of active components, availability of the system as a whole, and performance of the sequence that brings the system into operation. Atomic Alchemy will determine which non-safety-related components will fall within the scope of the Atomic Alchemy 10 CFR 50.65(b) program.

FSAR Chapter 9, Section 4 will describe the periodic inspection of the components that comprise the confinement, radioisotope production process module and radwaste module building air filtration systems.

FSAR Chapter 13, Appendix A, and the QAPD will describe the Atomic Alchemy Maintenance Rule program.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.7, 1.52 and 1.163.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(8).

A-44.0 GDC CRITERION 44 – COOLING WATER

A system to transfer heat from structures, systems, and components important to safety to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished assuming a single failure.

Atomic Alchemy Position

Atomic Alchemy will not adopt this 10 CFR 50 Appendix A GDC 44 for its PDC because the NPUF design does not have this system. Atomic Alchemy includes this discussion in this TR as part of the regulatory gap analysis.

Atomic Alchemy Departure

The Atomic Alchemy facility design does not have a containment vessel or containment type structure. As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining containment boundary is addressed in PDC 16.

The VIPR core is located in open-to-atmosphere light-water pool (along with the spent fuel) within a concrete and steel confinement module building. The light-water pool is the ultimate heat sink for the Atomic Alchemy reactor confinement module building. Atmospheric heat within the confinement module building is removed by condensation and convection from the building structure. The intent of 10 CFR 50 Appendix A GDC 44 is met by PDC 38.

The building will be maintained at -0.25 W.G. with respect to the other contiguous facility areas and the environment under all wind conditions up to the wind speed at which diffusion becomes sufficient to assure site boundary exposures less than those calculated for the design basis event even if exfiltration occurs.

The reactor and spent fuel light-water pool can be cooled without onsite or offsite AC electric power. There are no additional safety-related active components performing cooling functions other than the RCS system (during normal operations) and the DHR system (during any transient conditions).

The ventilation cooling systems, Reactor Confinement Module HVAC System (RCV) and the Reactor Confinement Module Re-Circulating Sensible Cooling/Heating System (RCX) are redundant non-safety-related systems that perform cooling/heating functions during normal operations.

The Atomic Alchemy ultimate heat sink does not rely on any external natural sources of water. Additionally, Atomic Alchemy has conservatively added a ECC type of system, designated as Reactor Decay Heat Removal (DHR). Emergency shutdown can utilize the cool water from the molybdenum[99] target transfer light-water canal system (TTW) as an "emergency core cooling" type of system. The target transfer light-water canal is a passive seismically designed Cat-I system to meet this requirement (as described in PDC 35).

Additionally, the TTW system also includes a makeup water storage tank with the capacity to refill the transfer canal by operator action if needed.

Any postulated transient-initiated temperature or pressure buildup within the radioisotope production process module building or radwaste module building will also be mitigated by condensation and convection alone without onsite or offsite AC power. Any temperature or pressure transients that are initiated in the radioisotope module or radwaste module will be evaluated in FSAR Chapter 15, Section 9 for their impact on the reactor module functions.

FSAR Chapter 6, Section 2 will describe the inspection of components that comprise the confinement module, radioisotope production process module, and radwaste module building heat removal systems.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27.

A-45.0 GDC CRITERION 45 – INSPECTION OF COOLING WATER SYSTEM

The cooling water system shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the system.

Atomic Alchemy Position

Atomic Alchemy will not adopt 10 CFR 50 Appendix A GDC 45 for its PDC because the NPUF design does not have this system. Atomic Alchemy includes this discussion in this TR as part of the regulatory gap analysis.

Atomic Alchemy Departure

The Atomic Alchemy facility design only uses passive safety-related methods for post loss of coolant transient heat removal in the reactor confinement module building. Therefore, Atomic Alchemy departs from the language of this 10 CFR 50 Appendix A General Design Criterion 45 requirement for periodic inspections of "components such as HX's, piping and pumps etc." as it is not applicable to the Atomic Alchemy passive design features.

The reactor confinement structure is Seismic Cat-I, built to ACI 349, and AISC-N690 standards. The passive safety system relies upon natural convection and condensation to occur within the reactor confinement module building to reduce internal pressure of the building.

Initial inspection verification of the heat transfer capability of the passive confinement heat removal system is performed by conducting a natural circulation test. This test is conducted during hot functional testing.

Atomic Alchemy does intend to perform periodic inspections for component structure integrity. FSAR Chapter 13, Appendix A will describe the structures monitoring program, and Atomic Alchemy will determine if any non-safety-related components fall within the scope of 10 CFR 50.65(b).

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27.

A-46.0 GDC CRITERION 46 – TESTING OF COOLING WATER SYSTEM

The cooling water system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and the performance of the active components of the system, and (3) the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss of coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

Atomic Alchemy Position

Atomic Alchemy will not adopt 10 CFR 50 Appendix A GDC 46 for its PDC because the NPUF design does not have this system. Atomic Alchemy includes this discussion in this TR as part of the regulatory gap analysis.

Atomic Alchemy Departure

The Atomic Alchemy facility design only uses passive safety-related methods for post loss of coolant transient heat removal in the confinement module building. Therefore, Atomic Alchemy departs from the language to perform periodic "full operational" functional testing of "protection I&C systems, transfer of between power sources etc." as it is not applicable to the Atomic Alchemy passive design methodology.

The reactor confinement structure is Seismic Cat-I, built to ACI 349, and AISC-N690 standards. The cooling system relies upon natural convection and condensation to occur within the confinement module building to reduce internal pressure of the building. Initial testing verification of the heat transfer capability of the passive confinement heat removal system is performed by conducting a natural circulation test. This test will be conducted during hot functional testing of the RCS system.

Atomic Alchemy does intend to perform periodic tests for component structure integrity. FSAR Chapter 13, Appendix A will describe the structures monitoring program, and Atomic Alchemy will determine if any non-safety-related components fall within the scope of 10 CFR 50.65(b).

FSAR Chapter 13, Appendix A will describe the Atomic Alchemy Maintenance Rule program.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27.

A-50.0 GDC CRITERION 50 – CONTAINMENT DESIGN BASIS

The reactor containment structure, including access opening, penetrations, and the containment heat removal system, shall be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss of coolant accident. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as energy in steam generators and energy from metal-water and other chemical reactions that may result from degraded emergency core cooling functioning, (2) the limited experience and experimental data available for defining accident phenomena and containment responses, and (3) the conservatism of the calculational model and input parameters.

A-50.1 PDC CRITERION 50 DEPARTURE – CONFINEMENT DESIGN BASIS

The reactor confinement module, radioisotope production process related modules, and radwaste module structure, including access opening, penetrations, and any heat removal system, shall be designed so that these confinement structures and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss of coolant DBE transient or other radioisotope process related DBE transient. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as energy from chemical reactions or radioisotope exothermic processes, (2) the limited experience and experimental data available for defining transient phenomena and confinement responses, and (3) the conservatism of the calculational model and input parameters.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 50 as presented in this PDC Departure.

Atomic Alchemy Departure

The typical ALWR, PWR, and BWR reactor containment building structure and vessel critical pressures, leakage rates and temperatures criterion are not applicable to the design of the Atomic Alchemy reactor confinement module building. An over pressurization event caused by a pipe rupture within the reactor confinement module or any type of similar DBE transient within the reactor auxiliary module, radioisotope module, or radwaste module buildings that can challenge the structural integrity of these buildings are not credible transient events in the FSAR Chapter 15 accident analysis.

Atomic Alchemy expands the requirement of this PDC to the reactor auxiliary module, radioisotope production process module, target fabrication module, and radwaste module structures in addition to the reactor confinement module.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to the re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The design of the reactor confinement module, reactor auxiliary module, radioisotope production process module, target fabrication module, and radwaste module buildings prevents the rapid, uncontrolled release of radioactive material to the environment. The Atomic Alchemy module buildings establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the design conditions important to safety are not exceeded for as long as postulated transient conditions require.

The design of the reactor confinement module, reactor auxiliary module, radioisotope production process module, target fabrication module, and radwaste module structures are based on their respective design basis events, which conservatively included the rupture of reactor coolant piping and loss of coolant for the reactor confinement and reactor auxiliary modules. These five buildings are constructed to Seismic Cat-I, built to ACI 349, and AISC-N690 standards. The maximum pressure and temperature reached, a description of the calculational model, and input parameters for the reactor confinement module building design basis events will be presented in FSAR Chapter 15, Table 15.7-01.

The reactor confinement module, reactor auxiliary, radioisotope production process module, target fabrication module and radwaste module buildings are capable of maintaining a negative pressure in relation to the outside atmosphere during normal operation and will have a measurable leakage rate less than 5% over 24 hours.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.27, 1.29, 1.82, and Regulatory Guide 1.141.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(9).

A-51.0 GDC CRITERION 51 – FRACTURE PREVENTION OF CONTAINMENT PRESSURE BOUNDARY

The reactor containment boundary shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the containment boundary material during operation, maintenance, testing, and postulated accident conditions, and the uncertainties in determining (1) material properties, (2) residual, steady-state, and transient stresses, and (3) size of flaws.

A-51.1 PDC CRITERION 51 DEPARTURE – FRACTURE PREVENTION OF A CONFINEMENT BOUNDARY

The reactor confinement module, radioisotope production process related modules and radwaste module confinement boundaries shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated transient conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of conditions of the confinement boundary material during operation, maintenance, testing, and postulated transient conditions, and the uncertainties in determining (1) material properties, (2) residual, steady-state, and transient stresses, and (3) size of flaws.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 51 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy expands the requirement of this PDC to the reactor auxiliary module, radioisotope production process module, target fabrication module, and radwaste module structures in addition to the reactor confinement module structure.

Atomic Alchemy Compliance

The Atomic Alchemy design follows the code requirements for nuclear safety-related structures of ACI-349 and AISC-N690, thereby reducing the probability of fracture propagation. The concrete and steel module building walls are designed for dead, live, thermal, pressure, safe shutdown earthquake, and conservatively, loads due to postulated pipe breaks.

The Atomic Alchemy confinement design will apply the ASME Section III, Division 1, Class MC (Metal Containment) and/or Section III, Division 2, Class CC (concrete containment) fracture toughness testing requirements to the reactor confinement module and radioisotope production process module building materials as applicable. This will be further evaluated and subsequently detailed in the procurement and construction specifications.

The VIPR is located within an open to atmosphere light-water pool which has an aluminum liner. For similar material surveillance type programs see FSAR Chapter 13, Appendix A and QAPD will describe Atomic Alchemy's "Material Control and Accountability Program", Reactor Light-water Pool Liner Inspection", and the "Reactor Coolant Piping Material Inspection Program".

FSAR Chapter 3, Section 8 will describe the seismic category I structures and systems.

A-52.0 GDC CRITERION 52 – CAPABILITY FOR CONTAINMENT LEAKAGE RATE TESTING

The reactor containment and other equipment which may be subjected to containment test conditions shall be designed so that periodic integrated leakage rate testing can be conducted at containment design pressure.

A-52.1 PDC CRITERION 52 DEPARTURE – CAPABILITY FOR CONFINEMENT LEAKAGE RATE TESTING

The reactor confinement, radioisotope process module, and other selected components which may be subjected to potential leakage conditions shall be designed so that periodic integrated leakage rate testing can be conducted at their respective confinement bounding design pressures.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 52 as presented in the Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPRs as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

At this preliminary design phase, Atomic Alchemy extends the criteria for leakage testing to include the confinement boundary of the radioisotope production process module building in addition to the reactor confinement module building along with specific (yet to be determined) systems and/or components (e.g., pneumatic conveying system, hot cells, glove boxes etc.).

Atomic Alchemy Compliance

Atomic Alchemy will develop a leakage test of the boundaries of the reactor confinement and radioisotope process module buildings to be developed similar to 10 CFR Part 50, Appendix J, Option B with leak detection, isolation, and performance testing capabilities, this will be provided in the Technical Specifications LCO 3.6.7 and LCO 3.6.14 for confinement module building and radioisotope module building, respectively.

Atomic Alchemy will also develop test intervals, pre-test inspections, and as found inspections as part of the leakage tests, which will be provided in the Technical Specifications.

FSAR Chapter 3, Section 8 will describe the leakage testing requirements for the reactor confinement module building, radioisotope module building and other systems and components.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.11, 1.26, 1.141, and Regulatory Guide 1.163.

A-53.0 GDC CRITERION 53 – PROVISIONS FOR CONTAINMENT TESTING AND INSPECTION

The reactor containment shall be designed to permit (1) appropriate periodic inspection of all important areas, such as penetrations, (2) an appropriate surveillance program, and (3) periodic testing at containment design pressure of the leak-tightness of penetrations which have resilient seals and expansion bellows.

A-53.1 PDC CRITERION 53 DEPARTURE – PROVISIONS FOR CONFINEMENT TESTING AND INSPECTION

The reactor confinement module and radioisotope process module shall be designed to permit (1) appropriate periodic inspection of all important areas, such as penetrations, (2) an appropriate surveillance program, and (3) periodic testing at their respective confinement design pressures of the leak-tightness of penetrations which have resilient seals and/or expansion bellows.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 53 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPRs as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

At this preliminary design phase, Atomic Alchemy extends the criteria to include the confining boundary of the radioisotope production process module building in addition to the reactor confinement module building along with specific (yet to be determined) systems and/or components (e.g., pneumatic conveying system, hot cells, glove boxes etc.).

Atomic Alchemy Compliance

Atomic Alchemy will develop a leakage test of penetrations of the reactor confinement and radioisotope building modules to be developed similar to 10 CFR Part 50 Appendix J, Option B with leak detection, isolation, and performance testing capabilities, this will be provided in the Technical Specifications, (or possibly moved to TRM if determined appropriate). Atomic Alchemy will establish conservative limits on the total fraction of allowable reactor confinement module building leakage. The technical specifications (or possibly moved to the TRM) will also specify periodic testing to detect bypass leakage paths, determine leakage rates, and verify operability of the reactor confinement module building. Tentatively at the preliminary design phase, these requirements have been placed in the Technical Specifications.

Technical Specifications LCO 3.6.1 – Reactor Coolant System, LCO 3.6.8 – Radioisotope Production Process System, and Administrative Controls Section 5.6 - Programs, will describe testing and inspection requirements for the reactor confinement module building, radioisotope production process module building and other necessary (to be determined) systems and components.

A-54.0 GDC CRITERION 54 – PIPING SYSTEMS PENETRATING CONTAINMENT

Piping systems penetrating the primary reactor containment shall be provided with leak detection, isolation and containment capabilities having redundancy, reliability, and performance capabilities which reflect the importance to safety of isolating these piping systems. Such piping systems shall be designed with a capability to test periodically the operability of the isolation valves and associated apparatus and to determine if valve leakage is within acceptable limits.

A-54.1 PDC CRITERION 54 DEPARTURE – SYSTEMS PENETRATING REACTOR CONFINEMENT

Liquid, Solid or Gaseous Systems penetrating the reactor confinement module shall be provided with isolation and confinement capabilities having redundancy, reliability, and performance capabilities which reflect the importance to safety of isolating these systems. The RCS system shall also be provided with leak detection. Such systems shall be designed with a capability to test periodically the operability of the isolation valves and dampers and associated apparatus and to determine if valve and/or damper leakage is within acceptable limits.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 54 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

At this preliminary design phase, Atomic Alchemy extends the criteria to include specific (yet to be determined) liquid, solid or gaseous systems (e.g., pneumatic conveying system, cascade ventilation exhaust etc.) that penetrate the reactor confinement module building.

Atomic Alchemy does not extend the requirements for leak detection to systems penetrating the confinement boundary of the radioisotope production process module, target fabrication module or radwaste module buildings. These piping or ductwork system penetrations will however be designed to meet the requirements of Atomic Alchemy PDC 57 for isolation. This design philosophy is consistent with applying less stringent requirements due to reduced level of risk and challenges to NPUF system and components' safety limits.

Atomic Alchemy Compliance

The Atomic Alchemy design incorporates a significant reduction in the number of penetrations between the reactor confinement module and the reactor auxiliary module and radioisotope production module buildings, respectively.

The reactor coolant piping system passes between the light-water pool located in the reactor confinement module and reactor auxiliary module buildings in a water-tight pipe chase.

The Atomic Alchemy technical specifications will establish conservative limits on the total fraction of reactor coolant leakage. The technical specifications also specify periodic testing to detect bypass leakage paths, determine leakage rates, and verify operability of the reactor coolant system isolation valves.

The VIPR design also utilizes a pneumatic "rabbit" tubing conveying system (Seismic Cat-II) to transport radioisotope samples from inside the reactor pool (located inside the reactor confinement module) to the radioisotope production process module building. Once inside the radioisotope production process module building, the samples are collected inside an isolated chamber (under negative pressure with respect to the process module environment) and subsequently re-routed to hot cells for processing. These tubing/pipes are provided with isolation mechanisms that automatically close on an ESF isolation signal inside the confinement module and immediately outside the confinement module.

Each reactor confinement module building is connected to the radioisotope production process module building via a common light-water transfer canal (TWW system). For the purpose of this PDC, this will be conservatively considered as a piping system penetration, as it connects to the primary reactor coolant water in the light-water pool. The portion of the canal system within the radioisotope production process building is separated by series of water-tight combination gates/air locks from the reactor confinement module building portion of the canal.

The Atomic Alchemy confinement piping penetration design will satisfy the current NRC requirements including the post-TMI requirements (which will be discussed in FSAR Chapter 1, Appendix C (Compliance with 10 CFR 50.34(f)) and FSAR Chapter 1, Appendix D (Compliance with Generic Safety Issues)).

In general, this means that for all piping/tubing/canals two barriers are provided, one inside the reactor confinement and the other outside the reactor confinement. In the Atomic Alchemy design these barriers are either automatic valves, automatic shut-off devices, or automatic canal gates, but in some cases, they are closed piping or pneumatic tubing systems not connected to the reactor coolant system or to the confinement atmosphere.

Reactor Confinement module isolation valves/dampers close automatically on a confinement isolation signal. The confinement isolation signal is actuated by the protection and safety monitoring system (IMS).

FSAR Chapter 7, Section 3 will describe the functional design of the IMS system.

FSAR Chapter 3, Section 2 will describe the functional design of the radioisotope target transfer canal system (TTW).

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.163.

A-55.0 GDC CRITERION 55 – REACTOR COOLANT PRESSURE BOUNDARY PENETRATING CONTAINMENT

Each line that is part of the reactor coolant pressure boundary and that penetrates primary reactor containment shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

1. *One locked closed isolation valve inside and one locked closed isolation valve outside containment; or*
2. *One automatic isolation valve inside and one locked closed isolation valve outside containment; or*
3. *One locked closed isolation valve inside and one automatic isolation valve outside the containment. A simple check valve may not be used as the automatic isolation valve outside containment; or*
4. *One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment.*

Isolation valves outside containment shall be located as close to containment as practical and, upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these lines or of lines connected to them shall be provided, as necessary, to assure adequate safety. Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for in-service inspection, protection against more severe natural phenomena, and additional isolation valves and containment, shall include consideration of the population density, and use characteristics, and physical characteristics of the site environs.

A-55.1 PDC CRITERION 55 DEPARTURE – REACTOR COOLANT BOUNDARY PENETRATING REACTOR CONFINEMENT

Each line that is part of the reactor coolant boundary and that penetrates the reactor confinement module shall be provided with confinement isolation valves as follows, unless it can be demonstrated that the confinement isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

1. One locked closed isolation valve inside and one locked closed isolation valve outside confinement; or
2. One automatic isolation valve inside and one locked closed isolation valve outside confinement; or
3. One locked closed isolation valve inside and one automatic isolation valve outside the confinement; or
4. One automatic isolation valve inside and one automatic isolation valve outside confinement.

Isolation valves outside confinement shall be located as close to confinement barrier as practical and, upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these lines or of lines connected to them shall be provided, as necessary, to assure adequate safety.

Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for in-service inspection, protection against more severe natural phenomena, and additional isolation valves and confinement, shall include consideration of the population density, and use characteristics, and physical characteristics of the site environs.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 55 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy departs from the language of the 10 CFR 50 Appendix A General Design Criterion 55 requirement of isolation for the RCS boundary that penetrates the reactor confinement boundary and will demonstrate an alternative basis of conformance to the intent of the GDC.

As an NPUF, Atomic Alchemy re-defines the reactor coolant pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to re-defining a pressure boundary is addressed in PDC 14.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining the containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The Atomic Alchemy reactor coolant piping system is an open-to-atmosphere system, routed between the light-water pool located in the reactor confinement module and the reactor auxiliary module buildings in a water-tight piping chase. Over pressurization of the RCS piping is therefore not a credible transient in the FSAR Chapter 15 accident analysis.

There are no locked closed isolation valves or automatic power operated isolation valves in the RCS system. (There are small-bore piping RCS lines carrying primary coolant outside the confinement module building, e.g., sample lines and CVC piping to/from the chemical and volume control system. These lines are used only periodically and are provided with automatic isolation valves inside and outside of the confinement module building). The RCS system utilizes two check valves in series whose function is to close on reversal of flow between the Light-water Pool and the RCS pumps. The maximum counter flow pressure exerted on a closed RCS check valve would be the equivalent static head of the depth of the light-water pool, which is easily bounded by the design performance of the safety-related check valve. Therefore, these valves can be relied upon in performing the automatic isolation design function inside and outside of the confinement module building.

To minimize the probability of an occurrence and the subsequent consequences of an accidental rupture, the RCS piping design will incorporate piping bends instead of welded fittings, thus reducing the overall number of welds subject to rupture or leakage.

Similarly, a higher quality in design, fabrication, as well as testing will be provided to minimize this risk.

The components in the Reactor Coolant System (RCS) are Atomic Alchemy Equipment Safety Class A (equivalent to ANS Safety Class 1), Quality Group A, and are designed and fabricated according to ASME Code Section III, Class 1. Atomic Alchemy also uses a "leak before break" analysis of ASME Section III Class 1 and Class 2 piping.

The qualification program for check valves that are part of the reactor coolant boundary shall include testing or analysis that demonstrate that these valves will not experience leakage beyond the design criteria when subjected to design loading.

A piping rupture hazards analysis will also be performed on high and medium energy secondary piping systems that connect to the RCS system.

The Atomic Alchemy Technical Specifications will establish conservative limits on the total volume of acceptable RCS leakage in the RCS piping chases.

Additional measures for leak detection will also be provided, Atomic Alchemy will provide a leakage test of the reactor coolant system boundaries and piping chases to be developed similar to Appendix J, Option B with leak detection, isolation, and performance testing capabilities, this will be provided in the Technical Specifications.

Based on the above design elements, the reactor coolant boundary (penetrating the confinement boundary) design conforms with the intent of GDC 55 to minimize the probability or consequences of an accidental rupture of RCS piping that passes in/out of the reactor confinement module building.

Technical Specifications LCO 3.3 will describe the RCS operational leakage and leak detection instrumentation.

Atomic Alchemy Technical Requirements Manual, Section 5.6.7 will describe the Reactor Coolant Heat Exchanger Inspection Program

FSAR Chapter 15, Section 7 will describe credible transients of the RCS system.

FSAR Chapter 5, Sections 3 and 4 will describe the RCS system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.50 and 1.141.

A-56.0 GDC CRITERION 56 – PRIMARY CONTAINMENT ISOLATION

Each line that connects directly to the containment atmosphere and penetrates the primary reactor containment shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

1. *One locked closed isolation valve inside and one locked closed isolation valve outside the containment; or*
2. *One automatic isolation valve inside and one locked closed isolation valve outside the containment; or*
3. *One locked closed isolation valve inside and one automatic isolation valve outside the containment. A simple check valve may not be used as the automatic isolation valve outside containment; or*
4. *One automatic isolation valve inside and one automatic isolation valve outside the containment. A simple check valve may not be used as the automatic isolation valve outside the containment.*

Isolation valves outside the containment shall be located as close to the containment as practical and, upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

A-56.1 PDC CRITERION 56 DEPARTURE – REACTOR CONFINEMENT ISOLATION

Each line that connects directly to the reactor confinement module atmosphere or light-water pool and penetrates the primary reactor confinement module building shall be provided with confinement isolation valves or dampers as follows, unless it can be demonstrated that the confinement isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

1. One locked closed isolation valve or damper inside and one locked closed isolation valve or damper outside the confinement; or
2. One automatic isolation valve or damper inside and one locked closed isolation valve or damper outside the confinement; or
3. One locked closed isolation valve or damper inside and one automatic isolation valve or damper outside the confinement; or
4. One automatic isolation valve or damper inside and one automatic isolation valve or damper outside the confinement.

Isolation valves or dampers outside the confinement shall be located as close to the confinement as practical and, upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 56 as presented in this PDC Departure.

Atomic Alchemy Departure

Over pressurization of the Reactor Confinement Module (RCM) building by a LOCA is not a credible transient in the FSAR Chapter 15 accident analysis.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to a re-defining a containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

Atomic Alchemy compliance with this PDC for the primary confinement isolation is demonstrated by at least one automatic isolation device located both inside and outside of the confinement module building.

The Reactor Confinement Air Filtration System (RCF) is a non-safety-related, seismic Cat-II system. The purpose of the filtration system is to control normal operating releases and assist in maintaining a negative pressure with respect to the environment and adjacent module buildings. It is not provided for transient mitigation or for confinement module isolation. The RCF system ductwork provides a transfer duct that permits air to cascade from the RCM module building to the PPM module building. The RCF system can be isolated by any combination of the following 3 devices, a motorized barometric damper, a normally open motorized isolation damper (fail closed) both of which are located inside the RCM building and a passive backdraft damper located within the PPM building.

The Reactor Auxiliary Module Cascade Exhaust System (RAE) is a non-safety-related, seismic Cat-II system. The purpose of the filtration system is to control normal operating releases and assist in maintaining a negative pressure with respect to the environment. It is also not necessary for transient mitigation or confinement isolation. RAE system ductwork provides a transfer duct that permits air to cascade from the RAM building to the RCM building, it can also be isolated by a combination of the following 3 devices, a motorized barometric damper, a normally open motorized isolation damper (fail closed) both of which are located inside the RCM building and a passive backdraft damper located within the RAM building.

A higher quality in design, fabrication, and testing will be provided for the RAE and RCF systems.

Atomic Alchemy intends to perform pre-operational functional testing of the RCF and RAE systems for component integrity, availability of active components, availability of the system as a whole and performance of the sequence that brings the system into operation.

The RCF and RAE ductwork will be automatically isolated by a signal from the radiation monitors located inside the confinement and auxiliary module areas. Ductwork radiation monitors provide an alarm signal to the control room for initiation of operator manual isolation.

The motorized ductwork Isolation devices will close automatically on receipt of engineered safety features confinement isolation signal. These devices will close in 60 seconds or less. This closure time frame is consistent with the physically based source term for non-power reactors.

Electrical containment penetrations are equipped with test connections and test vents or have other provisions to allow periodic leak rate testing so that leakage is within the acceptable limits established in Technical Specifications (or in the TRM).

Based on the above, the Atomic Alchemy design conforms with the intent of GDC 56 as described in the Departure PDC 56.

FSAR Chapter 9, Section 4 will describe the functional design of the RCF system.

FSAR Chapter 9, Section 4 will describe the functional design of the RAE system.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.141.

A-57.0 GDC CRITERION 57 – CLOSED SYSTEM ISOLATION VALVES

Each line that penetrates the primary reactor containment and is neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere shall have at least one containment isolation valve which shall be either automatic, locked closed, or capable of remote manual operation. This valve shall be outside the containment and located as close to the containment as practical. A simple check valve may not be used as the automatic isolation valve.

A-57.1 PDC CRITERION 57 DEPARTURE – CLOSED SYSTEM ISOLATION VALVES OR DAMPERS

Each line that penetrates the primary reactor confinement module and is neither part of the reactor coolant boundary/light-water pool nor connected directly to the reactor confinement module atmosphere shall have at least one isolation valve or damper which shall be either automatic, locked closed, or capable of remote manual operation. This valve or damper shall be located outside the reactor confinement module and located as close to the confinement barrier as practical.

Each line that penetrates the confining boundary of the radioisotope production process related modules, or radwaste module not connected directly to the respective module atmosphere shall have at least one isolation valve or damper which shall be either automatic, locked closed, or capable of remote manual operation.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 57 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16 and re-defines the reactor coolant pressure boundary for the VIPR as described in Atomic Alchemy's PDC 14. The basis for the departure for this PDC with respect to re-defining a containment boundary and a pressure boundary are addressed in PDC 16 and PDC 14 departures respectively.

Atomic Alchemy extends the scope of this PDC to also apply this requirement to the radioisotope production process module, target fabrication module, and radwaste module systems and components for isolation capabilities.

Atomic Alchemy Compliance

Lines that penetrate the reactor confinement boundary, and are neither part of the reactor coolant boundary/light-water pool nor connected directly to the reactor confinement module atmosphere are considered closed systems within the reactor confinement module and will be equipped with at least one isolation valve or damper of one of the following types:

a. An automatic isolation valve or damper (this can be a check valve or barometric/ differential pressure type damper)
b. Remote operation valve or damper
c. A locked-closed valve or damper

Lines that penetrate any other module confinement boundaries, and are not connected directly to the atmosphere of the respective module buildings are considered closed systems within these confinement areas and are equipped with at least one isolation valve or damper of one of the following types:

a. An automatic isolation valve or damper (this can be a check valve or barometric/ differential pressure type damper)

b. Remote operation valve or damper
c. A locked-closed valve or damper

This design philosophy is consistent with applying less stringent requirements due to reduced level of risk and challenges to NPUF system and components' safety limits.

FSAR Chapter 3, Section 2 will describe the Atomic Alchemy Quality Group Class C and Class D components.

A-60.0 GDC CRITERION 60 – CONTROL OF RELEASES OF RADIOACTIVE MATERIALS TO THE ENVIRONMENT

The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for the retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

A-60.1 PDC CRITERION 60 DEPARTURE – CONTROL OF RELEASES OF RADIOACTIVE MATERIALS TO THE ENVIRONMENT

The NPUF design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor, radioisotope production related processes and radwaste operations, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for the retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 60 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy will extend the requirements for control of releases of radioactive materials to the environment of PDC 60 to include the radwaste module, target fabrication module, and the radioisotope production process module buildings in addition to applying the requirements to the reactor confinement and reactor auxiliary module buildings.

Atomic Alchemy includes criticality control requirements as appropriate, in PDC 62.

Atomic Alchemy Compliance

Procedural processes and administrative controls are provided to control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, target fabrication, radioisotope production, and radwaste processing including anticipated operational occurrences. These procedural processes and administrative controls also include criticality control features, to prevent a criticality from occurring as well as design features to minimize personnel exposure to hazardous chemicals. Radiological shielding is provided as necessary during radioisotope and target fabrication processes.

The radioactive waste management systems are designed to minimize the potential for a criticality and an inadvertent release of radioactivity from the facility and to provide confidence that the discharge of radioactive wastes is maintained below regulatory limits.

The design of the Reactor Confinement Module (RCM), Reactor Auxiliary Module (RAM), Target Fabrication Module (MTM), Radioisotope Production Process Module (PPM), and Radwaste Module (RWM) buildings prevent the rapid, uncontrolled release of radioactive material to the environment.

The Atomic Alchemy RCM, RAM, MTM, RWM, and PPM buildings establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the design conditions important to safety are not exceeded for as long as postulated transient conditions require.

The Atomic Alchemy facility design does not depend on active or safety-related systems to remove airborne particulates or elemental iodine from the atmosphere of the RCM, RAM, MTM, RWM or PPM buildings following a postulated transient in any module building.

Naturally occurring passive removal processes provide significant removal capability such that airborne elemental iodine is reduced to very low levels within a few hours and the airborne particulates are reduced to extremely low levels within 12 hours.

The gaseous radwaste and liquid radwaste processing systems include continuous radiation monitoring of their discharge paths. Any high radiation detection automatically closes isolation valves in their respective trains.

The Atomic Alchemy Radwaste Program ensures compliance with the 10 CFR 20.1406 requirement that applicants describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment.

Radioactive processing, waste and management structures will be designed to the latest revision of ACI-318 for concrete structures and AISC-S326 for steel structures standards.

All Seismic Category I structures will be designed to the latest revision of AISC-N690. Where appropriate, the design of steel structures will incorporate provisions from the most recent AISC codes.

FSAR Chapter 3 Section 12 will describe hazardous waste and radwaste requirements and compliance with codes and standards.

FSAR Chapter 12, Section 2 will describe the hazardous chemicals that are used or may evolve during the radioisotope production process, along with the provisions to protect workers and the public from exposure.

FSAR Chapter 3, Section 2 will describe the RCM, RAM, MTM, RWM and PPM module buildings.

FSAR Chapter 3, Section 8 will describe the design of Seismic Category I structures.

FSAR Chapter 11, Section 3 will describe the Atomic Alchemy Radwaste Program.

FSAR Chapter 1, Appendix D, will describe Atomic Alchemy's compliance with NUREG-0933, Section 2, Task Action Plans Item A-28, Item A-36, and Item B-3, Section 3, and New Generic Issues, Issue 82, Issue 92, Issue 173, and Issue 202.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.21, 1.26, 1.143, and Regulatory Guide 5.11.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(5) and 10 CFR 70.64(a)(9).

A-61.0 PDC CRITERION 61 – FUEL STORAGE AND HANDLING AND RADIOACTIVITY CONTROL

The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions.

Atomic Alchemy Position

Atomic Alchemy adopts the language of 10 CFR 50 Appendix A GDC 61 with no modifications.

Atomic Alchemy Compliance

The evaluation of applicable similar requirements for radioactivity control of 10 CFR 50 appendix A GDC 61 as applied to the Radwaste Module (RWM), Target Fabrication Module (MTM), and the Radioisotope Production Process Module (PPW) will be described in Atomic Alchemy's departures in PDC 60 and PDC 63.

The compliance for this PDC 61 addresses only the radioactivity containing controls for the reactor fuel storage and reactor fuel handling, which is limited to the RCM building for the purposes of the original 10 CFR 50 Appendix A GDC 61.

Procedural processes and administrative controls will be provided to handle both new fuel and spent fuel during normal reactor operation, including anticipated operational occurrences.

FSAR Chapter 9, Section 1 will describe new fuel, fuel loading, and spent fuel containment and compliance with codes and standards, monitoring, testing, and inspections.

Both the VIPR core and spent fuel are located in a common light-water pool. The spent fuel sits in a lower cavity below the level of the reactor core at the opposite end of the pool from the reactor.

The light-water pool is designed so that a safe water level is maintained above the core and spent fuel assemblies for at least 72 hours following either a small-break or large-break LOCA, that level is sufficient to dissipate decay heat removal without the use of AC power. After 72 hours the light-water pool will continue to dissipate decay heat by natural convection alone for both the reactor core and the spent fuel for 30 days.

The walls of this pool are constructed using modular construction techniques. This allows higher quality than traditional construction. The advanced welding techniques used minimize the potential for weld failures during operation and allow for inspection to verify weld quality.

The pool leak detection system is zoned to allow identification of the area of the light-water pool liner, which is leaking, even for very small leaks.

Sampling of the light-water pool water (and overall RCS system) for gross activity, tritium, and particulate matter is conducted periodically. The concentration of tritium in the spent fuel pool water is maintained at less than (TBD in FSAR) microcuries per gram to provide confidence that the airborne concentration of tritium in the fuel handling area is within the limits specified in 10 CFR 20, Appendix B.

The non-safety-related RCV and RCX HVAC systems provide the radiologically controlled area ventilation for the reactor confinement module building. FSAR Chapter 9, Section 4 will describe these systems. However, no credit is taken for operation of these systems in the evaluation of fuel handling transients in the reactor confinement module which will be discussed in FSAR Chapter 15, Section 8.

FSAR Chapter 3, Section 2 will describe the Atomic Alchemy spent fuel storage SSC’s.

FSAR Chapter 13, Appendix A will describe the Fuel Loading Conditions Surveillance Program.

A description of the Spent Fuel Cooling System (SPF) components, which are a subsystem of the Reactor Coolant System (RCS) will be provided in FSAR Chapter 5, Section 3.

A description of the spent fuel pool radiation protection design features including testing and inspections, will be provided in FSAR Chapter 12, Section 3.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy’s compliance with Regulatory Guide 1.13, 1.157, 1.227, and 1.45.

A-62.0 GDC CRITERION 62 – PREVENTION OF CRITICALITY IN FUEL STORAGE AND HANDLING

Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.

A-62.1 PDC CRITERION 62 DEPARTURE – PREVENTION OF A CRITICALITY IN THE NPUF

Criticality in the Atomic Alchemy facility shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 62 as presented in this PDC Departure.

Atomic Alchemy Departure

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy’s PDC 16. The basis for the departure for this PDC with respect to re-defining a containment boundary is addressed in PDC 16.

Additionally, Atomic Alchemy will extend the evaluation of the requirements for prevention of a criticality of reactor fuel storage and handling of PDC 62 to also include the prevention of a criticality in the handling and storage of special nuclear material feedstock, processing and waste holdup in the radwaste module, target fabrication module, shipping & receiving module and the radioisotope production process module buildings in addition to the reactor confinement module building.

Atomic Alchemy Compliance

A description of potential inadvertent nuclear criticality transients will be provided in FSAR Chapter 15, Section 8 (RCM) and Section 9 (PPM, RWM and MTM). FSAR Chapter 9, Section 1 will describe the Atomic Alchemy criticality analysis for new fuel storage racks and an additional description of criticality monitoring.

Geometrically safe configurations as determined by an analysis of normal and abnormal fuel rack conditions and fuel rack designs will be performed and procedural processes, administrative controls, passive design features (shielding) will be provided to handle new fuel, spent fuel, and radioactive waste during normal reactor operations, including anticipated operational occurrences to prevent the possibility of a criticality event. The abnormal conditions include alternative depletion conditions, modified rack spacing, a single fuel assembly in various positions external to the spent fuel storage racks and filling various part-length rod locations with fuel material to represent dropped or damaged fuel configurations.

Procedural processes, administrative controls (i.e. material accountability), and passive design features (shielding) will be provided and geometrically safe configurations (including floor geometry, and layout of tanks, piping etc.), as determined by analysis of normal and abnormal facility conditions, will be performed for the handling and storage of raw inventory nuclear material and the physical transfer of radioisotope targets along the processing train (assembly, irradiation, disassembly) to prevent the possibility of a criticality event. The chemicals hazards associated with the processing of nuclear target material will be bounded by the radiological hazards. The design features and administrative controls preventing release of radioactive material and limiting radiation exposure from radioisotope processing will simultaneously protect employees from any chemical hazards.

Procedural processes, administrative controls, passive design features (shielding, containment dikes), will be provided and geometrically safe configurations (including floor geometry, and layout of tanks, piping etc.) as determined by analysis of normal and abnormal facility conditions will be performed for the handling, collection, (nuclear material recovery - possible future design feature), and storage of radioactive wastes (solid, liquid gaseous) to prevent the possibility of a criticality event. Waste volumes have not yet been determined. The chemicals hazards associated with the processing of nuclear waste material will be bounded by the radiological hazards. The design features and administrative controls preventing release of radioactive material and limiting radiation exposure from nuclear waste will simultaneously protect employees from any chemical hazards.

The Atomic Alchemy design also includes a Criticality Area Detection and Alarm System (ICA) and a separate Hot Cell Criticality Detection and Alarm System (ICC). FSAR Chapter 7, Section 9 will describe the criticality system and will also provide requirements and functional descriptions.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.13, and 3.71.

FSAR Chapter 1, Appendix D, will describe Atomic Alchemy's compliance with NUREG-0933, Section 6, Nuclear Material Safety and Safeguards Issues, NMSS-0006, and NMSS-0015.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(5) and 10 CFR 70.64(a)(9).

A-63.0 GDC CRITERION 63 – MONITORING FUEL AND WASTE STORAGE

Appropriate systems shall be provided in the fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in the loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.

A-63.1 PDC CRITERION 63 DEPARTURE – MONITORING FUEL, SNM AND WASTE STORAGE

Appropriate systems shall be provided in the radioisotope process, target fabrication, radioactive waste and shipping modules and associated handling areas (1) to detect conditions that may result in excessive radiation levels and (2) to initiate appropriate safety actions. Appropriate systems shall be provided in the reactor confinement module and associated handling areas (1) to detect conditions that may result in the loss of residual heat removal capability (2) excessive radiation levels and (3) to initiate appropriate safety actions.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 63 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy will extend the evaluation of monitoring reactor fuel and radioactive waste storage of PDC 63 to the monitoring of the handling and storage of special nuclear material feedstock, processing, waste holdup etc. in the radwaste module, target fabrication module, shipping & receiving module, and the radioisotope production process module buildings in addition to the reactor confinement module building.

Atomic Alchemy Compliance

As described in PDC 5, the Atomic Alchemy VIPR two light-water reactor pools share a common light-water Transfer Canal System (TTW). Each reactor light-water pool also stores its own spent fuel at the far end of the pool in a cavity below the core elevation. The light-water pool spent fuel cavity is sized for a volume of 60 years + 10% margin worth of spent fuel. Spent fuel storage conditions will be administratively controlled by Atomic Alchemy programs.

Atomic Alchemy will describe the Reactor I&C Systems "Significant Monitored Parameters" in FSAR Chapter 7, Section 15 which includes: water level in the confinement light-water pool, reactor core cooling, light-water pool inventory, light-water pool temperature, transfer canal pool inventory, transfer canal pool temperature, and N16 quantity.

Area radiation monitoring will be provided in the RCM, MTM, RWM, and PPM module buildings for personnel protection and general surveillance. Additionally, area radiation monitoring will be provided in the area of the RCS pumps and Heat Exchanger located in the RAM module building. The area monitor alarms locally and in the main control room.

Radiation levels are also monitored in the respective ventilation systems of each module building, should the levels reach a predetermined setpoint, an alarm is actuated in the main control room.

FSAR Chapter 7, Section 3 will describe the safety-related instrumentation systems, including the Safety-related Reactor Instrument and Control Systems and the Safety-related Process Instrument and Control Systems.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guide 1.13, 1.227, and Regulatory Guide3.71.

This PDC criterion also satisfies the intent of 10 CFR 70.64(a)(9).

A-64.0 GDC CRITERION 64 – MONITORING RADIOACTIVITY RELEASES

Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.

A-64.1 PDC CRITERION 64 DEPARTURE – MONITORING RADIOACTIVITY RELEASES

Means shall be provided for monitoring the reactor confinement, radioisotope production process, target fabrication, and radwaste modules atmosphere, spaces containing components for recirculation of loss of coolant transient fluids, effluent discharge paths, and the facility environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from design basis events.

Atomic Alchemy Position

Atomic Alchemy revises the language of the 10 CFR 50 Appendix A GDC 64 as presented in this PDC Departure.

Atomic Alchemy Departure

Atomic Alchemy will extend the evaluation of the requirements for monitoring radioactivity releases of PDC 64 to the radwaste module, target fabrication module, and the radioisotope production process module buildings in addition to the reactor confinement module building.

As an NPUF, Atomic Alchemy re-defines the containment boundary for the VIPR as described in Atomic Alchemy's PDC 16. The basis for the departure for this PDC with respect to re-defining a containment boundary is addressed in PDC 16.

Atomic Alchemy Compliance

The design of the reactor confinement module building prevents the rapid, uncontrolled release of radioactive material to the environment. The Reactor Confinement Module (RCM), Radwaste Module (RWM), Target Fabrication Module (MTM), and Radioisotope Production Process Module (PPM) buildings establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the design conditions important to safety are not exceeded for as long as postulated transient conditions require.

Area radiation monitoring is provided in the RCM, MTM, RWM, and PPM module buildings for personnel protection and general surveillance. The area monitor alarms locally and in the main control room. Radiation monitoring for the reactor auxiliary module building will be addressed by portal monitoring.

Radiation levels are also monitored in the respective ventilation systems of each module building. Should the levels reach a predetermined setpoint, an alarm is actuated in the main control room. A high radiation signal in a ventilation path causes an ESF automatic closure of the isolation damper or valve and indication in the main control room.

Radiation detection & monitoring and criticality detection & monitoring systems are Atomic Alchemy Seismic Class C-I, and Safety Class C.

Procedural processes and administrative controls will be provided to control the release of radioactive materials. Atomic Alchemy Offsite Dose Calculation Manual, Section ODM 5.6.1 will describe the Radioactive Process Effluent Control Program. The Atomic Alchemy Standard Radiological Effluent Controls (SREC) compiled in the ODM manual, and its accompanying procedures, will meet the requirements of 10 CFR 20.106, 40 CFR 190, 10 CFR 50.36(a), 10 CFR 70.59, and Appendix I to 10 CFR 50.

Atomic Alchemy will submit the following: Semiannual Radioactive Effluent Release Report (iaw 10 CFR 20.1302) and an Annual Radiological Environmental Operating Report. A list of all reports to be submitted by Atomic Alchemy will be provided in FSAR Chapter 13, Section 7.

Technical Specifications Administrative Controls section 5.6.5 will describe the Atomic Alchemy Radiation Protection Program.

Technical Specification Administrative Controls section 5.6.1 and FSAR Chapter 16, Appendix C will describe the Atomic Alchemy Offsite Dose Calculation Manual.

FSAR Chapter 1, Appendix A, will describe Atomic Alchemy's compliance with Regulatory Guides 1.21, 1.97, 3.71, 8.2, and 8.8.