7.0 INSTRUMENTATION AND CONTROL SYSTEMS

Instrumentation and control (I&C) systems comprise the sensors, electronic circuitry, displays, and actuating devices that provide the information and means to safely control the Northwest Medical Isotopes, LLC (NWMI or the applicant) production facility processes. I&C systems are also employed to avoid or mitigate accidents. Instruments are provided to monitor, indicate, control, and record such operating parameters as process system flowrate, pump actuation, heater actuation, pump motor speed, valve actuation, valve position, solution temperature, solution density, solution conductivity, vessel level, and radiation intensities in selected areas. I&C subsystems may also be designed to actuate engineered safety features (ESFs) upon the detection of abnormal conditions.

This chapter of the NWMI construction permit safety evaluation report (SER) describes the U.S. Nuclear Regulatory Commission (NRC) staff (the staff) technical review and evaluation of the preliminary design of the NWMI production facility I&C systems as presented in Chapter 7.0, "Instrumentation and Control Systems," of the NWMI preliminary safety analysis report (PSAR), Revision 3 (Reference 60) and supplemented by requests for additional information (RAIs). As explained in SER Section 1.1.1, "Scope of Review," the NWMI construction permit application generally refers to the building that will house all activities, structures, systems, and components (SSCs) related to medical isotope production as its radioisotope production facility (RPF). The RPF consists of the production facility and the target fabrication area as discussed below. In the SER, the staff refers to the SSCs within the RPF associated with the activities that NWMI states it will conduct under a license for a Title 10 of the Code of Federal Regulations (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," production facility as "the NWMI production facility" or "the facility." In this SER, the staff refers to the SSCs within the RPF associated with the activities that NWMI states it will conduct under a separate 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," license as "the target fabrication area." The staff reviewed the entire NWMI construction permit application to understand the anticipated interface between and impact on the NWMI production facility from the target fabrication area. However, the staff's findings and conclusions in this SER are limited to whether the NWMI production facility satisfies the 10 CFR Part 50 requirements for the issuance of a construction permit.

7.1 Areas of Review

NWMI PSAR Chapter 7.0 describes the preliminary I&C configuration for the special nuclear material (SNM) preparation and handling processes, radioisotope extraction and purification processes, process utility systems, criticality accident alarm system (CAAS), and radiation monitoring systems.

The staff reviewed NWMI PSAR Chapter 7.0 against applicable regulatory requirements using appropriate regulatory guidance and standards to assess the sufficiency of the preliminary design and performance of the NWMI production facility's I&C systems. As part of this review, the staff evaluated the design criteria, design bases, system descriptions, and system performance analysis of the NWMI production facility's I&C systems, with special attention to design and operating characteristics, unusual or novel design features, and principal safety considerations. The preliminary design of the NWMI production facility's I&C systems was evaluated to ensure the sufficiency of principal design criteria, design bases, and information relative to general arrangement sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the staff reviewed NWMI's identification and

justification for the selection of those variables, conditions, or other items that are determined to be probable subjects of technical specifications (TSs) for the facility, with special attention given to those items that may significantly influence the final design. The staff documented its review of NWMI's probable subjects of TSs for I&C systems in Chapter 14.0, "Technical Specifications," of this SER.

Areas of review for this chapter included facility I&C process control system descriptions, ESFs actuation systems, control console and display instruments, and radiation monitoring systems. Within these review areas, the staff assessed the preliminary analysis of I&C systems needed to monitor key parameters and variables, maintain parameters and variables within prescribed operating ranges, alert operators when operating ranges are exceeded, assure safety limits are not exceeded, and initiate mitigating systems and components important to safety.

7.2 Summary of Application

NWMI PSAR Chapter 7.0 describes the preliminary design of the NWMI production facility I&C systems, including the process control systems, ESFs and alarm functions, control console and display information, and radiation monitoring systems. The applicant states that the RPF is at a separate site, independent from the reactors used to irradiate the targets and that the RPF does not have or need I&C subsystems to monitor reactor operating parameters (i.e., reactor control system) or to place the reactor in a subcritical shutdown condition (i.e., reactor protection system), as described in Section 7.3, "Reactor Control System," and Section 7.4, "Reactor Protection System," of NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content," (Reference 8), and Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria," (Reference 9), that are necessary to maintain reactor facility conditions within the range of design conditions. Therefore, the preliminary design of the NWMI production facility I&C systems does not include any features related to reactors.

The NWMI facility process control (FPC) system is the overall production process controller that monitors and controls the process instrumented functions within the facility and monitors safety-related components within the facility. The building management system (BMS) monitors the facility ventilation system and monitors and controls the mechanical utility systems. ESF systems are designed to automatically operate on actuation of an alarm setpoint reached for a specific monitoring instrument or device using hard-wired analog controls and interlocks. For redundancy, this automatic operation is in addition to the FPC system or BMS ability to actuate ESFs as needed. The ESF parameters and alarm functions are integrated into and monitored at the FPC system or BMS to support manual operation of the ESF systems. The fire protection system has a dedicated central alarm panel that reports the status of fire protection equipment to the central alarm station and the facility control room. The preliminary concept for the facility I&C system configuration is supported by NWMI PSAR Figure 7-1, "Radioisotope Production Facility Instrumentation and Control System Configuration."

7.2.1 Design of Instrumentation and Control Systems

The NWMI production facility I&C basic components include the FPC system, ESF actuation systems, control console and display instruments, and BMS. The FPC system is a digital control system that controls and monitors the target fabrication system, molybdenum recovery and purification system, uranium recovery and recycle system, process utility and support systems, and waste handling activities. The primary control location of the FPC system is in the

control room. The control room FPC system operates with a synchronized, redundant, hot standby system with identical programmable logic controller (PLC) software systems. Items relied on for safety (IROFS) (i.e., ESF safety functions) are activated by hard-wired interlocks. The operator has direct visualization of critical values and the ability to allow, perform, or modify a task or event through a static display, an alarm and event annunciator display panel, and human-machine interfaces (HMIs). The BMS is a subsystem of the FPC system and monitors the facility ventilation system.

The applicable design criteria and guidelines that apply to the NWMI production facility I&C systems are summarized in the following NWMI PSAR tables:

- Table 7-1, “Instrumentation and Control System Design Criteria”
- Table 7-2, “Instrumentation and Control Criteria Crosswalk with Design Basis Applicability and Function Means.”

7.2.2 Process Control Systems

The process control system includes both hard-wired interlocks and computer logic to automatically actuate ESF functions when a parameter approaches or is outside its setting. In addition to interlocks, the facility also implements a permissive philosophy that allows HMI operations to be enabled once the control room has confirmed the prerequisite conditions have been completed. Permissives differ from interlocks in that a permissive requires manual approval for an activity to occur. Interlocks are engineered features while permissives are administrative features.

The FPC system will administer process control for the uranium recovery and recycle system, target receipt and disassembly system, target dissolution system, molybdenum recovery and purification system, waste handling system, and the CAAS.

The uranium recovery and recycle system processes raffinate from the molybdenum recovery and purification system for recycle to the target fabrication system. Normal uranium recovery and recycle system process functions are performed remotely using the FPC system in the control room. Control parameters include, in part, flowrate, pump actuation, pump motor speed, density, level, temperature, and valve actuation. Monitored parameters include, in part, density, differential pressure, flowrate, level, pressure, temperature, valve position, and analyzer uranium concentration. Hard-wired safety interlocks are provided to reroute condensate in the event of high uranium concentration in the condensate tanks. The description of the uranium recovery and recycle system is summarized in the following NWMI PSAR tables:

- Table 7-3, “Uranium Recovery and Recycle Control and Monitoring Parameters”
- Table 7-4, “Uranium Recycle and Recovery System Interlocks and Permissive Signals”

The target receipt and disassembly system includes the delivery and receipt of irradiated target casks from offsite, transfer of irradiated targets into the hot cell, disassembly of irradiated targets, and retrieval and transfer of irradiated target material for processing. Normal target receipt and disassembly system process functions are performed remotely using the FPC system HMI in the truck bay, cask preparation airlock, and the operating gallery (i.e., local control station). Redundant control functions are provided in the control room. Permissive signals required to start disassembly operations include an operable hot cell ventilation system,

functional and operational fission gas capture hood, proper positioning of the irradiated target material collection container, and an open waste drum transfer port.

The target dissolution system receives low-enriched uranium target material from the target receipt and disassembly system and dissolves the solid uranium and molybdenum target material in hot nitric acid. The concentrated uranyl nitrate solution is transferred to the molybdenum recovery and purification system. Normal target dissolution system process functions are performed by operators using remote in-cell cranes and manipulators and remotely using the FPC system HMI in the operating gallery. Redundant control functions are provided in the control room. Control parameters include, in part, dissolver agitator actuation and speed, flowrate, pump actuation, pump motor speed, temperature, and valve actuation. Monitored parameters include, in part, dissolver agitator speed, flowrate, flowrate totalizer, level, pressure, radiation, temperature, and valve position. Hard-wired safety interlocks are provided to capture dissolved gases in the event of high pressure in the pressure relief tank. The description of the target dissolution system is summarized in the following NWMI PSAR tables:

- Table 7-7, “Target Dissolution System Control and Monitoring Parameters”
- Table 7-8, “Target Dissolution System Interlocks and Permissive Signals”

The molybdenum recovery and purification system receives impure, concentrated molybdenum/uranium solution from the target dissolution system that is processed through ion exchange units to achieve the desired purified molybdenum product. The functions of product transfer and packaging in the molybdenum recovery and purification process are performed by operators using remote in-cell manipulators and remotely using the FPC system HMI in the operating gallery. Redundant control functions are provided in the control room. Control parameters include, in part, temperature, valve actuation, pump status, and capping unit actuation. Monitored parameters include, in part, density, flowrate, level, pressure, radiation, temperature, molybdenum weight, and valve position. The description of the molybdenum recovery and purification system is summarized in the following NWMI PSAR tables:

- Table 7-9, “Molybdenum Recovery and Purification System Control and Monitoring Parameters”
- Table 7-10, “Molybdenum Recovery and Purification System Interlocks and Permissive Signals”

The waste handling system consists of storage tanks for accumulating high-dose and low-dose waste liquids and adjusting the waste composition, and equipment that handles and encapsulates solid waste. Liquid waste is mixed with an adsorbent material. Solid waste is placed in a waste drum and encapsulated with a cement material to fill voids. All normal operating functions for low-dose liquid solidification are controlled locally using HMIs in the low-dose waste room. All normal operating functions for the high-dose liquid waste solidification, high-dose waste decay, spent resin dewatering, and solid waste handling hot cell operations are controlled and/or monitored from the low-dose waste room. Liquid waste collection and low-dose liquid waste evaporation operations are controlled from the facility control room. Control parameters include, in part, valve position, flowrate, pump actuation, pump motor speed, temperature, and grout mixer actuation. Monitored parameters include, in part, density, differential pressure, flowrate, flowrate totalizer, level, pressure, radiation,

temperature, and valve position. The description of the waste handling system is summarized in the following NWMI PSAR tables:

- Table 7-11, “Waste Handling System Control and Monitoring Parameters”
- Table 7-12, “Waste Handling System Interlocks and Permissive Signals”

The CAAS provides continuous monitoring indication, and recording of neutron or gamma radiation levels in areas where personnel may be present and wherever an accidental criticality event could result from facility operational processes. The CAAS is a vendor package with an integrated control system. Two detectors are provided in each area needing coverage. The CAAS control HMI is located in the control room and provides local alarms at the detector locations and at the CAAS HMI. The FPC system provides alarm and status monitoring in the control room. Uninterruptible power supplies provide emergency power to the CAAS during a loss-of-offsite power. Further discussion of the CAAS is found in Chapter 6.0, “Engineered Safety Features,” of this SER.

7.2.3 Engineered Safety Features Actuation Systems

The ESFs are active or passive features designed to mitigate the consequences of accidents and to keep radiological exposures to workers, the public, and the environment within acceptable values. The ESF systems have hard-wired controls that operate independently from the FPC systems. However, the ESFs are integrated into the FPC systems as a common point of HMI, monitoring, and alarming at the control room and local HMI workstations. ESFs that are required to be actuated by the I&C system and monitoring systems credited in the safety analysis are summarized in NWMI PSAR Table 7-13, “Engineered Safety Feature Actuation or Monitoring Systems.”

7.2.4 Control Console and Display Instruments

The control room contains overall process controls, monitoring, alarms, and acknowledgement and consists of a control console with two or three operator interface stations or HMIs and a master PLC or distributed controller. The control system is supported by a data highway of sensing instrument signals gathered by an Ethernet interface. The control room also contains dedicated controllers and HMI stations for the facility crane, closed-circuit television system, CAAS, and radiation monitoring systems.

7.2.5 Radiation Monitoring Systems

The radiation monitoring systems provide the facility control room personnel with a continuous record and indication of radiation levels at selected locations where radioactive materials may be present, stored, handled, or inadvertently introduced. The radiation monitoring systems include continuous air monitors located in work areas where there is a potential for airborne radioactivity; continuous exhaust stack monitoring for noble gases, particulates, and iodine; radiation area monitors located in areas where personnel may be present and where radiation levels could become significant; process control instruments to analyze for uranium concentrations; personnel monitoring including count rate meters, hand/foot monitors, and portal monitors; and passive dosimeters for all personnel entering restricted areas. When radiation levels exceed predetermined levels, visual and audible alarms actuate in the control room and at selected detector locations.

7.3 Regulatory Basis and Acceptance Criteria

The staff reviewed NWMI PSAR Chapter 7.0 against applicable regulatory requirements, using appropriate regulatory guidance and standards, to assess the sufficiency of the preliminary design and performance of the NWMI production facility's I&C systems for the issuance of a construction permit under 10 CFR Part 50. In accordance with paragraph (a) of 10 CFR 50.35, "Issuance of construction permits," a construction permit authorizing NWMI to proceed with construction of a production facility may be issued once the following findings have been made:

(1) NWMI has described the proposed design of the facility, including, but not limited to, the principal architectural and engineering criteria for the design, and has identified the major features or components incorporated therein for the protection of the health and safety of the public.

(2) Such further technical or design information as may be required to complete the safety evaluation, and which can reasonably be left for later consideration, will be supplied in the final safety analysis report (FSAR).

(3) Safety features or components, if any, which require research and development have been described by NWMI and a research and development program will be conducted that is reasonably designed to resolve any safety questions associated with such features or components.

(4) On the basis of the foregoing, there is reasonable assurance that: (i) such safety questions will be satisfactorily resolved at or before the latest date stated in the application for completion of construction of the proposed facility, and (ii) taking into consideration the site criteria contained in 10 CFR Part 100, "Reactor Site Criteria," the proposed facility can be constructed and operated at the proposed location without undue risk to the health and safety of the public.

With respect to the last of these findings, the staff notes that the requirements of 10 CFR Part 100 is specific to nuclear power reactors and testing facilities, and therefore not applicable to the NWMI production facility. However, the staff evaluated the NWMI production facility's site-specific conditions using site criteria similar to 10 CFR Part 100, by using the guidance in NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content," (Reference 8) and NUREG-1537, Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria," (Reference 9) and "Final Interim Staff Guidance [ISG] Augmenting NUREG-1537, Part 1, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," (Reference 10) and "Final Interim Staff Guidance Augmenting NUREG-1537, Part 2, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors" (Reference 11). The staff's review in Chapter 2.0, "Site Characteristics," of this SER evaluated the geography and demography of the site; nearby industrial, transportation, and military facilities; site meteorology; site hydrology; and site geology, seismology, and geotechnical engineering to ensure that issuance of the construction permit will not be inimical to public health and safety.

7.3.1 Applicable Regulatory Requirements

The applicable regulatory requirements for the evaluation of the NWMI production facility's I&C systems are as follows:

> 10 CFR 50.34, "Contents of applications; technical information," paragraph (a), "Preliminary safety analysis report."

7.3.2 Regulatory Guidance and Acceptance Criteria

The staff used its engineering judgment to determine the extent that established guidance and acceptance criteria were relevant to the review of NWMI's construction permit application, as much of this guidance was originally developed for completed designs of nuclear reactors. For example, in order to determine the acceptance criteria necessary for demonstrating compliance with the NRC's regulatory requirements in 10 CFR, the staff used:

- NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content," issued February 1996 (Reference 8).

- NUREG-1537, Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria," issued February 1996 (Reference 9).

- "Final Interim Staff Guidance Augmenting NUREG-1537, Part 1, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," dated October 17, 2012 (Reference 10).

- "Final Interim Staff Guidance Augmenting NUREG-1537, Part 2, 'Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,' for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors," dated October 17, 2012 (Reference 11).

The ISG Augmenting NUREG-1537 updated and expanded the guidance, originally developed for non-power reactors, to address medical isotope production facilities. For example, whenever the word "reactor" appears in NUREG-1537, it can be understood to mean "radioisotope production facility" as applicable. In addition, the ISG, at page vi, states that use of Integrated Safety Analysis methodologies as described in 10 CFR Part 70 and NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility" (Reference 24), application of the radiological and chemical consequence likelihood criteria contained in the performance requirements of 10 CFR 70.61, "Performance requirements," designation of IROFS, and establishment of management measures are acceptable ways of demonstrating adequate safety for a medical isotope production facility. The ISG also states that applicants may propose alternate accident analysis methodologies, alternate radiological and chemical consequence and likelihood criteria, alternate safety features and alternate methods of assuring the availability and reliability of safety features. The ISG notes that the use of the term "performance requirements" when referring to 10 CFR Part 70, Subpart H, does not mean that the performance requirements in Subpart H are required for a RPF license, only that

their use may be found acceptable. NWMI used this ISG to inform the design of its facility and prepare its PSAR. The staff's use of reactor-based guidance in its evaluation of the NWMI PSAR is consistent with the ISG Augmenting NUREG-1537.

As appropriate, additional guidance (e.g., NRC regulatory guides, Institute of Electrical and Electronics Engineers standards, American National Standards Institute/American Nuclear Society standards) has been used in the staff's review of the PSAR. The use of additional guidance is based on the technical judgment of the reviewer, as well as references in NUREG-1537, Parts 1 and 2; the ISG Augmenting NUREG-1537, Parts 1 and 2; and the NWMI PSAR. Additional guidance documents used to evaluate NWMI's PSAR are provided as references in Appendix B, "References" of this SER.

7.4 Review Procedures, Technical Evaluation, and Evaluation Findings

The staff evaluated the technical information presented in NWMI PSAR Chapter 7.0, as supplemented by the applicant's responses to RAIs, to assess the sufficiency of the preliminary design and performance of the NWMI production facility's I&C systems for the issuance of a construction permit, in accordance with 10 CFR Part 50. Sufficiency of the preliminary design and performance of the NWMI production facility's I&C systems is determined by ensuring the design and performance meet applicable regulatory requirements, guidance, and acceptance criteria, as discussed in Section 7.3, "Regulatory Basis and Acceptance Criteria," of this SER. A summary of the staff's technical evaluation is described in SER Section 7.5, "Summary and Conclusions."

For the purposes of issuing a construction permit, the preliminary design of the NWMI production facility's I&C systems may be adequately described at a functional or conceptual level. The staff evaluated the sufficiency of the preliminary design of the NWMI production facility's I&C systems based on the applicant's design methodology and ability to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety. The staff's evaluation of the preliminary design of the NWMI production facility's I&C systems does not constitute approval of the safety of any design feature or specification. Such approval, if granted, would occur after an evaluation of the final design of the NWMI production facility's I&C systems, as described in the FSAR submitted as part of NWMI's operating license (OL) application.

7.4.1 Summary Description

The staff evaluated the sufficiency of NWMI's summary description of its production facility's I&C systems, as described in NWMI PSAR Section 7.1, "Summary Description," for the issuance of a construction permit using the guidance and acceptance criteria from Section 7.1, "Summary Description," of NUREG-1537, Parts 1 and 2, and Section 7b.1, "Summary Description," of the ISG Augmenting NUREG-1537, Parts 1 and 2.

NWMI PSAR Section 7.1 discusses the I&C design in terms of RPF processes and systems including SNM preparation and handling processes, radioisotope extraction and purification processes, process utility and support systems, CAAS, radiation monitoring systems, facility ventilation system, and mechanical utility systems. NWMI PSAR Section 7.1 states that the FPC system and the BMS provide monitoring and control functions. The summary description is supported by a schematic showing the preliminary concept for the I&C system configuration.

As stated in Section 7b.1 of the ISG Augmenting NUREG-1537, Parts 1 and 2, the description of the I&C systems should, in part, provide "a summary description of the I&C systems, including the design bases; the safety, considerations, and objectives; the operational characteristics of the production facility that determine or limit the I&C design; and the ways in which the various subsystems constitute the whole and interact to contribute to its essential functions. This summary should also include schematic, logic, and flow diagrams illustrating the various subsystems."

During its review, the staff noted that NWMI PSAR Section 7.1 identifies how and where the processes or systems are monitored and controlled without identifying any specific I&C technical aspects, philosophy, or objectives of the instrumentation. The discussion did not address redundancy, diversity, or isolation of functions except for the ESFs which are stated to be independent, hard-wired analog controls. In its responses to RAIs 7.1 through 7.4 (Reference 31) regarding the I&C systems, the applicant states that the I&C systems preliminary design was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C systems (e.g., details regarding the design bases, technical aspects, safety, philosophy, and objective for all I&C components that monitor and control RPF processes or systems) was not developed for approval of the safety of any design feature or specification. The applicant noted that concepts like redundancy, independence, and diversity of systems are specifically identified as necessary in NWMI PSAR Sections 7.2 through 7.6. The applicant further stated that for the construction permit application, the preliminary design of the I&C systems is considered functional and at a conceptual level and that the intent at this stage was to describe the design methodology and provide reasonable assurance that the final design will conform to the design bases with an adequate margin for safety.

The staff found that this response addressed the acceptance criteria of NUREG-1537, Part 2, Section 7.1, because NWMI sufficiently described the I&C systems in the PSAR for the staff to understand the design methodology and demonstrated an adequate design basis for a preliminary design. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration in the FSAR, as it is not expected to significantly impact the construction of the facility.

NUREG-1537, Part 1, Section 7.1 states, in part, that the general description of each category of I&C subsystems should include the types of parameters monitored, the number of channels designed to monitor each parameter, and the actuating logic. NUREG-1537, Part 2, Section 7.1 states, in part, that the acceptance of the summary description should be based on its completeness in addressing the factors listed in NUREG-1537, Part 1.

NWMI PSAR Section 7.1 identifies how and where the processes or systems are monitored and controlled. NWMI didn't describe the types of parameters monitored, the number of channels monitoring each parameter, or the actuation logic. In response to RAI 7.1-1 (Reference 31), the applicant stated that NWMI PSAR Section 7.2 does not address specific aspects of the I&C system, although NWMI PSAR Tables 7-4 through 7-12 list the location and types of parameters anticipated to be monitored. The applicant further stated that for the construction permit application, the preliminary design of the I&C systems is considered functional and at a conceptual level and that the intent at this stage was to describe the design methodology and provide reasonable assurance that the final design will conform to the design bases with an adequate margin for safety.

The staff found that this response addressed the acceptance criteria of NUREG-1537, Part 2, Section 7.1, because NWMI sufficiently described the I&C systems in the PSAR for the staff to understand the design methodology and demonstrated an adequate design basis for a preliminary design for a construction permit. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration, and will be provided, in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that all aspects of the final design conform to the design basis during the evaluation of NWMI's FSAR submitted as part of the OL application.

NUREG-1537, Part 1, Section 7.1 states, in part, that the general description of each category of I&C subsystems should include a summary of the HMI principles used in the location of I&C. NUREG-1537, Part 2, Section 7.1 states, in part, that the acceptance of the summary description should be based on its completeness in addressing the factors listed in NUREG-1537, Part 1.

During its review, the staff noted that NWMI PSAR Section 7.1 discusses the I&C design in terms of RPF processes and systems and that the target fabrication process, target receipt and disassembly process, target dissolution process, molybdenum recovery and purification process, and low-dose liquid waste handling will be controlled by operators at local HMIs. NWMI PSAR Section 7.1 also identifies that operators at local HMIs will control the plant air system, gas supply system, process chilled water chillers, process steam boilers, demineralized water system, chemical supply system, and standby electric power system. NWMI PSAR Section 7.1 uses several different terms (i.e., operator interface displays, operator interface terminals, and HMIs) when referring to operator-controlled equipment. The applicant stated in its responses to RAIs 7.1 through 7.4 regarding the I&C systems (Reference 31) that the I&C systems preliminary design was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C subsystems, including specific details on HMI, was not developed for approval of the safety of any design feature or specification. The applicant stated that to be consistent in the PSAR, terms like "operator interface displays" and "operator interface terminals" will be replaced with the single term, HMI (e.g., pages 7-I, 7-iv, 7-4, 7-15, 7-17, 7-18, 7-20, and 7-21). The applicant further stated that for the construction permit application, the preliminary design of the I&C systems is considered functional and at a conceptual level and that the intent at this stage was to describe the design methodology and provide reasonable assurance that the final design will conform to the design bases with an adequate margin for safety.

The staff finds that this response addressed the acceptance criteria of NUREG-1537, Part 2, Section 7.1, because NWMI sufficiently described the production facility I&C systems in the PSAR for the staff to understand the design methodology and demonstrated an adequate design basis for a preliminary design for a construction permit. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration, and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that all aspects of the final design conform to the design basis during the evaluation of NWMI's FSAR submitted as part of the OL application.

Based on its review, the staff finds that the NWMI production facility I&C systems are designed to perform functions commensurate with the complexity of the processes therein and that the description of the NWMI production facility I&C systems contains a sufficient level of detail for an overall understanding of the design methodology, functions, and relationships of the I&C systems to the preliminary design of the facility and satisfies the applicable acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 7b.1. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration, and will be provided, in the FSAR, as it is not expected to significantly impact the construction of the facility.

Therefore, the staff concludes that the description of the NWMI production facility I&C systems, as described in NWMI PSAR Section 7.1, and as supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance for the issuance of a construction permit in accordance with 10 CFR Part 50.

7.4.2 Design of Instrumentation and Control Systems

The staff evaluated the sufficiency of the design of the NWMI production facility's I&C systems, as described in NWMI PSAR Section 7.2, "Design of Instrumentation and Control Systems," and as supplemented by the applicant's responses to RAIs, for the issuance of a construction permit by evaluating the design criteria, design basis requirements, system description, and system performance analysis of the I&C systems using the guidance and acceptance criteria from Section 7b.2, "Design of Instrumentation and Control Systems," of the ISG Augmenting NUREG-1537, Parts 1 and 2, and the guidance from Section 7.2, "Design of Instrumentation and Control Systems," of NUREG-1537, Parts 1 and 2. NWMI PSAR Table 7-1 lists the standards and guidance used to support the design basis for the I&C systems.

NUREG-1537, Part 1, Section 7.2.3, "System Description," states, in part, that the system description in the PSAR should include equipment and major components as well as block, logic, and schematic diagrams. NUREG-1537, Part 1, Section 7.2.3 also states, in part, that the applicant should submit hardware and software descriptions and software flow diagrams for digital computer systems and that the applicant should describe how the system operational and support requirements will be met, how the operator interface requirements will be met, and should address the methodology and acceptance criteria used to establish and calibrate the trip or actuation setpoints, or interlock functions. The staff requested additional information to understand the relationship among all of the major I&C components.

In its response to RAI 7.2-1 (Reference 31), the applicant states that the I&C systems preliminary design was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant states that the preliminary design of the I&C systems describing all of the equipment and major I&C components (e.g., block, logic, and schematic diagrams, software flow diagram, and description of how system operational and support requirements and operator interface requirements are met) was not developed for approval of the safety of any design feature or specification.

With respect to trip or actuation setpoints, the applicant states that as discussed in NWMI PSAR Section 7.2.4.1, "Facility Trip and Alarm Design Basis," and Section 7.2.4.2, "Analysis," trip or actuation setpoints for systems in Section 7.2 will be established to indicate a warning when a given parameter is approaching a setpoint and alarm/trip when it has reached a setpoint, both at

the HMI and the control station, as appropriate. Alarm/trip setpoints will be established at levels that are protective of systems relied on for safety, as described in the PSAR (and follow-on FSAR), particularly IROFS. The applicant explained that this means that alarm/trip setpoints will be established to provide reasonable assurance that these systems will be consistent with the design requirements and limitations established by the bounding analysis provided in the PSAR and follow-on FSAR. The applicant further stated that for the construction permit application, the preliminary design of the I&C systems is considered functional and at a conceptual level and the intent at this stage was to describe the design methodology and provide reasonable assurance that the final design will conform to the design bases with an adequate margin for safety.

The staff finds that the applicant addressed the format and content guidance of NUREG-1537, Part 1, Section 7.2.3, by providing sufficient detail of the design criteria, design bases, and system description for the NWMI production facility I&C system in the PSAR, related to the acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 7b.2, and demonstrates an adequate design basis for a preliminary design. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration in the FSAR, as it is not expected to significantly impact the construction of the facility.

NUREG-1537, Part 1, Section 7.2.4, “System Performance Analysis,” states, in part, that the applicant should conduct a performance analysis of the proposed system to ensure that the design criteria and design bases are met and that licensing requirements for the performance of the system are specified. The analysis should describe the operation of the I&C system and present the analysis of how the system design meets the design criteria and design bases including a discussion of accuracy, reliability, adequacy and timeliness of I&C system action, trip setpoint drift, quality of components, and redundancy, independence, and impact of single failures. The staff requested additional information to understand the operation of the integrated I&C system.

In its response to RAI 7.2-2 (Reference 31), the applicant states that the I&C systems preliminary design was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C systems describing the detailed methodology and operation of the integrated FPC system as it relates to ESF managing, monitoring, and actuation was not developed for approval of the safety of any design feature or specification.

The applicant indicated that NWMI PSAR Section 7.1 states, in part, “Engineered safety feature (ESF) systems will operate on actuation of an alarm setpoint reached for a specific monitoring instrument/device. For redundancy, this will be in addition to the FPC system or BMS ability to actuate ESF as needed.”

NUREG-1537, Part 1, Section 7.2.5, “Conclusion,” states that the applicant should summarize why the system design is sufficient and suitable for performing the functions stated in the design basis. The staff requested additional information to understand the suitability for performing the I&C functions stated as part of the design basis of the integrated I&C system.

In its response to RAI 7.2-3 (Reference 31), the applicant states that the preliminary design of I&C systems was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will

conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C systems describing the detailed methodology and operation of the integrated I&C systems was not developed for approval of the safety of any design feature or specification. The applicant further stated that NWMI PSAR Chapter 7.0, Table 7-2, will be expanded in the FSAR to provide a cross-reference to the specific section of each I&C section and how the system is suitable for performing the functions stated for each design basis applicability item.

Based on its review, the staff finds that the description of the NWMI production facility I&C systems contains a sufficient level of detail for an overall understanding of the functions and relationships of the I&C system to the preliminary design of the facility and satisfies the applicable acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 7b.2.

Therefore, the staff concludes that the design of the NWMI production facility I&C systems, as described in NWMI PSAR Section 7.2, and as supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance for the issuance of a construction permit in accordance with 10 CFR Part 50. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that all aspects of the final design conform to the design basis during the evaluation of NWMI's FSAR submitted as part of the OL application.

7.4.3 Process Control Systems

The staff evaluated the sufficiency of the preliminary design of the NWMI production FPC systems, as described in NWMI PSAR Section 7.3, "Process Control Systems," for the issuance of a construction permit by evaluating the design criteria, design basis requirements, system description, and system performance analysis of the uranium recovery and recycle system, target receipt and disassembly system, target dissolution system, molybdenum recovery and purification system, waste handling system, and CAAS using the guidance and acceptance criteria from Section 7b.3, "Process Control Systems," of the ISG Augmenting NUREG-1537, Part 2.

Consistent with the review procedures in the ISG Augmenting NUREG-1537, Part 2, Section 7b.3, the staff confirmed by reviewing the information in NWMI PSAR Table 7-1 that process control system information for all normal functions and systems described in other chapters of the PSAR is addressed in this section and verified that all design bases are justified, as presented in NWMI PSAR Chapter 7.0 and other relevant chapters of the PSAR.

The ISG Augmenting NUREG-1537, Part 2, Section 7b.3 states, in part, that the system should be designed with sufficient control of reactivity for all required production and SNM fuel reconditioning process operations. NWMI PSAR Table 7-3 lists the anticipated monitored and controlled parameters that may be used for reactivity control such a tank levels, flowrates, and uranium density. Additionally, NWMI PSAR Table 7-4 contains a preliminary list of interlocks and permissive switches to control processes to support the control of reactivity. The staff requested additional information to understand the key parameters that are monitored to ensure adequate criticality control.

In its response to RAI 7.3-1 (Reference 31), the applicant states that the I&C systems preliminary design was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and

approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C systems describing how the key parameters are monitored to ensure adequate criticality control (e.g., instruments to detect deviations from nominal concentrations and quantities, status of software development procedures) was not developed for approval of the safety of any design feature or specification.

Based on its review, the staff finds that the description of the NWMI production FPC systems contains a sufficient level of detail for an overall understanding of the functions and relationships of the I&C systems to the preliminary design and satisfies the applicable acceptance criteria of the ISG Augmenting NUREG-1537, Part 2, Section 7b.3.

Therefore, the staff concludes that the preliminary design of the NWMI production FPC systems is sufficient and meets the applicable regulatory requirements and acceptance criteria of NUREG-1537, Part 2 for the issuance of a construction permit in accordance with 10 CFR Part 50. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that the final design conforms to this design basis during the evaluation of the NWMI FSAR.

7.4.4 Engineered Safety Features Actuation Systems

The staff evaluated the sufficiency of the preliminary design of the NWMI production facility ESF actuation systems, as described in NWMI PSAR Section 7.4, “Engineered Safety Features Actuation Systems,” for the issuance of a construction permit by reviewing the system description, annunciation and display, and system performance analysis of the ESF actuation systems using the guidance and acceptance criteria from Section 7.5, “Engineered Safety Features Actuation Systems,” of NUREG-1537, Parts 1 and 2.

Consistent with the review procedures of NUREG-1537, Part 2, Section 7.5, the staff compared the design criteria and bases of the ESF actuation systems with the ESFs and accident scenarios, as well as compared the design and functional descriptions of the ESF actuation systems with the applicable criteria and functions in NWMI PSAR Chapter 6.0, “Engineered Safety Features,” and NWMI PSAR Chapter 13.0, “Accident Analysis.”

The ISG Augmenting NUREG-1537, Part 2, Section 7b.4, “Engineered Safety Features Actuation Systems,” states, in part, that this section of the PSAR should describe the actuation systems for any ESFs discussed in NWMI PSAR Chapters 6.0 or 13.0. NUREG-1537, Part 1, Section 7.5, states, in part, that the applicant should describe the ESF actuation systems in sufficient detail to describe the functions required of the ESFs and the operation of the systems. The staff requested additional information to understand the functions and operation of the ESF actuation system.

In its response to RAI 7.4-1 (Reference 31), the applicant states that the preliminary design of the I&C systems was developed to ensure the sufficiency of the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design basis. In addition, the applicant stated that the preliminary design of the I&C systems describing the functionality and operation required of the ESFs was not developed for approval of the safety of any design feature or specification. NWMI PSAR Table 7-13

provides information on the anticipated technical means by which an ESF would be actuated. The staff notes that this mechanism is not described further in NWMI PSAR Section 7.4 because the design has not been finalized, however this is not expected to significantly alter construction and can reasonably be left for later consideration during the staff's review of the FSAR submitted as part of the OL application.

The staff found that this response addressed the acceptance criteria of NUREG-1537, Part 2, Section 7.5 and the ISG Augmenting NUREG-1537, Part 2, Section 7b.4, and demonstrated a sufficient design basis for a preliminary design. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration in the FSAR, as it is not expected to significantly impact the construction of the facility.

Based on its review, the staff finds that the description of the NWMI production facility ESF actuation systems contains sufficient information for an overall understanding of the functions and relationships of the I&C system to the preliminary design of the facility and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 7.5, allowing the staff to make the following findings: (1) the applicant analyzed postulated accident scenarios at the facility, including accidents for which consequence mitigation by the ESFs is required or planned, and (2) the design considerations of the ESF actuation systems give reasonable assurance that the final design will detect changes in measured parameters as designed and will initiate timely actuation of the applicable ESFs.

Therefore, the staff concludes that the level of detail in the design of the NWMI production facility ESF actuation systems, as described in NWMI PSAR Section 7.4 and as supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance for the issuance of a construction permit in accordance with 10 CFR Part 50. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that the final design conforms to this design basis during the evaluation of the NWMI FSAR.

7.4.5 Control Console and Display Instruments

The staff evaluated the sufficiency of the preliminary design of the NWMI production facility control console and display information, as described in NWMI PSAR Section 7.5, "Control Console and Display Instrumentation," for the issuance of a construction permit using the guidance and acceptance criteria from Section 7.6, "Control Console and Display Instruments," of NUREG-1537, Parts 1 and 2, and Section 7b.5, "Control Console and Display Instruments," of the ISG Augmenting NUREG-1537, Part 2.

Consistent with the review procedures of NUREG-1537, Part 2, Section 7.6, the staff compared the design bases and functional requirements of the control console and display information with other facility systems, compared the design of the control console with the acceptance criteria, and studied the arrangement of parameter displays, control devices, and the planned operator station to determine whether the operator can quickly understand information and take proper action.

NUREG-1537, Part 1, Section 7.6, states, in part, that the applicant should describe how the manual control inputs (i.e., pushbuttons, switches, and other equipment) have been grouped, oriented, and located with respect to the relevant display instruments. Further, the description

and analysis should address how the output instruments are placed and should include drawings or photographs showing the arrangement of the display instruments and console control equipment. NUREG-1537, Part 2, Section 7.6 states that the objective of the review is to evaluate whether displays and operator control systems are designed and located to promote ease and efficiency and should include descriptive information such as logic, functional control and schematic diagrams, and equipment location drawings.

During its review, the staff noted that NWMI PSAR Section 7.5 provides a high-level description of the control room and local HMIs and does not provide specific information on how the controls are physical grouped, oriented, or located with respect to the relevant display instruments and does not provide logic or functional control and schematic diagrams. This information is not expected to alter construction of the production facility and therefore can be reasonably be left for later consideration in the FSAR.

Based on its review, the staff finds that the description of the control console and display information contains a sufficient level of detail for an overall understanding of the functions and relationships of the I&C system to the preliminary design of the production facility and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 7.6, allowing the staff to make the following findings: (1) the applicant indicated that systems important to the safe and effective operation of the facility (i.e., FPC system, BMS, CAAS, facility crane, closed-circuit television system, radiation monitoring systems, and all facility on-site and off-site communications) will be displayed at the control console or be present in the control room, and (2) the annunciator and alarm panels on the control console will give assurance of the operability of systems important to adequate and safe facility operation.

Therefore, the staff concludes that the preliminary design of the NWMI production facility control console and display information, as described in NWMI PSAR Section 7.5 and as supplemented by the applicant's responses to RAIs, is sufficient and meets the applicable regulatory requirements and guidance for the issuance of a construction permit in accordance with 10 CFR Part 50. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that the final design conforms to this design basis during the evaluation of the NWMI FSAR.

7.4.6 Radiation Monitoring Systems

The staff evaluated the sufficiency of the preliminary design of the NWMI production facility radiation monitoring systems, as described in NWMI PSAR Section 7.6, "Radiation Monitoring Systems," for the issuance of a construction permit, in part, by reviewing the descriptions of the radiation monitoring equipment, as well as the description of the CAAS in NWMI PSAR Section 7.3.7, "Criticality Accident Alarm System," using the guidance and acceptance criteria from Section 7.7, "Radiation Monitoring Systems," of NUREG-1537, Parts 1 and 2.

Consistent with the review procedures of NUREG-1537, Part 2, Section 7.7, the staff compared the design bases for the radiation monitoring systems with giving reliable indication of the presence of radiation or release of radioactive material in the various areas monitored and in the monitored effluent streams from the facility.

Based on its review, the staff finds that the description of the NWMI production facility radiation monitoring systems contains a sufficient level of detail for an overall understanding of the

functions and relationships of the I&C system to the preliminary design and satisfies the applicable acceptance criteria of NUREG-1537, Part 2, Section 7.7, allowing the staff to make the following findings: (1) the applicant described the preliminary design of the radiation monitoring system and the preliminary design is applicable to the anticipated sources of radiation; (2) the PSAR discusses all likely radiation and radioactive sources anticipated at the NWMI production facility and describes equipment, systems, and devices that will give reasonable assurance that all such sources will be identified and accurately evaluated; and (3) the radiation monitoring systems described in the PSAR give reasonable assurance that dose rates and effluents at the facility will be acceptably detected, and that the environment and the health and safety of the facility staff and public will be acceptably protected.

Therefore, the staff concludes that the level of detail of the NWMI production facility radiation monitoring systems, as described in NWMI PSAR Section 7.6, is sufficient and meets the applicable regulatory requirements and guidance for the issuance of a construction permit in accordance with 10 CFR Part 50. Further technical or design information required to complete the safety analysis can reasonably be left for later consideration and will be provided in the FSAR when NWMI finalizes its design because it is not expected to significantly alter the construction of the facility. The staff will confirm that the final design conforms to this design basis during the evaluation of NWMI's FSAR.

7.4.7 Probable Subjects of Technical Specifications

In accordance with 10 CFR 50.34(a)(5), the staff evaluated the sufficiency of the applicant's identification and justification for the selection of those variables, conditions, or other items that are determined to be probable subjects of TSs with special attention given to those items which may significantly influence the final design. The evaluation of the TSs is provided in SER Chapter 14.0.

NWMI PSAR Chapter 14.0, "Technical Specifications," states that the integrated safety analysis (ISA) process identified SSCs that are defined as IROFS. The importance of these SSCs will also be reflected in the TSs. Each IROFS will be examined and translated into a limiting condition for operation (LCO). This translation will involve identifying the most appropriate specification to ensure operability and a corresponding surveillance periodicity for the IROFS.

The PSAR also provided an outline for the TSs that will be prepared during the development of the OL application. This outline includes actions, administrative controls, LCOs, limiting safety system settings, safety limits, and surveillance requirements.

In response to RAI 14.0-1 (Reference 13), NWMI developed a table of the potential items or variables that are expected topics of TSs. This table was subsequently incorporated in Chapter 14.0 of the NWMI PSAR as Table 14-1, "Potential Technical Specifications." NWMI identifies the CAAS as a probable subject of TSs based on its involvement with preventing releases of radioactive materials in the event of an accident.

7.5 Summary and Conclusions

The staff evaluated the descriptions and discussions of the NWMI production facility I&C systems, including probable subjects of TSs, as described in NWMI PSAR Chapter 7.0, and finds that preliminary design of the I&C systems, including the principal design criteria, design bases, and information relative to materials of construction, general arrangement, and approximate dimensions: (1) provides reasonable assurance that the final design will conform to the design

basis, and (2) meets the applicable regulatory requirements and acceptance criteria in NUREG-1537, Part 2.

Based on these findings the staff makes the following conclusions for the issuance of a construction permit in accordance with 10 CFR Part 50:

(1) NWMI has described the proposed design of the production facility I&C systems, including, but not limited to, the principal architectural and engineering criteria for the design, and has identified the major features or components incorporated therein for the protection of the health and safety of the public.

(2) Such further technical or design information as may be required to complete the safety analysis of the production facility I&C systems and which can reasonably be left for later consideration, will be supplied in the FSAR.

(3) There is reasonable assurance that: (i) the construction of the NWMI production facility will not endanger the health and safety of the public, and (ii) construction activities can be conducted in compliance with the Commission's regulations.

(4) The issuance of a permit for the construction of the production facility would not be inimical to the common defense and security or to the health and safety of the public.