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DOCKET NO: 70-143
LICENSE NO: SNM- 124

LICENSEE: Nuclear Fuel Services, Inc.
Erwin,TN.

SUBJECT: TECHNICAL EVALUATION REPORT FOR NUCLEAR FUEL SERVICES, INC.'S INTEGRATED SAFETY ANALYSIS SUMMARY FOR THOSE FACILITIES NOT APPROVED AS PART OF THE BLENDED LOW-ENRICHED URANIUM AMENDMENTS

1.0 INTRODUCTION

10 CFR 70.62(c) requires the licensee to conduct and maintain an integrated safety analysis (ISA) of appropriate detail for the complexity of the process that identifies:

- radiological hazards related to possessing or processing licensed material;
- chemical hazards of licensed material and hazardous chemicals produced from licensed material;
- facility hazards that could affect the safety of licensed materials and thus present an increased radiological risk;
- potential accident sequences caused by process deviations or events internal to the facility, and credible external events, including natural phenomena;
- the consequence and the likelihood of occurrence of each potential accident sequence identified pursuant to 10 CFR 70.62(c)(1)(iv), and the methods used to determine the consequences and likelihoods; and
- each item relied on for safety (IROFS), pursuant to 10 CFR 70.61(e). The characteristics of its preventive, mitigative, or other safety function, and the assumptions and conditions under which the item is relied on to support compliance with the performance requirements of 10 CFR 70.61.

Enclosure

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10 CFR 70.65(b) requires that an ISA Summary be submitted to the U.S. Nuclear Regulatory Commission (NRC) for approval and that it must include information for the following nine items:

- a general description of the site, with emphasis on factors that could affect safety;
- a general description of the facility, with emphasis on areas that could affect safety;
- a description of each process; in sufficient detail to understand the theory of operation and the hazards, and a general description of the types of accident sequences;
- information that demonstrates compliance with the performance requirements of 10 CFR 70.61, including management measures, criticality alarms, and baseline design criteria, if applicable;
- a description of the ISA team, its qualifications, and methods used in the ISA;
- a brief list of IROFS, in sufficient detail to understand their functions in relation to the performance requirements;
- a description of the quantitative standards used to assess consequences from a chemical exposure on-site;
- a list of sole IROFS; and
- definitions of unlikely, highly unlikely, and credible, as used in the ISA.

NUREG-1520, "Standard Review Plan of a License Application for a Fuel Cycle Facility," (NUREG 1520) was used by the NRC staff as guidance for the review and evaluation of the health, safety, and environmental aspects of the ISA Summary. The new Subpart H to 10 CFR Part 70 identifies risk-informed performance requirements and requires licensees to conduct ISAs and submit an ISA Summary. Chapter 3, "ISA," and Chapter 11, "Management Measures," of the NUREG are the primary chapters that address the staff's review in relation to the performance and other requirements of Subpart H.

The purpose of the ISA Summary is to document potential accident sequences that may occur during the facility's operations. Once these potential accident sequences are ranked, based on potential consequences, the facility then designates IROFS that will prevent or mitigate intermediate- or high-consequence accident sequences to an acceptable level of risk. The application of management measures provides reasonable assurance that IROFS will be available and reliable.

2.0 ISA SUMMARY

By letter dated October 15, 2004, Nuclear Fuel Services, Inc. (NFS) submitted its site-wide ISA Summaries for existing processes. These ISA Summaries, as well as this Technical Evaluation Report, do not include the review of the ISA Summaries for: (a) the Uranyl Nitrate Building; (b) the Blended Low-Enriched Uranium (BLEU) Preparation facility; (c) the existing processes that were relocated from the 200 Complex; or (d) BLEU Oxide Conversion Building and Effluent Processing Building, since these ISA Summaries were approved by letters dated July 7, 2003, January 13, 2004, and July 30, 2004. (ML031890743, ML040130530, and ML041970681).

2.1 Description of Site and Facility

The NFS Erwin site is located in the center of Unicoi County in the northeastern portion of the State of Tennessee. The site is in the Banner Hill community within the town of Erwin limits, approximately 50 miles north-northeast of Asheville, North Carolina, and approximately 20 miles south of Johnson City, Tennessee. It is located 800 to 1000 feet from the southeastern bank of the Nolichucky River, is bounded by Carolina Avenue to the east, a CSX Transportation railroad yard to the west, Martin Creek to the north, and the Studsvik Processing Facility to the south. The site occupies approximately 70 acres of land, in a southwest-to-northeast-oriented valley, bounded on both sides by the Blue Ridge Mountains of the Appalachian Mountain chain. The site elevation ranges from approximately 1,638 to 1,680 feet above sea level, and the surrounding mountains have a maximum elevation of about 2,480 feet above sea level.

The NFS site Controlled Area is surrounded by a double fence line and a perimeter intrusion detection and assessment system, patrolled by armed guards, and is access-controlled. The NFS site boundary is approximately 518 feet from the main stack, Building 309.

The NFS site is in the Blue Ridge physiographic province of northeastern Tennessee. The area topography consists of a series of alternating valleys and ridges that have a northeast-southeast trend, with NFS in a valley. The topography of the valley is the result of stream erosion of softer shales and limestones. The bedrock strata in the valley are consolidated.

For seismic application, the NFS site is in the moderately active Appalachian Tectonic Belt, with a Seismic Zone 2 designation, indicating moderate damage corresponding to Intensity VII on the Modified Mercalli scale. There is no evidence of capable faults in the immediate area of NFS.

2.2 Process Description

The primary activity on the NFS Erwin site is the production of highly-enriched uranium (HEU) fuel material for the U.S. Department of Energy (DOE), for which most information is Classified - Restricted Data.

2.2.1 Product Processing Operations

NFS is authorized to: (a) produce fuel containing HEU; (b) convert HEU hexafluoride to other uranium compounds; (c) recover and purify low-enriched uranium (LEU) and HEU from process scrap that is generated internally or at other facilities; and (d) to perform enrichment blending of high-enriched liquid uranyl nitrate solution, to produce a low-enriched uranyl nitrate solution, and to convert the down-blended uranyl nitrate solution into uranium oxide. NFS also has a contract with the Tennessee Valley Authority to produce LEU fuel from down-blended HEU. NFS will convert the LEU from its present form to an oxide powder.

2.2.2 Laboratory Operations

NFS is authorized to perform wet chemical and instrumental analyses and physical tests on material consisting of and/or containing special nuclear material (SNM)

2.2.3 Research and Development Operations

NFS is authorized to perform research and development work on source and SNM compounds and mixtures in areas with containers arranged specifically for maintenance of radiological and nuclear safety.

2.3 Description of ISA Team Qualifications, ISA Methods, and Management Measures

2.3.1 ISA Team Qualification

In Section 5.1 of the ISA Summary, NFS provided a general discussion of the ISA teams. The ISA teams, with expertise in engineering and process operations, will consist of members experienced and knowledgeable in the areas of nuclear criticality safety, radiation safety, fire protection, and chemical process safety. The teams will have a member with knowledge and experience pertaining to the specific processes being evaluated, as well as an experienced operator. At least one team member will be knowledgeable in the ISA methodology being used. Process-hazard-analysis leader training has been provided for engineers and safety specialists who serve as team leaders. The NRC staff has reviewed the above information and finds that the licensee's ISA team qualifications are acceptable.

Based on the above information, the staff concluded that the ISA team qualifications, as described, meet the requirements of 10 CFR 70.62(c)(2) and 10 CFR 70.65(b)(5).

2.3.2 ISA Methods

NFS ISA methodology is based on the index method of NUREG-1520. The NRC staff approved NFS ISA methodology by Amendment 39 of SNM -124, dated July 7, 2003.

2.3.3 Management Measures

10 CFR 70.62(d) requires that each licensee establish management measures to ensure compliance with the performance requirements of 10 CFR 70.61. The measures applied to a particular engineered or administrative control or control system may be graded commensurate with the reduction of the risk attributable to that control or control system. Management measures ensure that engineered and administrative controls and control systems, identified as IROFS, are designed, implemented, and maintained, as necessary, to ensure they are available and reliable to perform their function when needed. Chapter 11 of the NUREG, titled, "Management Measures," includes acceptance criteria for the following eight areas of management measures: (1) configuration management; (2) maintenance; (3) training and qualifications; (4) procedures; (5) audits and assessments; (6) incident investigations; (7) records management; (8) and other question/answer (QA) elements.

NFS's license application, Section 2.12, "Management Measures for Items Relied on for Safety," contains commitments addressing each of these eight areas. The NRC approved NFS's Management Measures by Amendment 39 of SNM -124, dated July 7, 2003.

2.4 Hazard Analysis

NFS used a process hazards analysis method to identify undesirable consequences for a process or activity. As part of this analysis for process hazards, NFS also analyzed natural-phenomena hazards, external events, and site layout issues. NFS looked at the likelihood and/or consequences of these hazards and eliminated hazards deemed to be non-credible. The remaining credible hazards included: (a) earthquake; (b) high winds; (c) snow loading; (d) site evacuations; (e) bulk chemical storage accidents; (f) criticality accidents and radiological releases; (g) off site explosions or fires; (h) diesel generator fire; (i) other storage tank fires; (j) vehicle fires; (k) maintenance; (l) electrical short circuit; (m) administrative processes; (n) plane crash; (o) freeway traffic accidents; (p) meteorites; and (q) lightning. NFS excluded the following hazards because they're non-credible nature or the low consequences arising from their occurrences: (a) tornado striking facility; (b) hurricane; (c) flood; (d) NFS bulk liquid/vapor release accident; (e) NFS bulk chemical storage accident resulting in explosion or fire (bounded by hydrogen storage vessel accident); (f) Studsvik bulk chemical storage accident, resulting in release of liquids or vapor; (g) Studsvik criticality accident or radiological release; (h) railroad accident, resulting in release of bulk liquids or vapor; (i) standing rainwater on roof; and (j) off-site fires. In accordance with NUREG 1520 and NUREG 1513, the NRC staff concluded that NFS: 1) has used an acceptable method of hazard identification and process hazard analysis; 2) applied the method correctly; 3) did not overlook any accident sequences for which consequences could exceed the performance requirements of 10 CFR 70.61; and 4) used a method that identified all facility processes. Therefore, the staff finds NFS's analysis of accident sequences to be complete and therefore acceptable.

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2.5 Criticality Safety

NFS applied the same methodology for the criticality safety portion of the ISA, as was used for other disciplines. Aspects of this methodology are the same as that for other safety disciplines. Aspects of the methodology, unique to criticality safety, are discussed in this section. The licensee considers a criticality accident to be a high-consequence event, because of the potential to exceed radiological consequences in 10 CFR 70.61(b). Because high-consequence events require the highest level of protection, designating criticality accidents as high-consequence events is conservative. Besides requiring criticality to be "highly unlikely' (as defined for other high-consequence hazards), the licensee is required to show that "under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety" and "preventive controls and measures must be the primary means of protection against nuclear criticality accidents" [10 CFR 70.61(d)]. The subcriticality requirement of 10 CFR 70.61(d) preceded the performance of the ISA, having originated in the widely accepted industry standard (ANSI)/(ANS)-8.1, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors." It was implemented through the licensee's historical approach for evaluating criticality hazards, in accordance with the double-contingency principle (DCP). The margin of subcriticality for safety pertains to criticality calculations, and was reviewed and approved during the last license renewal. The staff's review of the ISA Summary found that the licensee is only taking credit for preventive IROFS to meet the performance requirements for criticality events. Therefore, the staff finds that the licensee is correctly applying the requirements of 10 CFR 70.61 to criticality events.

In addition, 10 CFR 70.64(a)(9) requires the applicant to ". . . provide for criticality control including adherence to the double-contingency principle." Although this regulatory provision applies only to new facilities or processes, compliance with the DCP is required in Section 4.1.1 of the license application. In addition, the licensee used the same methodology to evaluate criticality events as it did for the BLEU project, which, as a new process, was required to comply with 10 CFR 70.64. The NRC found this acceptable. The staff found that the licensee complied with the DCP in its Nuclear Criticality Safety Evaluations (NCSEs), that supports the ISA Summary, which was reviewed during the on-site vertical-slice review, as discussed below.

The only other requirement unique to criticality safety is demonstrating compliance with the criticality monitoring and alarm system in 10 CFR 70.2 [10 CFR 70.65(b)(4)]. During the on-site vertical-slice review, and other visits to the facility, the staff determined that the applicant does have a criticality monitoring system meeting the requirements of 10 CFR 70.24(a). In Section 3.2.4.3 of the license application, the licensee committed to a criticality evacuation alarm that complies with ANSI/ANS-8.3-1997, "Criticality Accident Alarm Systems." This was reviewed and approved during the last license renewal. As required by 10 CFR 70.65(b)(5), the criticality monitoring system is also described in Section 2.8 of the ISA Summary. This description includes: (a) a commitment to ANSI/ANS-8.3-1997 (not just for the evacuation alarms, as in the license application); (b) a description of the type of detectors used; (c) the detector logic; (d) backup

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power; and (e) a diagram showing the location of the detectors. The staff confirmed this meets the requirements of 10 CFR 70.24(a) and the criteria in ANSI/ANS-8.3-1997. Based on the above, staff has concluded that the licensee has made adequate commitments to address criticality events, in accordance with Subpart H of Part 70.

Criticality accident sequences are first identified in facility NCSEs, to demonstrate that all normal and credible abnormal conditions are subcritical, and are in accordance with the DCP. During the on-site vertical-slice review, the staff determined that the NCSEs adequately demonstrated subcriticality and identified the controls needed to meet the DCP. The scenarios identified during hazard identification were flowed into the ISA Summary, and sufficient double-contingency controls were identified as IROFS, in the NCSEs, to meet the performance requirements. Flowdown of accident sequences and IROFS to the ISA Summary was facilitated by the licensee's inclusion of risk-indexing information and the listing of IROFS in NCSEs. The staff reviewed a sampling of ISA Summary sequences during the vertical-slice review, and determined that they were in one-to-one correspondence with double-contingency scenarios in the corresponding NCSE's.

Because not all criticality controls were needed to meet the performance requirements, not all double-contingency controls were made IROFS. In response to staff questions concerning which double-contingency controls were selected as IROFS, the licensee stated that its practice was to select the most reliable controls from the NCSEs (e.g., passive features). Some of the earlier risk-indexing credited the less significant administrative controls from the NCSEs instead of the more reliable passive and active engineered controls. The licensee subsequently revised a number of accident sequences to credit engineered double-contingency controls and stated that it would adhere to the practice generally in making future changes, so as to place the greatest emphasis on those items providing the greatest risk reduction and to ". . . align the IROFS much more consistently with the previously existing double-contingency arguments and controls." Although a licensee is allowed to chose any sufficiently reliable controls as IROFS, this practice is consistent with the generally accepted preference of engineered over administrative controls (consistent with the licensee's commitment in Section 4.1.1 of the license application), and also produces an unusually close correspondence between the NCSEs and the ISA Summary, and therefore is acceptable.

Some criticality-safety accident sequences involved sole IROFS. The staff paid particular attention to these to ensure they complied with the DCP. In some instances, the licensee credited initiating events or "enabling events" other than the failure of IROFS (e.g., roof leaks, spills), that, together with the IROFS, formed the basis for double contingency protection. Some cases involved highly reliable passive IROFS with no credible failure mechanisms, that could lead to criticality (e.g., siphon breaks, passive overflows). The staff reviewed each instance of sole criticality IROFS identified by the licensee, and determined that each case involved either a highly reliable passive control, with no credible failure mechanisms leading to criticality, or other initiating or enabling events besides the sole IROFS. In addition, the licensee stated that there are a large number of other double-contingency controls that are not designated as IROFS and

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ensure double contingency protection even when the sequence credits a sole IROFS. As an example of releases from process equipment, the licensee stated that floor elevation (which is not an IROFS) contributes to the low likelihood of accumulating a critical configuration on the floor. Although the floor elevation is not an IROFS, ". . . floor elevations are designated as Configuration Controlled Equipment (CCE), and NFS has agreed that all CCE will be designated as IROFS."

The licensee has further committed that this designation of all CCE as an IROFS will be effected by means of a general IROFS to be described as: "structures, systems, components, such as favorable geometry columns, dikes, floors, and piping that require configuration control for criticality safety" (by letter dated May 24, 2007). Because such controls tend to be highly reliable passive features, that have been included as CCE in the licensee's configuration-control system, the inclusion of CCE as such a generic IROFS, is acceptable.

The licensee has also indicated that it was revising its ISA Summary to reduce the reliance on sole-criticality IROFS, to make compliance with double contingency more transparent. The staff found that all the sequences reviewed did comply with the performance requirements ,as well as the DCP, and therefore were acceptable.

The staff also raised several questions concerning the licensee's determination of likelihood for IROFS and accident sequences. Several sequences took credit for failure-duration indices, as allowed under the index method of NUREG-1520. The staff noted that, in some cases, the licensee applied a duration index to the last IROFS in the sequence. One of these was an isolated error, which the licensee corrected. Other cases involved either a duration index applied to a sole IROFS, or duration indices applied to both IROFS. The licensee stated that sequences where duration indices are applied to sole IROFS remained as a subcritical failure of the sole IROFS (i.e., the occurrence of criticality requires one or more "enabling events" in addition to the IROFS failure). Although the initiating event is necessarily the first event in the sequence, an enabling event does not necessarily have to take place at the start of the event. The staff reviewed several sequences of this type and determined that each had enabling events that would also have to occur. Given this new understanding that enabling events could occur at any time during the accident sequence, staff determined that the time sequence of the event could not be readily determined in all cases. The staff did determine that each sequence reviewed was reasonable and logically met the performance requirements, although this determination was not always straightforward. The licensee stated that cases in which duration indices were applied to each of the two IROFS really represented two different accident sequences: the "forward" sequence, in which the first IROFS failed first, and the "reverse" sequence, in which the second IROFS failed first. For each such sequence, two likelihood values were computed; if the failure durations of the two IROFS were different, then the forward and reverse sequences would have different likelihoods. The staff evaluated each of these sequences and determined that this interpretation was correct, and that each permutation of failures only took credit for one of the duration indices (not both). The staff therefore finds this to be acceptable.

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The staff also questioned the licensee's assignment of indices to individual IROFS failures The licensee stated that an operator action that could be considered a "routine planned operation" is assigned an index of -1, whereas an action considered as a "rare unplanned event" is assigned an index of -2. Therefore, the definition of a "routine planned operation" (which is contained in procedure NFS-HS-A-68) is very important. The staff noted that in almost all cases, administrative IROFS are scored -2. The staff questioned why the response to some safety system alarms is considered a "routine planned operation," when such safety systems are rarely demanded. The licensee explained that operators are trained to respond to alarms from process controllers for non-safety reasons, and rely on operators' response for routine operation of its processes. These alarms are similar to those that would be used as part of an enhanced administrative control. The staff questioned whether other considerations besides the type of control (i.e., passive, active, or administrative) were evaluated in assigning indices, because a large number of other factors can affect reliability and availability (these are discussed as "reliability and availability qualities" in Section 3.4.3.2 NUREG-1520), and almost all administrative controls were assigned an index of -2. The licensee referred to Section 5 of the ISA Summary (page 59), which states that indices are assigned based on "industry accepted values, past experience, engineering judgment, analytical data, and/or any other applicable information." The licensee clarified, in a phone call, that it routinely considers characteristics of IROFS that can affect reliability, and that it does not just apply indices based on the type of control. With regard to administrative IROFS, the licensee stated that an index of -2 is generally conservative, relative to the failure probability data from "Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities" (i.e., it was determined by taking the midpoint of the nominal and high administrative control failure probability values from the Savannah River database). A specific example of the adequacy of administrative control indices concerned operators' responses to roof leaks in a moderation-controlled portion of the facility. The response to such leaks required assessment of the situation and planning of appropriate responses (e.g., securing fissile material, mitigating the leak, diverting the leak away from fissile material); the staff's questions concerned adequacy of the index in light of the task complexity and concerns about an operator's response time . The licensee stated that roof leaks are not uncommon occurrences, as operators are called on to respond to such leaks approximately 3-5 times per year. The licensee subsequently clarified that leaks occurring 3-5 times per year are minor drips and not major occurrences that would challenge the integrity of enclosures containing fissile material. Major leaks are conservatively estimated to occur once per year. Based on these considerations, the staff finds that assigning an index of -2 to operator responses to roof leaks was appropriate in this instance. Besides the roof-leak scenario, the staff reviewed several other sequences in which administrative controls were assigned an index of -1, and determined that in each case the index appeared reasonable or conservative. Based on its review of selected sequences, the favorable comparison of the administrative IROFS indices to the Savannah River Site database, and assurances that other factors besides control type are considered, the staff finds the approach to assigning indices to administrative IROFS relied on for criticality control appropriate.

Another issue concerning likelihood determination involved a situation in which the licensee assigned a lower index to an active engineered IROFS that would otherwise be applied, but provided no justification (-3 instead of -2) . The licensee stated that this was because the component in question was a simple mechanical device (a spring actuation to shut a valve) rather than an electrical or electronic device that would require complicated testing to verify its functionality. The licensee further stated that this was also based on performance data using these types of devices, and clarified that lower indices were applied on a case-by-case basis, not programmatically to all mechanical devices. In this particular case, however, the licensee eventually applied the more conservative index of -2 to the active device.

One additional issue concerned the inclusion of equipment necessary for the performance of administrative controls within the boundary of the IROFS. Examples of this included controls to prevent the chronic accumulation of fissile material in the facility's ventilation system. Two IROFS involved: (1) the measurement of differential pressure across in-line high-efficiency particulate air (HEPA) filters, and (2) periodic non-destructive assay (NDA) scans of ventilation ductwork. The administrative requirements to measure the differential pressure and scan the ductwork were identified as administrative IROFS. However, the differential pressure gauges and NDA equipment were not included within the boundary of the IROFS. The licensee clarified that the IROFS consisted of the HEPA filter and the NDA scans. The equipment used was thus part of the management measures for maintaining the filters and surveilling the ductwork, rather than part of the IROFS. Both the differential pressure gauges and NDA equipment are subject to periodic calibration as part of the facility's management measures programs. However, the licensee also stated that it revised the ventilation NCSE to more clearly distinguish between the management measures and IROFS. The staff reviewed this information and determined that it provided a better characterization of what was being relied on for safety, and is thus acceptable. To address the concern generally, the licensee committed to maintain the equipment needed for the proper performance of administrative IROFS. Equipment such as differential pressure gauges on HEPA filters, NDA instrumentation, and scales will be periodically calibrated as part of the management measures for administrative IROFs. NFS has committed to add calibration to the administrative controls section of Table 2.2 of License Application, Section 2.12 (by letter dated May 24, 2007).

Based on the review of individual accident sequences and IROFS, and programmatic commitments to address the aforementioned regulatory requirements and concerns, the staff has reasonable assurance that the licensee's ISA adequately analyzes criticality safety hazards and provides sufficient controls to ensure that criticality accidents will be highly unlikely, that nuclear processes will be subcritical under normal and credible abnormal conditions, and that the facility complies with the DCP. The staff therefore concludes that the licensee's application of its ISA methodology to criticality accident sequences and IROFS is adequate.

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2.6 Radiological Safety

A radiological safety analysis was performed for each credible accident scenario. Credible radiological accidents that were of intermediate or high consequences were identified. All credible radiological accidents were made unlikely or highly unlikely. The NRC staff reviewed a sample of the credible accident sequences and the associated IROFS for those sequences. The staff finds that the radiological safety analysis is adequate to ensure that the requirements of 10 CFR 70.61(b)(1)-(b)(3) and 10 CFR 70.61(c)(1)-(c)(3) will not be exceeded.

2.7 Fire safety

The Fire Safety Review of the NFS ISA Summary consisted of: (a) a vertical-slice review of ISA sequences FRE-05 and FRE-09, which address fire/explosion in the Area 600 Furnaces in Buildings 302 and 303, respectively; (b) a review of the combustible-loading control methods; (c) a discussion of the potential for releases from filter fires; and (d) a general tour and review of the facility fire protection features. The furnace sequences were of special interest because the furnaces could result in a number of different fire scenarios, including a torch fire, flash fire, confined explosion, and semi-confined explosions. The torch fire and flash fire were evaluated and found to result in low radiological and chemical consequences for all receptors. A confined explosion (inside the furnace) could result in intermediate-level chemical and radiological consequences to workers. A semi-confined explosion (outside the furnace) could result in intermediate chemical consequences to the environment, and high chemical consequences to workers. The confined explosion requires the addition of oxygen to the furnace environment. This in-leakage may be divided into oxygen present in the furnace before hydrogen addition and oxygen leakage into the furnace during operation. Oxygen presence before hydrogen addition is prevented by the following IROFS:

- FIRE6-10, Administrative Control, System purge with inert gas.
- FIRE6-11, Administrative Control, Independent verification of purge
- FIRE6-22, Enhanced Administrative Control, Inert gas supply low-pressure alarm, operator action.

The licensee's control strategy consists of grouping these IROFS into two combined IROFS, IROFS1 and IROFS2. IROFS1 and IROFS2 may contain "and" or "or" combinations of the IROFS, and both IROFS1 and IROFS2 must fail for the sequence to result in a consequence. For example, in the sequence, "Oxygen present in furnace prior to startup," IROFS1 consists of FIRES6-10 and FIRES6-22, and IROFS2 consists of FIRES6-11.

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A confined explosion may also be caused by oxygen leakage into the furnace during operation, which is prevented by the following IROFS:

- FIRE6-3, Active Engineered Control, Charge door interlocked with intermediate charge door.
- FIRE6-4, Administrative Control, Flame-curtain verified before opening furnace charge door.
- FIRE6-6, Active Engineered Control, Discharge chamber continuously purged with inert gas.
- FIRE6-13, Administrative Control, Entrance chamber is continuously purged with inert gas.
- FIRE6-14, Active Engineered Control, Relief valve on discharge chamber.
- FIRE6-22, Enhanced Administrative Control, Inert gas supply low-pressure alarm, operator action.
- FIRE6-15, Administrative Control, Furnace temperature greater than 500° C

An example accident sequence evaluated for the oxygen-intrusion type of confined explosion event was "Significant oxygen enters the discharge chamber during operation." The control strategy for this sequence was to list FIRES6-8 and FIRES6-22 as IROFS1, and FIRES6-14 as IROFS2.

The staff reviewed the control strategies and compared the procedures with the requirements of NFPA 86, "Standards for Ovens and Furnaces." The staff concluded that the applicant's control strategies exceeded the requirements of NFPA 86. In addition, there are no high-consequence events, and the likelihood of all controlled sequences are "highly unlikely."

The semi-confined explosion requires hydrogen to leak out of the furnace or supply lines during operation. Hydrogen leakage is detected /prevented by the following IROFS:

- Fire-1, Hydrogen detectors interlocked with maxon valves to close at 50 percent lower flammable limit (LFL).
- FIRE6-2, Enhanced Admin Control, Entrance chamber is vented through FLAREX-0601.
- FIRE6-3, Active Engineered Control, Charge door interlocked with intermediate charge door.
- FIRE6-4, Administrative Control, Flame curtain before opening furnace charge door.

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- FIRE6-6, Active Engineered Control, Discharge chamber continuously purged with inert gas.
- FIRE6-7, Enhanced Administrative Control, Discharge chamber is vented through FLAREX-0602.
- FIRE6-8, Administrative Control, Discharge chamber continuously purged with inert gas.
- FIRE6-9, Active Engineered Control, Storage chamber door and discharge chamber door timed nitrogen purge.
- FIRE6-12, Administrative Control, Personnel perform a startup hydrogen leak test around boots and seals.
- FIRE6-21, Active Engineered Control, High-hydrogen pressure isolation.
- FIRE6-22, Enhanced Administrative Control, Inert gas supply low-pressure alarm, operator action.
- FIRE6-26, Enhanced Administrative Control, Hydrogen detectors provide warning at 10 percent LFL. Personnel monitor for leaks and secure Maxon valves at 25 percent LFL.

An example of an accident sequence evaluated for semi-confined explosion type of event was "Hydrogen leaks out of furnace opening during operation." The control strategy for this sequence was to list FIRES6-21 and FIRES6-12 as IROFS1 and FIRES6-1 or FIRE6-26 as IROFS2. All semi-confined explosion sequences had a controlled likelihood of "highly unlikely."

The installed hydrogen detectors, which will alarm at a hydrogen concentration of 10 percent LFL and close the Maxon valves when the hydrogen concentration reaches 50 percent LFL, meet the requirements of NFPA 69, "Standard on Explosion Prevention Systems," and NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials."

The staff determined that the design and operation of the furnaces meet the performance requirements of CFR 70.61.

Combustible loading controls consist of IROFS # FIRE-2, "Periodic Surveillances of the Combustible Material Control Program." This IROFS pertains to the 300 Complex, 300 A/B Warehouse, 310 Warehouse, 105 Lab, 110 Lab, 110D Lab, 131 Lab, and the Waste Water Treatment Facility. The licensee's internal guidance for administering these surveillances is contained in Procedure "NFS-GH-62." This procedure: (1) defines transient combustibles and incidental materials; (2) defines the responsibilities of building managers regarding combustible materials inside their buildings; (3) establishes the frequency of inspections for identified facilities; (4) establishes the distance between combustibles and other items or equipment; and (5) provides general guidance for plant maintenance or modifications.

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Also reviewed was the combustible control program area limit guidelines. These guidelines contained specific guidelines for storing and placing combustibles in various areas of the facility. These areas were represented by a one- or two-page checklist, which lists the items to be evaluated in each facility area.

The procedure and area limit guidelines were found to be generally consistent with NFPA 801 "Standard for Fire Protection for Facilities Handling Radioactive Materials", and NFPA 30, "Flammable and Combustible Liquids Code," with an exception to: Section 4.3 (2) of NFPA 801 (2003), which states that the fire prevention program shall include "documented facility inspections conducted at least monthly, including provisions for remedial action to correct conditions that increase fire hazards." In response to Request for Additional Information (RAI), the licensee committed to revise IROFS #FIRE-2, to include specific equipment/areas, which will be inspected monthly. The list of areas to be inspected monthly under IROFS #FIRE-2, was included in letter 21-G-07-0052 (April 27, 2007). The staff considers the licensee's combustible loading program and IROFS #FIRE-2 to be acceptable.

At the request of the NRC staff, the applicant provided an analysis of fires in a glove box, a HEPA filter, and an exhaust duct, in letter 21G-05-0185, which were evaluated as follows:

The glove boxes consist of stainless steel frames and bottoms, LEXAN polycarbonate windows, and are typically equipped with a local HEPA filter. Glove-box penetrations include butyl rubber gloves, loading door, and bag-out port. The discharge from the HEPA filter goes through a damper in the process off-gas (POG) vent line (to allow HEPA filter replacement). The POG ducts are connected to a fiberglass reinforced plastic duct, that runs above the roof to the scrubber room, which contains two in-series scrubbers. From the scrubber room, the discharge is drawn through the blowers and then to the stack.

The licensee evaluated five cases of fires inside the filter system:

1) Fires caused by accumulation of pyrophoric dust, or fines on a HEPA filter, or within exhaust-duct lines.

2) Ignition of combustibles inside a glove box, of sufficient heat-release intensity to possibly cause the local HEPA filter to fail and transmit hot combustion gases through the vent line to the POG duct.

3) Fire inside a glove box where sufficient combustible material is present and where ignition-source potential exists. Fires pose the potential for sufficient heat-release intensity and burning duration to fail the local HEPA filter, cause thermal damage to the exhaust line vent and POG duct, and to potentially melt and ignite the LEXAN windows.

4) An external fire (a fire outside a glove box or exhaust-vent line), which melts and ignites the LEXAN glove-box windows and creates the domino effect of igniting any combustibles

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estimated that it would take approximately 20 kw/m[2] of radiant-heat energy or direct flame impingement at the glove box for this to occur. Such a fire condition is not likely to take place in the area with combustible loading controls in place.

5) Hot POG could expose HEPA filters, exhaust-vent lines, and POG ducts to failure temperatures.

In regard to fire case number one, the licensee asserts that there are no pyrophroric licensed materials at NFS; therefore, this fire exposure is not credible.

In regard to the second case, the licensee states that glove boxes are maintained free of ignition sources. The combustible sources within the glove box could generate sufficient heat to cause localized burn-through of the butyl rubber gloves and failing of the adhesive holding the HEPA filters. Conceivable combustible loadings are not high enough to involve the LEXAN windows or the PVC POG duct.

For the third case of glove-box fires, LEXAN enclosures associated with the 300-500 processes that present this type of potential, are protected by automatic total flooding CO_2 fire extinguishing systems.

For the case of an external fire, the facility's combustible-control program is considered sufficient to protect the polycarbonate glove-box windows. In addition, the low consequence of a fire-induced release, the fire detection system and the fire brigade response makes the risk of a release from a glove box, because of an external fire, low.

Hot POGs are controlled by heat-detection systems designed to shut down the heat source in the event of an over-temperature. For the calciner located in a glove box, stainless steel vent lines will be installed from the HEPA filter to the ceiling-level POG duct. In addition, fire arresters will be installed directly downstream of the HEPA filter for each calciner glove box. A fire damper has been installed downstream of the point where the two glove boxes are manifolded together. The Area 600 Furnace flares and ribbon burner are vented through stainless steel ductwork sections, which include finned cooling sections to dissipate excessive heat before the HEPA filters and POG duct.

The NRC staff considers the applicant's analysis of potential filter fires to be acceptable.

The general tour of the facility included a tour of the following areas: (a) the 300 complex, [redacted] (b) the 600 furnace areas; (c) and the 800 furnace areas; the building 304 breeze way (wet-sprinkler system); (d) rated fire walls and fire penetration seals; and (e) the liquid hydrogen storage tank. The fire protection IROFS observed were:

- FIRE-1, the Building 302 and Building 303 CO_2 Fire Suppression system, is a local application system and is designed to suppress a fire involving TBP and norpar [redacted] The system covers four separate zones within the area. The system is

[redacted]

- FIRE-1, the Building 302 and Building 303 CO_2 Fire Suppression system, is a local application system and is designed to suppress a fire involving TBP and norpar [redacted] The system covers four separate zones within the area. The system is designed to activate with signals from two separate heat detectors within a protection zone and has a delay between alarm and activation to allow personnel to escape. In addition to the delay, there are also small self-contained oxygen units for operators to escape from the upper platforms in the recovery area. The system uses low-pressure CO_2 in a refrigerated tank, and can be activated multiple times.

- FIRE6-24 closes the hydrogen supply Maxon valves to the area 600 furnaces when the CO_2 system activates. This addresses the potential loss of the flame curtain during CO_2 activation and the escape of hydrogen from the furnace.

- FIRE-12 is the Building 306 Breeze way wet-pipe sprinkler system. This system will protect the Maxon valves that control the furnaces in buildings 302 and 303. The water supply for these fire protection systems is the municipal water supply.

- FIRE-18 and FIRE-19 are 2-hour rated fire walls and fire-rated penetration seals that prevent fires in building 302 and/or 303 from spreading into adjacent areas. Other listed IROFS that are fire walls are FIRE-20 and FIRE-21, in Buildings 306 and 307.

These IROFS were determined to be adequate for the fire/explosion accident sequences that they were designed to prevent or mitigate.

Based on the vertical-slice review of the furnace-explosion sequences, combustible loading controls, filter fires, and general fire protection features, the staff concludes that the fire safety program and associated IROFS provide adequate protection against fires at the NFS facility. Therefore, the staff concludes that the NFS ISA Summary adequately ensures fire safety pursuant to the requirements of 10 CFR 70.61(b)(1)-(b)(3) and 10 CFR 70.61(c)(1)-(c)(3).

2.8 Chemical-Consequence Standards

The regulations in 10 CFR 70.61 provide that the ISA must evaluate compliance with performance requirements. These requirements specify that the risk of each credible high-consequence event must be limited such that the likelihood of occurrence is highly unlikely and the risk of each credible intermediate-consequence event must be limited such that the likelihood of occurrence is unlikely. The consequence evaluations for chemical exposures used Emergency Response Planning Guidelines (ERPGs) as action levels, or Temporary Emergency Exposure Levels (TEELs) when there were no ERPGs yet developed to assess consequences to the public and the workers. Because of the constant evolution of the ERPGs and TEELs, the licensee has agreed, in its response to the RAI, to add to Chapter 7 of the NFS Site-wide ISA Summary a requirement to review the limits used in the ISA against the ERPGs and TEELs for chemicals of concern, before initiating the annual ISA update. Chemicals present in the facility, as well as chemicals evaluated as part of the consequence analysis will be included in the chemical standards table of Chapter 7 of the Site-Wide ISA Summary. The applicant also

[redacted]

[redacted]

stated, in its response to the RAIs, that in instances where high and intermediate consequences are defined by the same exposure level for personnel and/or off-site individuals, the licensee has agreed to follow the most conservative approach and to assign the highest severity level to the accident. In the case of hydrogen (which is also considered a fire hazard) the licensee has established IROFS to avoid explosive conditions as a result of a potential hydrogen release.

In the case of soluble uranium intake, 10 CFR 70.61(b)(3) specifies a high consequence to the individual outside the controlled area (the public) to be greater than or equal to 30 mg of soluble uranium. The licensee defines an intermediate consequence to the public as 10 mg of soluble uranium. The intake must meet the requirements of 10 CFR 70.61(b)(4) and (c)(4) when setting high- and intermediate-consequence levels for soluble uranium. The licensee chose an intake of 40 mg of soluble uranium, which corresponds to the threshold for permanent renal damage, for determinating high-consequence events for workers, and 30 mg of soluble uranium for intermediate-consequence events for workers.

The NRC staff reviewed the licensee's approach for proposing chemical-consequence standards, and determined that it is in conformance with 10 CFR 70.61(b)(4) and (c)(4), as required by 10 CFR 70.65(b)(7), and is acceptable.

2.9 Identification of IROFS

For each IROFS, a description of the control type, method of control, control maintenance, and parameter limits, if applicable, was provided. The staff reviewed the list of IROFS, the management measures supporting the IROFS, and the general list of accident sequences, presented in the ISA Summary, that support the determination of the acceptability of proposed IROFS.

The list of IROFS given in the ISA Summary represent preventive and mitigative controls that were determined to be necessary to meet the performance requirements on 10 CFR 70.61. For each IROFS, NFS provided a description of the control type, method of control, control maintenance, and parameter limits, if applicable. The staff reviewed the list of IROFS, management measures, the general list of accident sequences, and the appropriateness of the applied IROFS.

The staff confirmed, by a detailed review of selected processes, that there is a consistent approach between the ISA Summary and the detailed descriptions given in the Safety Analysis Report sections for those processes reviewed. Based on the review of the IROFS listed in the ISA Summary, the NRC determined that the IROFS meet the necessary criteria to support a determination of "highly unlikely" and "unlikely."

2.10 List of Sole IROFS

The NRC staff verified that NFS provided a list of sole IROFS in accordance with the requirements of 10 CFR 70.65(b)(8).

2.11 Definitions of "Credible," "Unlikely," and "Highly Unlikely"

NFS provided its definitions of Credible, Unlikely, and Highly Unlikely in Section 9.0 of the ISA Summaries. The NRC approved the NFS definitions by Amendment 39 of SNM -124, dated July 7, 2003.

3.0 DESCRIPTION OF VERTICAL SLICE

On May 27, 2005, the staff performed an on-site review visit to the NFS facilities in Erwin, Tennessee. The licensee gave the staff a tour through the fuel manufacturing process. After the tour, the licensee made presentations on the scenarios NRC had selected for the vertical-slice review of the ISA. During the on-site review, the licensee also provided ISA documentation, supporting information, and site-wide procedures. The meetings held focused on specific technical areas (e.g., chemical safety, fire protection, criticality, etc.). In the ISA Summary, the licensee developed computer spreadsheet models using NRC and other Federal agency guidance (e.g., U.S. Environmental Protection Agency), and incorporated hand calculations to evaluate the magnitude of the consequences to the receptor. General assumptions used for these computations were provided in the ISA and ISA Summary. The NRC staff has determined that these are appropriate techniques and assumptions in estimating the concentrations, or predicting releases of hazardous chemicals, produced from licensed material, or by abnormal plant conditions, that could affect the safety of licensed materials.

4.0 CONCLUSIONS

Many hazards and potential accidents can result in unintended exposure to persons, to radiation, radioactive materials, or toxic chemicals incident to the processing of licensed materials. The NRC staff finds that NFS has performed an ISA at the appropriate level of detail for the complexity of the processes, and has identified and evaluated potential hazards and accidents, as required by the regulations. The NRC staff has reviewed the ISA Summary and other information and finds that this material provides reasonable assurance that the licensee has established a safety program, maintains process safety information and an ISA, and has established management measures that demonstrate that the safety program meets the performance requirements of 10 CFR 70.61. Specifically, the NRC staff finds that the ISA results, as documented in the ISA Summary, provide reasonable assurance that the IROFS, management measures, and programmatic commitments will make all "credible" high-consequence events to be "highly unlikely," and all "credible" intermediate-consequence events to be "unlikely." The NRC staff concludes that NFS's safety program provides reasonable assurance that IROFS will be available and reliable to perform their intended safety functions when needed in the context of the performance requirements.

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The Region II inspection staff has no objections to the proposed action.

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