Attachment II

ISA Summary
(Non-Proprietary Version)

21T-02-0298
NCS-07-02

Revision 1

Integrated Safety Analysis Summary

Blended Low Enriched Uranium (BLEU) Project
Uranyl Nitrate Building (UNB)

AUGUST 2002

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Introduction and Scope

Nuclear Fuel Services, Inc. (NFS) and Framatome ANP, INC are designing and will construct and direct operation of the BLEU (Blended Low Enriched Uranium) Complex at the NFS site in Erwin, TN. The new complex and facilities therein will be licensed under the new rule 10 CFR Part 70, enacted on September 29, 2000. According to the rule, an Integrated Safety Analysis, (ISA) is to be conducted on currently operating and new facilities to assure that the performance criteria delineated in 10 CFR 70.61 are met. Industry guidance on the conduct of an ISA and content of the ISA Summary is provided in NUREG-1513 "Integrated Safety Analysis Guidance Document". Additionally, NUREG-1520, "Standard Review Plan", Chapter 3.0 Integrated Safety Analysis, outlines the NRC review and acceptance criteria for the ISA and ISA Summary.

For the BLEU Complex, compliance with the performance criteria of 10 CFR 70.61 will be demonstrated by conducting individual ISAs for each process building in the Complex. Support equipment located outside of the buildings will be evaluated where appropriate. Each of the processes in each building will be evaluated as a subset to the building ISA. This document covers the first process building in the BLEU Complex to enter operation, the Uranyl Nitrate Building (UNB). The other process buildings (and balance of plant systems) will be analyzed in a timely manner at a later date, reflecting the BLEU complex construction schedule.

A summary of the results of the ISA for the UNB is presented in this ISA Summary. Specifically included in the scope of this document is the following building and its subsystems (process systems):

Uranyl Nitrate Building [redacted]

a) BLEU UN Receipt
b) BLEU UN Storage
c) Natural UN storage and download

This summary encompasses all of the processes handling Special Nuclear Material (SNM) and any associated equipment and/or off-stream processes that could be impacted by or intermingled with SNM. As specified in 10 CFR 70.64 'Requirements for new facilities or new processes at existing facilities', the ISA considers initiating events resulting from natural phenomena to the extent that such phenomena are considered credible for the plant site.

The scope of the ISA does not include initiating events caused by sabotage, acts of war or meteorite impacts.

1.0 General Site Description

Citations in this section are from the NFS 1996 Environmental Report and the 2001 Supplemental Environmental Report for Licensing Actions to Support the Blended Low-Enriched Uranium Project at Nuclear Fuel Services.

The BLEU Complex will be located in the City of Erwin, in Unicoi County, which is in the northeast portion of the State of Tennessee The complex is on NFS owned property which is approximately 65 acres of land in a long, narrow mountain valley oriented in the southwest-to-northeast direction. The valley is bounded on both sides by the Appalachian mountains. The site elevation ranges approximately 1638 to 1680 feet above sea level, and the surrounding mountains have a maximum elevation of 2,480 feet above sea level.

The BLEU Complex property boundary and the Controlled Area of the site are shown in Figure 1. *The Controlled Area encompasses the UNB, which encloses the tanker load and unload* areas. The Controlled Area is surrounded by an access control fence line patrolled by armed guards.

The closest BLEU Complex property boundary is approximately 160 feet from the UNB exhaust stack and approximately 82 feet from the UNB. The closest residence is approximately 400 feet from the site boundary. Appendix C provides the NFS plant , BLEU Complex and Studsvik Processing Facility Layout. Appendix D provides a 360 degree 1 mile radius area map with NFS as the focal point. The BLEU facility is not shown on this map but is located in between the NFS plant and the Studsvik Processing Facility. Appendix E is the approximate 100-year flood plain supplanted on an NFS and BLEU Complex map. Appendix F provides an aerial view of the BLEU Complex site showing spatial relationships to the NFS and Studsvik Processing Facility sites.

1.1 *Climate*

The climate in the vicinity is characterized by warm, humid summers and relatively mild winters. Cooler, drier weather in the area is usually associated with polar continental air masses, whereas, warmer, wetter weather is generally associated with gulf maritime masses. The average annual temperature in 2000 was 55.1°F. The average daily minimum temperature was 23.8°F in January; and 83.4°F was the average daily maximum temperature in July.

1.2 *Meteorology*

The average annual precipitation in the Erwin area is 41 inches and the average snowfall is 16 inches. Prevailing winds tend to be from the southwest following the orientation of the valley. The 30 year average wind speed is 6.9 mph.

1.3 *Floods*

Surface water runoff from the NFS Site and BLEU Complex are directed into Martin Creek via local branch streams and site drainage structures. Martin Creek empties into North Indian Creek and then into the Nolichucky River. The 100-year flood plain for Martin Creek extends to an elevation of 1,640 feet above sea level. The floor of the UNB is at approximately 1,655 feet above sea level. Therefore, the UNB is well above the 100-year flood level of Martin Creek and *flooding is not of significant concern* to UNB operations.

1.4 *Winds and Storms*

Severe storm conditions are rare in the Erwin region, which is east of the center of tornado activity, south of most blizzard conditions, and too far inland to be affected by hurricane activity. NOAA regional data recorded a maximum sustained wind of 50 mph in 1951, and a peak wind gust of 86 mph in 1995. Wind data from the NFS Site collected over approximately the past three years indicate a maximum sustained wind of 29 mph.

A risk analysis for the NFS Site indicates a moderate to severe risk of facilities being damaged by lightning. The UNB and BLEU facilities design are reviewed for lightning risk and the appropriate protection is specified. The BLEU Complex will install lightning protection in accordance with NFPA 780. Therefore, lightning strikes would not be a significant concern for the BLEU Complex.

The UNB design and construction is in accordance with the Standard Building Code (1997) with a design wind load of 80 mph. Therefore, wind and storms are not of significant concern to UNB operations.

1.5 *Tornadoes*

Only one tornado has been recorded in the county since 1950. Two adjacent counties have reported two tornadoes each over the same time period. The topography of the area (the site is located in a valley surrounded by higher terrain) provides a measure of natural protection against tornado strikes.

For Unicoi County the data indicates a probability of 2 tornadoes per 100 years (1E-2 per year over 186 sq. miles), or 2.5 E-6 per year for a tornado striking the NFS Controlled Area (0.047 sq. miles).

Considering the low probability of tornados in the Unicoi area, and lower probability at the NFS site, a damaging tornado at the BLEU Complex is not considered a significant concern for site operations. In the unlikely event that a tornado did occur on site, protective actions would be implemented in accordance with the NFS Emergency Plan.

1.6 *Seismology*

The NFS site is located within the Southern Appalachian Tectonic Province, which extends from central Virginia to central Alabama and from the western edge of the Piedmont Province to the Cumberland Plateau Province. The Southern Tectonic Province has a moderate level of historical and recent earthquake activity. The NFS Site location is designated as Seismic Zone 2.

A seismic analysis of the NFS Site determined there is no evidence of geologically recent fault displacements on the site that would be associated with capable faults in the surrounding region. For a 1000-year return period, the analysis yielded an effective peak horizontal ground acceleration rate of 0.06 gravity.

The UNB is designed and constructed in accordance with the Standard Building Code (1997). The seismic design specification for all process vessel restraint systems is a value of 0.1 gravity for the effective peak acceleration.

1.7 *Population Information*

The NFS facility is located approximately fifty miles north-northeast of Asheville, North Carolina and twenty miles south of Johnson City, Tennessee near the southwest boundary of the Town of Erwin in Unicoi County, Tennessee. According to the 2000 U.S. Census, Erwin has a population of 5,610 and Unicoi County has a population of 17,667. A one mile radius includes portions of residential neighborhoods of Banner Hill, Love Station, and Evergreen. The estimated population density within one mile of the Complex is approximately 2,800 people.

1.8 *Adjacent Facilities*

1.8.1 Studsvik Processing Facility

The Studsvik Processing Facility (SPF), owned by Studsvik, LLC, is a State of Tennessee licensed low level radioactive waste processing facility located greater than 223 feet southwest of the Complex site boundary. The SPF processes low level contaminated ion exchange resins from secondary coolant operations at nuclear power plant facilities. The total average inventory of radioactivity during 2001 was approximately [redacted] with the following radionuclides providing significant contributions (>1%) to the inventory: Co^{58}, Co^{60}, Mn^{54}, Fe^{55}, Cs^{134}, Cs^{137}, and Ni^{63}.

A failure of engineering controls at Studsvik could potentially lead to a release of radiological materials to the air. However, because of its source term, the facility constitutes a low hazard facility, which State of Tennessee regulations exempt from having an Emergency Plan. In the event that a radiological release should occur, Studsvik would notify BLEU Complex of appropriate protective actions to take. Additional response measures may be taken by NFS, which may include the activation of its Emergency Response Organization. The response would be initiated in accordance with the NFS Emergency Plan.

1.8.2 CSX Transportation Railroad Yard

The CSX Transportation Railroad yard starts approximately one-half mile south of the Complex site and extends several miles north into the main yard in downtown Erwin. The main line expands to 7 sets of tracks, as it passes by NFS, and eventually into approximately 30 lines at the main terminal in downtown Erwin. The function of the yard is mainly to provide for inspection, maintenance, and repair of rail cars. None of the tracks pass straight through the yard, and they all stop for crew change or yard operations. The speed in the yard is controlled to less than 10 mph.

The closest track to the Complex is approximately 50 feet from the outer fence line. The UNB is approximately 150 feet east of the outer fence adjacent to the railyard. Due to the low speeds, any derailments that occur only affect an area within 1 or 2 feet of the track (W.F. Spears, CSX Transportation Terminal Manager). Considering the low speed of the rail lines in the yard, and the significant distance to the Complex, the CSX Transportation railroad yard is not considered to be a significant concern for BLEU operations.

Due to the various types of hazardous materials carried by the railroad, in addition to railroad refueling operations, there is a potential for the Complex to be impacted by fire, explosion or hazardous chemical releases from the railroad yard. The potential fire and explosion scenarios from the railroad are addressed in the BLEU Complex FHA, and would be bounded by the on-site fire and explosion hazards already analyzed. In the event that a fire, explosion, or hazardous chemical release occurred, protective actions (e.g., evacuation or shelter) would be initiated in accordance with the NFS Emergency Plan.

1.8.3 Local and Regional Airports

The Tri-Cities Regional Airport is located approximately 40 miles north of the BLEU Complex near the town of Gray, which is centrally located between the three major cities of Kingsport, Bristol, and Johnson City. The airport consists of an 8,000 foot primary east-west runway and a 4,447 foot secondary north-south runway. The flight patterns for airliners arriving and departing from the runways do not cross over the NFS site. Considering the relatively small size of the airport, and significant distance from the site, the air traffic from this airport does not represent a significant concern for the Complex.

Other local airports are operated in Johnson City and Elizabethton, however, these are small operations and at least 25 miles from the Complex. The flight patterns to these airports are not a concern for site or BLEU Complex operations.

1.8.4 Carolina Avenue

Carolina Avenue runs parallel to the east property boundary of the Complex. There is only one access point to the site from Carolina Avenue. The vehicle traffic on Carolina Avenue has not been specifically evaluated, however, the road is approximately 500 feet from the site boundary. Considering this distance, vehicles on Carolina Avenue would not be a significant concern for site operations.

2.0 *Facility Description*

The BLEU Complex is located on approximately five acres of land adjacent to NFS' normal processing area. The property lies approximately 800 to 1000 feet from the southeastern bank of the Nolichucky River, and is bounded by Carolina Avenue to the east, the CSX rail yard to the west, NFS to the north and the Studsvik Processing Area to the south. (See Figure 1).

Figure 1: BLEU Complex Site Plan

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The BLEU Complex will be fenced and have a 24-hour guard station at the entrance. Site layout concerns that are related to the processing of nuclear materials and worker safety are specifically addressed by the Nuclear Criticality Safety Evaluation and the Radiation Protection Program. On-site traffic patterns do not appreciably increase the accident likelihood for the UNB. Evacuation routes and emergency vehicle access to the site are planned such that egress during an accident does not increase the risk to employee health nor impede site access for emergency personnel.

3.0 Process and Accident Scenario Descriptions

This section describes the UNB processes and the associated high consequence accident scenarios that were identified in the PHA. Table 1 lists these accident scenarios, summarizing the hazards and the controls implemented to meet the performance criteria. Also, Section 3.4 describes non-process related accident scenarios (e.g. fire) that result in intermediate or high consequences if unmitigated.

3.1 *UN Receipt Process Description*

3.1.1 UN Receipt Equipment

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3.1.2 UN Receipt Process

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Figure 2: UNB Process Flow Diagram

3.1.3 UN Receipt Hazards

Consequence assessments applied to the PHA determined that the only UNB Facility process-related hazards that exceeded the 10 CFR 70.61 action requirements were nuclear criticality related. Fire, chemical, radiological, industrial, and nuclear safety elements are evaluated for the process and for natural phenomena and external events in the PHA. Non-process related hazards are discussed in section 3.4. Refer to section 4.2 for an overview of the PHA process and section 4.7 for an overview of the consequence analyses.

3.1.4 UN Receipt Accident Scenarios

The ISA identified several accident scenarios that could lead to unacceptable safety consequences for the UNB process systems. These scenarios are listed in Table 1, along with consequence and likelihood ratings and measures (IROFS) taken to reduce the risk to acceptable levels.

The initiating event number in the first column of Table 1 is the same identifier used in the PHA accident scenario tables. The Initiating Event Index in column (2) is taken from Table 3 (Section 4.7.2) below. The preventive and/or mitigative IROFS are listed in columns (3)-(5), along with a failure index from Table 4. The calculated Likelihood Index T is shown in column (6). The uncontrolled value of T is just the initiating event frequency index. The controlled T is the sum of columns (2) through (5). From T, a Likelihood Category is derived per Table 6 for both uncontrolled and controlled cases. The Consequence Category is selected based on the severity of the consequence per Table 2. The Risk Indices are calculated by multiplying the values in column (7) by column (8). The result is compared to the Risk Matrix in Table 7 to determine if sufficient protection has been provided. All of the scenarios have a Consequence Category of 3, and so must be controlled to "Highly Unlikely", so the Risk Index must be equal to 3 for each scenario.

Scenarios 1.5.1 through 1.62.1 relate to the UN Receipt processes described above. All of the scenarios are criticality safety issues, specifically related to loss of concentration control leading to a potential criticality. The initiating events and IROFS for the scenarios listed in Table 1 are explained in more detail below.

Scenario 1.5.1:

This scenario results in high U or %U-235 (enrichment) concentration in TK-10, caused by the supplier (the Savannah River Site (SRS)) filling the Liqui-Rad shipping containers with UN that exceeds safety limits. [

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Scenarios 1.5.2, 1.7.1, and 1.18.1:

These scenarios result in high U concentration in TK-10, caused by receipt of UN solution that had partially frozen in a Liqui-Rad shipping container because of low temperature. [

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Scenario 1.14.1:

This scenario results in high U due to solids formed by adding precipitant to UN in TK-10 from the Liqui-Rad shipping container, caused by the supplier (the Savannah River Site (SRS) filling one or more Liqui-Rads with precipitant solution. [

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Scenarios 1.25.1, 1.38.1, 1.54.1, 1.55.1, 1.59.1, 1.61.1, and 1.62.1:

These scenarios result in U carryover to the unsafe geometry building exhaust ductwork via the TK-10 vent line caused by either overflow from TK-10 or failure of the TK-10 de-entrainment system to remove UN from the offgas during transfer. Carryover of UN to the ductwork is not an immediate concern. It becomes a concern if it is not identified and appropriate corrective action is not performed to remove the liquid and prevent concentration. [

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Scenario 1.26.1:

This scenario results in UN with increased U concentration pumped to TK-10 via the off-spec material feed line (from the UNB spill basin sump) following a spill inside the facility and concentration of the solution via evaporation. [

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Scenario 1.12.1:

This scenario results in an increase in U concentration via precipitation caused by introduction of a precipitating agent into TK-10 from the UN download area. An operator transferring a precipitating agent from an incorrect tank (non Liqui-Rad) to TK-10 causes this event.

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Scenarios 1.26.2 and 1.76.1

These scenarios result in an increase in U concentration in the off-spec UN tank (TK-10U) via evaporation resulting from high ambient temperature and/or high flow through the ventilation system.

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Scenario 1.26.3

This scenario results in an increase in U concentration via precipitation caused by introduction of a large amount of precipitating agent to TK-10 from the spill basin sump or sink. An operator adding a solution containing a precipitant to the spill basin sump or sink causes this event.

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Table 1: Accident Sequence Summaries Which Require IROFS and Resultant Risk Assignments

(1) Accident Sequence	(2) Initiating Event / Freq Index	(3) Preventive IROFS 1 / Freq Index	(4) Preventive IROFS 2 / Freq Index	(5) Mitigation / Freq Index	(6) Likelihood Index T Uncontrolled / Controlled	(7) Likelihood Category Uncontrolled / Controlled	(8) Consequence / Category	(9) Risk Indices Uncontrolled / Controlled	(10) Comments and Recommendations
1.5.1 High U conc. or %235	Shipper error, unsafe UN received into TK-10	[ ]	[ ]	None	U = -3	U = 2	Possible Criticality Accident	U = 6	[ ]
	-3	-1	-1		C = -5	C = 1	3	C = 3	
1.5.2 UN Receipt High U in TK-10	UN Freezing in Shipping Container	[ ]	[ ]	None	U = 0	U = 3	Possible Criticality Accident	U = 9	*This scenario can only occur during transfers (one per week) that take place in extremely cold weather.*
	0	-2	-2		C = -4	C = 1	3	C = 3	
1.7.1 UN Receipt High U in TK-10	UN Freezing in Shipping Container	[ ]	[ ]	None	U = 0	U = 3	Possible Criticality Accident	U = 9	*Essentially the same as 1.5.2*
	0	-2	-2		C = -4	C = 1	3	C = 3	

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T Uncontrolled Controlled	(7) Likelihood Category Uncontrolled Controlled	(8) Consequence Category	(9) Risk Indices Uncontrolled Controlled	(10) Comments and Recommendations
1.12.1 UN Receipt: High U in TK-10	Operator Transfers Precipitant via Feed Line -1	[ ] -1	[ ] -3	None	U = -1 C = -5	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
1.14.1 High U conc. in TK-10	Shipper error, precipitant transferred into TK-10 from LiquiRad -3	[ ] -1	[ ] -1	None	U = -3 C = -5	U = 23 C = 1	Possible Criticality Accident 3	U = 69 C = 3	*Same as 1.5.1:* [ ]
1.18.1 UN Receipt High U in TK-10 (Feed Line)	UN Freezing in Shipping Container 0	[ ] -2	[ ] -2	None	U = 0 C = -4	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	*Essentially the same as 1.5.2*
1.25.1 U in Ductwork from TK-10	High Flow in Off-Spec Material Feed Line causes U carryover, w/ subsequent evaporation -1	[ ] -3	[ ] -3	None	U = -1 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T Uncontrolled Controlled	(7) Likelihood Category Uncontrolled Controlled	(8) Consequence Category	(9) Risk Indices Uncontrolled Controlled	(10) Comments and Recommendations
1.26.1 TK-10 High U Conc.	UN Spill evaporates, high conc. U transferred via offspec feed line -2	[ ] -1	[ ] -1	None	U = -2 C = -4	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
1.26.2 TK-10 High U Conc from TK-10U	UN in TK-10U evaporates, high conc U transferred to TK-10 -2	[ ] -3	[ ] -1	None	U = -2 C = -6	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
1.26.3 TK-10 High U due to Precip	Operator transfers Precipitating Agent from sink during remediation -1	[ ] -1	[ ] -2	None	U = -1 C = -4	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]

(1) Accident Sequence	(2) Initiating Event *Freq Index*	(3) Preventive IROFS 1 *Freq Index*	(4) Preventive IROFS 2 *Freq Index*	(5) Mitigation *Freq Index*	(6) Likelihood Index T Uncontrolled Controlled	(7) Likelihood Category Uncontrolled Controlled	(8) Consequence Category	(9) Risk Indices Uncontrolled Controlled	(10) Comments and Recommendations
1.38.1 U in Ductwork from TK-10	TK-10 High level causes overflow to HVAC duct, w/ subseq. Evaporation -1	[ ] -3	[ ] -3	None	U = -1 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	*Essentially the same as 1.25.1.*
1.54.1 U in Ductwork from TK-10	Loss of TK-10 demister, UN carryover and subseq. Evaporation -1	[ ] -3	[ ] -3	None	U = -1 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	*[ ]*
1.55.1 U in Ductwork from TK-10	Compressed air left on, carryover of UN, w/ subseq evaporation 0	[ ] -3	[ ] -3	None	U = 0 C = -6	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	*Essentially the same as 1.54.1.*

(1) Accident Sequence	(2) Initiating Event	(3) Preventive IROFS 1	(4) Preventive IROFS 2	(5) Mitigation	(6) Likelihood Index T Uncontrolled	(7) Likelihood Category Uncontrolled	(8) Consequence	(9) Risk Indices Uncontrolled	(10) Comments and Recommendations
	Freq Index	Freq Index	Freq Index	Freq Index	Controlled	Controlled	Category	Controlled	
1.59.1 U in Ductwork from TK-10	Loss of TK-10 demister, UN carryover and subseq. Evaporation	[ ]	[ ]	None	U = -1	U = 3	Possible Criticality Accident	U = 9	*Essentially the same as 1.54.1.*
	-1	-3	-3		C = -7	C = 1	3	C = 3	
1.61.1 U in Ductwork from TK-10	Partial filtration; Loss of TK-10 demister, UN carryover and subseq Evaporation	[ ]	[ ]	None	U = -1	U = 3	Possible Criticality Accident	U = 9	*Essentially the same as 1.54.1.*
	-1	-3	-3		C = -7	C = 1	3	C = 3	
1.62.1 U in Ductwork from TK-10	Entrainment; Loss of TK-10 demister, UN carryover and subseq. Evaporation	[ ]	[ ]	None	U = -1	U = 3	Possible Criticality Accident	U = 9	*Essentially the same as 1.54.1.*
	-1	-3	-3		C = -7	C = 1	3	C = 3	

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T *Uncontrolled* Controlled	(7) Likelihood Category *Uncontrolled* Controlled	(8) Consequence Category	(9) Risk Indices *Uncontrolled* Controlled	(10) Comments and Recommendations
1.76.1 TK-10U High U Conc	UN in TK-10U evaporates over long period of time -2	[ ] -3	[ ] -1	None	U = -2 C = -6	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	*[ ]*
1.106.1 Storage Tank High U Conc	UN in any storage tank evaporates due to hi outside temp -3	[ ] -3	[ ] -1	None	U = -3 C = -7	U = 2 C = 1	Possible Criticality Accident 3	U = 6 C = 3	*[ ]*
1.109.1 Storage Tank High U Conc by freezing	See Comment →								*Scenario bounded by* 1.106.1, 106.2, 1.111.1, 1.121.1 and 1.121.2

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T *Uncontrolled* Controlled	(7) Likelihood Category *Uncontrolled* Controlled	(8) Consequence Category	(9) Risk Indices *Uncontrolled* Controlled	(10) Comments and Recommendations
1.111.1 & *1.120.1* Storage Tank High U Conc.	UN in storage *tank partially* freezes due to low outside temp -3	[ ] -2	[ ] -2	None	U = -3 C = -76	U = 2 C = 1	Possible Criticality Accident 3	U = 6 C = 3	[ ]
1.115.1 Storage Tank High U Conc.	UN in storage tank evaporates due to airflow from missing manway cover See Comments	[ ] -3 Dur Ind -3	[ ] -1	None	U = -3 C = -7	U = 2 C = 1	Possible Criticality Accident 3	U = 6 C = 3	[ ]

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T Uncontrolled Controlled	(7) Likelihood Category Uncontrolled Controlled	(8) Consequence Category	(9) Risk Indices Uncontrolled Controlled	(10) Comments and Recommendations
1.115.1 Storage Tank High U Conc.	UN in storage tank evaporates due to airflow from missing manway cover *See Comments*	[ ] -1 Dur Ind -3	[ ] -3	None	U = -1 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
1.121.1 High U Conc in HVAC duct	UN overflows from storage tank, subseq. *evaporation* 0	[ ] -3	[ ] -3	None	U = 0 C = -6	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
1.121.2 High U Conc in HVAC duct	UN overflows from storage tank due to mech failure, subseq. evaporation -1	[ ] -3	[ ] -3	None	U = -1 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]

(1) Accident Sequence	(2) Initiating Event Freq Index	(3) Preventive IROFS 1 Freq Index	(4) Preventive IROFS 2 Freq Index	(5) Mitigation Freq Index	(6) Likelihood Index T Uncontrolled Controlled	(7) Likelihood Category Uncontrolled Controlled	(8) Consequence Category	(9) Risk Indices Uncontrolled Controlled	(10) Comments and Recommendations
1.132.1 & 1.132.2 High U Conc storage tank	During UN transfer to OCB, backflow of precipitating agent occurs due to overflow -1	[ ] -3	[ ] -3	None	U = -10 C = -7	U = 3 C = 1	Possible Criticality Accident 3	U = 9 C = 3	[ ]
Fire Scenario 29: Natural gas fire /explosion	Fire/explosion causes damage to storage tanks, releasing UN to environment 0	UNB-T Natural gas system safety controls -2	UNB-U Block wall between heater and UNB tanks -3	None	U = 0 C = -5	U = 3 C = 1	Environmental Damage 3	U = 9 C = 3	Not a process hazard – see Appendix B, scenario 29
Fire Scenario A: FRP Tank Fire	Fire causes damage to FRP tanks, releasing UN to the UNB sump and outside environment -1	UNB-V UNB fire suppression and automatic sprinkler systems -2	UNB-W A trained operator performing a routine task with an approved procedure -1	None	U = -1 C = -4	U = 3 C = 1	Environmental Damage 3	U = 9 C = 3	Not a process hazard

3.2 *UN Storage Process Description*

3.2.1 UN Storage Equipment

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3.2.2 UN Storage Process

There are five basic operations performed with these tanks and associated equipment: filling from TK-10; storage; recirculation; transfer between storage tanks; and transfer to the OCB.

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3.2.3 UN Storage Process Hazards

The PHA and ISA determined that the only UNB Facility process-related hazards that exceeded the 10 CFR 70.61 action requirements were nuclear criticality related. Fire, chemical, radiological, industrial, and nuclear safety elements are evaluated for the process and for natural phenomena and external events in the PHA. [

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3.2.4 UN Storage Accident Scenarios

Accident scenarios 1.106.1 through 1.132.1 in Table 1 relate to the UN Storage systems. The initiating events and IROFS for the scenarios listed in Table 1 are explained in more detail below:

Scenarios 1.106.1, 1.106.2, and 1.115.1

These scenarios result in an increase in U concentration in the UN storage tanks (TK-11A through 14F) via evaporation resulting from high ambient temperature and/or high flow through the tanks and the vessel vent system.

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Scenarios 1.111.1 and 1.109.1

This scenario results in an increase in U concentration in one or more of the UN storage tanks (TK-11A through 14F) via crystallization resulting from low ambient temperature for a period of many days inside the UNB itself.

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Scenarios 1.121.1 and 121.2

This scenario results in U carryover to the ductwork due to overflow in the UN storage tanks. As discussed above for TK-10 (scenario 1.25.1, etc.), carryover of UN to the ductwork is not an immediate concern. It becomes a concern if it is not identified and appropriate corrective action is not performed to remove the liquid and prevent concentration. An overflow condition is readily detected by the CCS, which monitors the level of solution in all the storage tanks. Only a complete failure of the CCS, along with failure of all fail-safe modes, and complete inattention by the operating staff could cause an overflow to go undetected.

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Scenarios 1.132.1 and 1.132.2

This case results in U precipitation in the UN storage tanks after backflow of a large amount of solution from the OCB precipitation tank TK-21. UN from the UNB is transferred to UN Feed Tank TK-20 in the OCB. This UN is then transferred to the precipitation tank TK-21, where ammonia is added to precipitate the uranium. Only a complete failure of the CCS, along with failure of all fail-safe modes, and complete inattention by the operating staff could cause an overflow to go undetected.

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3.3 *Natural Uranyl Nitrate (NUN) Storage Process Description*

Natural UO_3 will be dissolved in the OCB and the resulting uranyl nitrate collected in a storage tank located in the UNB, from where it will be downloaded into tanker trucks. The storage tank TK-18 and download station will be installed during UNB construction but the equipment will not be placed in service until the OCB begins operation. Installation of the equipment was evaluated in the UNB PHA, *but an evaluation of the operation of this system must be performed with the* OCB safety evaluations and cannot be completed at this time. The system will be isolated and not used until OCB operation commences.

3.4 *Non-Process Hazards Description*

External events and fire hazards were analyzed in the PHA and FHA and, with the following exceptions, no intermediate or high consequence scenarios were identified. See Section 4.2 for an overview of the PHA and Appendix B for a summary table of the external events that were analyzed.

PHA Non-Process Hazards Scenario 29

This scenario consists of loss of U containment due to a natural gas fire and/or explosion in the mechanical room that causes at least high level consequences due to environmental and health physics effects resulting from the failure of more than one of the storage tanks in the UNB. Refer to Scenario 29 in Appendix B for more detail on this scenario.

Contingency #1: The natural gas burner system has internal controls to prevent leakage (flame detector, etc.) and potential natural gas fires

Contingency #2: The block wall between the mechanical room and the process area will provide adequate structural protection that even in a worst case natural gas explosion, rupture of even one tank is unlikely.

Defense in depth: The fire alarm and automatic sprinkler system will stop any fire before significant damage could occur.

PHA Non-Process Hazards Scenario A

Any fire scenarios severe enough to light even one FRP tank is unlikely due to the lack of combustible materials in and around the facility, the material properties of the FRP tanks as specified in Reference 9, and the presence of operating and security personnel in the UNB. However, it is assumed that once a fire is initiated, the ensuing environmental and health physics consequences are High. Therefore, the Active Engineering Control (AEC), UNB fire alarm and automatic sprinkler systems, and the Administrative Control, a trained operator performing a routine task with an approved procedure, are designated as IROFS to prevent and mitigate any fire accident sequence that ignites and fails the FRP tanks excluding Scenario 29. In addition, designating these as IROFS and applying the management measures specified in Section 4.8 of this Summary to ensure they are available and reliable when called upon to function satisfies the performance criteria set forth in 10 CFR 70.61.

Contingency #1: The fire alarm and automatic sprinkler system will stop any fire before significant damage could occur to more than one tank. The UNB sump is designed to contain the contents of one tank plus the sprinkler system discharge for 30 minutes.

Contingency #2: A trained operator performing a routine task with an approved procedure will sufficiently prevent the accident sequence initiation. However, should the initiating event occur the operator will perform the required operations as trained to prevent and mitigate the accident sequence.

Defense in depth: The building is constructed of non-flammable materials, no significant amounts of combustible materials are stored in or around the building, the site is kept free of brush, etc.

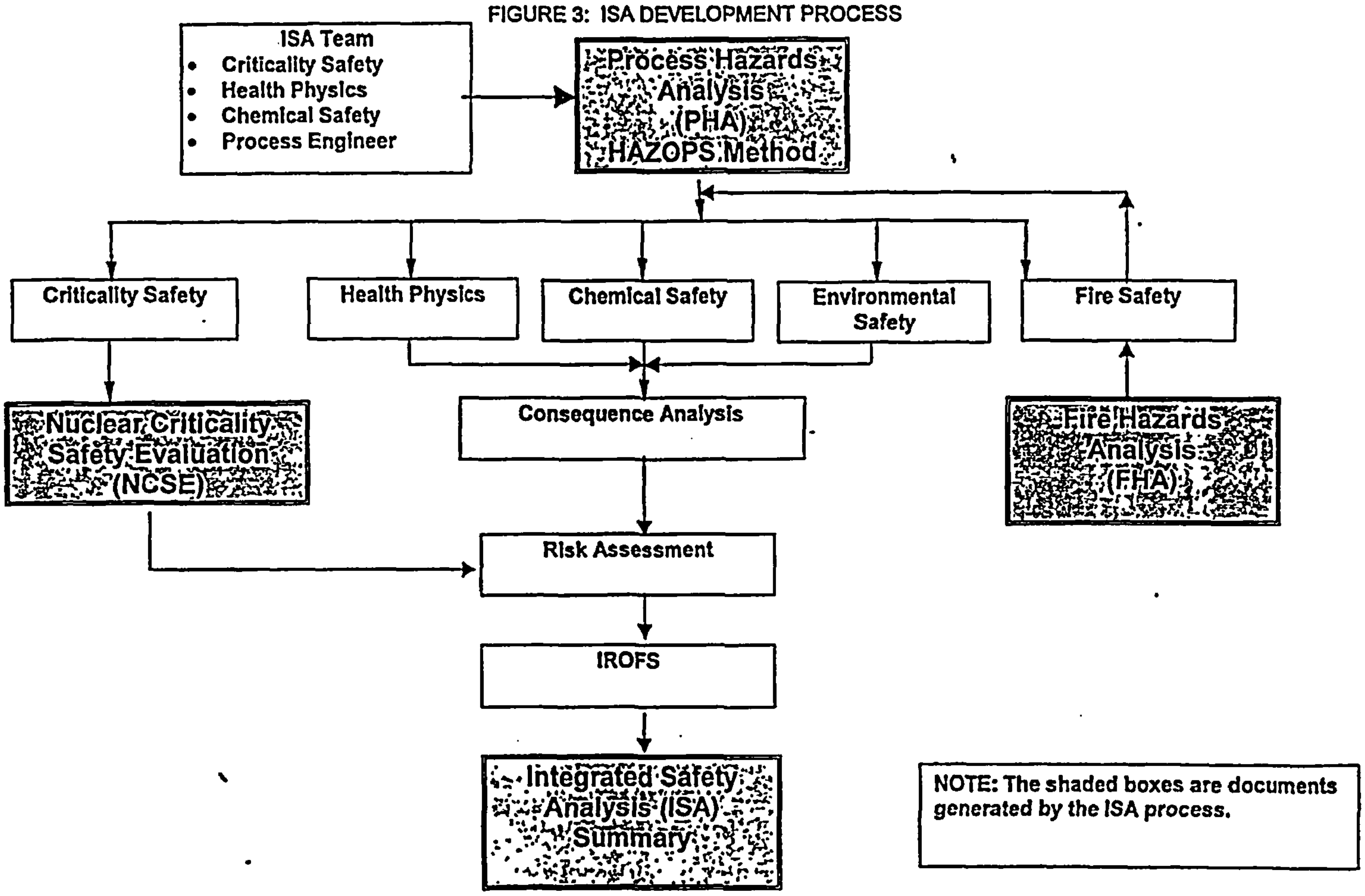
4.0 Compliance with 10 CFR 70.61

This section demonstrates how the ISA procedure complies with the requirements of 10 CFR 70.61.

4.1 *ISA Procedure*

The UNB ISA is conducted in stages as depicted in Figure 3. First, individual and specific hazards analyses are performed to identify hazards and accident sequences. The next step in the process is the consequence assessment and risk categorization of all accident sequences identified. Finally, Items Relied on for Safety (IROFS) are identified which control all accidents resulting in consequences of concern to an acceptable risk. The shaded blocks in the Figure represent separate documents.

FIGURE 3: ISA DEVELOPMENT PROCESS



Individual and specific hazards analyses are conducted by industry approved methods to identify specific hazards, process upsets, accident conditions, causes for the accident condition, and potential consequences. After the accident sequences have been identified, a consequence analysis is performed to identify 'Intermediate' and 'High' consequence events. Integration accomplishes the final two steps of the ISA procedure. Accident sequences resulting in consequences of concern are further defined and potential consequences are compared to the performance criteria listed in 10 CFR 70.61. The charter of the ISA is to review the accident sequences for risk, and identify appropriate controls and/or mitigation to control the risk to an acceptable level.

4.2 *Process Hazards Analysis*

A Process Hazards Analysis (PHA) is a systematic approach for identifying hazards and accident conditions that could result in undesirable consequences for a process or activity. A PHA is conducted on each process system with joint consideration of radiological, criticality, fire, and chemical hazards using appropriate methodologies as described in *Guidelines for Hazard Evaluation Procedures, Second Edition,* (Reference 1). A qualified team is utilized in the conduct of the PHA. Specifically included in the PHA team meetings are; 1) a team leader trained in the methodology(ies) being used, 2) a person familiar with the design, and operation of the process, 3) one or more persons familiar with radiological, chemical, fire, and criticality safety. The complete analysis comprises two segments.

The first segment of the analysis focuses on the process design, equipment, and operations using the Hazard and Operability Analysis (HAZOP) method described in Section 4.2.1. This segment encompasses all of the unit operations housed in the UNB as well as UN solution downloading from transport containers, natural UN solution (NUN) transfers from the OCB, and NUN loadout to tanker trucks.

The second segment of the analysis focuses on natural phenomena and external events that could potentially effect plant equipment and operations or be hazardous to on-site personnel. This segment of the analysis is described in Section 4.2.2.

In general, the PHA is very thorough due to the use of an appropriate methodology, but identified accident scenarios are somewhat broadly defined. Better definition, risk categorization and identification of control is accomplished during integration of the analyses. Because the PHA is so thorough and has representation from all disciplines, it is considered the foundation for subsequent ISA steps. Reference 10 is the PHA for the UNB.

4.2.1 <u>HAZOP Analysis</u>

During the conduct of the PHA, process safety information is collected then reviewed for completeness. The team leader then selects the methodology to be used for identifying accident sequences. Selecting the most appropriate methodology is important for efficient and effective execution of the hazards analysis. Reference 1 contains a listing and discussion of the various methodologies. Directions for selecting the most appropriate methodology and a decision tree to aid in the selection process are provided.

The "HAZOP" methodology was selected for this segment of the analysis which focuses on the process design, equipment, and operations. The principal justification for this choice is the fact that these systems are primarily chemical and/or process in nature. Using the decision tree,

Figure 5.3 in Reference 1, confirms that the HAZOP methodology is preferred in this analysis for the following reasons:

1. This is a new Hazard Evaluation study.
2. The desired outcome is a list of specific accident situations and safety improvements.
3. Detailed quantitative results are not necessary.
4. Process is not operating.
5. Detailed design information is available.
6. Single and multiple failure events.
7. Perceived High risk.
8. Not a mechanical or electrical system.
9. Not a simple or small system.

Following the branches of the decision tree shows that the HAZOP methodology is appropriate for both single AND multiple failure events for this system.

The reader is referred to Reference 1 for detailed descriptions of the methodologies and appropriate applications.

The basic premise of the HAZOP technique is to divide the process system into small pieces called 'study nodes'. The study nodes for the UNB processes were defined by team members based on process knowledge and are listed in the Node Table. Figure 4 shows the UNB process flow diagram with study nodes identified as encircled numbers that correspond to the numbers in the first column of the Node Table. The last column of the table gives a description of the intended design function and operational parameters for each node. The function and/or parameters are used with a series of "Guide Words" that are applied to each node to identify potential deviations from the plant's intended operation. An example of this methodology follows the table and flow diagram below.

Node Table: Study Nodes for UNB Hazards Analysis

Figure 4: UNB Nodes for HAZOP Study

At each study node, the following guide words are applied to the function and/or process parameters to identify potential deviations.

Guide Word	Meaning
No	Negation of the Design Intent
Less	Quantitative Decrease
More	Quantitative Increase
Part Of	Quantitative Decrease
As Well As	Quantitative Increase
Reverse	Logical Opposite of the Design Intent
Other Than	Complete Substitution

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4.2.2 Natural Phenomena, External Events, and Site Layout Analysis

This segment of the analysis focuses on natural phenomena, external events, and general site layout factors that could potentially effect process equipment, operability, or be hazardous for on-site personnel. Considerations include:

Natural Phenomena (including earthquake, flooding, windstorm, lightning, tornado, hurricane)

External hazards (including accidents at nearby facilities, aircraft or traffic accident, natural or man-made off-site fire)

Site evacuation

On-site accidents (including fire scenarios for standby generator, propane tank, tow vehicle in unload area, UN storage tank, HVAC natural gas heater, electrical room, mechanical room, office area, lightning strike)

Location of on-site populations relative to the facility

Location of critical systems

Potential for interaction with adjacent systems

On-site traffic patterns (pedestrian and motor vehicle)

Evacuation routes, emergency exits, safe gathering places

Access for fire fighting and other emergency services

Refer to Appendix B for a complete listing of the external event scenarios considered and the results of the analyses (extracted from the PHA, Reference 10).

4.3 *Nuclear Criticality Safety Evaluation(s)*

Nuclear Criticality Safety Evaluations (NCSEs) are specialized studies that assure the risk of having a criticality accident is 'Highly Unlikely' and that the double contingency principle is satisfied. NCSEs are required for all nuclear facilities and the contained fissile material units and/or arrays. These evaluations provide the technical bases for limits and controls to assure criticality safety. Highly skilled and extensively trained personnel in the area of criticality safety perform NCSEs. In addition, a multi-disciplined team reviews all accident sequences, barriers, and bounding assumptions used in the evaluations. Reference 11 is the NCSE for the UNB.

4.4 *Fire Hazards Analysis*

Fire Hazards Analyses (FHA) are conducted for processing buildings which are located within the BLEU Complex site boundary. The charter of the FHA is to evaluate the facility design with respect to fire safety codes, and to ensure that the facility is built such that there is acceptable risk for postulated fire accident scenarios. The FHA is generally conducted by an outside consultant that specializes in fire safety. Reference 9 is the FHA for the UNB.

4.5 *ISA Team*

An ISA Team shall consist of 5-8 members (the team may include more members if necessary). The minimum team shall meet the requirements of 10 CFR 70.62. Refer to section 5.0 for a listing of the personnel that made up the evaluation team for this ISA.

The team is required to have at least one member knowledgeable in each of the following areas for the subject system: 1) criticality safety, 2) radiological safety, 3) fire safety, 4) chemical process safety, 5) process/equipment engineering, and 6) process operation. A single member may be knowledgeable in more than one area and therefore may be relied upon to provide analysis expertise in more than one area. The Team will consult with additional safety, operations, engineering and maintenance personnel on an as-needed basis.

The ISA Team Leader is expected to be cognizant of the requirements for Integrated Safety Analyses as prescribed in 10 CFR Part 70 as well as the applicable NRC guidance in NUREG-1520 Chapter 3, Integrated Safety Analysis (ISA). Guidance is also provided in NUREG-1513, and the AIChE publication, "Guidelines for Hazard Evaluation Procedures."

4.6 *Integration*

To meet NRC requirements the ISA will, strictly speaking, be concerned only with high or intermediate consequences and the IROFS necessarily applied to them. The ISA is intended to give assurance that the potential failures, hazards, accident sequences, scenarios, and IROFS have been investigated together so as to adequately consider common mode and common cause situations, impacts of IROFS that may be simultaneously beneficial and harmful with respect to different hazards, and interactions that may not have been considered in previously completed analyses.

Some items that warrant special consideration during the integration process are:

- External events. This is due to the broad effects they will usually have on the entire plant site, and because they may not have been fully considered in the individual analyses, which were directed principally toward internal events.
- Common mode failures and common cause situations.
- Closely allied to common cause situations are utility system losses, e.g., loss of electrical power or city water, which can have simultaneous effects on multiple systems.
- Divergent Impacts of IROFS. Assurance must be provided that the negative impacts of an IROFS, if any, do not outweigh its positive impacts; i.e., to ensure that the application of an IROFS for one situation does not degrade a different risk situation. The standard example is use of water in a fire situation, which can add moderation with respect to criticality control.
- Other safety and mitigating factors that do not achieve the status of IROFS that could impact system performance.
- Identification of scenarios, events, or event sequences with multiple impacts, i.e. impacts on chemical safety, fire safety, criticality safety, and/or radiation safety e.g., a flood might *cause both loss of containment and moderation impacts.*
- Potential interactions between processes, systems, areas, and buildings; any interdependence of systems, or potential transfer of energy or materials.
- Major hazards or events, which tend to be common cause situations leading to interactions between processes, systems, buildings, etc.

In this ISA, the Fire Hazards Analysis and Criticality Safety Analyses were reviewed and it was deemed that the accidents in each were either evaluated from the PHA, or bounded by scenarios that were evaluated from the PHA.

4.7 *Risk Categorization*

The Integrated Safety Analysis (ISA) is required to be conducted by the licensee to determine whether the performance requirements listed in 10 CFR 70.61 are met. This requires the identification of all credible High and/or Intermediate consequence accident sequences and an evaluation with respect to the performance requirements. That is, all credible High consequence accident sequences and all credible Intermediate consequence accident sequences shall be shown to be Highly Unlikely and Unlikely respectively, upon application of Items Relied on for

Safety (IROFS). Risk Assessment, as described below, presents a consequence-likelihood risk assessment method by which this evaluation is performed.

4.7.1 Consequence Category

For each credible accident sequence identified, a Consequence Category is assigned. The Consequence Category is assigned based on hazards analysis(es) results, past experience, industry standards, engineering judgment, analytical data, and/or any other applicable information. In addition, the potential consequences are compared against bounding accident sequences. The Consequence Categories are defined in Table 2 as follows:

Table 2: Consequence Severity Categories Based on 10 CFR 70.61

	Workers	Offsite Public	Environment
Consequence Category 3: High	TEDE ≥ 100 rem ≥ ERPG3	TEDE ≥ 25 rem 30 mg soluble Uranium Intake ≥ ERPG2	
Consequence Category 2: Intermediate	25 rem ≤ TEDE < 100 rem ≥ ERPG2 But <, ERPG3	5 rem ≤ TEDE < 25 rem ≥, ERPG1 But < ERPG2	Radioactive Release averaged over a 24 Hour Period of > 5000 x Table 2 Appendix B 10 CFR 20
Consequence Category 1: Low	Accidents of lesser radiological and chemical exposures to workers than those above in this column	Accidents of lesser radiological and chemical exposures to workers than those above in this column	Radioactive releases producing effects less than those specified above in this column.

Note: AEGL, PEL, TEL, or IDLH values are used as justified when ERPG values do not exist.

Consequence Categories for all credible High or Intermediate consequence accident scenarios are assigned and documented in Table 1, Column 8.

4.7.2 Initiating Event Frequency

For each credible accident sequence, the initiating event leading to the accident is identified. If a single initiating event cannot be identified, the conditions that must be met to create the accident are analyzed.

An Initiating Event Frequency Index is assigned to each credible accident scenario based on past experience, engineering judgment, analytical data, industry acceptable values, and/or any other applicable information. Initiating Event Frequency is defined as the probability of occurrence of the initiating event or initiating set of conditions. The index assignments are defined in Table 3.

Table 3: Initiating Event Frequency

Frequency Index	Failure Frequency	Description	Comments
-5	1 Failure/100,000 years	Not credible	If initiating event, no IROFS needed
-4	1 Failure/10,000 years	Physically possible, but not expected to occur.	
-3	1 Failure/1,000 years	Not expected to occur during plant lifetime.	
-2	1 Failure/100 years *(Loss of cooling (redundant* cooling water pumps)) (Loss of Power (redundant power supplies))	Not expected, but might *occur during plant lifetime.*	
-1	1 Failure/10 years	Expected to occur during plant lifetime.	
0	1 Failure/year (Loss of cooling) (Loss of Power)	Expected to occur regularly during plant lifetime.	
1	Several occurrences per year	A frequent event	

The index value assigned to an initiating event may be one value higher or lower than the value. Criteria justifying assignment of the adjusted value should be given in the narrative describing ISA methods. Exceptions require individual justification.

Initiating Event Frequency Indices for all credible High or Intermediate consequence accident scenarios are assigned and documented in Table 1, Column 2.

4.7.3 <u>Identification of IROFS</u>

Applicable IROFS are identified and assigned to all High or Intermediate consequence accident scenarios.

IROFS are designated engineered or administrative "items relied on for safety" that provide reasonable assurance, through preventive or mitigative measures, that the safety performance requirements of 10 CFR 70.61 are met. These must be:

- Designed to prevent or mitigate specific, potentially hazardous events. Each identified potential hazard has corresponding, specific protection strategies.
- Independent so that there is no dependence on components of other protective layers associated with an identified hazard. There must also be no linkage between the initiating event and the ability of the IROFS to perform as required.
- Dependable so that they can be relied on to operate in the prescribed manner. Both random and specific failure modes are considered in the assessment if the probability exists of protection layers failing on demand or failing during their mission. If human intervention is included as an IROFS, the response time and corresponding human error probability is considered.
- Auditable in that they are designed to facilitate regular validation (including testing) and maintenance of the protective functions.

Each IROFS is assigned an IROFS Failure Frequency Index as specified in Table 4. The Failure Frequency is defined as the probability that the identified controls will prevent or mitigate the accidental consequence given the initiating event (or set of conditions) occurs. The Index is assigned to each IROFS based on industry accepted values, past experience, engineering judgment, analytical data, and/or any other applicable information. The numerical assignments for the IROFS Failure Frequency Index are provided in Table 4.

A special case of accident scenario is when a failure of an IROFS is the initiating event. In these scenarios, an Initiating Event Frequency Index is not assigned. Instead, the IROFS Failure Frequency Index is selected for the IROFS from Table 4. The IROFS that triggers the accident scenario is assigned a Duration Index as specified in Table 5. The Duration Index is a qualitative measurement of the time the system is vulnerable to the failure of a second IROFS when the second IROFS prevents a credible High or Intermediate consequence accident sequence from occurring. As such, the accident sequence is also evaluated by reversing the sequence of failure to determine the system vulnerability based on failing the second IROFS first.

Setpoints for interlocks in active engineered controls or alarms used in administrative controls are determined by engineering analysis that takes into account safety limits, instrument and system accuracy (from vendors), response time, anticipated instrument drift (based on vendor recommendations and operating experience), and other performance factors as appropriate. Setpoints are generally set very conservatively to ensure that the IROFS performance is reliable and making statistical calculations unnecessary. Calibration and functional test frequencies are also determined based on this data. Specifications for procurement of devices used as IROFS take these performance criteria into account and ensure that the device (and the whole IROFS) is reliable and available.

Table 4: IROFS Failure Frequency Index

Effectiveness of Protection Index	Type of IROFS**
-4* ***	Protected by an exceptionally robust passive engineered control (PEC). Exceptionally Robust Management Measures to ensure availability.
-3*	Protected by a single PEC or exceptionally robust AEC. Adequate Management Measures to ensure availability.
-2*	Protected by a single AEC. Adequate Management Measures to ensure availability.
-1	Protected by a trained operator performing a routine task with an approved procedure, an enhanced administrative control, or an administrative control with large margin.
0	Protected by a single administrative control or a trained operator performing a non-routine task with an approved procedure.

*Indices less than (more negative than) "-1" should not be assigned to IROFS unless the configuration management, auditing and other management measures are of high quality, because without these measures, the IROFS may be changed or not maintained

**The index value assigned to an IROFS of a given type may be one value higher or lower than the value given. Criteria justifying assignment of the lower value should be given in the narrative describing ISA methods Exceptions require individual justification.

***Rarely can be justified by evidence. Further, most types of single IROFS have been observed to fail.

Preventive and Mitigative IROFS Failure Frequency Indices for all credible High or Intermediate consequence accident scenarios are assigned and documented in Table 1, Columns 3, 4 and 5.

Table 5: Failure Duration Index Numbers

Duration Index Numbers	Avg. Failure Duration	Duration in Years	Comments
1	More than 3 years	10	
0	1 year	1	
-1	1 month	0.1	Formal Monitoring to justify indices less than "-1)
-2	A few days	0.01	
-3	8 hours	0.001	
-4	1 hour	10^{-4}	
-5	5 minutes	10^{-5}	

Failure Duration Indices for all credible High or Intermediate consequence accident scenarios that result from a failure of an IROFS are assigned and documented in Table 1, Column 3.

4.7.4 Likelihood

To demonstrate compliance with 10 CFR 70.61, all credible accident scenarios upon application of IROFS require a likelihood determination. A Controlled Likelihood and an Uncontrolled Likelihood are calculated to demonstrate the relative importance of the IROFS in preventing or mitigating the accident sequence to meet the performance requirements. A Controlled Likelihood Index T is calculated by summing the Initiating Event Failure Frequency Index to the IROFS Failure Frequency Index(s). If the Initiating event is an IROFS failure then the Controlled Likelihood Index T is calculated by summing the IROFS Failure Frequency Indexes and the Failure Duration Index. An Uncontrolled Likelihood Index T is calculated by using the Initiating Event Failure Frequency Index or the IROFS Failure Frequency Index as applicable. Controlled and Uncontrolled Likelihood Categories are then assigned from Table 6 based on the respective Likelihood Index.

Table 6: Total Risk Likelihood Category

Likelihood Category	Likelihood Index T (=sum of index numbers)
1	$T \leq -4$
2	$-4 < T \leq -3$
3	$T > -3$

Controlled and Uncontrolled Likelihood Indices for all credible High or Intermediate consequence accident scenarios are assigned and documented in Table 1, Column 6. Controlled and Uncontrolled Likelihood Categories are assigned and documented in Table 1 Column 7.

4.7.5 Resultant Risk Category

The qualitative values for the Likelihood and Consequence Categories are plotted on the Risk Matrix (Table 7) for categorization of Controlled and Uncontrolled Risk. The Controlled Risk is calculated by multiplying the Consequence Category by the Controlled Likelihood Category. The

Uncontrolled Risk is calculated by multiplying the Consequence Category by the Uncontrolled Likelihood Category. 10 CFR 70.61 performance requirement acceptability is determined by comparing the Controlled Risk to Table 7. As shown in Table 7, a risk greater than 4 is unacceptable and does not meet the 10CFR70.61 performance requirements.

Table 7: Risk Matrix

	Likelihood Cat. 1 Highly Unlikely	Likelihood Cat. 2 Unlikely	Likelihood Cat. 3 Not Unlikely
Consequence Cat. 3 High	3 Acceptable	6 Unacceptable	9 Unacceptable
Consequence Cat. 2 Intermediate	2 Acceptable	4 Acceptable	6 Unacceptable
Consequence Cat. 1 Low	1 Acceptable	2 Acceptable	3 Acceptable

Controlled and Uncontrolled Risk for all credible High or Intermediate consequence accident scenarios are assigned and documented in Table 1, Column 9.

4.8 *Management Measures for IROFS*

Management Measures are defined for credited IROFS to ensure they are available and reliable to perform their required function when needed (10 CFR 70.62.d). The defined set of Management Measures for each IROFS will consist of selected elements of the following management measure programs: Configuration Management, Maintenance, Training and Qualification, Procedures, Audits and Assessments, Incidents and Investigations, Records Management, and Quality Assurance. The type of IROFS control, along with the risk reduction level credited in the ISA, will determine the specific management measures applied to a particular IROFS.

The three types of IROFS controls, along with the management measures that apply to them are as follows:

Administrative Control IROFS

- Posting or Procedure Identification
- Training and Qualification
- Testing of Training Effectiveness
- Pre-operational audit or test
- Periodic audit
- Records management, Investigations, and QA

Passive Engineered IROFS

- Controlled listing identification
- Drawing identification
- Verification after maintenance
- Procedure identification
- Pre-operational audit or test
- Independent installation verification
- Periodic audits or Inspections
- Vendor specifications
- Training and Qualification
- Records management, Investigations, and QA

Active Engineered IROFS

- Periodic functional test
- Verification after maintenance
- Calibration
- Controlled listing identification
- Drawing identification
- Procedure Identification

- Pre-operational audit or test
- Periodic audits
- Training and Qualification
- Records management, investigations, and QA

Not all of the listed management measures would be applied to each IROFS. The management measures applied to a specific IROFS will be based on the level of risk reduction credited for the particular IROFS in the ISA. High or Intermediate consequence events depend on IROFS to reduce the overall risk to an acceptable level. High consequence events must be justified as highly unlikely, and intermediate consequence events justified as unlikely, after implementation of credited IROFS.

Table 8 defines how management measures are applied based on Risk Reduction levels (Level A or B). IROFS credited with a high level of risk reduction (Level A) will require a high level of management measures to ensure a high level of reliability. IROFS with an intermediate level (Level B) of risk reduction, or intermediate failure likelihood, will require an intermediate level of management measures. **Note that all IROFS in Table 1 for the UNB are considered Level A.**

4.8.1 Configuration Control

The NFS Configuration Management Program (CMP) defines how plant equipment, structures, systems and components (SSC) are to be identified and controlled. Safety significant components may be designated as IROFS. Subsets of these IROFS may be designated as Configuration Control Equipment (CCE) and Safety Related Equipment (SRE). The CCE and SRE programs encompass methods to evaluate and implement proposed changes. CCE and SRE, are identified on controlled equipment lists, controlled drawings, and/or controlled procedures. They are also maintained through engineering and quality assurance document specifications and equipment design control. Applicable management measures as described in Table 8 are applied to these components based on the type of control to ensure that the selected IROFS failure frequency index meets the index specification set forth in Table 4.

Proposed changes involving site structures, equipment, processes, storage areas, safety limits, or procedures are submitted to the safety discipline manager for review to determine if a license amendment is required or if the change may be made using the Nuclear Fuel Services, Inc. (NFS) Internally Authorized Change (IAC) process. The criteria for exemption from license amendment are specified in License Condition S-25, which implements the requirements of 10CFR 70.72a. The resulting determination is documented and then reviewed and approved by the safety review committee. The NFS organizational structure is defined in Section 11.1 of Part II of License SNM-124.

4.8.2 Safety Review Committee

The Safety Review Committee, chartered as the Safety and Safeguards Review Council (SSRC), consists of membership appointed by the President, or designated alternate. Membership, at a minimum, is comprised of the SSRC Chairman, Safety Director, Fuel Production Director, Decommissioning Director, Engineering Director, Safeguards and Security Director, and Materials Manager. Additional disciplines may be represented on the committee, as approved by the President or designated alternate. The committee meets as a body, at least monthly, to review and approve proposed equipment and facility modifications, as well as proposed process changes, which have substantial safety, security, or uranium accountability significance.

The committee reviews and approves operating procedures including Standard Operating Procedures, Decommissioning Procedures, Criticality Safety Procedures, General Safety Procedures and Emergency Procedures. The committee reviews ALARA goals, safety inspections, audits, and investigations which are required by the license. The SSRC also reviews and approves all proposed changes involving IROFS credited in the ISA Summary, including those determined to require or not require a license amendment per 10CFR 70.72.

4.8.3 Maintenance

NFS maintains a maintenance program to ensure that designated IROFS and other structures, systems and components (SSC) are maintained in a manner so as to ensure they are capable of performing their intended function when called upon. The maintenance program consists of several key program elements including: a maintenance management system that provides for scheduling and documentation of functional testing of SRE and maintenance activities; preventive maintenance to ensure the equipment can effectively perform its function; a system for specifying and documenting maintenance work activities and approvals; and, maintenance skills training for mechanics involved in maintenance activities at NFS.

Maintenance, calibration, testing, and/or inspection of IROFS and other safety related equipment, to ensure continued reliability and functional acceptability, will be performed in accordance with written procedures. Frequencies will be established based on manufacturer and industry guidance, with approval by the safety review committee. If an IROFS or other safety related equipment has undergone maintenance, or has been inactive for an extended period, it shall be functionally tested, calibrated, or inspected (as applicable) prior to restart.

4.8.4 Training and Qualification

The objective of the site training and qualification program is to provide all personnel on site with the knowledge and skills to safely and efficiently perform their job function. Specific safety related goals are to train personnel to effectively deal with the hazards of the workplace and to properly respond to emergency situations. The qualification aspect of this program ensures that operations are performed only by properly trained personnel. The objectives, requirements, and methods of the training and qualification programs are approved by site management, who also provide ongoing evaluation of the effectiveness of the programs. Safety related training/qualification for specific work stations includes general site safety issues (alarms, emergency response, etc.); IROFS and other safety related controls (passive and active engineered controls) relevant to that workstation; and administrative controls relied on for safety for that workstation, as stated in the ISA, SOP's, limit cards, etc.

The NFS Training Program requires that all personnel who are granted unescorted access to the protected area receive formal Safety Orientation Training. Safety Orientation Training covers plant safety rules, radiological, nuclear criticality, industrial, and environmental safety topics as appropriate to the job function of the individuals being trained. In addition, this training covers proper response to emergencies. Previously trained employees receive formal refresher training in Safety on an annual basis.

The NFS Training Program includes Work Training for operating personnel and others who directly handle greater than laboratory sample quantities of special nuclear material. Work Training typically includes classroom, on-the-job and guided-work-experience training necessary to provide the desired knowledge and/or skill. It covers the operating procedures and radiological and nuclear criticality safety controls specific to the particular work assignment. Work Training also includes appropriate re-instruction for previously qualified individuals prior to implementation of a process change or procedural modification. In addition, special "tool-box" training sessions are conducted when necessary to reinforce a particular requirement of the safety program or the operating procedure. Previously qualified individuals also participate in periodic procedure review training sessions designed to allow them time to re-review the operating procedures applicable to their particular work assignment. Those individuals are also required to undergo a re-qualification process for applicable work assignments every three years (maximum internal not to exceed 42 months). Additional details of the Work Training Program are provided in approved written procedures.

The NFS Training Program provides for the instruction and training of mechanics involved in maintenance activities at NFS. Maintenance skills training may include such topics as basic math/precision instrument reading, laser alignment/vibration analysis, basic programmable logic controller (PLC), welding, industrial electricity (basic, intermediate, and advanced), and machine tool operation, as appropriate. The type and level of training will be commensurate with the job assignments.

The training records system includes a means to document training objectives, individuals trained, course content and other data necessary to satisfy requirements. Such training records will be maintained throughout the life of the facility.

All training is conducted by, or under the supervision of, individuals recognized by NFS management as possessing the necessary knowledge and skills to conduct the training.

The effectiveness of the training program and the individual comprehension of the subject matter is measured by appropriate measurement tools (e.g., written and/or oral examination, demonstration of skills, questionnaire, etc.). Results from these assessment tools will be used to identify individuals that require special re-training, and to further enhance future training efforts and systems.

4.8.5 Procedures

NFS uses several systems of operating and safety function procedures to conduct SNM operations and related support functions. Typical types of procedures are as follows: Standard Operating Procedures, Maintenance Procedures, General Safety Procedures, Support Group Procedures, and Letters of Authorization. The procedure review and change process is defined in Section 11.7 of Part II of License SNM-124.

Issuing Procedures

Operating procedures are prepared by the appropriate discipline manager and approved by the safety discipline manager. The operating procedures will incorporate criticality safety controls, radiation safety controls, environmental protection controls, and industrial safety controls as defined by the ISA or ISA Summary, in addition to other safety requirements. Operating procedures are made readily available to foremen, operators and other affected personnel. Additionally, work place posting of limits and controls, training and other communication devices will be used to enhance comprehension and understanding of operating procedures. The operating procedures are reviewed and approved by the safety review committee. Review, to assure they reflect current practice, is performed by the safety review committee at least every two years.

4.8.6 Audits and Assessments

Audits and inspections are performed to assure Plant operations are conducted in accordance with established regulatory requirements, standard industry practice, and approved procedures. The objective of these audits and inspections is to provide for a critical self-assessment of the safety program and recommendations for continuous improvement.

Audits

Members of each safety function conduct formal, safety audits of nuclear manufacturing and support areas on a quarterly basis and in accordance with written procedures, which have been approved by the appropriate safety function manager. Such audits are performed to determine that actual operations, including IROFS, conform to safety requirements. The quarterly safety audit will be conducted by senior members of the appropriate safety discipline.

Inspections

Monthly criticality safety, radiation safety, environmental protection, and industrial safety inspections of operating, manufacturing and support areas are conducted in accordance with procedures which have been reviewed and approved by the applicable safety manager. The inspection includes review of functional and administrative IROFS and is performed by persons appointed by the appropriate safety function manager.

Training Programs

Safety training programs are audited annually by a member of the safety discipline as appropriate for the subject of the training.

Inspection reports documenting discrepancies are submitted to the responsible discipline managers. Where items of nonconformance are identified, they are brought directly to the attention of the responsible supervisor. Copies of audit reports are sent to the discipline vice-president and appropriate discipline managers for corrective. action. Audits and inspection reports, as well as any subsequent reviews, investigations, corrective actions, etc., are documented and maintained throughout the life of the facility.

Findings of required audits and inspections and the corrective actions are reviewed by the safety review committee. Corrective action items are tracked until closure.

External Audits

The NFS safety programs are audited at a frequency of at least every three years by an appropriate function outside the NFS Erwin organization. The audit team is composed of individuals whose qualifications are approved by the safety discipline vice-president.

Audit results are reported in writing to the safety discipline vice-president. The discipline vice-president will assure that necessary response actions are taken.

Audit results in the form of corrective action recommendations are reported to the safety discipline vice-president and his staff for tracking until their closure.

4.8.7 Incidents and Investigations

Upon discovery of a reportable event (10CFR 70.50, 70.74) the appropriate function vice-president will appoint an appropriate investigation team from his staff with representation from the disciplines necessary to conduct a thorough inquiry with the goal of identifying the root cause and recommending appropriate corrective action. The purpose of this inquiry is to insure that lessons learned are identified and incorporated into plant procedures and/or systems to prevent a recurrence.

Investigation of Reportable Events

The safety function manager is responsible for preparing, reviewing, and approving the procedures for conducting investigations of reportable events. Responsibility for initiating and conducting the investigation is assigned to the team chairperson appointed by the appropriate function vice-president. The investigation will be initiated and completed as soon as practical after the discovery of the event.

The investigation will be documented in a written report, which shall include a statement regarding the probable cause(s) of the event, with recommendations for immediate and long-term corrective actions. Provisions for tracking and completing corrective actions will be initiated following approval of the report. The report will be retained for the life of the facility.

Event Reporting

Nuclear criticality and other safety related events will be reported in accordance with NRC requirements (10 CFR 70.50, 70.74) and License conditions.

4.8.8 Records Management

Records appropriate to safety activities, occupational exposure of personnel to radiation, releases of radioactive materials to the environment, and other pertinent activities, are maintained in such a manner as to demonstrate compliance with Commission license conditions and regulations. Records of criticality safety analyses are maintained in sufficient detail and form to permit independent review and audit of the method of calculation and results. Records associated with personnel radiation exposures and environmental activities are generated and retained in such a manner as to comply with the relevant requirements of 10 CFR 20.

All records pertaining to safety will be retained for the life of the facility.

4.8.9 Quality Assurance

Quality Assurance (QA) includes systematic programs for indoctrination and training of personnel, specification and receipt verification of design requirements, and the extent of quality assurance or confidence necessary for safety structures, systems, and components including computer software for safety-related items.

The QA program also provides for the planning and accomplishment of quality-related safety activities under controlled conditions, including the use of appropriate equipment, suitable environmental conditions for accomplishing the activity, and assurance that prerequisites for a given activity have been satisfied. Special controls, including process, test equipment, tools, and skills to attain the required quality for verification of quality specifications, are also included in the program. Quality is considered a line responsibility wherein each performer and supervisor involved in design, construction, startup, operation, maintenance, and repair, as well as certain support activities (e.g., laboratory analysis), is accountable for the quality of the work assigned to them.

Table 8

Management Measures for IROFS

CONTROL TYPE/Measures	RISK REDUCTION LEVEL	
	A IROFS credited with a high level of Risk Reduction for High or Intermediate consequence events	B IROFS credited with a moderate level of Risk Reduction for Intermediate consequence events
ACTIVE ENGINEERED CONTROLS		
Periodic Functional Test	X	
Verification After Maintenance	X	
Calibration	X	X
Controlled Listing Identification	X	
Drawing Identification	X	
Procedural Identification	X	X
Pre-operational Audits or Tests	X	X
Periodic Audits	X	X
Training and Qualifications	X	
Records Management, Investigations, and QA	X	
ADMINISTRATIVE CONTROLS		
Procedural or Posting Identification	X	X
Pre-operational Audits	X	X
Periodic Audits	X	X
Training and Qualification	X	
Testing of Training Effectiveness	X	
Records Management, Investigations, and QA	X	
PASSIVE CONTROLS		
Verification After Maintenance	X	
Controlled Listing Identification	X	
Drawing Identification	X	X
Procedural Identification	X	X
Pre-operational Audits or Tests	X	X
Independent Installation Verification	X	
Periodic Audits or Inspections	X	X
Vendor Specifications	X	
Training and Qualifications	X	
Records Management, Investigations, and QA	X	

*Note: The Management Measure identified for Level B risk reduction are the minimum, and may be increased based on the specific IROFS involved, the credited risk reduction, industry standards, vendor specifications, or engineering recommendations.

5.0 ISA Team

The ISA Team for the BLEU UNB consisted of personnel from both Framatome-ANP and Nuclear Fuel Services. The list of team members follows:

- Kirk D. Barlow, Sr. Chemical Engineer, FRA-ANP, Team Leader

  ISA Leader training by the Process Safety Institute, Knoxville, TN, July 23-25, 2001

  Hazard & Operability (HAZOP) Studies for Process Safety & Risk Management training by the American Institute of Chemical Engineers, Raleigh, NC, July 22-24, 1998.

- Jeffrey M. Deist, Criticality Safety Specialist, FRA-ANP
- John J. Korenkiewicz, Technician, Chemical Operations, FRA-ANP
- Steve R. Lockhaven, Industrial Hygienist, FRA-ANP
- James H. Parker, Manager, Industrial Safety (Fire Protection), NFS
- L. Randy Sanders, Licensing Specialist, CHP, NFS
- David Hopson, Nuclear Criticality Safety Engineer, NFS
- Gail Tapp, Industrial Safety Specialist, NFS
- Brian Gleckler, Health Physicist, NFS
- Allen Cure, Health Physicist, NFS
- Sonya Sanders, Health Physicist, NFS
- Jimmy Napier, Environmental Scientist, NFS
- Joseph Chew, Industrial Safety Specialist, NFS
- Richard Montgomery, Nuclear Criticality Safety Engineer, NFS
- Clifford J. Yeager, P.E., Process and I&C Engineer, FRA-ANP
- Charles F. Holman, Process Engineer, FRA-ANP

6.0 List of IROFS for the UNB Facility

Table 9 lists and provides details about the IROFS referenced in Table 1 above. Refer to Table 8 for management measures corresponding to the Type and Risk Reduction Level (RRL) for each IROFS.

Table 9: Items Relied On For Safety (IROFS)

IROFS ID #	Description	Type	Failure Index	Failure Description	RRL
UNB-A	[ ]	Active Engineered Control	-2	[ ]	A
UNB-B	[ ]	Active Engineered Control	-2	[ ]	A
UNB-C	[ ]	Administrative Control	-1	[ ]	A
UNB-D	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-E	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-F	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-G	[ ]	Administrative Control	-1	[ ]	A
UNB-H	[ ]	Administrative Control	-1	[ ]	A

IROFS ID #	Description	Type	Failure Index	Failure Description	RRL
UNB-I	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-J	[ ]	Administrative Control	-1	[ ]	A
UNB-K	[ ]	Administrative Control	-1	[ ]	A
UNB-L	[ ]	Active Engineered Control	-2	[ ]	A
UNB-M	[ ]	Active Engineered Control	-2	[ ]	A
UNB-N	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-O	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-P	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-Q	[ ]	Active Engineered Control	-2	[ ]	A
UNB-R	[ ]	Administrative Control	-1	[ ]	A
UNB-S	[ ]	Administrative Control	-1	[ ]	A

IROFS ID #	Description	Type	Failure Index	Failure Description	RRL
UNB-T	[ ]	Active Engineered Control	-2	[ ]	A
UNB-U	[ ]	Passive Engineered Control	-3	[ ]	A
UNB-V	[ ]	Active Engineered Control	-2	[ ]	A
UNB-W	[ ]	Administrative Control	-1	[ ]	A

7.0 Chemical Consequence Standards

AEGLs, PELCs, TEELs, or IDLH values are utilized as justified when ERPG values do not exist. Nitric Oxide (NO) ERPG action levels do not exist. Therefore, the following NO Action level justification is provided:

Selection of (NO) Action levels:
Chemical exposure to the offsite population was considered in this evaluation. Since no emergency response planning guides exist for nitric oxide (NO), temporary emergency exposure limits (TEELs) developed by the Department of Energy (DOE) Subcommittee on Consequence Assessment & Protective Actions (SCAPA) were adopted as comparative action levels. TEELs are approximations of ERPG level 1, 2 and 3 values. The TEEL-1 and 2 values for NO are 25 ppm. The TEEL-3 value for NO is 100 ppm. These values were obtained from TEELs revision 17 available at www.bnl.gov/scapa/.

8.0 Sole IROFS in the UNB Facility

There are no "sole IROFS" used for this facility.

9.0 Definitions

Highly Unlikely – Physically possible or credible, but not expected to occur. A Credible Accident Scenario/Sequence, that is based upon a graded combination of IROFS such as Active Engineering Controls (AEC), Passive Engineering Controls (PEC) and Administrative Controls that mitigate or prevent the accident from occurring such that a Qualitative Likelihood Category 1 (per Table 6) or a quantifiable probability of less than 10^{-4} per accident per year exists. For nuclear criticality safety purposes, a system that possesses Double Contingency protection is considered Highly Unlikely, provided that the performance requirements specified in 10 CFR 70.61 are fulfilled.

Unlikely – Not expected to occur during the plant lifetime. A Credible Accident Scenario/Sequence that is based upon a graded combination of IROFS such as Active Engineering Controls (AEC), Passive Engineering Controls (PEC) and Administrative Controls that mitigate or prevent the accident from occurring such that a Qualitative Likelihood Category 1 or 2 (per Table 6) or a quantifiable probability of less than 10^{-3} per accident per year exists.

Not Unlikely – Credible Accident Scenarios that are not Unlikely or not Highly Unlikely (Category 3 below). Although this category includes unintended events that might actually be expected to happen, others might be less frequent. For this reason, the term "likely" was not used for these events.

10.0 References

1. *Guidelines for Hazard Evaluation Procedures*, 2nd ed., Center for Chemical Process Safety, AIChE, New York, 1992.
2. 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*, Occupational Safety and Health Administration, Washington, DC, 1992.
3. *Layer of Protection Analysis – Simplified Risk Assessment*, Center for Chemical Process Safety, AIChE, New York, 2001.
4. 10 CFR Part 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, Washington, DC, September 2000.
5. A. D. Swain and H. E. Guttman, *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*, NUREG/CR-1278, U.S. Nuclear Regulatory Commission, Washington, DC, August 1983.
6. *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (DRAFT)*, NUREG-1520, U.S. Nuclear Regulatory Commission, Washington, DC, June 1999.
7. R.L. Milstein, *Integrated Safety Analysis Guidance Document*, NUREG-1513, U.S. Nuclear Regulatory Commission, Washington, DC, May 2001.
8. *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, NUREG/CR-6410, U.S. Nuclear Regulatory Commission, Washington, DC, March 1998.
9. *Fire Hazard Analysis BLEU Uranyl Nitrate Building (UNB)*, William H. Julius, P.E. Revision 2, August 6, 2002.
10. *BLEU Project Process Hazards Analysis; Uranyl Nitrate Building (UNB)*, K. D. Barlow, 54T-02-006, NCS-07-02, Revision 1. July 2002.
11. *Nuclear Criticality Safety Evaluation for the BLEU Complex Uranyl Nitrate Building*, J. M. Deist, 54T-02-0014, NCS-07-02, Revision 1. August 2002.

Appendix A: BASELINE DESIGN CRITERIA FOR BLEU COMPLEX UNB FACILITY

The following information is provided to demonstrate that the Baseline Design Criteria of 10 CFR 70.64, "Requirements for New Facilities or New Processes at Existing Facilities" have been addressed in the design of UNB. Each of the ten sections of 10 CFR 70.64(a) "*Baseline Design Criteria,*" as well as the "*defense-in-depth*" sections of 10 CFR 70.64(b), are addressed below.

(a) **Baseline Design Criteria**

(1) Quality Standards & Records: *The design must be developed and implemented in accordance with management measures, to provide adequate assurance that IROFS will be available and reliable to perform their function when needed. Appropriate records of these items must be maintained by or under the control of the licensee throughout the life of the facility.*

Refer to Section 4.8 in the ISA Summary.

(2) Natural Phenomena Hazards: *The design must provide for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site.*

Refer to Section 1.0 of the ISA Summary.

(3) Fire Protection: *The design must provide for adequate protection against fires and explosions.*

The UNB facility will have a full-featured fire detection and suppression system. Fire hazards are evaluated in a Fire Hazard Analysis (Reference 9). Fire accident scenario A in Table 1 requires the use of IROFS UNB-V from Table 9 to prevent and mitigate the accident sequence to meet the 10 CFR 70.61 performance criteria. This IROFS consists of a full-featured fire detection and suppression system as specified in NFPA 72 ,NFPA 25, NFPA 13 and Reference 9.

(4) Environmental & Dynamic Effects: The design must provide for adequate protection from environmental conditions and dynamic effects associated with normal operations, maintenance, testing, and postulated accidents that could lead to loss of safety functions.

The UNB facility is designed to minimize problems from environmental conditions and dynamic effects. Consideration in the design of the facility and equipment is given to the following:

- Protection of piping and vessels from vehicles and forklifts.
- Protection of fittings from external impact.
- Corrosion protection.
- Other facility siting factors including the railway, air traffic patterns, and the nearby commercial facilities.

(5) Chemical Protection: *The design must provide for adequate protection against chemical risks produced from licensed material, facility conditions which affect the safety of licensed material, and hazardous chemicals produced from license material.*

The only chemicals used in the UNB are DIW and UN solution (which contains < 1M nitric acid). Chemical safety is achieved through administrative as well as passive and active engineered controls. The proper handling, use, and storage of chemicals is addressed through procedures and Hazard Communication training. The ISA has evaluated any scenarios that could result in hazardous chemicals contacting or resulting in the dispersion of licensed material.

(6) Emergency Capability: *The design must provide for emergency capability to maintain control of:*

i. Licensed material and hazardous chemicals produced from licensed material.
ii. Evacuation of on-site personnel.
iii. On-site emergency facilities and services that facilitate the use of available offsite services.

The UNB facility is designed to meet the NFS emergency plans. Emergency evacuation routes are well marked throughout the facility. Periodic exercises are conducted to maintain employee's awareness of the proper evacuation routes to follow and the location of assembly areas. These exercises also serve to train the on-site emergency team and to exercise communications with offsite services.

(7) Utility Services: *The design must provide continued operation of essential utility services. The new process is designed to be compatible with existing utility services.*

Systems such as the fire alarm system and criticality monitors have dedicated sources of emergency power in the event power is lost. Accident scenarios related to the loss of primary and backup power and the effects on other service utilities have been evaluated. Further, the effect of loss of power on the effectiveness of IROFS was evaluated. No unsafe conditions were identified resulting from loss of power. The entire facility is designed fail safe so that loss of power causes control devices to fail into a safe state. An exception is the building HVAC, which is only a safety consideration in extremely cold, extremely long power outage situations which are highly unlikely to occur. A full discussion of this situation can be found in Section 3.2.3. Finally, fire detection systems, criticality monitors/alarms, and building evacuation alarms are located in areas where they should not be susceptible to damage.

(8) Inspection, Testing & Maintenance: *The design of IROFS must provide for adequate inspection, testing and maintenance, to ensure their availability and reliability to perform their function when needed.*

See Section 4.8 of the ISA Summary for a discussion of IROFS selection and maintenance.

(9) Criticality Control: *The design must provide for criticality control including adherence to the double contingency principle.*

All SNM operations in the UNB are designed with sufficient factors of safety to require at least two unlikely, independent and concurrent changes in process conditions before a criticality accident is possible. This concept is known as the "double contingency principle." Whenever practicable, the effectiveness of the controls will be enhanced through diversity and redundancy of reliable barriers, and defense in depth.
Any changes to the criticality monitoring system are administered via the change management system described in Section 4.8. Criticality controls and Defense in Depth are evaluated for the UNB in the Nuclear Criticality Safety Evaluation (NCSE), Reference 11.

(10) Instrumentation & Controls: *The design must provide for inclusion of instrumentation and control systems to monitor and control the behavior of IROFS.*

Active engineered controls are used extensively for safety purposes in the UNB facility. Section 4.8 of the ISA Summary addresses the requirements for inspection, periodic functional checks, and maintenance to maintain the effectiveness of IROFS.

(b) Facility and system design and facility layout must be based on defense-in-depth practices.

(1) *Preference for the selection of engineered controls over administrative controls to increase overall system reliability.*

Per the risk-based ISA process, as defined in NUREG-1520, risks are minimized by selecting the appropriate level of controls that will render each accident scenario that has a high consequence "highly unlikely." However, in general the following is the listed order of preference:

1. Passive Engineered Control (most preferred)
2. Active Engineered Control
3. Enhanced Administered Control
4. Administrative Control (least preferred)

When used, administrative controls are appropriately enhanced through the use of postings, procedures, and computer programs that act as aids for the operator. In addition, appropriate safety margins are provided for administrative controls.

(2) *Features that enhance safety by reducing challenges to items relied on for safety.*

The design of the UNB includes many features than enhance the safety of the process. Because of this, and because of the benign nature of the UNB operations, no scenarios have been identified in which the IROFS are challenged frequently.

Appendix B. Natural Phenomena, Fire, and External Event Scenarios Table

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
1	Earthquake	Potential to rupture multiple tanks in the UNB, causing radiological contamination extending outside of the building.	UNB and UN storage tank restraint system are designed to meet or exceed Zone 2A seismic requirements (0.1g horizontal acceleration). NFS seismic analysis determined that for a 1,000 year return period, the horizontal acceleration is 0.06 g. Small falling objects (i. e. pipe, light fixtures, pieces of metal siding, etc.) will not cause catastrophic failure of tanks. The probability of earthquake damage severe enough to cause failure of major structural components of the building and subsequent catastrophic damage to multiple tanks is Low. An evaluation of damage after a 1994 earthquake in California with horizontal acceleration of 0.5 g showed properly anchored FRP tanks were undamaged. The probability of earthquake damage severe enough to cause failure of multiple tanks in a manner that would allow the total contents to spill is Low. No criticality issues due to concentration control. No short-term mechanism to concentrate solution.
2	Storm - High Winds	Potential for building damage and subsequent rupture of multiple tanks in the UNB, causing radiological contamination extending outside of the building.	UNB is designed to withstand 80 mph wind in accordance with the Standard Building Code. NOAA data collected at the regional airport indicates maximum sustained wind of 50 mph (recorded in 1951) and a peak gust of 86 mph (recorded in 1995). Small objects striking tanks at or near the top will not cause damage that would allow the total contents of the tank to spill. The probability of wind damage severe enough to cause failure of major structural components of the building and subsequent catastrophic damage to multiple tanks is Low. No criticality issues due to concentration control. No short-term mechanism to concentrate solution.

Scenario #	Initiating Events	Unmitigated Consequence	Controls/Mitigating Factors
3	Tornado	Potential for building damage and subsequent rupture of multiple tanks in the UNB, causing radiological contamination extending outside of the building.	UNB is designed in accordance with the Southern Building Code. One tornado recorded in county since 1950. Tornadoes travel in narrow irregular paths tending to strike higher terrain rather than valleys. Likelihood of a tornado striking UNB is Low. Small falling objects striking tanks at or near the top will not cause damage that would allow the total contents of the tank to spill. The probability of tornado damage severe enough to cause failure of major structural components of the building and subsequent catastrophic damage to multiple tanks is Low. No criticality issues due to concentration control. No short-term mechanism to concentrate solution.
4	Hurricane	Potential for building damage and subsequent rupture of multiple tanks in the UNB, causing radiological contamination extending outside of the building.	Plant location is too far inland to be considered a credible risk due to hurricane. No criticality issues due to concentration control. No short-term mechanism to concentrate solution.
5	Flood	Potential to rupture multiple UN storage tanks causing radiological contamination extending outside of the building.	Plant location is above the 100 year flood level of all nearby rivers and streams (100 year flood plain of Martin Creek is 1640 feet, floor of UNB is 1655 feet). No criticality issues due to concentration control. No short-term mechanism to concentrate solution.
6	Site evacuation with operators leaving stations prior to shut down	Deviations from designed process that could occur due to operator error or absence and which may result in an accident scenario with significant consequence.	HAZOPS analysis (summary table in Section 13.0) verifies that the process design includes passive and/or engineered fail-safe controls to protect against potentially hazardous deviations in case of operator absence.

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
7	NFS bulk chemical storage accident resulting in release of bulk liquid and evaporated chemicals.	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, flammable, explosive, asphyxiant, or other health hazard for on site personnel.	Bulk chemical storage area located inside NFS fence is > 400 feet from UNB. Bulk liquids will be contained within NFS facilities. Site is graded for drainage - no significant bulk liquid will flow across open, graded ground to UNB. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
8	NFS bulk chemical storage accident resulting in release of bulk vapor.	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, flammable, explosive, asphyxiant, or other health hazard for on site personnel.	Bulk chemical storage area located inside NFS fence is > 400 feet from UNB. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
9	NFS bulk chemical storage accident resulting in explosion or fire (most likely bounded by scenarios involving hydrogen storage vessels)	Potential off-site fire that could spread to UNB	Bulk chemical storage area located inside NFS fence is > 400 feet from UNB. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
10	NFS criticality accident or radiological release	Potential exposure for on site workers causing evacuation of site.	NFS controls and operating procedures. Emergency evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
11	Studsvik bulk chemical storage accident resulting in release of bulk liquid and evaporated chemicals.	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, flammable, explosive, asphyxiant, or other health hazard for on site personnel.	Bulk chemical storage area located inside Studsvik fence is > 300 feet from UNB. Bulk liquids will be contained within Studsvik facilities. Site is graded for drainage - no significant bulk liquid will flow across open, graded ground to UNB. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
12	Studsvik bulk chemical storage accident resulting in release of bulk vapor.	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, flammable, explosive, asphyxiant, or other health hazard for on site personnel.	Bulk chemical storage area located inside Studsvik fence is > 300 feet from UNB. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
13	Studsvik bulk chemical storage accident resulting in explosion or fire	Potential off-site fire that could spread to UNB	Bulk chemical storage area located inside Studsvik fence is > 300 feet from UNB. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
14	Studsvik criticality accident or radiological release	Potential exposure for on site workers causing evacuation of site.	Low inventory of radioactive material. Studsvik controls and operating procedures. Emergency evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
15	Railroad Accident Causing Explosion or Fire	Off-site explosion and fire that spreads to UNB.	Railroad is ~220 feet NW of the UNB. Speed limit in rail yard is 10 mph. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).

Scenario #	Initiating Events	Unmitigated Consequence	Controls/Mitigating Factors
16	Railroad accident causing release of bulk liquid and evaporated chemicals	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, *flammable, explosive*, asphyxiant, or other health hazard for on site personnel.	Railroad is ~220 feet NW of the UNB. Speed limit in rail yard is 10 mph. Bulk liquids will be contained within rail yard. Site is graded for drainage - no significant bulk liquid will flow across open, graded ground to UNB. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see scenario #6 for operator evacuation).
17	Railroad accident causing release of bulk vapor	Material concerns - material interactions from corrosive, oxidative, reactive, or flammable chemicals. Chemical concerns - reactivity with UNB process equipment or with UN solutions causing criticality accident. Personnel concerns - release of chemicals that may be toxic, flammable, explosive, asphyxiant, or other health hazard for on site personnel.	Railroad is ~220 feet NW of the UNB. Speed limit in rail yard is 10 mph. No credible interaction with process equipment or UN solutions for following reasons: 1) Only dilute vapors will reach UNB. Limited by plume concentration, diffusion rate, distance, atmospheric conditions. 2) Building protected by ventilation system. Storage tanks are sealed. Building evacuation plan in unlikely case that threatens on site personnel (see *scenario #6 for operator evacuation*).

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
18	Plane Crash	Possible destruction of UNB due to impact and/or fire Plane does not impact UNB but fire starts and spreads to UNB	UNB not in any landing or takeoff pattern of any airport. Nearest public airport is 40 miles away. Probability of large aircraft striking UNB is Highly Unlikely. Nearest private airport for small planes is in Washington County. Other landing strips nearby are for ultralight aircraft only. Probability of small aircraft striking UNB and causing severe enough damage to result in catastrophic failure of multiple tanks is Highly Unlikely. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
19	Freeway Traffic Accident	Structural damage to UNB due to impact and/or fire Accident causes an off-site fire that spreads to UNB	UNB located far from freeway and other roads. Closest road, Carolina Avenue is ~500 feet from UNB). Probability of vehicle striking UNB and causing severe enough damage to result in catastrophic failure of multiple tanks is Highly Unlikely. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
20	Others - Meteorites, etc..	Destruction of UNB	meteorites etc. = Highly Unlikely.

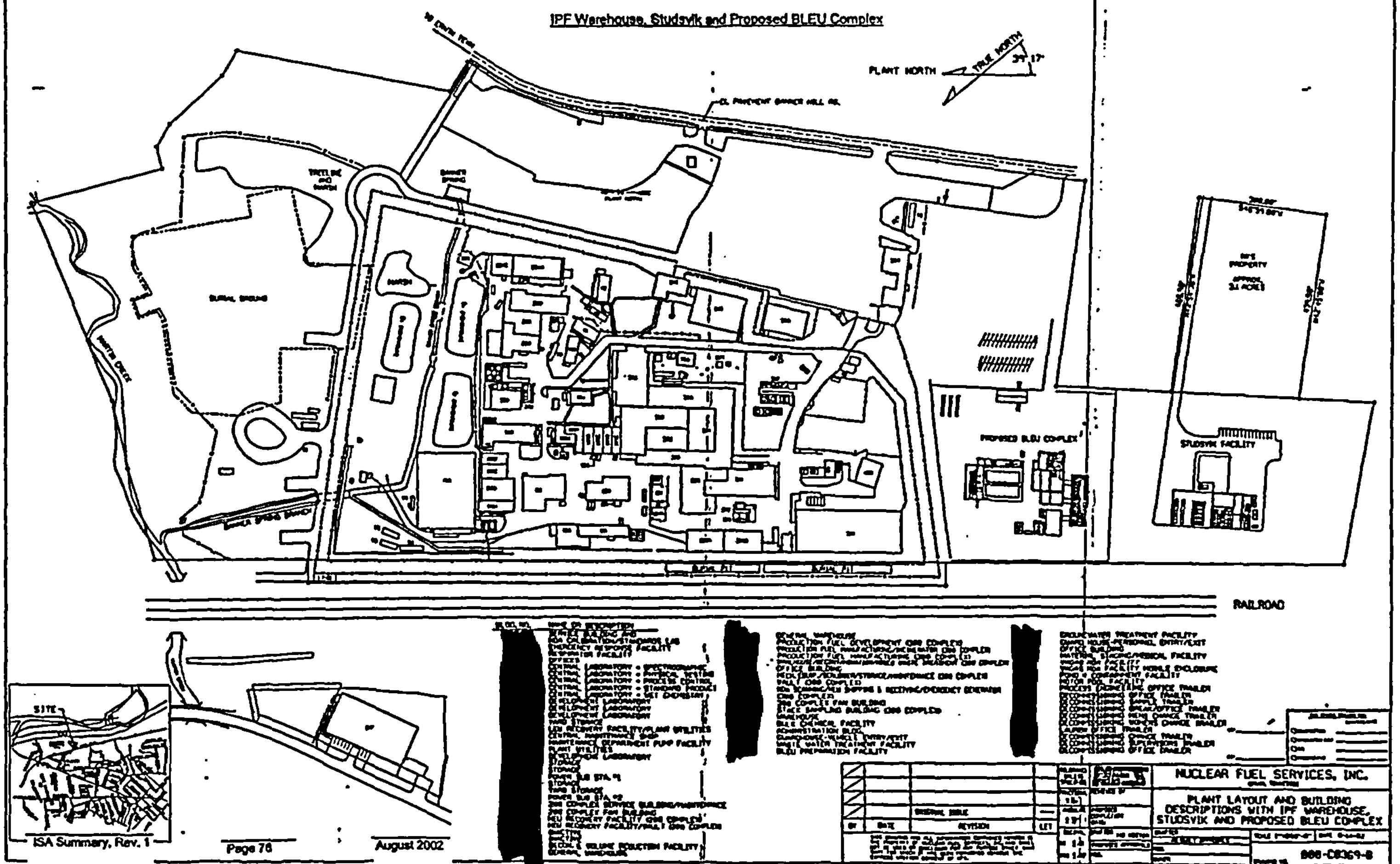
Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
21	Diesel fire at Standby Generator	Moderate fire damaging emergency generator equipment - Fire spreads to UNB	Designed and installed in accordance with NFPA 70 & 110. Generator is UL 2200 compliant with non-combustible enclosure. Generator will be 10' from UNB which exceeds requirement of NFPA 37. NFPA 37 requires stationary combustion engines and enclosures to be located 5" from structures having combustible walls. UNB constructed of non-combustible materials. Although not required by NFPA 37 or 110, the generator enclosure will have automatic fire detection. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
22	BLEU Complex - [redacted] propane storage tank fire	Fire destroys the propane storage tank area - spreads to UNB	Propane storage tank located ~200 feet from UNB and ~30 feet from fence line. Propane storage tank will be constructed and installed in accordance with NFPA 58. Propane storage tank will be located much more than the minimum 10 feet from the nearest building (for storage vessels up to 500 gallon) specified in NFPA 58. Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
23	Tow vehicle fire in load-out area	A small tow vehicle will be used to tow trailers in and out of load-out area. Low consequence due to limited amount of fuel.	UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.

Scenario #	*Initiating Events*	*Unmitigated Consequence*	*Controls/Mitigating Factors*
24	Natural or man-made off-site fire (brush fire, rubbish fire, careless campers, smokers, etc.)	Off-site fire that spreads to UNB.	Site will be maintained to provide at least a 50' fire break. UNB constructed of non-combustible materials. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
25	Plastic tank fire caused by external events or actions such as welding, grinding, etc.	Low consequence because fire damage to more than one tank is unlikely.	UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade. No criticality issues due to concentration control. No short-term mechanism to concentrate solution.
26	HVAC duct/filter fire	Fire destroys filter with potential release to the environment. Duct fire would be small due to minimal fuel.	Duct and filter housings constructed of non-combustible material and filter material is fire retardant. Quantity of combustibles in mechanical room is small. Mechanical room protected by sprinkler system.
27	Electrical Room short circuit	Small fire in the electrical room burning up circuit breakers and distribution panels. Low combustible load, and contained in the electrical room	UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
28	Carelessness in the Office area	Moderate fire due to increased combustible load, potentially destroying offices. Contained in the office area due to fire wall separation from controlled area	UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.

Scenario #	Initiating Events	Unmitigated Consequence	Controls/Mitigating Factors
29	Fire in mechanical room	Fire involving natural gas heating unit, HVAC equipment, air compressors, electrical equip. Contained in mechanical room.	Natural gas heating unit has burner management system designed in accordance with industry standards and verified by UL/FM. Gas supply system and piping installation in accordance with NFPA 58. UNB design includes fire walls and fire sprinklers in accordance with NFPA code. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.
30	Lightning	Local destruction due to large energy release - small fire results	Site will be maintained to provide at least a 50' fire break. UNB design includes lightning protection per NFPA 780, fire wall, and fire sprinklers in accordance with NFPA code. UNB constructed of non-combustible materials. Response groups include Erwin Fire District Response (primary responder) & NFS Fire Brigade.

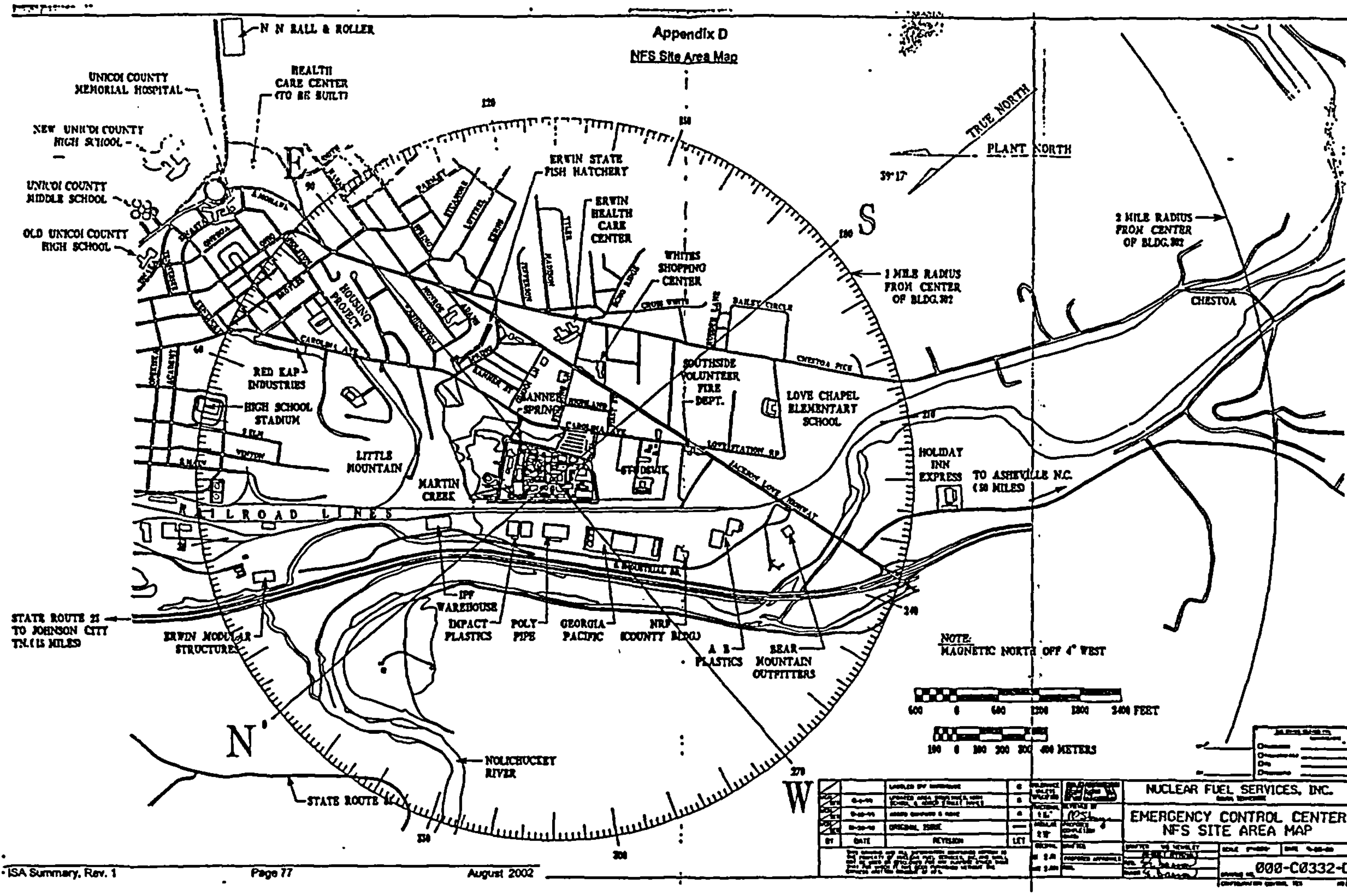
Appendix C

Plant Layout and Building Descriptions with IPF Warehouse, Studsvik and Proposed BLEU Complex



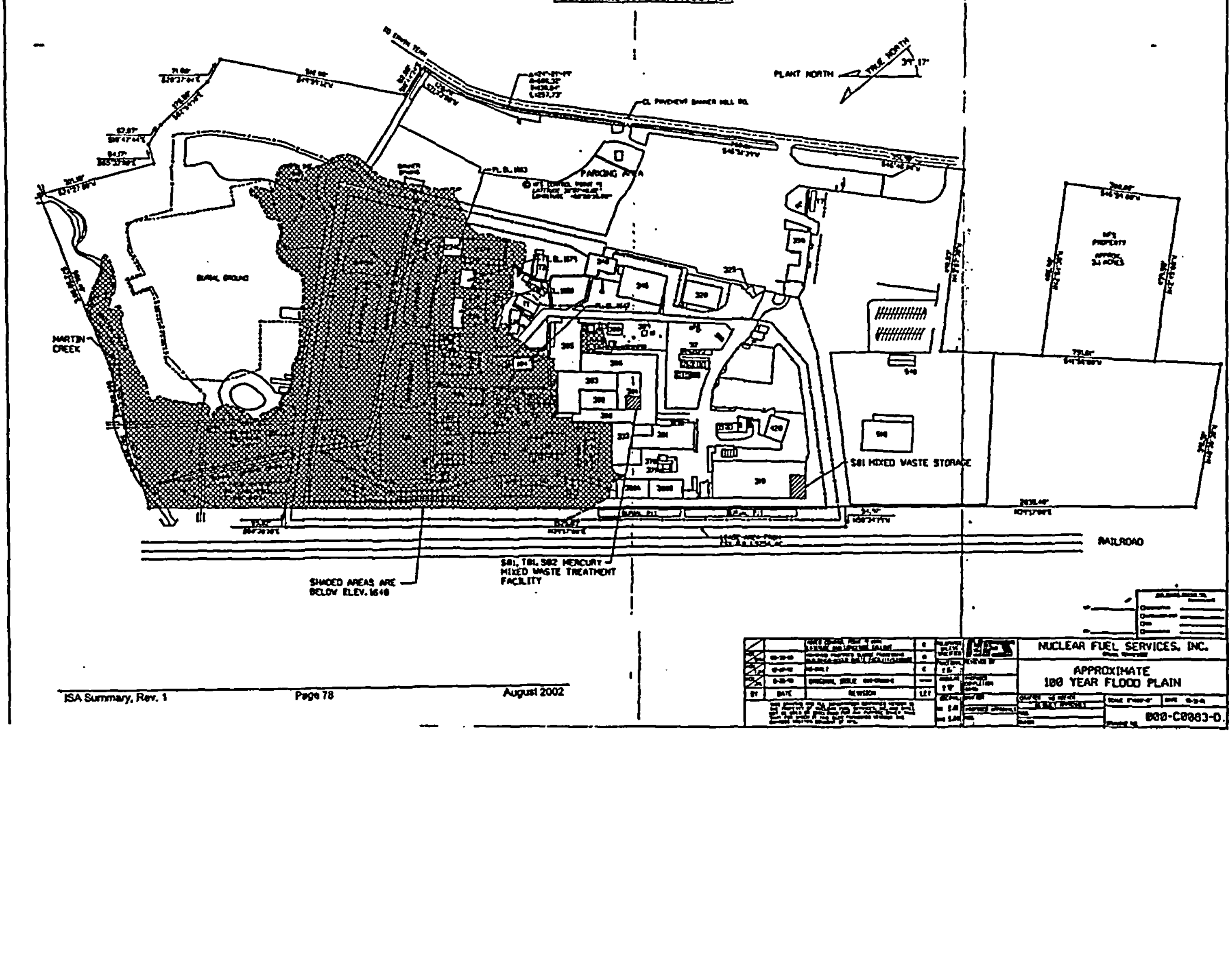
Appendix D

NFS Site Area Map



Appendix E

Approximate 100 Year Flood Plain



APPENDIX F: AERIAL VIEW OF FACILITY

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MISSING FROM ORIGINAL

Attachment III

"Crosswalk Developed from NRC's On-Site Review

"Punch list Items", Letter from NRC to B.M. Moore, Nuclear Fuel Services, Inc. (TAC NO. L31599) Uranyl Nitrate Building License Amendment Application and Integrated Safety Assessment On-Site Review, June 11-13, 2002

No.	Description of Punch List Item	Corresponding Safety Basis Document
1.	Update UNB Fire Hazards Analysis	Completed – results factored into PHA and ISA Summary revisions
2.	Exposures from external accidents associated with fire or explosion.	Completed as documented in PHA and FHA, summarized in Appendix B of the Summary:
	Fire at Studsvik Processing Facility	See ISA Summary, App B, scenario 13
	Fire or explosion from natural gas service and/or propane tank explosion in BLEU Complex	Completed as analyzed in FHA and PHA. Also incorporated in Appendix B, scenarios 9, 13 and 22 of ISA Summary
	Rail car explosion on CSXT railroad yard tracks	See ISA Summary, App B, scenario 15
	Propane tank truck explosion during delivery to NFS Plant propane tanks	See ISA Summary, App B, scenario 7
	Hydrogen tank trailer explosion during delivery to NFS Plant bulk H2 tank	See ISA Summary, App B, scenario 9
	Brush fire	See ISA Summary, App B, scenario 24
3.	Update information on other external events	Completed as documented in PHA and ISA Summary, App B
	Studsvik Processing Facility radiological materials release	See ISA Summary, App B, scenario 14, section 1
	Rail car derailment on CSXT railroad yard tracks	See ISA Summary, App B, scenario 15-17, section 1
	Flood	See ISA Summary Section 1.3 and App B, scenario 5
	Lightning	See ISA Summary, App B, scenario 30, section 1
	Tornado	See ISA Summary Section 1.5 and App B, scenario 2-3
	Seismic	See ISA Summary Section 1.6 and App B, scenario 1
4.	Add any process materials or construction changes	See ISA Summary Sections 3.1.1 and 3.2.1, also FHA
5.	Fire sprinkler density update, should materials of construction change	As documented in FHA, no change in sprinkler density required based on change in materials of construction
6.	Verify distances between buildings inside the BLEU Complex	See ISA Summary, Figure 1, Appendices C-F
7.	Verify alarms transmitted from buildings are reliable and supervised	Alarm verification and system reliability to be ensured as required per SNM-124, Section 6.2
8.	Update UNB Process Hazards Analysis	Completed
	Address additional fire scenarios developed during FHA update	Completed, See ISA Summary, App B
	Reevaluate the consequence evaluations and provide results	See example provided in Attachment IV to Submittal
	Add any changes in the external events. After updated external event information to the PHA, reevaluate the consequence evaluations and provide.	See ISA Summary, App B
9.	Update UNB Nuclear Criticality Safety Evaluation	Completed as documented in NCSE
	Add calculations on evaporation because of a fire	Completed as documented in NCSE

"Punch list Items", Letter from NRC to B.M. Moore, Nuclear Fuel Services, Inc. (TAC NO. L31599) Uranyl Nitrate Building License Amendment Application and Integrated Safety Assessment On-Site Review, June 11-13, 2002

No.	Description of Punch List Item (Continued)	Corresponding Safety Basis Document (Continued)
10.	Update UNB ISA Summary	Completed as documented in ISA Summary
	Expand baseline design criteria compliance write up, include fire safety and external events	See ISA Summary, App A
	Pull in process descriptions from NCSE	See ISA Summary, Sections 3.1 and 3.2
	Add figures suggested by Vanice Perin	See ISA Summary Figure 2, Figure 3, Figure 4, Node Table in Section 4.2
	Add applicable process flow diagrams	See above
	Title fence line in site layout drawing "controlled area" or "restricted area"	See ISA Summary, Figure 1
	Add risk assessments for high and intermediate consequences including the revised consequence evaluation from updated PHA (fire scenarios and external events) information	Only high consequence accident sequences identified (i e., criticality, fire and explosions), all other accident scenarios resulted in low consequence events
	Include all 11 management measures	See ISA Summary, Section 4.8
	Update the fire scenario and risk assessment	Completed as documented in PHA, FHA and ISA Summary
	Add dimensions of buildings, tanks, sump, and basin plus materials of construction information from fire hazards analysis	ISA Summary, Sections 2 and 3 where appropriate
	Add how LE UN will be pumped from the receiving tank to a bank of manifolded tanks	ISA Summary, Sections 3.2.1 and 3.2.2
	Add discussion on multiple tank failures	ISA Summary, Section 3.2.3
	Add information on seismic analysis of the tank supports, no analysis of the UNB structure necessary as the structure complies with the requirements in Southern Building code Congress International's *Standard Building Code*	ISA Summary, section 3.2.1
	Add accident scenario descriptions from HAZOP tables	Not included – expanded ISA Summary Section 4.2 to better explain PHA process
	Add utility electrical power reliability	See ISA Summary Appendix A, and IROFS Table 9
	Expand text and Table 1 to address initiating event 1.5.1	ISA Summary, Section 3.1.3 and Table 1
	Specify boundaries of IROFS	Generally, the boundary of an active engineered control is sensor, transmitter, CCS, and final control device. All components fail safe, so no supporting systems are required for safety.
11.	Reference documents	Completed as Documented in ISA Summary

Attachment IV

Occupational Health Physics Consequence Analysis Methodology

Health Physics Consequence and Evaluation Summary
For Uranyl Nitrate Building

Occupational Health Physics Consequence Analysis Methodology

The accident scenarios for evaluation are provided on tables developed by a qualified ISA team during a Process Hazard Analysis, as specified in NFS-GH-55, "Integrated Safety Analysis". Multiple types of consequences can result from the same event (item number) on the table, therefore the analysis is conducted for the most severe consequence for each item number. As per NFS-HS-A-68 "ISA Risk Assessment Program", the methods used for consequence evaluation are acceptable if the methods and calculations are consistent with the referenced approaches, they are scientifically correct as a reasonable estimate, and the use of generic assumptions and data is reasonably conservative for the types of accidents analyzed. Upon completion of the analysis, each credible accident scenario is assigned an unmitigated, uncontrolled consequence severity category based on 10 CFR 70.61 as shown below:

- High Consequence – An accident resulting in an acute worker TEDE of 100 Rem or greater
- Intermediate Consequence - An accident resulting in an acute worker TEDE of greater than or equal to 25 Rem but less than 100 Rem
- Low Consequence – Consequences that are not high or intermediate

The following is a generalized summary of the methodology utilized for the Uranyl Nitrate Building (UNB) Occupational Health Physics Consequence Analysis:

For uranium processing, the dose from the inhalation pathway will dominate the Total Effective Dose Equivalent (TEDE). A potential airborne release of radioactive material can occur in the UNB if one of the following types of stress is imposed; thermal stress, explosive release (i.e. pressurized venting effects), free-fall spills and aerodynamic entrainment and resuspension. The Material at Risk (MAR) is the material(s) specific to the scenario that could potentially be affected by the event. The average radionuclide concentrations for the UNB Materials are assigned as specified in the *ISA Source Term Data and Radioactive Effluent Estimates for the TVA Project* (HEA-21, 21T-02-0300, BPG-02-011). The uranium concentration of the LE UN solution is conservatively assumed as the upper operating limit as per NFS Special Nuclear Material License SNM-124 (235 gU/L). This is ~20% above the projected concentration as per BPF Mass Balance dated March 2002. The Engineering Mass Balance value is assumed for the uranium concentration of the source material (400 gU/L Natural UN solution). The chemical form of the MAR determines the solubility and consequent transportability in body fluids. 10 CFR 20 classifies all materials into three inhalation classes (D, W and Y) according to its rate of clearance from the pulmonary region of the lung. Uranyl nitrate solution, the MAR for the UNB, is classified as Class D (i.e. most transportable with pulmonary removal half-time of days) For determining accident sequences, the Damage Ratio (DR) is the worst-case fraction of the MAR that is impacted by the specific event under consideration. It is assumed the entire contents of the component impacted by the specific event is released. For fire scenarios, the structural/equipment affected as provided in the Fire Hazard Analysis of BLEU Uranyl Nitrate Building, Rev. 2, August 6, 2002 is assumed. The Airborne Release Fraction (ARF) is the fraction of the release (MAR x DR) that is made airborne as a consequence due to the type(s) and level(s) of stress imposed by the event. Release fractions are utilized as per DOE Handbook 3010-94 "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" and NUREG/CR-6410 "Nuclear Fuel Cycle Facility Accident Analysis Handbook." The Respirable Fraction (RF) is the fraction of the airborne release (MAR x DR x ARF) that is composed of material (solid and/or liquid with $\leq$ 10 micrometers aerodynamic equivalent diameter) that can be transported to and taken into the deep lung of the receptor. The options available for assigning the RF are as follows: assume the RF as measured for the corresponding ARF or assume the most conservative value of 1.0. The resultant airborne concentration is calculated utilizing a dilution factor. A building volume of 6177 m^3 is used for spills within Building 510. For outdoor liquid releases, the dilution volume is based on the total potential area of the liquid spill estimated as per the Federal Emergency Management Agency's (FEMA) document titled *Handbook of Chemical Hazard Analysis Procedures* and conservatively applying a 6 ft worker height. The duration of worker exposure is conservatively assumed as half of a 4-hour shift. For a catastrophic rupture, the time to empty component is assumed as 10 minutes with the worker exposed to resuspension of the material for the remaining half of a 4-hour shift. For fire scenarios, the burn time is estimated as provided by the Fire Protection Specialist with the worker exposed to resuspension of the material for the remaining half of a 4-hour shift. The worker dose for each event is estimated by determining the Derived Air Concentration - hour (DAC-hour) for the mixture and applying a dose equivalent of 5 Rem per 2000 hours.

Although the primary hazard to personnel from uranium processing is from internal exposure, exposure to direct radiation produced by the decay of uranium daughter products and recycled by-product isotopes contributes to the Total Effective Dose Equivalent (TEDE) Modeling with MicroShield Version 5 was used to estimate exposure from gamma radiation using the proposed source term contained in a tank (i.e. conservative geometry). From the results, the deep-dose equivalent was conservatively assumed to be 5 mR/hour for each accident scenario. Given a two-hour worker stay time per scenario, the resultant 10 mrem [2 hours (5 mR/hour)] is considered an insignificant contribution to an intermediate (25 rem $\leq$ TEDE < 100 rem) or high (TEDE $\geq$ 100 rem) consequence determination

Integrated Safety Analysis (ISA)
Health Physics Safety Evaluation of Consequences to the Worker for the BLEU Project

Health Physics Consequence and Evaluation Summary
For Uranyl Nitrate Building

Evaluation Number	Scenario Evaluated	Accident Sequence Number(s)	High, Intermediate or Low Consequence
1	Release of NUN from a [redacted] tank within Bldg. [redacted] [Node 16 (9.19.1)]	Calculation bounds: Node 14 (9.1.3, 9.3.1, 9.9.1) Node 15 (9.11.1, 9.11.2, 9.17.1, 9.18.1) Node 16 (9.19.1, 9.21.1, 9.22.1, 9.24.1, 9.26.1, 9.28.1) Node 19 (9.55.1)	Low
2	Release of [redacted] NUN Tanker outside North end Bldg. [redacted] *[Node 18 (9.39.1)]*	Calculation bounds: Node 17 (9.30.1, 9.30.2, 9.36.1, 9.37.1) *Node 18 (9.39.1, 9.42.1, 9.46.1)*	Low
NA	Release of [redacted] NUN outside South end of Bldg. [redacted]	Calculation bounds: Node 14 (9.1.1, 9.1.2, 9.7.1, 9.8.1)	Note: OCB feed to UNB bound by OCB ISA Summary
3	Release of LE UN from a [redacted] gallon tank within Bldg [redacted] [Node 10 (1.94.1)]	Calculation bounds: Node 3 (1.22.1, 1.22.2, 1.25.1, 1.29.1, 1.31.1) Node 4 (1.33.1, 1.38.1, 1.42.1) Node 5 (1.44.1, 1.44.2, 1.50.1, 1.51.1) Node 7 (1.64.1, 1.64.2, 1.70.1, 1.71.1) Node 8 (1.73.1, 1.74.1, 1.78.1, 1.82.1) Node 9 (1.85.1, 1.85.2, 1.91.1, 1.92.1) Node 10 (1.94.1, 1.94.2, 1.95.1, 1.96.1, 1.100.1, 1.101.1) *Node 11 (1.103.1, 1.105.1, 1.108.1, 1.112.1)*	Low
4	Rupture/Resuspension of LE UN [redacted]allon tank within Bldg. [redacted] [Node 12 (1.114.1)]	Calculation bounds: Node 4 (1.34.1) Node 6 (1.53.1, 1.56.1, 1.58 1) Node 12 (1.114 1, 1.116.1)	Low
NA	Release o[redacted]allons LE UN outside South end of Bldg [redacted]	Calculation bounds Node 13 (1.123.1, 1.123.2, 1.127.1, 1.129.1, 1.130.1)	Note: UNB feed to OCB bound by OCB ISA Summary
5	Rupture/Resuspension o[redacted]allon LE UN transport container outside North end Bldg. [redacted] [Node 2 (1.14.1)]	Calculation bounds: Node 2 (1.14.1)	Low
6	Release o[redacted]*allon LE UN* transport container outside North end Bldg [redacted] [Node 1 (1.1.1)]	Calculation bounds: Node 1 (1.1.1, 1.1.2, 1.2.1, 1.8.1, 1.10.1, 1.13 1) Node 2 (1.19.1, 1.20.1)	Low
7	Tank Fire resulting in Free-fall spill of LE UN solution	Calculation bounds: Fire of 2.4 Fiberglass Reinforced Plastic Tanks plus Free-fall spill of entire contents of 3 LE UN tanks	Low

Sonya L Sanders — 08-16-02

Consequences Calculated by Sonya L. Sanders — Date

J. Scott Kirk — 08-16-02

Reviewed by J. Scott Kirk, CHP — Date