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AIRBORNE EXPRESS

21G-03-0310
GOV-01-55-04
ACF-03-0412

November 19, 2003

Director
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

References:
1) Docket No. 70-143; SNM License 124
2) Letter from B.M. Moore to NRC, License Amendment Request for BLEU Preparation Facility, dated October 11, 2002 (21G-02-0310)
3) Letter from NRC to B.M. Moore, Nuclear Fuel Services, Inc., Blended Low-Enriched Uranium Preparation Facility Remaining Questions (TAC NO. L31693), dated October 17, 2003
4) Letter from B.M. Moore to NRC, Revised Response to Question 39 Regarding License Amendment Request for BLEU Preparation Facility, dated November 7, 2003 (21G-03-0299)

Subject: Non-Proprietary Revised Response to Question Number 39 Regarding License Amendment Request for BLEU Preparation Facility

Dear Sir:

Nuclear Fuel Services, Inc. (NFS) hereby submits a non-proprietary response to the subject NRC question regarding the licensing action pertaining to the BLEU Preparation Facility (BPF) to fulfill the commitment made in Reference 4. This response contains non-proprietary information and is suitable for public disclosure.

NMSS01

If you or your staff have any questions, require additional information, or wish to discuss this, please contact me, or Mr. Rik Droke, Licensing and Compliance Director at (423) 743-1741. Please reference our unique document identification number (21G-03-0310) in any correspondence concerning this letter.

Sincerely,

NUCLEAR FUEL SERVICES, INC.

B. Marie Moore
Vice President
Safety and Regulatory

/lsn

Attachment

cc:
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ATTACHMENT

(Non-Proprietary Information)

"Non-Proprietary Revised Response to Question Number 39 Regarding License Amendment Request for BLEU Preparation Facility"

Non-Proprietary Revised Response to Question Number 39 Regarding License Amendment Request for BLEU Preparation Facility

RAI Question 39 (bold type) and REVISED NFS Response (standard type):

Provide quantitative and qualitative assumptions considered in the red oil scenario such as:

- **Whether the system was analyzed as an open or a closed system and include the definition of closed and open systems for this facility and for this specific process.**

  An open system is one that is vented to process off-gas (or wet off-gas). The reflux column is, therefore, part of an open system.

  A closed system is one that has no vent. The steam system that supplies heat to heat the reflux column during U solution evaporation is a closed system.

- **Provide supporting information regarding the statement that the red oil phenomena will occur at higher temperatures in than in kerosene.**

  Based on documents referenced by the NRC, NFS will establish a margin of safety before conditions are such that a red oil accident could occur. NFS will control the steam temperature to less than which is less than the accident threshold for occurrence of . In addition, NFS will control the evaporator solution temperature to to add additional margin. NFS has confirmed the adequacy of the temperature control after additional review of recent work performed at the Department of Energy site at Savannah River. This will be discussed later in this series of questions requesting the strategy NFS uses to prevent the red oil accident from occurring.

- **Parameters (e.g., temperature, pressure), values, and conditions to evaluate the red oil scenario.**

  The controlling parameter is temperature. NFS controls the temperature through and by monitoring solution temperature to below . The solution in the reflux column (evaporator column) will not exceed the saturation temperature associated with the steam pressure in the closed steam loop. NFS has confirmed the adequacy of the temperature control after additional review of recent work performed at the Department of Energy site at Savannah River. This will be discussed later in this series of questions requesting the strategy NFS uses to prevent the red oil accident from occurring.

  The original solvent make-up is . The specific gravity of TBP is 0.973 and the ; therefore, the calculated density of the . Over time, the solvent make-up can decrease to nominally . Adjustments are periodically made to bring the solvent make-up back to

- **Quantity of solvent assumed to enter to the system as part of the analysis of the red oil scenario including the reaction time for the operator to stop the flow of solvent.**

  This information is required to determine compliance with 70.65(b)(3) which states that the application should contain a description of each process analyzed in sufficient detail to understand the theory of operations and its hazards.

  The flow rate and concentration of the solvent, assuming IROFS fail and strip column interface has been lost, that can be supplied to the reflux column is

  For operator reaction time:

The IROFS would have secured the strip column underflow pump as soon as interface was lost in the strip column. Therefore, the operator reaction time is not an IROFS. The protection strategy is specified in the answer to the next question.

Provide and justify the safety strategies (e.g., appropriate ventilation, prevent local high temperatures) to be used to prevent a runaway reaction in the system with Tributyl Phosphate (TBP), , and nitric acid. Response to RAI question 39 mentions several quotations from literature depicting safety strategies for a runaway reaction but it is not clear if NFS will implement these strategies. Also, provide any references associated with this assessment (e.g., Wilbourn and others, temperature, temperature range, different quotations). These are statements taken from literature but the source is not clearly provided.

This information is required to determine compliance with 70.65(b)(3) which states that the application should contain a description of each process analyzed in sufficient detail to understand the theory of operation and its hazards.

NFS' safety strategy is to prevent the red oil accident from occurring. NFS has assumed that a red oil accident, should it occur in the reflux column, is a high consequence event. As such, NFS has supplied IROFS to mitigate two accident sequences to make the accident sequences highly unlikely, thus meeting the 10 CFR 70.61 performance criteria. The critical parameter NFS is controlling to make the accident sequence highly unlikely is temperature in the reflux column. These IROFS are as follows:

1. The solution temperature will be monitored through a temperature indicator that will be located on the hot leg solution side of Evaporator 2O16/2P16. When solution temperature reaches , power will be removed from the evaporator heaters. This IROFS

will prevent or mitigate the following two accident sequences, and this IROFS is an additional IROFS to the three presented below.

2. The initiating event accident sequence is 1PX10.55 Controller LC-2A11B fails resulting in a loss of Strip Column 2A11 interface. A corresponding accident sequence is provided in

<u>IROFS SX interlock # 1</u>

Should this initiating event occur,

<u>IROFS SX interlock # 2</u>

Should the initiating event occur and solvent reaches the reflux column, and pressure in the closed loop steam system reaches

Application of these two IROFS to the initiating event makes the accident sequence highly unlikely and thus meets the performance criteria in 10 CFR 70.61.

3. The initiating event accident sequence is a loss of column interface occurs and the (IROFS SX Interlock # 1) fails resulting in solvent entering the reflux column. When solvent enters the reflux column as a result of this accident sequence the concentration of TBP/ is as previously specified.

<u>IROFS SX Interlock # 39</u>

Should the initiating event occur and the steam system temperature exceeds This action removes the heat generation capability of the steam system and thus limits the heat transferred to the reflux column solution through Evaporator 2O16,

IROFS SX Interlock # 2

Should the initiating event occur and solvent reaches the reflux column, and pressure in the closed loop steam system reaches

Although these two IROFS share the same heaters, independence is demonstrated through the established electrical circuit before the signal reaches the heaters. The signals from the pressure and temperature indicators are sent in parallel to the power cable supplying the heaters. These temperature and pressure signals remove power from the power cable through series contacts that open upon the loss of power. Each signal acts independently by removing power from its associated series contact, thus shutting down the heaters. The heaters will always shut down because temperature and pressure signals supply their respective contacts to remove power from the circuit.

Application of these two IROFS to the initiating event makes the accident sequence highly unlikely and thus meets the performance criteria in 10 CFR 70.61.

4. Defense in Depth for both accident sequences include:

Provide and explain in detail the controls, other than steam temperature, that will be used to ensure that the solution temperature will not exceed 121° C as suggested in response to RAI question 49. Monitoring the temperature of the solution is not mentioned as a control. In a runaway reaction, most of the heat comes from the exothermic reaction taking place in the solution.

This information is required to determine compliance with 70.65(b)(3) which states that the application should contain a description of each process analyzed in sufficient detail to understand the theory of operation and its hazards.

Steam pressure and temperature are monitored, and both will shut down the evaporator heaters if temperature and pressure set points are exceeded.

NFS has confirmed the adequacy of the temperature control after additional review of recent work performed at the Department of Energy site at Savannah River. The report WSRC-TR-2000-00427 (Revision 0) concludes on page 17:

> "The runaway reaction initiation temperatures for TBP contacted with nitric acid solutions containing no dissolved solids were in good agreement with Colven's data (2). The initiation temperature gradually decreased with increasing aqueous phase nitric acid concentration. The decrease in the initiation temperature was due to the increase in the available oxidant (nitric acid) extracted by the TBP. The minimum initiation temperature, 137°C measured at 14-15M nitric acid was consistent with the values (132-137°C) measured by Colven at nominally 15.7M nitric acid."

An exothermic reaction occurs continuously during heating of the TPB/Nitric acid mixture. When this occurs, the NFS evaporator vent system removes any reaction gases generated up to 137°C (279°F). Per the work cited above, the "runaway" reaction is not initiated until reaching a temperature of 137°C (279°F). This is consistent with NFS' previous analysis.

In addition, NFS will install a temperature control placed in the product evaporator that limits the product temperature to . The appropriate ISA evaluations will reflect this change. This additional IROFS is implemented primarily to address a failure mode of blocking the vent line and creating "a closed system".

The following description of chemical reactions is described in response to RAI question 39:

a. **Hydrolysis of TBP in contact with nitric acid to produce butanol and dibutyl phosphate.**
b. **Reaction of butanol with nitric acid to produce butyl nitrate**
c. **Partial oxidation reaction of butanol**
d. **Exothermic reactions producing gases such as CO, CO_2, steam, nitrogen, and nitrogen oxides that "can proceed with explosive violence.**

Provide the chemical reactions described above and the controls used to avoid the formation and accumulation of the potential products and by-products of the runaway reaction (e.g., butene). Include information on the controls used to avoid overpressurization of the system if gases from the exothermic reaction build up in the evaporator (e.g., credit for the ventilation systems).

This information is required to determine compliance with 70.65(b)(3) which states that the application should contain a description of each process analyzed in sufficient detail to understand the theory of operation and its hazards.

See the answer to the previous question that presents NFS' safety strategy. The exothermic reaction is prevented by assuming the accident sequence occurs, assigning it a high consequence status, and providing IROFS to make the sequence highly unlikely to occur, thus meeting the performance criteria specified in 10 CFR 70.61. It is highly unlikely that an exothermic reaction will occur.

Provide information on whether an analysis was performed of a scenario for a heat of reaction, during a red oil runaway reaction that is greater than the heat provided by the steam. This may generate gases and undesired by-products, even though the steam is shut off. Provide the details of the assessment and criteria considered to analyze or not analyze this situation.

This information is required to determine compliance with 70.65(b)(3) which states that the application should contain a description of each process analyzed in sufficient detail to understand the theory of operation and its hazards.

Initial NFS evaluations utilized results of published works previously provided to the NRC to assign a threshold temperature value for the "runaway" reaction. NFS did not specifically analyze the formation of red oil as a function of the heat of reaction. Reputable experimental work done by others had determined the temperature at which the runaway action occurs. NFS designed to prevent the "runaway" reaction which, in turn, prevents gas generation rates of concern.