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NRC-96-054

November 14, 1996

U. S. Nuclear Regulatory Commission
ATTN: Mr. Charles Gaskin, Acting Section Leader
Licensing Section 1, Licensing Branch
Division of Fuel Cycle Safety and Safeguards, NMSS
Washington, D.C., 20555-0001

Dear Mr. Gaskin:

Subject: Response to Request for More Information

Attached please find the response to questions concerning our Safety License Condition S-2 of Materials License SNM-1107, application dated September 29, 1995.

Please note that our response to item #7 will be forthcoming the first week in December, as agreed October 31, 1996.

If you have any questions, please contact me at (803) 776-2610 x3426.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

C. F. Sanders, Manager
Nuclear Materials Safety & Safeguards

Enclosure

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The Westinghouse Commercial Nuclear Fuel Division — Winner of the 1988 Malcolm Baldrige National Quality Award.

1. In the Powder Blending System, samples are taken from the polypaks to determine the moisture content before the polypaks are dumped into an unfavorable geometry container. The safety analysis stated that a composite sample is taken (consisting of a small amount from each polypak), and a few polypaks are individually sampled as the second moisture measurement. Provide justification that supports the adequacy of these two sampling methods to assure that moisture limits are not exceeded in the unfavorable geometry device.

Justification to support adequacy of each sampling method is provided below.

First Sample - 100 % Composite Sampling Method:

UO2 powder is generated in a continuous process at each line's fitzmill and is collected in favorable geometry polyethylene packs. A grab sample is collected from the top of each container after it is filled. Then the next container is filled and another grab sample is collected. This sampling is continued until the batch is completed. All n samples are mixed and the resulting mixture is sent to the lab for analysis. Since, this is a continuous process the composite sample is representative of the moisture content in the batch.

The statistical bases for sampling and acceptance of moisture samples, along with additional data and results of tests conducted to substantiate material variability within a batch and within a pack, are included in Section 5.5 of the CSE.

The action limit is set at 0.3 % moisture while our criticality safety limit is 1.0% moisture in the bulk blender. Using a historical average of 0.20% H2O in typical packs the 0.3 % limit will effectively detect rouge packs containing high moisture.

Second Sample - Random Sample Verification Method:

The original batch is checked to ensure that all of the same items still exist. Then a second independent sample is collected consisting of a random selection of three items. These three packs are sampled and each sample analyzed for moisture content. The average of the three analysis will represent the moisture content of the batch. This result is tested against the 0.3 % limit and also must be within a statistical range limit of the first sample. Since all items within the batch have an equal probability of being sampled and measured for moisture content there is a significant probability of detecting a pack containing high moisture.

2. For the large lot blender in the Powder Blending System, the safety analysis report indicates that to ensure that a potential critical quantity of moderator does not enter the blender, the mass of material is restricted. However, the safety analysis report indicated that the mass measurement is performed after the material is in the blender. After powder is in the blender, how does the mass measurement effectively prevent a critical quantity of moderator from entering the blender?

For the ADU Bulk Powder Blending System CSE, the hypothesized "moisture migration" was addressed because, as stated in the fault tree notes on p. 6-2, of undocumented events in the MAP 5000 kg blender. Initiating events (IE) #11-14

were postulated (Section 5.1.2), and the fault tree was prepared (p. 6-6). Failure to weigh the container after filling, and before tumbling, is IE #13.

Section 5.1.2 is an academic discussion of the maximum amount of moisture that could be in a bulk container IF all the powder were at the specification limit (0.4 wt. % moisture), and IF the container were completely filled. Note: the resulting 6800 kg is 388% of the design amount (1750 kg). Also note that if the moisture remains evenly distributed, criticality is not possible. The section then goes on to further discuss that criticality is theoretically possible if all the moisture somehow migrates into a sphere by further processing, for example, by tumbling. (If the container were completely full, tumbling action would not take place.)

The blend of material (1750 kg) assumed to be at the specification limit of 0.4 wt. % moisture would contain 7 liters of water. Therefore proper weighing of the container after material addition would detect excessive powder mass, and the moisture contained therein, before conditions were reached that would allow theoretical criticality (21 liters per p. 5-58). Note that powder released for blending normally contains approx. 0.20 wt. % moisture.

The fault tree on p. 6-6 states that there is no defined mechanism for moisture migration, and concludes that moisture migration as a criticality precursor is not credible.

Weighing a bulk container after filling is a process step for uranium accountability. Its failure, however, was included as an initiating event relating to the hypothesized moisture migration. IE #12 discusses how the blend weight is controlled before material addition. This control includes (1) a picklist prepared by process engineer, who specifically checks that blend weight is less than 1750 kg, and (2) subsequent bar code scanning of each pack on the floor, which would detect any pack not on the list.

3. The safety analysis reports for the Powder Blending and UN Bulk Storage Tank Systems contained remarks that indicate that there was the potential for common mode failure (CMF). In addition, there are several remarks that some initiating events might have an indeterminate safety question. How have these been resolved?

Common Mode Failure

As evaluation of a system proceeds using the initiating event methodology, common mode failure potential between and among events is uncovered. If the potential is unacceptable, it is noted in the CSE. There were no occurrences of unacceptable common mode failure potential uncovered in any systems. Common mode failure potential may be acceptable if, after the failure, double contingency protection is still intact.

In cases where acceptable common mode failure potential was found, it was so noted in the CSE. Within the context of the evaluation of each initiating event and the fault tree shown in Section 6, acceptance of the common mode failure risk can be inferred.

At the next revision of each CSE, and as part of any new evaluations, an explicit justification for acceptance of any identified common mode failure potential will be added.

Indeterminate Issue - Powder Blending CSE

The word "indeterminate" was initially used to describe the residual defense for Initiating Event #22 because the nitrogen system was not within the scope of the CSE, but was part of a supporting system. Subsequently, it has been determined that ingress of significant quantities of moderator from the nitrogen system is not credible, and this will be so noted in the next revision to the CSE for the ADU Bulk Powder Blending System.

Indeterminate Issue - UN Bulk Storage Tank CSE

At the time the UN Tank CSE was issued, process controls and characteristics were not generally cited as part of a defense for double contingency protection. With the acceptance of the Westinghouse License Renewal in 1995, it became acceptable practice to take appropriate credit for them.

The word "indeterminate," though used approximately 16 times in the CSE, was used primarily in reference to the ability to prevent the transfer of significant solids or a precipitating or extracting agent into a UN tank, and the possible consequences thereof. The ability to prevent transfer of solids to the UNH Tank system is a function of the effectiveness of process controls and process characteristics associated with the uranyl nitrate generating systems, which feed material to the tanks.

The UN tanks receive uranyl nitrate from two primary sources: solvent extraction product concentrators (SOLX I and SOLX II) and the clean favorable geometry dissolver system. (Note that the favorable geometry dissolver system began operation in 1994, replacing the older "clean scrap" and "contaminated scrap" dissolvers. This change will be reflected in Revision 1 to the CSE.)

It was determined that effective solution filtration is present in both uranyl nitrate generating systems. The clean favorable geometry dissolver system transfers uranyl nitrate to the UN tanks through dual inline 1 micron cartridge (CUNO) filters. Specifically, the dissolver system has two banks of three tanks each (V-736 A/B/C and V-746 A/B/C). Each bank discharges through its own parallel inline cartridge filters (FL-736 A/B and FL-746 A/B). Then, solutions going to the UN tanks flow through additional inline cartridge filters (FL-748 A/B) in the transfer line. Filters are changed out as necessary.

The prevention of solids transfer to a UN tank from SOLX I or SOLX II is controlled principally by the effective filtration of the uranyl nitrate going from the dirty dissolver system into SOLX. This uranyl nitrate is also filtered twice. The inline filter press (FP-755 A/B) and cartridge filter (FL-756 A/B) combination effectively removes solids from the solution.

Concerning the likelihood of a precipitating agent getting into a UN tank, analysis provides several reasons that the controls are very strong. First, no high pH systems have the capability of transferring material to the uranyl nitrate tank system. Second, the solutions leaving the dissolver systems typically have a free acid content greater than 15% (significantly greater than the criticality safety limit which is 4%), making the possibility of precipitation virtually impossible. Even so, conservative calculations indicate that a significant amount of a common precipitating agent, such as ammonia (NH_4OH), on the order of 400 gallons, is needed to neutralize 5000 gallons of $5.0 \text{ g } ^{235}\text{U}/\ell$ uranyl nitrate with 4% free acid. Hence, the likelihood of this happening is very remote.

Concerning the possibility of an extracting agent getting into a UN tank in quantities large enough to cause a critical configuration to form, analysis shows that this, too, has a very small likelihood of occurring. First, the only source for an extracting agent is from SOLX, that being TBP (tri-butyl phosphate). TBP assimilates with uranium at a ratio of 2 moles TBP per 1 mole uranium. The SOLX process uses approximately 50 gallons of TBP to process two or three 7000 gallon batches of uranyl nitrate. Chemical Operating Procedure COP-830128, Adjusting And Making Up Solvent For Solvent Extraction Systems I And II, requires that operators check the solvent once each week, checking and adjusting the specific gravity, and adding make up solvent as required. Provisions are included for making up solvent in 10 or 25 gallon increments when the level is low. Note that, because TBP is actually just a fraction of the solvent mixture, the actual TBP addition to the solvent extraction process is small. Therefore, the controls in place are satisfactory.

The SOLX processes includes a means for removing TBP from the uranyl nitrate stream prior to transfer. The final operation in the SOLX process is to pump the uranyl nitrate through a kerosene bath, which removes virtually all residual TBP. (Kerosene is the preferential solvent for TBP. Therefore, while it cannot be said that there is absolutely no TBP in a UN tank, the minute quantities that are carried in with the uranyl nitrate do not impact the homogeneity of the nitrate solution. Therefore, the controls preventing solids and extracting agent transfer provide a substantial margin of safety.

Clarification is needed to explain the use of the term "Indeterminate" in describing the effects of heterogeneity with respect to a $19.5 \text{ g } ^{235}\text{U}/\ell$ concentration CSL in the diked area. The analysis stated that the potential exists to concentrate the solution to this limit. This limit is the License limit for normal operation, namely $k_{\text{eff}} = 0.95$, as indicated in Attachment 3 of the CSE. The actual delayed critical concentration for the dike, as shown in Attachment 4, is $24 \text{ g } ^{235}\text{U}/\ell$. The effect of heterogeneity at either of these concentrations, though perhaps "possible," and indeterminate from an analytical standpoint, is an academic issue, in that the margin of safety for getting a concentration that large into the dike is extremely strong. In fact, it is highly unlikely that enough uranium could ever be available. Note that the dike holds approximately 15,000 gallons (56,781 ℓ). Assuming a dike full of UN at a concentration of $19.5 \text{ g } ^{235}\text{U}/\ell$ gives a total of 1107 kg ^{235}U , or $> 22,000 \text{ kg U}$ in the dike. A concentration of $24 \text{ g } ^{235}\text{U}/\ell$ gives 1362 kg ^{235}U , or $> 27,000 \text{ kg U}$. The total uranium inventory in a single 7500 gallon UN tank at $10 \text{ g } ^{235}\text{U}/\ell$ is 283 kg ^{235}U , or 5678 kg U. Therefore, at least four UN tanks at $\geq 10 \text{ g } ^{235}\text{U}/\ell$ must be dumped into the dike, with no uranium escaping in the dike, in order for

enough fissile material to be present to form a critical configuration. In fact, one would need to dump at least three 7500 gallon tanks at $15.0 \text{ g}^{235}\text{U}/\ell$ in order to provide enough fissile material. The CSE will clarify this improbable condition in Revision 1.

4. Provide an analysis to demonstrate that monitoring of the UN Bulk Storage Tanks is adequate to preclude a criticality. Specifically, how does your analysis show that monitoring is frequent enough to avert a potential criticality should precipitation or settling occur?

Criticality safety significant controls on the uranyl nitrate feed streams, as well as the process controls and process characteristics associated with the uranyl nitrate generating systems, provide strong controls for control against precipitation and settling in the UN Storage Tanks. Introduction of a precipitating or extracting agent is extremely remote due to the lack of availability of a precipitating agent, and the measures in place in the SOLX process, which prevent introduction of the extracting agent. These were addressed in Item #3 above.

Even so, the UN storage tank system provides adequate controls to monitor uranium concentration, and to detect and mitigate an increase. Tank monitoring is both continuous and periodic. Each tank features a 100% redundant recirculation system, with dual inline gamma monitors in the recalculation line. By procedure (COP-836015, Normal Operation of UN Storage Tanks), the recirculation systems for each tank are checked twice per shift ensuring that real time monitoring of concentration is maintained. In addition, tanks are sampled for g U/ ℓ and free acid in accordance with a sampling schedule, depending on the source of the uranyl nitrate.

5. There are several discrepancies between Table 6.2.3 in your license and the CSEs. For example, the vaporizer CSE requires mass and configuration defenses to fail for double contingency protection., however, the Table 6.2.3 only addresses "geometry (level control)" as the criticality safety basis. "Level control" is also not defined in the license. Likewise, the hydrolysis column CSE requires favorable geometry and limits on the concentration of uranyl fluoride for double contingency protection, but Table 6.2.3 only requires geometry as a criticality safety basis. There are a number of other examples of these differences between the license and the CSEs. Provide an explanation or correction of these differences.

Table 6.2.3 in the License lists in the Criticality Safety Basis column the primary parameters which may be used as controlled parameters in the double contingency evaluation. If only one parameter is listed (e.g., vaporizer and hydrolysis column), then geometry is indeed the primary controlled parameter, but not the only parameter that may be used. Another parameter may be used in conjunction with it. If two parameters are listed, then either or both may be used, but it is not necessary to always use both.

Concerning the matter of geometry with level control, this qualifier ("level control") was added at the request of NRC to indicate that geometry is being controlled not by relying on a passive engineered control such as a "bullet" tank or favorable slab, but rather by maintaining proper level in a vessel.

6. Provide a justification for ensuring that tank ruptures will occur before exceeding geometry limits. Specifically, have analyses been performed to show that less than rupture stresses can not expand tanks to their geometry limit?

A structural analysis of cylindrical vessels shows that, for thin wall pipes such as the hydrolysis column, the calculated maximum pressure rating (hoop stress) is given by the expression

$$\text{Hoop Stress} = \frac{\Delta p * d}{2t}$$

Where

Δp = differential pressure

d = vessel diameter

t = wall thickness

Hoop stress is the circumferential stress level above which wall deformation is expected to occur. The maximum wall deformation, visually imperceptible, will not exceed 0.2% of the vessel diameter. At some pressure greater than the hoop stress, the vessel will rupture. The calculated hoop stress is typically significantly below the actual yield stress level (σ_y), which is 30,000 psi.

For the hydrolysis column (normal pressure = ambient; maximum pressure rating = 250psi, vessel diameter = 10.75 inches OD, wall thickness = 0.307 inches, 10.136 inches ID, [12.87 cm radius]), hoop stress = 4377 psi., which is, indeed, significantly below σ_y . Further, the hydrolysis column deformation will not exceed 0.2% of the vessel diameter, or 10.78 inches OD; 10.16 inches ID. Calculations show that the critical radius ($k_{\text{eff}}=0.99$; CALCNOTE CRI-94-058) for a partially reflected UO_2F_2 -filled hydrolysis column, assuming optimum density, is 15.2 cm, or 11.97 inches ID. Clearly then, the tank will rupture prior to expanding to the critical diameter.

7. The CSEs provide numerous parametric/sensitivity calculations to show the effect on k_{eff} , from changes in parameter limits from normal to off-normal quantities. However, there are no analyses that demonstrate that the physical margin of safety is sufficient to show the likelihood of changing parameters to these off-normal quantities. Provide analyses to show the margin of safety is sufficient.

In a telephone conversation October 31, 1996, between Messrs. Charles Gaskin, Acting Section Leader, Licensing Section 1, Licensing Branch, NRC, and Charles F. Sanders, Manager Nuclear Material Safety and Safeguards, Westinghouse, permission was granted Westinghouse to submit its response to question #7 during the first week in December, 1996.