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Our ref: HEM-09-140
Date: December 4, 2009

Subject: Hematite Decommissioning Project Criticality Alarm Exemption Request (License No. SNM-00033, Docket No. 070-00036)

Reference: NRC (M. A. Satorius) letter to Westinghouse (E. K. Hackmann), CAL 3-08-005B, dated November 13, 2009, "Confirmatory Action Letter Second Addendum"

Westinghouse Electric Company LLC hereby requests an exemption pursuant to 10 CFR 70.17(a) from the requirements for a criticality monitoring alarm system of 10 CFR 70.24(a) for the Hematite facility. Such an exemption is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest. The attachment to this letter provides the justification for this request.

Section 70.24(a) of Title 10, Code of Federal Regulations, is applicable to the Hematite facility in that the SNM-33 license authorizes the licensee to possess special nuclear material (SNM) in a quantity exceeding 700 grams of contained ^{235}U. The Hematite facility is therefore required to "... maintain in each area in which such licensed special nuclear material is handled, used or stored a criticality monitoring system ...", unless the NRC grants an exemption from that requirement. The attachment to this letter, Justification for 10 CFR 70.24 Exemption Request at the Hematite Site, justifies that the absence of a criticality monitoring system will not endanger life or property or the common defense and security and is otherwise in the public interest. Such criticality monitoring system is unnecessary since a criticality accident is not credible.

This request addresses Item 8 of the referenced Confirmatory Action Letter Second Addendum for an exemption to the requirement for a criticality monitoring alarm system. The Stop Work Order with the allowances specified in the aforementioned Item 8 remains in effect. **Westinghouse requests that the NRC review this exemption request on an expedited basis for approval to allow sufficient time for preparatory work early next year to complete process building demolition during the summer.**

NMSS01

Please contact Gerard Couture, Licensing Manager of my staff at 803-647-2045 should you have questions or need any additional information.

Sincerely,

Kevin Harris

for E. Kurt Hackmann
Director, Hematite Decommissioning Project

Attachment: Justification for 10 CFR 70.24 Exemption Request at the Hematite Site

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ATTACHMENT

Justification for 10 CFR 70.24 Exemption Request at the Hematite Site

EXECUTIVE SUMMARY

Westinghouse Electric Company LLC, as a licensee which is authorized to possess more than 700 grams of contained ^{235}U, is requesting an exemption from the requirements of 10 CFR 70.24(a) to maintain a criticality monitoring system in each area in which such special nuclear material (SNM) is handled, used or stored. Recent radiological surveys of the Hematite facility process buildings have identified the presence of enriched uranium that was not included in the previous estimate of the residual mass of uranium in such buildings which formed part of the technical basis for NRC approval of license amendment 52. This exemption request incorporates the recent survey and uranium mass estimate information to justify a criticality monitoring system exemption for the process buildings, in addition to consolidating the justification for other cases previously requested.

The results of the recent radiological surveys have been used in calculations to refine the ^{235}U mass inventory within each of the individual process buildings. For evaluation purposes, the process buildings have collectively been separated into five individual "facility areas." The relatively small quantity and highly dispersed configuration of ^{235}U in each facility area assures that there is no potential for a criticality incident under the current quiescent conditions.

If future Decontamination and Decommissioning (D&D) operations are deemed advisable to remove and/or decontaminate any further equipment, piping, ventilation duct, and miscellaneous items to ensure that they meet criteria for transportation and off-site disposal, then these future D&D operations would not result in any credible criticality accident scenarios. This is because the relatively small quantity of ^{235}U associated with the aforementioned items assures that there are no credible criticality accident scenarios for D&D operations, even without taking credit for Defense-in-Depth controls which would be used.

For future building demolition, subcriticality is assured because the ^{235}U contamination associated with all building surfaces is present at extremely low areal densities. Derived bounding average and peak ^{235}U concentration values for the building debris that will arise from building demolition are significantly smaller than the maximum subcritical value for 5 wt.% $^{235}U/U$ enrichment. The safety factor is 330 and more than 6, for the average and peak maximum concentration values, respectively. These factors of safety represent a significant margin of safety despite the derived margin being very conservative. The assessment demonstrates that demolition of the former process buildings could not result in a criticality accident.

Given that a criticality accident is not credible, it would be contrary to the guidance in ANSI/ANS-8.3 to have an active criticality accident alarm system (CAAS) since it could only increase personnel risk. These considerations provide ample justification for the issuance of an exemption to the requirement for a CAAS for the process buildings under the current quiescent conditions, during future D&D operations which may be performed in the process buildings, and during building demolition, and for those cases previously requested.

References: 1) Westinghouse (E. K. Hackmann) letter to NRC (Document Control Desk), HEM-09-121, dated October 23, 2009, "Hematite Decommissioning Project Summary Report of the 2009 Process Building"
2) Westinghouse (E. K. Hackmann) letter to NRC (Document Control Desk), HEM-09-51, dated May 21, 2009, "Request for License Amendment"
3) Westinghouse (E. K. Hackmann) letter to NRC (Document Control Desk), HEM-09-94, dated August 12, 2009, "Decommissioning Plan and License Application"

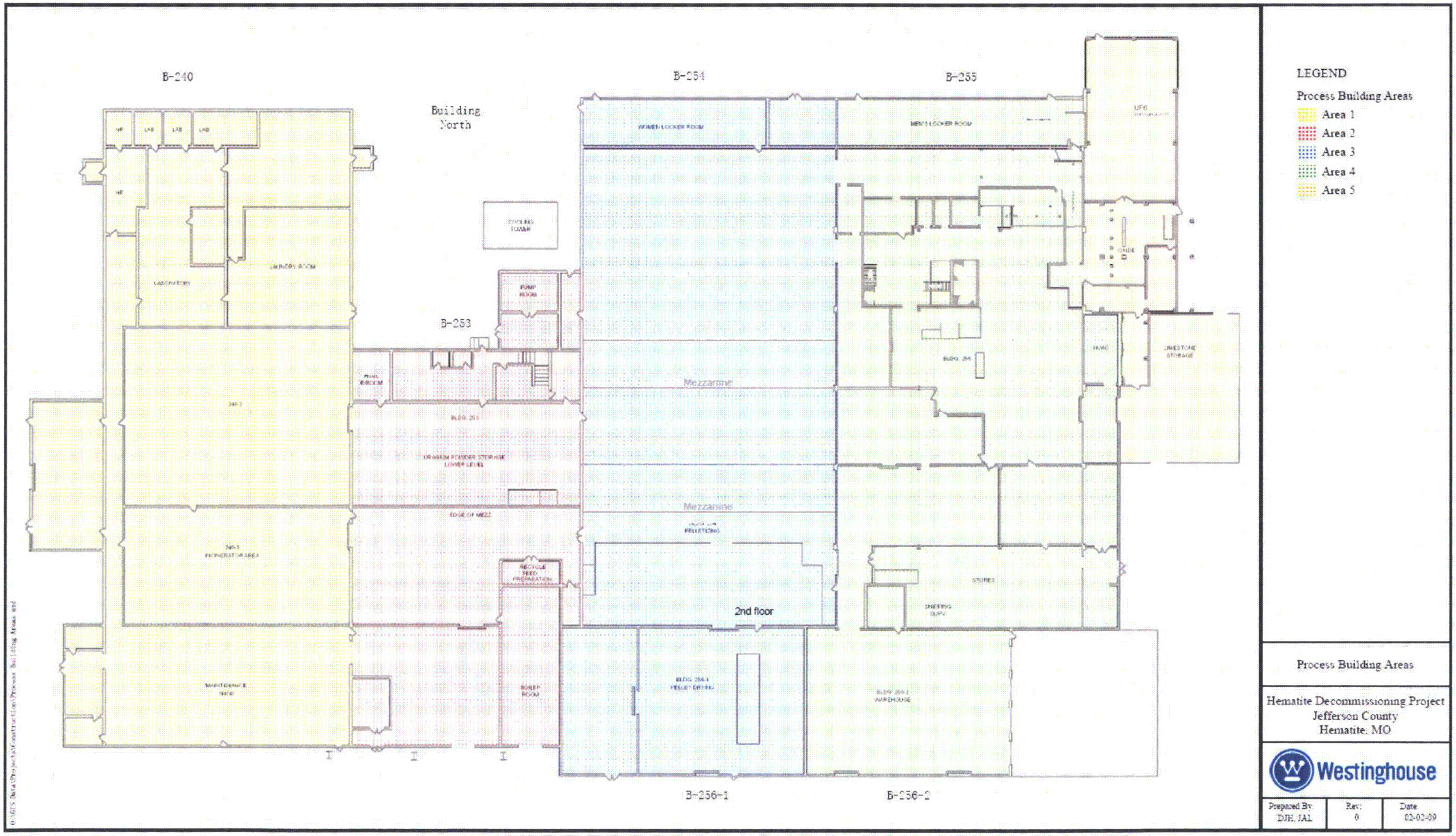
1.0 INTRODUCTION

In accordance with 10 CFR 70.17(a), Westinghouse Electric Company LLC, as a license which is authorized to possess more than 700 grams of contained ^{235}U, is requesting an exemption from the requirements of 10 CFR 70.24(a) to maintain a criticality monitoring system in each area in which such SNM is handled, used or stored. This filing provides the technical bases that the issuance of such an exemption will not endanger life or property or the common defense and security and is otherwise in the public interest.

The scope of the Hematite Decommissioning Project (HDP) includes the demolition of six adjacent process buildings with some common walls. These buildings were formerly used for fuel manufacturing operations and a plan view is shown in Figure 1. Accountable uranium inventory was removed and decontamination of equipment and surfaces within the process buildings was undertaken following cessation of fuel manufacturing operations in 2001. This effort resulted in the removal of the majority of process piping and equipment from the buildings, however some contamination remained. At the conclusion of that project phase, the accessible surfaces of the remaining equipment and interior surfaces of the buildings were sprayed with fixative in preparation for building demolition. After this phase, the criticality monitoring system (or, criticality accident alarm system; CAAS) was removed. In license amendment 52, NRC approved removal of the CAAS and building demolition based in part on the estimated mass of uranium remaining in the process buildings.

The next major effort of the HDP is building demolition, which was authorized under NRC license amendment 52. Further Decontamination and Decommissioning (D&D) operations may be performed in the process buildings prior to demolition. Following building demolition and NRC approval of the Decommissioning Plan, the HDP will proceed with other authorized activities up to and including license termination.

Figure 1 Hematite Site Process Buildings and Delineation of Facility Areas



2.0 RESIDUAL ^{235}U MASS ESTIMATES FOR THE FORMER PROCESS BUILDINGS

Reference 1 provided the results of the recent effort to characterize the current residual ^{235}U remaining in the process buildings. The residual ^{235}U is in the form of uranium oxide (UO_2) and is associated with a relatively small number of equipment, piping, ventilation duct, miscellaneous components/items, and buildings surfaces (i.e., floors, walls, ceilings, and roof).

The process buildings have been grouped to create five individual facility areas, consistent with Reference 1. These five individual facility areas are defined and illustrated in Table 1 and Figure 1, respectively.

Table 1 Facility Area / Building Nomenclature

Facility Area	Encompassed Buildings
1	240, Maintenance Building & Misc. Non-Production Buildings
2	253
3	254, 256-1
4	255, 256-2
5	UF_6 Storage Building, Oxide Building & Limestone Storage Building

Table 2 presents a summary of the ^{235}U mass estimates derived for equipment, piping, and the miscellaneous components/items within each facility area. Note that the ^{235}U mass values provided for the miscellaneous components/items includes the contribution from elevated ventilation ducts.

Table 2 ^{235}U Mass Estimates Derived for Equipment, Piping, and Miscellaneous Components/Items

Category	Mass Estimate ($g^{235}U$)				
	Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Equipment	16	8	357	21	2
Main Piping	0	0	68	410	152
Miscellaneous Components/Items	63	8	308	64	290
Total Equipment Piping, and Misc. Components/Items	**79**	**16**	**733**	**495**	**444**

Tables 3 and 4 provide a summary of the ^{235}U mass and average areal density estimates derived for the building surfaces in each facility area. Note that the derivation of these values in Reference 1 included consideration of the possibility that the ^{235}U associated with the building roof may have penetrated the surface over time. For example, contamination may have been covered over by roofing materials used in repair activities. Also, rainfall could have caused contamination to migrate into the roof substrate over time.

Table 3 ^{235}U Mass Estimates Derived for Building Surfaces

Category	Mass Estimate ($g^{235}U$)				
	Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Floors	896	254	977	629	758
Walls and Ceilings Combined	104	57	196	135	126
Roof	631	360	680	941	167

Table 4 ^{235}U Areal Density Estimates Derived for Building Surfaces

Category	Average Areal Density Estimate ($g^{235}U/ft^2$)				
	Area 1	Area 2	Area 3	Area 4	Area 5
Floors	0.053	0.031	0.033	0.028	0.118
Walls and Ceilings Combined	0.002	0.002	0.003	0.002	0.006
Roof	0.033	0.033	0.034	0.040	0.035

The building surfaces analysis also determined a peak areal density of 2.1 $g^{235}U/ft^2$ for the roof, which is bounding of all building surfaces in each of the five facility areas (i.e., floors, walls, ceilings, and roof, including the roof substrate). This peak areal density value corresponds to a limited portion of the building roof and explains why the average areal density values derived for each facility area are substantially smaller - by a factor of greater than 17, 350, and 52 for the building floors, walls/ceilings, and roof, respectively. The concrete floors and walls also exhibited variation in contamination levels. The peak areal density derived for floors was 1.8 $g^{235}U/ft^2$. The peak areal density derived for the building walls was very small (0.028 $g^{235}U/ft^2$) compared to that for the floors and roof.

3.0 NUCLEAR CRITICALITY SAFETY ANALYSIS

The results presented in Section 2.0 permit an appraisal of the likelihood of a criticality incident within the former process buildings under the current quiescent conditions, during possible future D&D operations in the process buildings, and during building demolition. This likelihood analysis is provided in Sections 3.1, 3.2, and 3.3, respectively. Section 3.4 provides justification for the issuance of an exemption to the requirement for provision of a CAAS for other site areas and activities.

3.1 Former Process Buildings - Current Quiescent Conditions

The relatively small quantity and highly dispersed configuration of ^{235}U associated with the elevated equipment, piping, ventilation duct, miscellaneous items, and the building surfaces (including the building roof substrate) assures that there is no potential for a criticality incident under the current quiescent conditions. This determination is justified below.

- The maximum mass total for all equipment, piping, ventilation duct, and miscellaneous items in any individual facility area is 733 $g^{235}U$ (Table 3, Area 3). This maximum value is significantly smaller (by a factor of greater than two) than the maximum sub-critical mass limit for UO_2 with 5 wt.% $^{235}U/U$ enrichment (1640 $g^{235}U$, Table 6, ANSI/ANS-8.1-1998). Furthermore, the UO_2 associated with the equipment, piping, ventilation duct, and miscellaneous items is highly dispersed covering very large areas at low, highly subcritical, areal densities. This sharply contrasts with the highly compact optimized spherical geometry, moderation, and full water reflection conditions on which the maximum subcritical mass limit of ANSI/ANS-8.1-1998 is based. Thus, there is insufficient UO_2 associated with equipment, piping, ventilation duct, and miscellaneous items within each individual facility area for a criticality incident to be possible, even under optimum highly idealized conditions.

- The probability of neutron interaction between UO_2 associated with equipment, piping, ventilation duct, and miscellaneous items located in different facility areas is essentially zero. The former process related floor surfaces of the five individual facility areas occupy a surface area of between 6,400 ft^2 and 30,000 ft^2, corresponding to a combined total surface area of approximately 84,000 ft^2. While the elevated equipment, piping, ventilation duct, and miscellaneous items do not necessarily encompass all regions of these floor areas, the area they do encompass is very large because they generally comprise a large number of dispersed low mass items, many of which occupy large areas due to their size (e.g., piping with significant linear lengths). Clearly, the potential for neutron interaction between facility areas is non-existent, even neglecting the shielding provided by building walls.
- The ^{235}U associated with building surfaces is highly subcritical because it is fixed to the buildings surfaces at extremely low areal densities. The peak areal density for any area is only 2.1 $g^{235}U/ft^2$, and this bounding value corresponds to a small surface area. This bounding peak value is more than two orders of magnitude (specifically more than a factor of 154) lower than the bounding maximum subcritical limit of 325 $g^{235}U/ft^2$ (Table 1, ANSI/ANS-8.1-1998) for highly enriched uranium. Clearly, this represents a significant margin of safety, despite the derived margin being very conservative on account of the average areal density being much lower than the peak value used in the calculation, and the maximum subcritical areal density limit for 5 wt.% $^{235}U/U$ enriched uranium being larger than the conservative 325 $g^{235}U/ft^2$ value used.
- Interaction potential between building surfaces and elevated equipment, piping, ventilation duct, and miscellaneous items within the respective facility areas is essentially zero. The extremely low areal densities afforded by the highly dispersed nature of the contamination associated with the building surfaces provides no mechanism to increase the reactivity of any significant localized accumulation of uranium within the environs of each area. Even if all of the ^{235}U associated with every item and every building surface in any facility area were somehow mobilized from their bound surfaces, selectively transported over thousands of square feet to a single coincident location, and assembled into a idealized compact spherical geometry, with optimum water moderation, and full water reflection, then a criticality accident would still not be possible in facility areas 2 and 5. This is because these two areas contain insufficient mass to assemble a maximum subcritical mass even when accounting for the inventory associated with every item (elevated equipment, piping, ventilation duct, and miscellaneous items) and every building surface (floors, walls, ceilings and roof). For facility areas 1, 3, and 4, the

percentage of the ^{235}U associated with the building surfaces (floors, walls, ceilings and roof) that would have to be mobilized and attain the incredible conditions noted above represents 96%, 49%, and 67%, respectively. These statistics provide abundant assurance that there is no potential for a criticality incident within the former process buildings under the current quiescent conditions.

3.2 Former Process Buildings - Future D&D Operations

Future D&D operations may be necessary to prepare the former process buildings for demolition and to remove and decontaminate any equipment, piping, ventilation duct, and miscellaneous items as necessary to ensure that they meet the relevant criteria for transportation and off-site disposal.

When performed, D&D operations will be conducted under a task specific work package and will adhere to any criticality safety precautions (Defense-in-Depth [DinD] controls) identified in the supporting Nuclear Criticality Safety Assessment (NCSA). The approach that will be used includes removal and decontamination of selected items from the process buildings, followed by their transit and loading into a transportation package/container situated either within or outside the environs of the former process buildings. The decontamination methods that will be employed will be limited to removal of any UO_2 holdup using mechanically induced agitation and suction provided by a safe volume vacuum cleaner. UO_2 recovered from the decontaminated equipment, piping, ventilation duct, and miscellaneous items will be recovered from the safe volume vacuum cleaner and transferred to a safe volume container, which will subsequently be sealed and placed in a secure area for interim storage.

As noted above, D&D operations will be conducted in a controlled and orderly manner as defined in task specific work packages, and will include compliance with any governing NCSA DinD controls. However, the relatively small quantity of ^{235}U associated with all elevated equipment, piping, ventilation duct, and miscellaneous items associated with the former process buildings assures that there are no credible criticality accident scenarios for D&D operations, regardless of how the D&D operations are performed. This conclusion is supported by the following considerations:

- The combined total mass of ^{235}U associated with all elevated equipment, piping, ventilation duct, and miscellaneous items associated with all five individual facility areas is 1767 $g^{235}U$ (Table 2). Although this maximum combined value is slightly greater than the 1640 $g^{235}U$ maximum sub-critical mass limit for UO_2 with 5 wt.% $^{235}U/U$ enrichment (Table 6, ANSI/ANS-8.1-1998), the potential to achieve a critical state during D&D operations, or during consignment of the removed equipment, piping, ventilation duct, and miscellaneous items to a transportation package/container is effectively zero. This is because the UO_2 associated with the equipment, piping, ventilation duct, and miscellaneous items is highly dispersed and in a poor configuration (i.e., predominantly surface contamination with low areal density). This sharply contrasts with the highly compact optimized spherical geometry, moderation, and full water reflection conditions on which the maximum subcritical mass limit is based. Even if all of the elevated equipment, piping, ventilation duct, and miscellaneous items were removed and placed together in one location they would occupy an extremely large area, encompassing thousands of square feet. Clearly, this extremely large spatial distribution is far removed from the highly compact (~16 L) optimized spherical geometry on which the maximum subcritical mass limit is based*. Thus, even if all elevated equipment, piping, ventilation duct, and miscellaneous items were removed during D&D operations and grouped in one location, no criticality potential would exist. Note that this conclusion is sustained even without recognizing the significant dilution and parasitic neutron absorption provided by the large quantity of steel generally associated with the D&D items.

- Significant mobilization of ^{235}U from D&D equipment loaded into a transportation package/container is unlikely because, with the exception of a small number of items, the ^{235}U is generally present only as surface contamination. Thus, even if D&D operations failed to recover loose ^{235}U, there would be little potential to spill and accumulate ^{235}U. Even if every single elevated equipment, piping, ventilation duct, and miscellaneous item was removed and placed in one location then the total mass of ^{235}U could not exceed 1767 $g^{235}U$ (Table 2). Furthermore, if all of the associated ^{235}U was hypothetically mobilized and transported to a single coincident location, a criticality incident could still not credibly occur. This is because the worst case credible conditions that could be achieved for an accumulation of ^{235}U would not closely match the idealized compact spherical geometry, optimum water moderation, and full water reflection conditions on which the maximum subcritical mass limit is based. Although non-optimized moderation, geometry, concentration, and reflection conditions could theoretically result in an unsafe condition, the mass of ^{235}U that would be required to achieve the critical state would have to be far greater than the maximum subcritical limit of 1640 $g^{235}U$. This is because as each parameter (moderation, geometry, concentration, and reflection) departs from its optimum condition the mass of ^{235}U required for the critical state increases. Departure of combinations of parameters from their optimum condition would require a disproportionately large increase in the ^{235}U mass to achieve the critical state. This effect is examined in Section 3.3 for building debris by examining a simple conservative analogue of an optimally concentrated and full water reflected spherical accumulation of highly enriched uranium in water. It is shown that when only one attribute of this idealized system is adjusted by a small degree the minimum critical mass increases by a factor of ~2.5. This acute sensitivity to minor variation of even a single parameter effectively ensures that an accumulation of ^{235}U far exceeding (by several factors) the maximum subcritical mass limit of 1640 $g^{235}U$ could not credibly achieve a critical state. Considering that the collective ^{235}U mass associated with every single elevated equipment, piping, ventilation duct,

* The optimum concentration of a spherical full water reflected sphere containing an homogeneous UO_2-H_2O mixture is ~2100 gU/L (Fig III.B.3-6 of ARH600 Vol. II). Applying this optimum concentration value to the maximum subcritical mass limit of 1640 $g^{235}U$ (Table 6, ANSI/ANS-8.1-1998) results in a derived UO_2-H_2O mixture volume of approximately 16 L.

and miscellaneous items is only 1767 g ^{235}U (Table 2), it is obvious that an unsafe condition could not occur from D&D equipment removal and packaging, even if every item was removed and every single gram of ^{235}U associated with those items was somehow mobilized and transported to a single coincident location.

- Removal and transit of UO_2 from the former process buildings presents no criticality safety concerns because the recovered mass of ^{235}U would not comprise a significant fraction of the 1767 g ^{235}U (Table 2) mass total derived for all items. This is because, with the exception of a small number of items, the ^{235}U is generally present only as surface contamination and would not be recoverable. Thus, the potential to recover greater than a maximum subcritical mass of ^{235}U during D&D operations is essentially zero. Even if every gram of ^{235}U was recovered from every elevated item there would be no credible potential for a criticality incident. This is because of the incredibility of achieving the highly idealized conditions required for a critical state to be possible. The acute parameter sensitivity effects discussed in the preceding bullet point indicate that a significant margin of safety would exist even if an accumulation of 1767 g ^{235}U was realized.
- The low areal densities afforded by the highly dispersed nature of the contamination associated with the building surfaces provides no mechanism to increase the reactivity of any significant localized accumulation of uranium within the environs of each area. For this reason, there is no non-trivial potential for interaction between building surfaces and the ^{235}U associated with the elevated equipment, piping, ventilation duct, and miscellaneous items within the respective facility areas. Refer to the discussion in the last bullet point of Section 3.1 for further justification.

The above assessment provides abundant assurance that there is no potential for a criticality incident during D&D operations within the former process buildings. Furthermore, this assurance is independent of the fact that the D&D operations will be conducted in a controlled and orderly manner as defined in task specific work packages, and will include compliance with governing NCSA DinD controls.

3.3 Former Process Buildings - Building Demolition

Demolition of the former process buildings will be conducted following removal of any equipment, piping, ventilation duct, and miscellaneous items, as necessary, to ensure that the building debris meets the relevant criteria for transportation and off-site disposal.

The results presented in Section 2.0 demonstrate that the ^{235}U contamination associated with all building surfaces (floors, walls, ceilings, and roof) is present at extremely low areal densities. Specifically, the average areal density established for all building surfaces is only 0.118 g $^{235}U/ft^2$. Furthermore, the peak maximum areal density established for any building surface is only 2.1 g $^{235}U/ft^2$, and corresponds to only a small surface area. Based on these bounding values, and using a building surface substrate depth of 4 inches, results in derived bounding average and peak ^{235}U concentration values of 0.12 g $^{235}U/ft^3$ and 6.3 g $^{235}U/ft^3$ for the building debris that will arise from building demolition. These bounding concentration values are significantly smaller than the minimum critical infinite sea concentration of 1.4 $g^{235}U/L$ (39.6 $g^{235}U/ft^3$) for a fictitious bounding medium consisting of only SiO_2 and ^{235}U (NUREG/CR-6505 Vol. 1). The corresponding factor of safety (i.e., the factor by which the derived concentration values must be scaled before a minimum critical concentration value could be realized) is 330 and greater than 6, for the average and peak maximum concentration values, respectively. These factors of safety represent a significant safety margin despite the derived margin being very conservative on account of:

- The minimum critical concentration limit of 1.4 $g^{235}U/L$ (39.6 $g^{235}U/ft^3$) being derived for highly enriched uranium. The corresponding limit for low enriched uranium with a maximum 5 wt.% $^{235}U/U$ enrichment would be considerably greater, resulting in a considerably larger margin of safety.
- SiO_2 represents a conservative media on which to base a minimum critical concentration limit because of its very small neutron capture cross-section compared to the materials that would comprise building demolition debris (predominantly concrete and steel).
- The average and peak maximum areal densities used in the above calculation are based on the values derived for the roof. The corresponding values for the building walls are considerably smaller (by a factor of between 5 and 20).
- The average and peak maximum areal densities used in the above calculation are based on the areal density values computed for the roof, where the ^{235}U contamination is assumed to be uniformly distributed within the roof substrate. Thus, the reported average and peak areal density values for the building roof are actually equivalent to concentration and do not require adjustment. Therefore, scaling the average and peak areal density values for the roof to account for the substrate volume introduces additional conservatism.

The above assessment demonstrates that demolition of the former process buildings could not result in a criticality accident. Even if the significant conservatisms associated with the large factors of safety derived above are neglected, the concentration of ^{235}U associated with the building debris is a factor of 330 smaller than the minimum critical limit. Even if only the building debris originating from the areas exhibiting the greatest ^{235}U contamination levels were somehow assembled together a substantial margin of safety would still exist. This is because conservatively assuming that all building surfaces are contaminated to a level equivalent to maximum contamination level observed for all surfaces results in a factor of safety greater than 6. Furthermore, as discussed above, due to the pessimisms associated with this derived factor of safety, the actual margin of safety is considerably greater. Thus, heterogeneity effects within the building debris cannot result in an unsafe condition.

Hypothetical dissociation of ^{235}U from the building debris could create the potential to exceed the maximum concentration value derived for the building debris. However, this would require mobilization of ^{235}U from copious volumes of building debris followed by selective transport over thousands of square feet to a single coincident location. Even if this implausible condition was somehow achieved the accumulated ^{235}U would have to comprise greater than 1640 $g^{235}U$ and be assembled to form an idealized compact spherical geometry approximately 16 L in volume, with optimum water moderation, and full water reflection before an unsafe condition could arise. Although less idealized moderation, geometry, concentration, and reflection conditions could theoretically result in an unsafe condition, the mass of ^{235}U that would be required to achieve the critical state would have to be greater than the maximum subcritical limit of 1640 $g^{235}U$. This is because as each parameter (moderation, geometry, concentration, and reflection) departs from its optimum condition the mass of ^{235}U required for the critical state increases. Departure of combinations of parameters from their optimum condition would require a disproportionately large increase in the ^{235}U mass to achieve the critical state.

Because of the obvious inefficient conditions represented by building debris compared to the highly idealized conditions on which the maximum subcritical mass limit of 1640 $g^{235}U$ is based, significant (i.e., many kilogram) quantities of ^{235}U would have to be mobilized and selectively transported to a single coincident location before a criticality incident could be credible. This fact can be illustrated by a simple conservative analogue of an optimally concentrated and full water reflected spherical accumulation of highly enriched uranium in water. When only one attribute of this idealized system is adjusted by replacing the water moderator with a fully water saturated soil moderator the minimum critical mass increases by a factor of ~2.5[†]. Clearly, the highly inefficient moderation, geometry, concentration, and reflection conditions presented by building debris would result in a significantly larger increase in the maximum subcritical mass limit. Nevertheless, the simple conservative analogue presented above clearly bounds any credible condition achievable from building demolition and the resultant increase in the minimum critical ^{235}U mass is sufficient to render this hypothetical scenario not credible. This is seen when multiplying the maximum subcritical limit of 1640 $g^{235}U$ by a conservative factor of 2.5 and comparing the resultant bounding subcritical mass limit for building debris (4.1 $kg^{235}U$) to the combined mass of ^{235}U (~3.4 kg) associated with all building debris (building walls, ceilings and roof).

Although the above calculation did not include the ^{235}U contamination bound to floor surfaces (because the floor surfaces will remain intact and will not be demolished under the current work scope), it is clear that any credible contribution of ^{235}U associated with the building floors is of no concern.

The above assessment provides substantial assurance that there is no potential for a criticality incident during or subsequent to demolition of the former process buildings.

[†] The minimum critical mass in a plutonium system moderated by fully water saturated soil (40% soil-in-water) (Fig III.A.6(97)-4 of ARH600 Vol. II) is a factor of ~2.5 greater than the minimum critical mass for an otherwise equivalent aqueous system (Fig III.A.6-1 of ARH600 Vol. II). Although this ratio is derived for plutonium, the derived factor of ~2.5 can be applied to a uranium system because the fission cross-section for ^{235}U (as a function of the incident neutron energy) follows a similar trend to the fission cross-section for plutonium. Note that the soil composition for the above data is defined in Table III.A.1-6 of ARH600 Vol. II.

3.4 Other Site Areas and Activities

This section provides the bases for the issuance of an exemption to the requirement for provision of a CAAS for other site areas and activities, i.e., site areas and activities not associated with the former process buildings.

The site areas and activities covered in this section were covered by CAAS exemptions previously requested in References 2 and 3. These previous requests were submitted as part of the requests for a license amendment. Although the wording of these recent exemption requests was slightly different, they contained similar requests as follows:

- an exemption for low concentration materials;
- an exemption for materials in containers for shipment; and
- an exemption for a maximum mass limit of ^{235}U per building or separate area.

This exemption request combines and supersedes those specific requests of References 2 and 3, and specifically adds an exemption for the process buildings. The complete exemption request verbiage is given in Section 5.0 (Conclusion). Westinghouse plans that following NRC approval of this exemption request, that exemption verbiage would be included or referenced in a license application page change to the previously submitted revision requests of References 2 and 3.

The basis of the exemption request for low concentration materials is that the diffuse nature of the ^{235}U contamination associated with the materials provides high levels of dilution, ensuring subcriticality. The concentration limits specified in Section 5.0 for solids and liquids are 1.4 $g^{235}U/L$ and 11.6 $g^{235}U/L$, respectively. These values correspond to subcritical infinite sea concentrations for solid waste-like materials and aqueous solutions. The limit specified for solids is based on a fictitious bounding medium consisting of only SiO_2 and ^{235}U (NUREG/CR-6505 Vol. 1). This limit is bounding of solid HDP remediation wastes (contaminated soils, contaminated materials and structures, exhumed buried wastes, etc.) because SiO_2 represents a conservative media on which to base a minimum critical concentration limit due to its very small neutron capture cross-section compared to HDP remediation wastes. The limit specified for liquids corresponds to the maximum subcritical limit for aqueous solutions (Table 1, ANSI/ANS-8.1-1998). Both solid and liquid concentration limits correspond to bounding optimized infinite media and therefore are not contingent on the quantity of material and its geometry, moderation and reflection state.

The basis for the exemption for materials in containers for shipment is that the condition is analogous to that of the existing regulatory provision of the second sentence of 10 CFR 70.24(a):

> "This section is not intended to require . . . monitoring systems when special nuclear material is being transported when packaged in accordance with the requirements of part 71 of this chapter."

While the above regulatory allowance applies during shipment, the condition of the contained materials is essentially the same while being prepared for shipment and while being staged pending shipment.

The basis of the exemption for the mass limits defined for individual buildings or separate areas in Section 5.0 is that the specified mass limits do not exceed the maximum subcritical mass limits for the corresponding ^{235}U enrichment. These mass limits are as follows and are set at or below the subcritical mass limits specified in Table 1 and Table 6 of ANSI/ANS-8.1-1998:

- 700 g^{235}U in uranium enriched to more than 5 wt.% $^{235}U/U$; and
- 1640 g^{235}U in uranium enriched to no more than 5 wt.% $^{235}U/U$.

Since the specified mass limits are not greater than the maximum safely subcritical limit for optimized compact spherical accumulations of uranium mixed with water at optimum concentration and with close fitting full water reflection, there is no potential for a criticality incident within each individual building or separate area. Limiting the collective mass of ^{235}U within each building or separate area satisfies the criteria provided in Section 4.2.1 of national consensus standard ANSI/ANS-8.3, which is endorsed in Regulatory Guide 3.71.

4.0 OVERALL SAFETY CONSIDERATIONS

The national consensus standard for CAASs, ANSI/ANS-8.3 which is endorsed by the NRC in Regulatory Guide 3.71 (with exceptions not relevant here) makes a seemingly obvious, but important, safety point. In Section 4.1.1 it is noted that a CAAS should only be installed when it will result in a reduction in total risk. Stated conversely, a CAAS should not be installed when it will result in an increase in personnel risk. The standard also makes it clear that the hazards associated with false alarms are an important consideration. Given that there is no credible risk of a criticality accident within the former process buildings under the current quiescent conditions, during possible future D&D operations, and during building demolition, the hazards associated with personnel evacuating from false alarms clearly increases personnel risk. Thus an active CAAS would be inconsistent with the guidance in this standard, and this fact supports the issuance of the requested exemption for the former process buildings. These same arguments also apply to the other site areas and activities addressed in Section 3.4 because of the absence of any credible criticality risk.

5.0 CONCLUSION

Given that a criticality accident is not credible, it would be contrary to the guidance in ANSI/ANS-8.3 to have an active CAAS since it could only increase personnel risk. These considerations provide ample justification for the issuance of an exemption to the requirement for a CAAS for the process buildings under the current quiescent conditions, during D&D operations which may be performed in the process buildings, and during building demolition, and for the previously requested cases of References 2 and 3.

The specific requested exemptions are as follows (Westinghouse plans that following NRC approval of this exemption request, this exemption verbiage would be included in a license application page change to the previously submitted revision requests of References 2 and 3):

Notwithstanding the requirements of Title 10, Code of Federal Regulations, Part 70.24, the licensed activity shall be exempted from the "monitoring system" requirements in the areas, and under any or all of the conditions specified below:

- Low concentration materials (1.4 $g^{235}U/L$ for solids, and 11.6 $g^{235}U/L$ for liquids) that are safely subcritical by virtue of their low concentration, irrespective of any other physical conditions, including mass, geometry, moderation, reflection, etc.; or
- Contaminated materials in shipping containers for shipment in accordance with NRC/DOT regulations, including 10 CFR 71.15; or
- Buildings and separate areas containing less than the following isotopic mass per building or separate area:
  - 700 $g^{235}U$ in uranium enriched to more than 5 wt.% $^{235}U/U$; and
  - 1640 $g^{235}U$ in uranium enriched to no more than 5 wt.% $^{235}U/U$; or
- In the former process buildings, namely Building 240, Maintenance Building, & Miscellaneous Non-Production Buildings, 253, 254, 256-1, 255, 256-2, UF_6 Storage Building, Oxide Building and Limestone Storage Building, including removal and transit of SNM from the former process buildings, providing no additional SNM is introduced into the former process buildings from sources external to the former process buildings.