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U. S. Nuclear Regulatory Commission
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Gentlemen:

The Cintichem Inc. decommissioning project has progressed to the last decontamination tasks and is nearing final survey work to assure that the end-of-project acceptance criteria have been achieved. The acceptance criteria are specified in Section 8 of the Cintichem Decommissioning Plan and in Conditions F and G of the SNM 639 license as follows:

- Building surfaces must meet the requirements of Regulatory Guide 1.86. (Condition F, SNM 639 license.)

- Soils must meet the requirements of the criteria approved by NRC letters August 26, 1993 and October 17, 1994.

- General whole-body direct radiation dose must not exceed 5 urem/hr above background in all areas. (Condition F, SNM 639 license.)

Until recently, Cintichem intended to apply Regulatory Guide 1.86 criteria to any bedrock that became exposed during the decommissioning process. Recent experience in decontaminating bedrock in the reactor building has prompted an investigation into an alternative set of acceptance criteria for bedrock that is exposed during the decontamination process but that ultimately will be covered by soil and other overburden material in the final stages of the project. These alternative limits for bedrock would have to be consistent with the overall bases of the presently approved acceptance criteria; namely, as a goal, the annual dose to maximally exposed individuals residing or working on site at any time in the future will not exceed a few millirem per year and that the dose limit to anyone on site in the future would not exceed 10 mrem/year provided that dose is deemed to be as low as reasonably achievable.

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While performing some final decontamination work in the reactor building we have found some bedrock that contained contamination in cracks or fractures that, due to the foliation of the rock formation, were both parallel and essentially normal to the plane of the exposed bedrock surfaces. This condition results in a volumetric source term of very low average concentration. Any contamination in the fractures could not be surveyed for compliance with the Regulatory Guide 1.86 surface criteria because of its inaccessibility. Removal of the bedrock would be the only recourse but, in view of the projected low risk associated with leaving it in place and the very high cost of removal, we believe that it is not reasonable to do so. The enclosed analysis of the projected dose from trace contamination in bedrock that will repose below the surface of the final grade at the end of the decommissioning project presents a pro-forma calculation of the projected dose from some hypothetical residual contamination in bedrock. Hypothetical but plausible assumptions have been made about the characteristics of the source to enable this calculation in this proposed model. This pro-forma calculation is presented to demonstrate the proposed methodology that will be used for determining the acceptance criteria for any bedrock as necessary. The derived criteria in this model are only for this sample calculation. Final criteria will be different and will depend on the actual characteristics of the bedrock that are found at the time of the final survey. Any resultant doses that are calculated by this method will be additive to projected doses from residual soil contamination and the combined total projected dose must be less than the 3 mrem/year goal or 10 mrem/year limit as appropriate.

We are proposing this alternative for deriving below-grade bedrock acceptance criteria because the Regulatory Guide 1.86 criteria are inappropriate. The risk from the projected resultant dose to future residents or workers on site are unchanged from the original basis of the 3 mrem/year goal and 10 mrem/year limit. Historical environmental data in the locale of the Cintichem site show that the variation in terrestrial background radiation exceeds 175 mrem/year and therefore the incremental dose from residual contamination on the Cintichem site will be imperceptible from this variation in background radiation.

This proposed alternative method for deriving acceptance criteria for below-grade bedrock residual contamination will supplement the currently approved criteria for structural surfaces and soil. We are currently working on tasks that include the decontamination of below-grade bedrock surfaces and your prompt review of this proposal is necessary for this work to continue efficiently and without delay.

Very truly yours,

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President/Plant Manager

JJMcG/bjc

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ANALYSIS SUMMARY OF HYPOTHETICALLY PROJECTED
DOSE DUE TO BEDROCK CONTAMINATION

1.0 PURPOSE

To determine a means for deriving radiological bedrock contamination limits for surface contamination and/or mass concentration to be used to demonstrate compliance with the existing basis for termination survey criteria, i.e. total projected annual dose less than or equal to the 3 mrem ALARA goal and the 10 mrem maximum as appropriate.

2.0 BASIS OF EXPOSURE

Limits must be derived using conservative but realistic pathways of human exposure to residual radioactive material in bedrock along with any associated direct radiation exposure. Two separate and mutually exclusive worst case exposure scenarios are envisioned to be plausible, an industrial intruder scenario and a non-intruder residential scenario. They are described as follows:

2.1 INDUSTRIAL INTRUDER SCENARIO

After the site is released from regulatory control, the property is sold and subsequently is used as a quarry to supply field stone and gravel. The former reactor and hot lab building sites are uncovered and the bedrock is exposed. A standard quarry operation is then conducted. The most conservative exposure case would involve drilling and blasting the rock containing residual RAM, loading and hauling the blast rock to a holding pile, loading the blast rock into a crusher, crushing it, and then loading it into delivery trucks. This scenario would produce the worst case exposure via the inhalation, secondary ingestion and direct radiation pathways. It would also be conservative to assume that all of these activities would be conducted sequentially by a limited number of individuals to produce the highest possible individual exposure. The duration of this scenario is limited due to the residual contamination being removed from site along with the rock products. It is estimated that this exposure scenario would last less than six months.

2.2 NON-INTRUDER RESIDENTIAL SCENARIO

After the site is released from regulatory control, the property is sold and subsequently is developed for residential use. This scenario is similar to one aspect that was used to derive the soil acceptance criteria, the drinking water pathway. While the soil criteria considered the direct radiation, inhalation, secondary ingestion and the water exposure pathways for the farmer-family scenario, the drinking water pathway is the only credible means by which residents could come into contact with residual radioactivity in bedrock. Affected bedrock would be buried under concrete rubble and soil fill, beyond the reach of a residential farmer-family. Residual radioactivity would be located within the foliar surfaces of the cracks, fissures and fractures of the bedrock. It is assumed that residual radioactivity in the bedrock would come into contact with ground water and would leach into the aquifer, and become available for human consumption via a water well.

3.0 DERIVATION OF LIMITS

3.1 INDUSTRIAL INTRUDER SCENARIO

3.1.1 ASSUMPTIONS AND VARIABLES

a) Affected bedrock characteristics:

Bedrock Location and Estimated In-situ Volume:

1. Reactor building north and northwest of reactor pool, under and adjacent to transfer canal.	6,000 ft^3
2. Hot laboratory building, under and adjacent to canal and gamma pit.	2,700 ft^3
3. Hot laboratory building, under and adjacent to hot cells, T-1/old evaporator room, primary filter bank room and outside "plume".	18,000 ft^3

Bedrock Affected Surface Area:

Preliminary core data indicates there is 0.517 cm^2 of crack, fissure, fracture surface area per cm^3 of bedrock volume.

b) Duration of intrusion scenario:

A total of 26,700 ft^3 of affected bedrock is drilled, blasted, removed, hauled, crushed and loaded for sale, after which no residual radioactivity remains in bedrock. A conservatively long exposure duration of 803 hours is estimated. This used work rates from Reference 1 with a small and relatively inefficient quarry operation (a crew of 3) and a sequential implementation of tasks. By area this would be allocated as 181 hours, 81 hours and 541 hours to the reactor, canal and hot lab bedrock respectively.

c) Physical and biological conversion factors (Reference 2):

Inhalation

Dust loading during work:	1 E-4 g/m^3
Breathing rate during work:	1.2 m^3/hour

Ingestion

Transfer rate:	1 E-2 g/hour
Secondary ingestion:	1 E-4 m^2/hour

Internal committed effective dose equivalent factors

(Reference 2, Table E.2)

Radionuclide	Ingestion (mrem/uCi)	Inhalation (mrem/uCi)
Sr/Y-90	1.53 E2	1.31 E3
Cs-137	5 E1	3.2 E1
Ce-144	2.1 E1	3.7 E2

d) Radiological contamination mixtures*

Bedrock location	Radionuclide	Fraction
1. Reactor building north and northwest of reactor pool, under and adjacent to transfer canal.	Cs-137 Sr-90	0.98 0.02
2. Hot laboratory building, under and adjacent to canal and gamma pit.	Cs-137 Sr-90	0.98 0.02
3. Hot laboratory building, under and adjacent to hot cells, T-1/old evaporator room, primary filter bank room and outside "plume".	Cs-137 Sr-90 Ce-144	0.67 0.30 0.03

* Preliminary core data indicated mixtures.

Reference 1: R. S. Means, Means Building Construction Cost Data, 1992 ed. R. S. Means Co.

Reference 2: NUREG/CR-5512 Residual Radioactive Contamination from Decommissioning, September 1992.

3.1.2 DERIVED LIMITS FOR INDUSTRIAL INTRUDER SCENARIO

Surface contamination/concentration per 1 mrem/yr*

	Surface Limit mrem/dpm / 100 cm²	Conc. Limit mrem/pCi-gm bedrock
- Reactor monolith:		
inhalation	1.16 E-9	1.25 E-6
ingestion	8.77 E-8	9.43 E-5
total	8.9 E-8	9.6 E-5
(or, inversely)	1.12 E7 dpm / 100 cm² / mrem	1.05 E4 pCi/gm / mrem

	Surface Limit mrem/dpm / 100 cm²	Conc. Limit mrem/pCi-gm bedrock
- Canal/gamma pit		
inhalation	5.26 E-10	5.6 E-7
ingestion	3.88 E-8	4.17 E-5
total	3.93 E-8	4.23 E-5
(or, inversely)	2.54 E7 dpm / 100 cm² / mrem	2.37 E4 pCi/gm / mrem
- Hot lab		
inhalation	2.58 E-8	2.78 E-5
ingestion	4.05 E-7	4.35 E-4
total	4.3 E-7	4.63 E-4
(or, inversely)	2.32 E6 dpm / 100 cm² / mrem	2.16 E3 pCi/gm / mrem

* NOTE: Must add average area direct radiation dose to internal doses when a comparison with the 10 mrem/year limit is made. Internal doses for each area are to be summed along with the average direct radiation dose.

3.2 RESIDENTIAL SCENARIO

3.2.1 ASSUMPTIONS AND VARIABLES

a) Affected bedrock characteristics (see 3.1.1 [a])

b) Duration of residential scenario (not applicable)

c) Physical and biological factors

Radioactive material site inventory equal to U.S. EPA drinking water criteria (4 mrem/yr)

Radionuclide	Site Soil Criteria (Reference 3) pCi/gm	or total mCi
Sr-90	80.1	65.3
Cs-137	9,000	7,350
Ce-144	3.85 E6	3.1 E6

d) Radiological contamination mixtures (see 3.1.1 [d])

Reference 3: Based upon existing soil criteria, water pathway only, at 4 mrem/yr, with an affected soil area of 3,200 m^2 at 0.15 m deep.

3.2.2 DERIVED LIMITS FOR RESIDENTIAL SCENARIO

Average surface contamination per 1 mrem/yr*

- Reactor monolith bedrock 1,425,000 dpm/100 cm^2 per mrem/yr
- Canal/gamma pit bedrock 3,150,000 dpm/100 cm^2 per mrem/yr
- Hot lab bedrock 44,800 dpm/100 cm^2 per mrem/yr

* NOTE: Water pathway doses from each of the three bedrock areas are to be summed along with the actual water pathway dose resulting from residual radioactive material in soil.

4.0 NON-RADIOLOGICAL FACTORS

4.1 COST TO REMOVE BEDROCK TO REGULATORY GUIDE 1.86 SURFACE CONTAMINATION GUIDELINES

- o Based upon Cintichem experience removing contaminated bedrock from the reactor building during 1994, with:

  - 2,460 ft^3 (in-situ volume) removed
  - 208 hours of actual work duration
  - Cintichem activity dependent labor cost, $33,000
  - Cintichem period dependent labor cost allocation, $21,000
  - Contractor costs, $49,000
  - Projected packaging, transportation and disposal cost, $251,000
  - Total cost $354,000 or $144 per ft^3 (in-situ volume)

- o Projected cost to remove, package, transport and dispose of bedrock considered in analysis (26,700 ft^3 in-situ volume): $3,845,000.

4.2 RISK OF WORKER INJURY AND DEATH FROM REMOVAL OF BEDROCK TO CONFORM TO REGULATORY GUIDE 1.86 SURFACE CONTAMINATION GUIDELINES

4.2.1 SITE WORKERS

- o Removal labor rate:

  0.635 person-hours per ft^3 removed
  (includes: laborers, foremen, radiation protection technicians, contractor personnel and waste management personnel)

- o 26,700 ft^3 removed
- o Lost time accident rate for heavy construction 10 per 10^6 person-hours (Reference 4)
- o Fatality rate for heavy construction 4.2 E-2 per 10^6 person-hours (Reference 4)
- o Total LTA's are 0.17 and total fatalities are 7.1 E-4

Reference 4: NUREG/CR-1756, Technology, Safety and Cost of Decommissioning Reference Nuclear Research and Test Reactors, March 1982.

4.2.2 TRANSPORTATION WORKERS

- o Total truck shipments: 108
- o Total miles driven (round trip from Tuxedo, NY to Envirocare, Clive, Utah and return): 487,080 miles
- o Transportation accident rate: 1.6 E-6 per mile (Reference 4)
- o Injury rate: 0.51 per accident (Reference 4)
- o Fatality rate: 0.03 per accident (Reference 4)
- o Totals

Accidents:	0.78
Injuries:	0.4
Fatalities:	0.023

5.0 CONCLUSIONS

5.1 Surface contamination criteria will be limited by the water pathway (residential drinking water pathway) at EPA criteria of 4 mrem/year.

5.2 The intruder scenario would be limited to less than 1/2 year duration. Total intruder dose would be less than 0.2 mrem CEDE when contamination levels are limited by the water pathway limits.

5.3 Cost to remove bedrock to Regulatory Guide 1.86 limits is estimated to exceed $3,800,000.

5.4 With the number of truck shipments required to dispose of bedrock, a high probability exists for a transportation accident. The proposed criteria will keep the dose to future residents and workers on site to less than 3 mrem/year. The risk of mortality associated with removing bedrock to reduce the 3 mrem/year dose rate is about 200 times higher than the mortality associated with the 3 mrem/year goal.

5.5 The total residual activity left on site in soil would be adjusted downward to account for residual radioactivity left in bedrock (i.e. no additional radioactivity would be left on site from that authorized for soil). All sources of radioactive material must be limited to meet EPA drinking water criteria.

5.6 Compliance with derived bedrock limits will be demonstrated through measurement of direct gamma exposure rate and measurement of radionuclides' concentration in the affected bedrock masses. The average area exposure rate at one meter (above background) will be determined by direct in-the-field measurement by techniques described in NUREG/CR 5849. Measurements for direct gamma exposure rate will be made at locations surrounding the affected bedrock areas where occupancy can be reasonably assumed for the industrial intruder scenario. A weighted average of all the affected bedrock areas may be used if the final site bedrock configuration indicates that an unequal amount of time would be spent in each of the areas.

Compliance with the limits for the drinking water pathway (residential scenario) and the inhalation/ingestion pathways (industrial intruder scenario) will be determined by core sampling the bedrock and performing laboratory analysis to determine the concentration of each non-background radionuclide. Concentration guidelines (pCi/gm) will be used whenever possible, rather than surface contamination measurements (DPM/100 cm^2) as the crack-fissure-fracture surface area per unit rock volume ratio could be variable and therefore less reliable. The surface contamination limits that were derived along with the bedrock concentration limits will be used for go-nogo screening during remaining D & D work before final rock sampling is performed. Average bedrock radionuclide concentrations along with affected volume/mass determinations will be used to determine the total radionuclide inventory in bedrock for comparison with site total radioactivity inventory limits (water pathway dose limit). The average radionuclide concentrations in bedrock will be used for direct comparison with the limits derived for the industrial-intruder inhalation/ingestion pathways.

Radionuclide concentration averaging will be done over the affected masses of bedrock only. The volume of affected bedrock will be bounded in three dimensions by rock core sampling and averaging will occur only within the confines of the rock volume that contains residual radioactive contamination. That is, the radionuclide concentrations will not be inadvertently diluted by averaging in clean unaffected bedrock.