CONCEPTUAL FRAMEWORK FOR AMENDING THE DECOMISSIONING PLAN FOR LICENSE NO. STB-527

INTRODUCTION

On July 19, 1996, the Nuclear Regulatory Commission (NRC) issued a license amendment to The Dow Chemical Company (Dow) authorizing the remediation and offsite disposal of thorium contaminated material from storage piles at the Dow Midland and Bay City Sites (License No. STB-527, Amendment No. 6). On July 21, 1997, NRC in License Amendment No. 7 approved the unrestricted use criteria and final survey methods for the remediated areas.

After the remediation of the majority of the stockpiled material at the Bay City site was completed, Dow discovered that there was a significant volume of contaminated material at the Bay City site below the water table, i.e., in the saturated zone. The material in the saturated zone was not specifically addressed in License Amendments 6 and 7. Dow intends to submit a supplemental decommissioning plan to NRC that addresses this material. The supplement will propose unrestricted use criteria, remediation methods, and final survey methods specifically applicable to the contamination in the saturated zone. This document provides a conceptual outline of the regulatory bases, technical approaches, and implementation methods that Dow proposes to use in the development of the supplemental decommissioning plan.

BACKGROUND

Site History

Beginning in the early 1940's and continuing into the early 1970's, The Dow Chemical Company (Dow) produced a metallic magnesium alloy used in aircraft applications. The alloy was a lightweight material with improved high temperature strength. Production took place at two locations - in Bay City, Michigan, and in Midland, Michigan. The production process yielded slag material as a by-product. The magnesium-thorium slag material, which is regulated as a radioactive material, has been stored on Dow property at Bay City, Michigan under a license from the Nuclear Regulatory Commission (NRC).

Licensing History

A single license (STB-527) was granted by the Nuclear Regulatory Commission (NRC) in 1973 for the Bay City and Midland sites to store up to 200,000 pounds of Thorium as slag. This license expired in 1978, but has remained in effect under timely renewal. The Thorium-contaminated material was removed from the Midland site and this area was surveyed by the NRC in May 1997 and removed from the license.

The initial decommissioning plan for the Bay City site, approved on July 7, 1996, was for the removal of approximately 40,000 cubic yards of Thorium-magnesium contaminated material located over an area of less than one acre. During the initial phase of material removal, new information regarding residual surface and subsurface contamination extending beyond the immediate slag pile area was discovered. Based on this information, it was determined that a new plan needed to be developed for the removal of the contaminated material. Subsequently, with communications with the NRC, the license was extended through October 2003.

RATIONALE FOR UNRESTRICTED USE CRITERIA FOR CONTAMINATION IN SATURATED ZONE

Amendment No. 7 approved unrestricted use criteria for contaminated slag and soil in storage piles above the ground surface or in surface soil. The approved SDMP criteria for soil contamination were designed to apply to surface soil conditions, and are not appropriate for subsurface contamination in the saturated zone. It would be technically infeasible to apply these criteria to material below the water table because it would require extensive underwater excavation. Even if a below watertable excavation were feasible, it would be prohibitively expensive using any known excavation technologies. In addition, the soil criteria is not appropriate to protect against the most likely exposure pathway, which is groundwater injestion.

The currently approved criteria are consistent with the SDMP Action Plan and are comprised of concentration limits and exposure rate limits. Both the concentration limits and exposure rate limits are derived from the 1981 Branch Technical Position (1981 BTP) "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations" (46 FR 52601). The 1981 BTP soil concentration limits are based on the most limiting of three criteria: 1) 1 mrad/year to the lung through inhalation, 2) 3 mrad/yr to the bone through ingestion, or 3) 10 uR/hr through direct exposure. For natural thorium, the limiting criterion was the 10 uR/hr exposure rate and this was the basis of the 10 pCi/g total thorium concentration limit.

The 1981 BTP assumes that contaminated soil is in the unsaturated zone at a sufficient depth to allow root uptake by plants. Depending on the type of plant, this depth could range from 0.15m to 0.9m. Material in the saturated zone of a site was not considered in the 1981 BTP analyses. Saturated zone material would not contribute to dose through the inhalation and ingestion pathways and therefore the 3 mrad bone and 1 mrad lung criteria would not apply. As described above, there is very low probability that the material in the saturated zone would be excavated and is not considered a plausible scenario. The more likely scenario is that additional fill would be added since fill is required before a residential or commercial structure could be constructed, which would reduce the exposure rate measured during the final survey.

The material currently in the saturated zone could contribute dose through the direct radiation pathway and therefore the 10 uR/hr exposure rate criteria would still apply. In

addition, the saturated zone material could result in groundwater contamination. This potential pathway is addressed in the SDMP Action Plan, which provides specific unrestricted use criteria for groundwater (i.e., the EPA Safe Drinking Water Regulations).

In summary, consistent with the SDMP Action Plan, Dow proposes that the unrestricted use criteria for the contaminated material in the saturated zone be based on compliance with the 10 uR/hr exposure rate criteria and the EPA Safe Drinking Water Regulations. Compliance with the drinking water regulations would be demonstrated at the time of license termination. In addition, as a conservative measure, the projected groundwater concentration of Ra-226 after 1000 years will be estimated and limited to 20 pCi/l, the limit in the EPA Proposed Drinking Water Standards (56 FR 33050, 1991).

The proposed unrestricted use criteria for the contamination on the saturated zone at the Bay City site are listed below:

- 10 uR/hr, above background at 1 meter above the existing ground surface
- EPA Proposed Drinking Water Standards (56 FR 33050, 1991) demonstrated at time of license termination
- 20 pCi/l Ra-226 after 1000 years in-growth

CURRENT SITE CONDITION

The site is located adjacent to the Saginaw River near the mouth of the river where it discharges to the Saginaw Bay. The site is surrounded by a series of industrial service water ditches located to the north, west, and south. The only access to the site is by a gravel road and the only permanent structures on the site include the old Coast Guard Lighthouse to the north and a water pump house adjacent to the southern service water ditch. Other facilities on site include temporary offices, laboratory, and decontamination facilities. Most of the topography can be characterized as generally flat, low lying land with an average surface elevation around 585 feet relative to the USGS datum. Most of the variation in the surface topography is a result of excavated areas or due to the temporary earthen berm located along the eastern and northern sides of the site.

The geology at the site is simple, and consists of 6-12 feet of river sediment and fill overlying a hard, dense till clay. The river sediments consist predominantly of sand, silty sand, and clayey sand with occasional lenses of clay and silt. Organic material is common throughout the river sediment, and occasional lenses of peat are also present.

Some areas of the site contain up to 6 feet of fill. This fill consists of rubble, soil, and magnesium/thorium sludge. It appears that the fill was probably placed directly into low-lying areas. These low areas were once wetlands contiguous to the Saginaw River.

The glacial till consists of very hard, very dense gray silty clay with a trace of gravel. Information from other sites in the area also indicates that sand lenses are sometimes present within the glacial till, although these bodies tend to be widely dispersed and often

discontinuous. Information from surrounding sites indicates that bedrock is encountered at between 80 and 90 feet below ground level in this area. Bedrock consists of sandstone and shale of the Saginaw Formation.

Groundwater is found within the river sediments, glacial till sands, if present, and Saginaw Formation. Groundwater in the river sediment is found between 3 and 5 feet below ground level at the site, and is essentially continuous with the surface water in the Saginaw River.

Groundwater levels indicate a very shallow east-northeast gradient (0.004 ft/ft) toward the Saginaw River. This gradient likely remains very low throughout the years and it is possible that there are occasional fluctuations in the flow direction based on the rise and fall of the Saginaw River.

The entire Bay City storage site is located within a wetland / floodplain adjacent to the Saginaw River. Decommissioning is being performed under Michigan Department of Environmental Quality, Natural Resources and Environmental Protection Act 451, PA 1994 Permit No. 00-09-0017-P and Department of the Army, Corps of Engineers Discharge and Dredge Materials Permit File No. 90-020-020-3. Under the conditions of the permits, excavated areas shall be graded and allowed to revert back into wetlands and will be left undisturbed.

Five water well records within a mile of the site were obtained from the Department of Health.

Three of the wells within a mile of the site were water supply wells, four (contained on one water well record,) were monitoring wells, and one was a cathodic protection well. Water supply well #1 appears to be screened in a glacial till sand, and is located across the Saginaw River to the east of the site. Water supply wells 2 and 3 appear to be screened in the Saginaw Formation, and are located to the northwest and southwest of the site, respectively.

Based on these logs and an evaluation of the local groundwater use for other sites in the area, it appears that the Saginaw Formation is the most significant source of groundwater in the area. Till sands may periodically be tapped for groundwater when present, but widespread use is unlikely given their sporadic and wide dispersal. It is unlikely that anything other than monitoring or cathodic protection wells are screened in the river sediment. Investigations at other sites in the area indicate that the river sediments thin significantly away from the Saginaw River, and may contain groundwater only on a sporadic or seasonal basis. Only those sediments adjacent to the Saginaw River provide a reliable groundwater source and the installation of wells in this area is unlikely, as it would be easier to pump directly from the river.

Decommissioning Status:

Pre-decommissioning activities were initiated in November 1995 and included contractor procurement, closure and safety planning, and transportation and disposal negotiations.

During January – June 1996 the following major items were designed and installed in support of the decommissioning effort:

- On-site office and laboratory facilities (7,200 square feet)
- 4.2 miles of exclusion fencing and a perimeter air monitoring system
- 2.8 miles of road upgrade
- Personnel and equipment decontamination facilities
- Two on /off loading ramps and three acres of lined storage pads
- 1,200 gpm raw water system
- Environmental control systems (dust and water)
- Rail facility including spurs, weigh station, and roofed loading station

Major excavations of waste materials were initiated in late June 1996 at both the Midland and Bay City sites. Waste shipping by rail to Envirocare of Utah was initiated in August 1996. The U. S. Nuclear Regulatory Commission (NRC) in May 1997 performed a final confirmatory survey of the Midland site and a determination was made in June 1997 that the site met unrestricted release guidelines.

With the exception of winter months, waste excavation activities at the Bay City site have continued to date. Five confirmatory surveys of six areas of the site have been completed by NRC Region III staff. Inspection reports received from the staff indicate that 31.33 acres (Table 1) meet unrestricted release guidelines.

Table 1
Decommissioning Status
Bay City, Michigan

U.S. NRC REGION III REPORT DATE	VERIFICATION AREA DESIGNATION	NO. OF SUBGRIDS (10m x 10m) MEETING UNRESTICTED CRITERIA	CORRESPONDING AREA IN ACRES
August 13, 1997	VA-I	430	10.750
January 7, 1998	VA-II	107	2.675
January 7, 1998	VA-III	335	8.375
October 20, 1998	VA-IV	163	4.075
December 17, 1998	VA-V	150	3.750
August 5, 1999	VA-VI	68	1.7
TOTALS		1253	31.33
REMAINING SITE AREA		364	9.1
TOTAL SITE AREA		1617	40

Of the remaining 364 subgrids (9.1 acres) at the site, work is in progress in remediating an additional 80 subgrids (2 acres) contiguous with the existing fence line.

METHODS FOR DETERMINING COMPLIANCE WITH UNRESTRICTED USE CRITERIA

We believe that the 10-uR/hr criteria can be demonstrated with the unsaturated surface soil in place. This is appropriate since, as discussed above, future excavation is very unlikely. The depth of the unsaturated zone ranges from 2-3 feet on the site. If remediation of the saturated zone is required in a given area, the noncontaminated unsaturated soil in the area will be excavated and stockpiled. The contaminated material in the saturated zone will then be removed until the exposure rate is reduced to levels that would result in 10 uR/hr criteria after noncontaminated saturated and unsaturated soil is replaced and regraded to the original contours. The Microshield Code will be used to calculate the saturated zone remediation action level using this approach and conservatively assuming a two-foot soil cover. The final compliance measure (i.e., the final survey measurement) for the 10 uR/hr criteria in the remediated area will be made after the original cover material is replaced.

Compliance with the EPA Drinking Water Regulations will be demonstrated through direct measurements of the groundwater in the area containing the contaminated material. At least 5 groundwater monitoring wells distributed throughout the contaminated area will be sampled.

Compliance with the 1,000 year projected Ra-226 criteria of 20 pCi/l will be demonstrated using the following assumptions and methods:

1. Since Ra-226 in not currently present, direct measurements of Ra-226 groundwater concentration cannot be made.
2. The ratio of Th-232 concentration in the saturated zone contamination (pCi/g) to the Ra-228 concentration in surrounding groundwater (pCi/l) will be used as a surrogate ratio for the future Th-230 pCi/g to Ra-226 pCi/l ratio after 1000 years in-growth.
3. This surrogate approach is valid since identical elements, i.e., thorium and radium, are being evaluated in identical matrices.
4. The Th-230 in the saturated zone will be limited to the concentration that is projected to result in 20 pCi/l Ra-226 in water after 1000 years in-growth.
5. The Th-230 concentration will be determined by ratio to Th-232 using the onsite gamma spectroscopy system. The Th-230/Th232 concentration ratio of 1.26 will be applied as demonstrated by the review of 103 samples results from the Bay City Site. This data set was provided to NRC on October 22, 1999, as a part of the DOW request to remove Th-230 from the remediation plan.

METHOD FOR MEASURING TH-230 CONCENTRATION IN SATURATED ZONE CONTAMINATION

As previously indicated, the current Th-230 concentration in the saturated zone will be used to predict the Ra-226 concentration 1000 years in the future. The Th-230 concentration used to demonstrate compliance will be calculated as follows:

- Compliance will be based on the mean concentration of Th-230 in saturated zone.
- The mean Th-230 concentration will be demonstrated at the 95% confidence level.
- A hot-spot criteria of three times the mean concentration limit will be applied.
- Sample frequency will be one borehole per 100 m^2 – the resulting sample size will be justified by demonstrating that the Type I and Type II errors for the mean are less than 5% using retrospective power curve analysis following the NRC and EPA Data Quality Objectives guidance.
- Each borehole sample will consist of a composite sample from the river sediment saturated zone, i.e., from water table to underlying clay layer.
- The composite sample will be analyzed for Th-232 using gamma spectroscopy.
- The Th-230 concentration will be determined by multiplying the Th-232 concentration by 1.26.
- Additional biased borehole samples may be collected at areas of elevated activity identified by final survey scans, samples, or exposure rate measurements

FINAL SURVEY PLAN FOR SATURATED AND UNSATURATED ZONE CONTAMINATION

A revised final survey plan will be required to demonstrate compliance with both the saturated zone and unsaturated zone contamination since the exposure rate criteria applies to the combination of both sources. In addition, clarification will be required to ensure that the averaging and hot spot criteria from NUREG-5849 are applied for the final survey of surface soil and that the results of the NaI surface scan surveys will be used for qualitative purpose only.

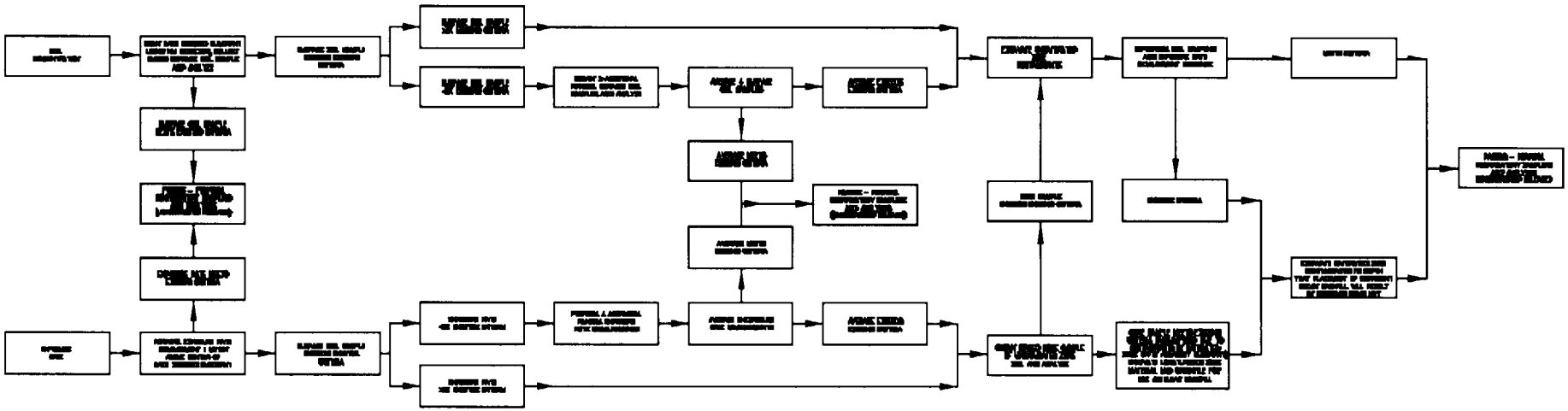
NUREG-5849 recommends the qualitative use of scan surveys by investigating or sampling areas exceeding two times background levels. Quantitative use of NaI surface measurement results is not recommended in NUREG-5849 since the correlation of NaI measurements to surface soil concentrations has proven to be unreliable in field applications. Therefore, Dow will rely on soil samples in area of highest concentration identified by the scan survey to quantify the contamination levels for demonstrating compliance.

The proposed final survey protocol is somewhat complex due to the need to account for both the contamination in the unsaturated zone at depths of up to 3 feet and contamination in the saturated zone. The outline of the final survey plan is as follows.

- Scan ground surface using NaI detector
- Within each 25 m^2 subgrid quadrant, at the location with NaI surface scan result, perform exposure rate measurement at 1 meter above ground surface and collect surface soil sample (biased soil sample 0- 6")
- **If exposure rate measurement and surface soil sample meet unrestricted use criteria no further sampling required**
- If exposure rate measurement exceeds average criteria but is less than 2 times average, four additional exposure rate measurements will be performed within the 25 m^2 subgrid

- **If the average of the resulting 5 exposure rate measurements meet the criteria no further measurements required**
- If the surface soil sample is greater then the criteria but less than 3 times the criteria, collect three additional samples in the 25 m^2 subgrid
- **If the average of the resulting 4 soil samples meets the criteria no further soil sampling required**
- If the soil meets the criteria but the exposure rate exceeds criteria, collect a composite sample of the unsaturated zone soil (1-3 feet). Compositing over a 1 meter depth of subsurface soil is consistent with NRC guidance provided in "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil," February 13, 1997, letter from John T. Buckley, NRC, to Howard A. Pulsifer, AAR Corporation.
- If the composite sample of the unsaturated zone soil column meets the 10 pCi/g soil criteria, then the elevated exposure rate is assumed to result from saturated zone soil and the following actions taken:

1. The noncontaminated unsaturated zone soil in the area exceeding the criteria will be removed and stockpiled
2. The saturated soil will be excavated below the water table until the exposure rate is reduced to levels that will meet the criteria after the unsaturated soil is replaced using pre-calculated remediation action level as described above
3. The area will be backfilled and regraded to original contour and exposure rate measurements performed to confirm compliance with the criteria



PROPOSED DECOMMISSIONING APPROACH
FOR THE REMAINING PORTIONS
OF THE BAY CITY, MI SITE

Discussion of the Conceptual Framework for Amending License No. STB-527

Establishing Unrestricted Release Criteria for Bay City Saturated Zone Contamination

The Dow Chemical Company

March 27, 2001

Attachment B

Meeting Agenda

- Overview of Bay City Site Today
- Subsurface Contamination in the Saturated Zone
- The Conceptual Plan
  - Proposed New Unrestricted Use Criteria
  - Plan for Subsurface Analyses
  - Final Survey Protocol
- Path Forward

Overview of Bay City Site Today

- Surface contamination area 77% cleared.
- Of 364 uncleared subgrids, 80 are currently being remediated for 2001.
- Waste has been continually removed from Bay City since 1996.
- The license has been extended through October 2003.

Subsurface Contamination in the Saturated Zone

- Random subsurface contamination in the saturated zone initially discovered in 1997.
- This contamination was not contemplated in the original decommissioning plan.
- Full scale excavation of uncleared areas could cost as much as $30 million or more.
- Full scale excavation is expected to result in no further risk reduction (i.e., not ALARA).

The Conceptual Plan

- Outline Dow's plan for addressing the subsurface contamination through the license amendment.

- Provide protocols for assuring SDMP action plan compliance at both the saturated and the unsaturated zones.

Proposed New Unrestricted Use Criteria for the Saturated Zone

- Combine SDMP exposure rate and EPA drinking water standard to achieve ALARA:
  - Surface exposure levels less than 10 uR/hr at 1 meter (establish action levels per Microshield) .
  - Groundwater Ra-226 concentrations below the 20 pCi/L EPA Proposed Drinking Water Standard (56 FR 33050, 1991) at license termination (directly measured w/ monitoring wells) and after 1000 years in-growth (extrapolated from Th-230).

Plan for Subsurface Analyses

- Characterize subsurface contamination in uncleared grids.
- Determine existing groundwater radium concentrations
- Estimate future Ra-226 groundwater concentrations by applying site specific ratio of Th-232 in soil (pCi/g) to Ra-228 in water (pCi/L) to estimated Th-230 levels.

Preliminary Subsurface Contamination Data

- The average Th-232 concentration of 334 core samples is 7.6 pCi/g.
- Removing the 7 samples higher than 25 pCi/g reduces the average to 1.24 pCi/g.
- Ra-228 concentrations range from 0.11 to 2.62 pCi/L (average = 0.83 pCi/L).
- Ratios of Th-232 to Ra-228 range from 12 to 2,244.

Final Survey Plan Protocols

- Surface exposure rate (uR/hr).
- Surface soil criteria (pCi/g).
- Unsaturated subsurface soil concentrations (pCi/g).
- Saturated subsurface soil concentration (pCi/g).
- SEE FLOWCHART

Path Forward

- Obtain NRC comments on conceptual plan groundwater/survey issues (4/30/01).
- Submit license amendment (5/31/01)
- Continue surface remediation in 2001.
- NRC decision on amendment prior to 2002 decommissioning schedule (1/01/02).
- Complete surface and subsurface remediation and verification by 2003.
- Apply for license termination October 2003.