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Environmental Restoration Contractor **ERC Team**

Interoffice Memorandum

Job No. 22192
Written Response Required: NO
Due Date: N/A
Actionee: N/A
Closes CCN: N/A
OU: N/A
TSD: N/A
ERA: N/A
Subject Code: 8300

TO: RP Henckel, X9-08

DATE: November 21, 2000

COPIES: See Below

FROM: MR Morton
Project Engineer
Decommissioning Projects
X9-05, 373-1628

SUBJECT: **REACTOR ISS PROJECT 105-DR VALVE PIT WALLS AND UNDERLYING SOILS**

Backfilling of the west reactor area 2.4 has been on hold until the issues with elevated levels of hexavalent chromium and PCBs were resolved.

Based on a meeting with Ecology, DOE/RL and BHI on 9/12/00, approval was received to backfill the 105-DR Valve Pit area and leave the remaining concrete in place. Please see Attachment 1 for the rationale and their approval signatures. Also attached are copies of email on the subject (Attachments 2 and 3).

If you have any questions please contact RR Nielson at 373-0089.

MRM:ls

Attachments:

1.) *Reactor ISS Project 105-DR Valve Pit Walls and Underlying Soils, Room 230b, Area 2.4*, dated 10/6/00.

2.) Email, DC Smith to RR Nielson, *ISS Cr/PCB Issue*, dated 9/14/00.

3.) Email, R Bond to MA Mihalic, *Valve Pit Soil at 105-DR*, dated 10/3/00

cc: Adler, JG, X9-05 w/a
Allenbaugh, WJ, X0-17 w/a
Ellenbest, RM, X9-09 w/a
Lucas, RG, X9-08 w/a
McGuffee, SM, X9-09 w/a
Nielson, RR, X9-05 w/a
Prichard, EA, X9-09 w/a
Administrative Record, H0-09 w/a
Project Files, H0-09 w/a
Document and Info. Services, H0-09 w/a

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Reactor ISS Project
105-DR Valve Pit Walls and Underlying Soils

Room 230b

Area 2.4

October 6, 2000

Analytical Data

- Sampling completed 7/19-20/00 following demolition in accordance with Phase III SAP for deep zone concrete
- 14 concrete surface (top 0.25 inch) samples were collected on the remaining walls
- 14 soil samples were collected in the newly exposed soils (contaminated slab removed except for 3 foot around perimeter that is part of wall foundation)

Analytical Data (cont.)

- Cr^{+6} data points in the wall concrete, 95% UCL of 3.07ppm
- Cr^{+6} in underlying soils, 95% UCL of 0.6 ppm which meets the action limit in the SAP (2.2ppm)
- PCB's in concrete wall , 95% UCL of 1.14 ppm
- PCB's in underlying (deep zone) soils do not have an action limit in the SAP due the immobility of PCB's in soil

Analysis

- Cr^{+6} data in concrete walls is just over what was accepted for DR FSB (3.07 vs. 2.74)
- PCB data in concrete walls is just slightly over DR FSB (1.14 vs. 1.08)
- Underlying soils meet cleanup criteria, remaining concrete walls need further discussion

Analysis (cont.)

- PNNL Leaching Studies
  - Diffusion coefficients for nitrate and $Cr^{+}6$
  - Leaching process decreases with time
- Other Study
  - Chemistry interaction capacity factor
  - Derivation of distribution coefficient (K_d)
- Basis of current Action Levels are soil standards
- K_d concrete >> K_d soil for both Cr^{+6} and PCB's

Conclusions

- The presented data for the DR Valve Pit concrete are not appreciably different than the soil action levels for PCB's and Cr^{+6}
- These values are still protective of groundwater
- No further remediation is needed
- The valve pit should be accepted as is and backfilled (with this exception being called out in the Closeout Verification Package)

Concurrence

- Applying logic of previous agreements and the attached white paper, the DR Valve Pit PCB and Cr^{+6} levels are acceptable in the remaining concrete
- ______________________ DOE
- ______________________ Washington State Dept of Ecology

DOE (DC Smith) to Ecology (Rick Bond, Tina Masterson-Heggen)

SUBJECT

Action Levels for Chromium (VI) and PCBs in Concrete at the 105-DR Room 230b Valve Pit Walls.

DISCUSSION

Some concrete sampling results in the subject areas completed as part of the Reactor Interim Safe Storage Projects Phase III Sampling and Analysis Plan (SAP) (DOE/RL 1999) have exceeded the action levels prescribed in the sampling plan. The purpose of this letter is to provide the technical basis for leaving these concrete structures in place and documenting concurrence of that basis by all the decision-makers for this project.

The affected area is the 105-DR Room 230b Valve Pit walls greater than 3 feet below grade and adjacent to the DR Reactor safe storage enclosure (SSE) that will be constructed around the reactor block. The reactor block will remain in a safe storage mode for up to 75 years as identified in the Record of Decision (ROD) (58 FR 48509). After the safe storage period, the reactor block will be removed in one piece to a 200 Area disposal facility per the above ROD.

The following contaminant/action level issues were discussed with the Ecology leads for the ISS Project at a meeting at 3350 GWW on 9/12/00. Informal approval to proceed with the backfill of the valve pit was received via email from Mr. Chris Smith on 9/14/00 (hexavalent chromium) and from Mr. Rick Bond on 10/3/00 (PCBs).

<u>Hexavalent Chromium</u>

In the 105-DR Room 230b Valve Pit walls, the hexavalent chromium ($Cr^{+}6$) 95% upper confidence limit (UCL) was found to be 3.07 ppm. The 95% UCL of 3.07 ppm was calculated based on the lognormal distribution of the data. Also, 3 of the 14 data points are above the cleanup standard. These 3 data points are 5.58 ppm, 2.99 ppm, and 3.23 ppm. None of these are adjacent and all are separated by at least 5 meters. The highest value (5.58 ppm) is located on the SSE wall. After removal of the concrete floor slab (known to be contaminated with $Cr^{+}6$), the underlying soils were also sampled. The 95% UCL (assuming a normal distribution) was found to be 0.49 ppm. Nine of 14 random samples came back at the detection limit. Therefore, none of the $Cr^{+}6$ contamination in the concrete floor of the valve pit has reached the underlying soil.

While the Model Toxics Control Act (MTCA) action level for Cr^{+6} is 2.2 ppm *in soil*, the fact that this Cr^{+6} is *in concrete* warrants additional consideration. This action level is based on the 100-HR-3/-KR-4 groundwater ROD (EPA 1996), which identified the *Water Quality Standards for the State of Washington* (WAC-173-201A) as an ARAR to ensure protection of aquatic receptors (salmon fry) in the Columbia River. The $Cr^{+}6$ standard from WAC-173-201A was 11 ug/L. To account for dilution within the aquifer between the monitoring location on-shore and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 2:1 was selected. Thus, a 22 ug/L standard in groundwater was subsequently used to establish a cleanup standard for 100 Area source units using the "100 times rule" established in MTCA (WAC-173-340). This rule assumes a default dilution factor of 100 times from the soil to the groundwater. Thus, 100 times the 22 ug/L groundwater standard results in a soil cleanup standard of 2.2 mg/kg.

A distribution coefficient (K_d) of zero is typically assumed when modeling $Cr^{+}6$ mobility in Hanford soils. However, the $Cr^{+}6$ contamination of interest resides in well-cured, subsurface concrete stub walls. It is expected that the diffusion coefficient (D) for $Cr^{+}6$ in concrete would be significantly lower than that for soil and would result in a higher K_d value. Thus, less $Cr^{+}6$ would be available to the soil-to-groundwater transport pathway.

In support of a performance assessment of the liquid low-level waste (LLW) grout system at Hanford, leaching studies on grouted LLW forms were conducted by the Pacific Northwest National Laboratory (PNNL). These studies resulted in average diffusion coefficients of 1.36E-11 cm^2/s and 2.84 E-8 cm^2/s for $Cr^{+}6$ and nitrate, respectively. Thus, $Cr^{+}6$ leached over three orders of magnitude slower than nitrate. The data also showed that the leaching process decreases significantly with time (Serne et al. 1992). The leaching of nitrate from concrete is thought to be almost exclusively a function of physical interactions. Chemical interactions (i.e., precipitation of pure compounds, co-precipitation of mixed compounds, ion exchange, sorption, etc.) are thought to be much more prevalent in the leaching of $Cr^{+}6$ from concrete. The PNNL data supports this contention. $Cr^{+}6$ apparently has strong reactions in the cement paste. It is highly likely that $Cr^{+}6$ (as chromate) substitutes into sulfate bearing cement minerals such as calcium monosulfate and ettringite.

In a similar study, a conceptual model for describing the transport of contaminants through a porous media such as cement is referenced. A chemistry interaction capacity factor (α) is developed as the ratio of an intrinsic diffusion coefficient due to physical interactions (D_i) and an apparent diffusion coefficient due to chemical interactions (D_a). An expression relating α to the distribution coefficient K_d is then derived as follows (Krupka and Serne 1996):

$$K_d = \frac{\alpha - \varepsilon}{\rho}$$

where K_d = Distribution coefficient (ml/g)
α = Chemistry interaction capacity factor (dimensionless)
ε = porosity (dimensionless)
ρ = bulk density of concrete (g/ml)

Using this expression, the data developed by the PNNL study first cited, and conservative estimates for concrete porosity and bulk density (0.4, and 2.40 g/ml, respectively), a K_d of 870 ml/g is calculated.

This derived K_d value for Cr^{+6} in concrete is significantly higher than that traditionally used for predicting the transport of Cr^{+6} in soil and indicates a tendency for the $Cr^{+}6$ to remain in the concrete matrix. While the grouted LLW form used in the PNNL studies is thought to be representative of the valve pit concrete, this assumption is conservative for several reasons. Since the valve pit concrete is significantly less harsh a matrix than standard concrete, and since the reactor concrete has had significantly more time to cure, an even higher K_d value could be expected for the reactor concrete. This was confirmed during recent discussions with the PNNL principle investigator. It is also unlikely that the concrete stubwalls will be subjected to the level of saturation used in the PNNL studies. From a leachability standpoint, the analytical results for Cr^{+6} may also be conservative as the sampling effort pulverized the concrete, thereby exposing much more surface area to laboratory leaching (i.e., higher measurable Cr^{+6}) than the remaining concrete will provide.

For these reasons, it is anticipated that the Cr^{+6} in the concrete at levels above the action level will remain in the concrete matrix and pose no problem for groundwater in the future.

Polychlorinated Biphenyls

Concrete Floor
In the 105-DR Room 230b Valve Pit concrete floor, the polychlorinated biphenyl (PCB) 95% UCL was found to be 0.97 ppm (assuming a normal distribution). Also, 4 of the 14 data points were above the 105-F/DR SAP clean up standard of 0.5 ppm. These 4 data points were 1.93 ppm, 1.79 ppm, 0.79 ppm, and 0.55 ppm. This concrete was removed and disposed of at the Environmental Restoration Disposal Facility.

Underlying Soils
Analytical results showed low levels of PCB contamination in the 105-DR Room 230b Valve Pit soils (under the floor slab) at the –18 foot level. The approved 105-F/DR Phase III Sampling and Analysis Plan (SAP) states that the soil cleanup standard for deep-zone PCBs (>15 feet below grade) is "no limit calculated" (NLC) (DOE/RL 1999). This standard is also identified in the 100 Area SAP (DOE/RL 1996a) and the 105-C SAP (DOE/RL 1997). All three SAPs state that the soil cleanup standard for deep-zone PCBs is NLC. The rational given for the NLC description is that RESRAD modeling predicts that PCBs in the deep zone soils will not break through to groundwater within a 1,000 year time frame. This determination originated with RESRAD modeling of PCBs as part of the 100 Area Remedial Action Work Plan (DOE/RL 1996b).

Concrete Walls
In the 105-DR Room 230b Valve Pit vertical walls, the PCB 95% UCL was found to be 1.14 ppm (assuming a normal distribution). Also, 4 of the 14 data points are above the 105-F/DR SAP cleanup standard of 0.5 ppm for concrete. These 4 data points are 2.01 ppm, 1.70 ppm, 1.62 ppm, and 0.53 ppm.

In May 2000, similar PCB contamination was found in the concrete floor slab of the Fuel Storage Basin (FSB) at the same facility (105-DR) at 1.08 ppm calculated at the 95% UCL (using a normal distribution). Due to the extremely low potential for PCBs to migrate through soil and concrete, Ecology and EPA agreed to change the action level for PCBs in concrete to 2 ppm and allowed the concrete to be left in place.[1]

In contrast to the FSB floor, PCB contamination in the valve pit resides in *vertical* concrete walls where there is little or no hydraulic pressure gradient (driving force) present. Thus, the potential for contaminant migration would be significantly less. Further, in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL 1996b), the Tri-Parties have agreed to K_d values for all of the 100 Area contaminants of concern, including PCBs. The K_d value for PCBs *in soil* is 550 mL/g and is based on an Environmental Protection Agency document entitled *Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A Compendium of Examples* (EPA 1989). When this value is used in the RESRAD model to predict PCB migration, results consistently show that this contaminant is relatively immobile and that groundwater will not be negatively impacted for at least 1,000 years.

Intuitively, K_d values for PCBs *in concrete* would be expected to be significantly higher than those for soil (e.g., a value of 1,000 ml/g has been suggested for PCBs in concrete). Also, the K_d value for PCBs in concrete would also be expected to be significantly higher than the K_d value for Cr^{+6} in concrete (870 ml/g) derived in the previous discussion. For these reasons, it is anticipated that PCBs in the concrete at levels below the revised action level of 2 ppm will remain in the concrete matrix and will not become available to the soil-to groundwater transport pathway.

RECOMMENDATION

It is recommended that the 105-DR Room 230b Valve Pit walls and soils below the three-foot depth be left in place and backfilled as in the initial plan.

CONCURRENCE

We received your e-mail concurrence with the above recommendations on Tuesday 10/3/2000. The purpose of this paper and the attached summary document is to document that concurrence in writing for the project files.

REFERENCES

58 FR 48509. 1993. *Department of Energy, Record of Decision, Decommissioning of Eight Surplus Production Reactors at the Hanford Site Near Richland,* Federal Register, Vol. 58, pp. 48509 (September 16)

DOE/RL. 1996a. *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington

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[1] Interoffice Memorandum, MR Morton to RP Henckel, *DOE / Ecology / EPA Approval of Various As-Left Conditions at DR and F ISS Project Areas* (CCN #079826), with attachments, dated 6/14/2000.

DOE/RL. 1996b. *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington

DOE/RL. 1997. *Sampling and Analysis Plan for the Release of the 105-C Below-Grade Structures and Underlying Soils*, DOE/RL-97-37, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington

DOE/RL. 1999. *Reactor Interim Safe Storage Projects Phase III Sampling and Analysis Plan*, DOE/RL-99-35, Rev.1, U. S. Department of Energy, Richland Operations Office, Richland, Washington

EPA. 1989. *Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A Compendium of Examples*, EPA/540/2-89/057, U. S. Environmental Protection Agency, Washington, D.C.

EPA. 1996. *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units*, U.S. Environmental Protection Agency, Richland, Washington

Krupka, K.M. and R.J. Serne. 1996. *Performance Assessment of Low-Level Radioactive Waste Disposal Facilities: Effects on Radionuclide Concentrations by Cement/Ground-Water Interactions*, NUREG/CR-6377, U.S. Nuclear Regulatory Commission, Washington, D.C.

Serne, R.J., R.O. Lokken and L.J. Criscenti. 1992. *Characterization of Grouted Low-Level Waste to Support Performance Assessment,* Waste Management, Vol. 12, pp 271-287

WAC-173-201A. 1995. *Water Quality Standards for Surface Waters of the State of Washington*, Washington Administrative Code, as amended

WAC-173-340. 1996. *Model Toxics Control Act Cleanup Regulation*, Washington Administrative Code, as amended

Nielson, Robert R

From: Smith, Douglas C (Chris)
Sent: Thursday, September 14, 2000 3:20 PM
To: Nielson, Robert R
Subject: RE: ISS Cr/PCB Issue

Rick doesn't have a problem with the levels of Cr, but he wants more samples taken with regards to the high levels of PCB's. He wants to see the number come down closer to the regulatory limit.

Chris

-----Original Message-----
From: Nielson, Robert R
Sent: Wednesday, September 13, 2000 7:43 AM
To: Bond, Rick
Cc: Smith, Douglas C (Chris); Morton, Mark R; Nielson, Robert R
Subject: ISS Cr/PCB Issue

Hi Rick-

As a follow-up to our meeting, feel free to give me a call if I can help answer any questions you may have from our discussion yesterday. Chris has signed the approval page, and we would like to deliver the record copy for your signature when you're ready. Thanks,

Robert Nielson
Office: 373-0089
Cell: 521-0877
Pager: 85-4134

Nielson, Robert R

From: Mihalic, Michael A
Sent: Thursday, October 05, 2000 10:10 AM
To: Smith, Douglas C (Chris)
Cc: Nielson, Robert R; Lucas, Rhea G
Subject: FW: Valve Pit Soil at 105-DR

INFO REGARDING VALVE PIT

-----Original Message-----
From: Bond, Rick (ECY) [SMTP:FBON461@ECY.WA.GOV]
Sent: Tuesday, October 03, 2000 4:53 PM
To: 'Mihalic, Michael A'
Cc: Peery, Valarie L.
Subject: RE: Valve Pit Soil at 105-DR

Mike,
Ecology agrees with the findings as stated below regarding PCBs in the valve pit soil at 105-DR and will sign off on a summary document as soon as we receive one.

Rick Bond
Nuclear Waste Program
Transition Project Manager
(509) 736-3007

-----Original Message-----
From: Mihalic, Michael A [mailto:MAMihali@mail.bhi-erc.com]
Sent: Wednesday, September 27, 2000 7:39 AM
To: 'fbon461@ecy.wa.gov'
Cc: Morton, Mark R; Smith, Douglas C (Chris); Nielson, Robert R; Henckel, Robert P; Adler, Jason G
Subject: Valve Pit Soil at 105-DR
Importance: High

Rick,
Information/discussion regarding the valve pit soil at 105-DR. Your concurrence to backfill is requested based on the information provided below..
Thanks
Mike Mihalic

-----Original Message-----
From: Morton, Mark R
Sent: Tuesday, September 26, 2000 3:30 PM
To: Mihalic, Michael A
Subject: FW: Proposed Email
Importance: High

Mike, Please forward to Rick Bond (fbon461@ecy.wa.gov) if you agree. Mark

Rick-

Please disregard the attachment that was sent to you yesterday regarding the elevated levels of PCB's in deep zone (-18 foot) soils below the 105-DR Valve Pit concrete slab. The argument made in the attachment regarding the low mobility of PCB's in sub-surface soils is also discussed in the approved 105-F/DR Phase III Sampling and Analysis Plan (SAP) (*Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below-Grade Structures and Underlying Soils*, DOE/RL-99-35, Rev 1., Table 2-1, pp II-4). This SAP states that the soil cleanup standard for deep-zone PCBs (>15 feet below grade) is "no limit calculated" (NLC). This standard is also identified in the 100 Area SAP (*100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev 1, Table I-6, pp I-22) and the 105-C SAP (*Sampling and Analysis Plan for the Release of the 105-C Below-Grade Structures and Underlying Soils*, DOE/RL-97-37 Rev 0, Table I-3, pp I-13). All three SAPs state that the soil cleanup standard for deep-zone PCBs is NLC. The rational given for the NLC description is that RESRAD modeling predicts that PCBs in the deep zone soils will not break through to groundwater within a 1,000 year time frame. This determination originated with RESRAD modeling of PCBs as part of the 100 Area Remedial Action Work Plan (*Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev 1, Table 2-5, pp 2-26 and Appendix C).

Until early this morning (when a person new to the project looked at the big picture), we had simply missed this section of the SAP. The root of the problem appears to be that we focussed on the data without consulting the SAP and reviewing how the data should be used. The information in the approved SAP indicates that PCBs are not a contaminant of concern in the deep zone because of their low mobility in soils. Consequently, they are not expected to migrate through the soil and negatively impact groundwater.

With this information (and the Chromium VI information presented to you on 9/12/00), it is recommended that the 105-DR Room 230b Valve Pit walls and soils below the three-foot depth be left in place and backfilled as in the initial plan. Please respond to this email with your concurrence as soon as possible. We will follow up with a summary document for your signature.

Please give me or Robert Nielson (373-0089) a call if you have any questions regarding this information.

Mike Mihalic

373-1382