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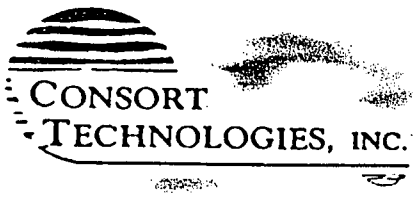

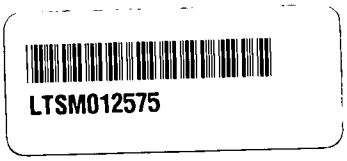

November 3, 1995

Mr. Kenny Fleming
Bechtel National Corporation
PO Box 350
Oak Ridge, TN 37831

Dear Mr. Fleming:

Consort Technologies is pleased to be able to provide you with technical health physics support. We have worked with the data provided, to recommend alternatives for remediation for the St.. Louis Downtown Site (fully implement 10 CFR 835) and the Bliss and Laughlin Site (2 phases remediation).
Attached is one original for each report and five copies.

If you have any questions or need additional information, we hope you will give us the opportunity to serve you once again.

Sincerely,

Glenn L. Murphy, CHP
Vice President

Attachments: 1 - Original (BLS)
1 - Original (SLDS)
5 - Copies (BLS)
5 - Copies (SLDS)

c: 1 - File

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Bliss and Laughlin Steel Site, Buffalo, NY:
Maximum Credible Dose Assessment for Evaluating the Appropriateness of Relaxed Radiological Controls

Prepared for

Bechtel National Corporation
Post Office Box 350
Oak Ridge, Tennessee 37831

Prepared by

Consort Technologies, Inc.
681A Emory Valley Road
Oak Ridge, Tennessee 37830

October 31, 1995

Summary

The Bliss and Laughlin Steel (BLS) FUSRAP Site is small and minimally contaminated with natural uranium. This report presents the methods and results of an evaluation of the maximum credible dose to which workers remediating this Site might be exposed. The purpose of that evaluation was to determine whether the remediation workers may be classified as general employees (*i.e.*, not radiological workers), and therefore whether it would be defensible to conduct the remediation of the Site with reduced radiological controls.

The results and recommendations of that evaluation are summarized as follows. The cleanup of the entire site can be performed safely by individuals who are not trained as radiological workers or monitored individually for external or internal exposures. However, the activity present in the most contaminated zone on the floor does justify the application of radiological controls for at least that portion of the work. Therefore, the BLS remediation *may* be controlled in a phased manner, with the localized high-activity sections cleaned up under full controls in the early stages of the project, and the bulk of the work performed under substantially reduced radiological controls.

The remainder of this report provides a complete description of the evaluation performed, as well more detailed recommendations for how the bulk of the remediation could be performed with reduced controls.

Background and History

The Bliss and Laughlin Steel (BLS) Site, currently owned by the Niagara Cold Drawn Corporation, is located at 110 Hopkins Street, Buffalo, New York. The site includes a single 204,440–ft^2 building surrounded by approximately 3.7 acres of grounds and a large asphalt parking area.

The original site owner, Bliss and Laughlin Steel, was a processor of cold-drawn steel. During the fall of 1952, BLS machined and straightened uranium metal rods under contract to National Lead of Ohio, in support of AEC work. Rods were shipped to BLS from Lake Ontario Ordnance Works, machined onsite, and shipped to AEC's Feed Material Production Center in Fernald, Ohio. AEC removed the turnings generated at BLS for disposal offsite.

A designation survey by ORISE in 1992 determined that the residual contamination at the site is confined to the floor, columns, and ceiling of the building, specifically in a small portion known as the Special Finishing Area. In 1995, DOE FUSRAP performed radiological and chemical characterization, confirming that the remainder of the building showed no evidence of contamination, and that subsurface soil samples contained no detectable radioactive or chemical contaminants. In conformity with the known site history, sample analysis shows that the contamination consists of processed natural uranium, and that the primary contaminants are approximately equal activities of U–234 and U–238.

Risk to the public from this contamination is minimal because it is confined in a small area. Therefore, at the property owner's request, remedial action has been postponed until at least FY 1997 to limit impacts on commercial operations. Remediation is expected to consist of surface decontamination of the columns, ceiling, and floors of the Special Finishing Area, either by surfactant chemical treatment or by mechanical removal. The total waste volume to be addressed under FUSRAP is not expected to exceed 20 yd^3, and remediation workforce of fewer than ten individuals is anticipated.

Available Site Data

Direct Radiation

No direct radiation survey or area TLD results have been reported.

Surface Contamination

Floor. The Special Finishing Area is a machine shop. The floor is reported to be typical for such a facility: a poured concrete slab, permeated with oil and dirt, and having scattered deposits of granular absorbent material.

Throughout the Special Finishing Area, a five-point total contamination survey of the floor was performed in a grid of 1-meter × 1-meter cells; transferable contamination was also measured at selected points. Essentially no *transferable* contamination (either alpha or beta-gamma) was found anywhere on the floor. Neither was any *alpha total* contamination measurable. However, of the approximately 725 measurement points, about two-thirds had *beta-gamma total* contamination detectable above background; of these, 17 had total beta-gamma contamination above 5000 dpm/100 cm^2.

Given that the floor has been in use for over forty years since it was contaminated, has probably been swept many times, and is impregnated with ground-in dirt, these results are not unexpected. Removable contamination has been swept out or tracked out, or has been ground into the concrete under a layer of accumulated inactive dirt. Thus, no contamination can now be removed by further wiping. Fixed contamination is detectable by beta-gamma emissions; its alpha emissions, though undoubtedly present, are absorbed by the cover layer of dirt.

Columns. Four roof support columns in the Special Finishing Area were surveyed for total contamination by measurements at two elevations per column, at four points per elevation around their circumference. Of these 32 total contamination measurements, most were not detectable above background. None had total beta-gamma contamination above 5000 dpm/100 cm^2 (highest, 4085); alpha total contamination was virtually undetectable (highest, 67 dpm/100 cm^2).

In addition, 2 removable contamination measurements were made. Both contained very low beta-gamma activity above background, and no significant alpha activity.

Ceiling. The ceiling and ceiling trusses in the Special Finishing Area were surveyed for total contamination by measurements at 45 points. Of these, two had total beta-gamma contamination above 5000 dpm/100 cm^2 (highest, 6318). Removable contamination (6 measurements) and total alpha contamination were at or near background.

Summary. The elevated beta-gamma *total* contamination readings indicate qualitatively that there is contamination at the site. However, because of the effects of wear, cleaning, and possibly painting, no weight can be given to the *removable* surface contamination measurements, or to any alpha measurements. Given the history and current state of the BLS Site, all those results would be consistent with there being significant but unquantified contamination immediately below the present surfaces. In this case, material sampling that extends below the present surfaces provides more reliable and meaningful quantities for estimating potential dose impacts of remediation activities. Those results are summarized immediately below.

Material and Soil Samples

Using the beta-gamma total contamination measurements and other factors as guides, 14 samples were collected and analyzed by gamma spectroscopy, and by uranium separation with alpha spectroscopy. These samples consisted of floor concrete and debris, subsurface soil from cores, and various materials on, in, or just beneath the surface of the floor. Other than K–40 (a natural radionuclide unrelated to the former operations at the Site), the only radionuclides consistently detected above background were Ra–226 and the uranium isotopes. Two samples also contained low but statistically significant levels of Th–232.

As anticipated, the highest results were measured in samples from locations where total beta-gamma contamination was highest, especially from a small zone near the center of the Special Finishing Area, at the east end of a finishing machine. Two floor samples from this vicinity contained respectively approximately 1200 pCi/g of U–238 (with equal U–234) [sample BLS018], and 24,000 pCi/g of U–238 (with equal U–234) [sample BLS017]; BLS017 also contained a smaller but statistically significant U–235 activity, about 1000 pCi/g. Outside this immediate area, floor samples in the Special Finishing Area were all found to contain less than about 100 pCi/g of U–238 (with equal U–234) [sample BLS008 being the highest, but several samples being in this range]. Ra–226 was detected above background in two non-soil samples, the higher being BLS018 at 3.8 pCi/g.

Subsurface soil samples yielded results in the range of about 2-6 pCi/g of U–238 (with equal U–234). Ra–226 in the soil was measured in the range of 1-2 pCi/g. On the basis of all these results, FUSRAP concluded that the subsurface soil requires no remediation.

Summary

By far the most significant contamination is immediately below the surface of the floor. However, isolated contamination measurements indicate that paint on the columns and ceiling may need to be removed and the underlying surface cleaned as well. Except for a few spots on the floor, the levels of contamination to be encountered will be relatively low.

There is a sharp separation within the activity measurement results, between those samples collected in the zone near the east end of the finishing machine and those collected anywhere else. This suggests that the BLS remediation may be conceived of as a two-phase job: the first phase would be a brief but intensive cleanup of the high-activity zone, and the second phase would be a more lengthy general cleanup of the entire Special Finishing Area. This two-phase concept is applied throughout the remainder of this assessment.

Methods and Approach for Evaluating Relaxation of Radiological Controls

General Approach

The purpose of performing a maximum credible dose assessment is to determine whether radiological controls can be relaxed for either or both phases of the remediation work, without the potential for workers exceeding the DOE limits for dose to members of the public (100 mrem annual TEDE). The general approach used in evaluating this possibility was as follows:

- Take a screening approach. That is, attempt to justify the decision using models with the least complexity, greatest conservatism, and fewest assumptions possible. Add complexity and refine assumptions only if the most conservative screening level is a borderline *unsuccessful* justification. The goal is overestimate the dose to workers and show that it is still acceptable for members of the public, not to determine with great precision what the dose to a specific real individual is likely to be.

- Base all estimates on exposure at the worst conditions that might occur in a given part of the job, for the entire length of that portion of the job. [For example, estimate the potential exposure during the high-activity phase based on exposure to the highest-activity samples for the entire length of the high-activity phase.] Base the assumed length of any portion of the job on a conservative estimate of the time required. This approach compensates for the fact that neither the exact distribution of activity in between the discrete sampling points, nor the exact distribution of effort required to clean up each unit area during a given phase, is known.

- Consider exposure only by the most direct work-related paths: dust and gas inhalation, and external radiation. This might include dust and soil ingestion (probably secondary effects compared to dust inhalation), and radon inhalation. It definitely excludes any food or water pathways.

- For quantifying worst-case exposures, use the available data closest to the intrinsic properties of the site: surface and volume contamination, direct radiation readings (or area TLDs), etc. Personnel dosimetry, bioassay, and even air sampling results (including radon cup results) depend on extrinsic factors such as temporal and spacial averaging, ventilation, worker habits, etc. that cannot be quantified *post facto*, and that cannot be guaranteed to prevail throughout the job.

Specific Assumptions

- The high-activity phase of the job consists of 5 days (5 d) of work in the locations with the worst radiological conditions on the site; Bechtel has estimated that the actual time to clean up the high-activity zone actually will not exceed 2 days. The general cleanup phase of the job consists of 10 weeks × 5 d/week = 50 d of work in the locations with the worst radiological conditions measured *outside* the high-activity zone; Bechtel has estimated that the actual time to complete the general cleanup phase actually will not exceed 6 weeks.

- At the most conservative level, all inhaled or ingested material is in the most disadvantageous chemical and physical form. Assumptions about chemical and physical form should be made only if there is very persuasive evidence about the form of the material, including the material that has not been uncovered yet.

- Inhalation is at the ICRP-23 (ICRP 1975) "light activity" rate of 20 L/min, or $20 \times 60 \times 8 = 9600$ L/d = 9.6 m^3/d.

- Soil and dust ingestion is at the RESRAD (ANL 1993) adult rate of 100 mg/d, or 0.1 g/d.

- The DOE dose factors for members of the public (DOE 1988) are applicable to the population being evaluated.

External Radiation Pathway

The maximum credible external dose is simply the most appropriate available dose or dose rate value, converted to a dose for the entire phase. The following preference order was used in determining what data to convert to the annual dose.

- First choice: area TLD readings. If they are well-located, they provide some spacial averaging, but a very realistic estimate of dose to a person.

- Second choice: convert worst soil sample or worst contamination levels into a direct radiation level. Appendix A of the RESRAD manual presents infinite-surface and infinite-volume EDE conversion factors for this purpose.

- Third choice: μR/h readings, net of background

At the BLS Site, only the second-choice data are available. They were used in the following equation:

$$H_{e,i} = C_i \cdot \rho \cdot DCF_{e,i}(\rho) \cdot \frac{8\ t}{8760}$$

where:

$H_{e,i}$ = the external dose equivalent [mrem for the phase of work] due to nuclide i in floor surface materials;

C_i = the concentration of nuclide i [pCi/g] in floor surface materials;

ρ = the density of floor surface materials [g/cm^3];

$DCF_{e,i}(\rho)$ = the infinite-depth, infinite-extent, volume-based external dose conversion factor, for nuclide i distributed uniformly in materials of density ρ [(mrem/whole year) per (pCi/cm^3)], from (ANL 1993);

t = the length of the phase of work [d]; and

8t / 8760 = the fraction of a whole year which is the length of the phase of work.

The maximum credible external dose equivalent is the sum of $H_{e,i}$ across all nuclides i. For initial evaluation of each phase of the work: C_i was chosen to be the highest concentration of nuclide i detected as statistically significant above background in any floor material sample applicable to the given phase; and ρ was chosen as the higher of the densities available in Appendix A of (ANL 1993), 1.8.

Dust and Soil Ingestion Pathway

According to the assumptions above, this pathway consists of ingesting 0.1 g/d of the worst soil or floor-material sample, converted to effective dose equivalent (EDE) using recognized DOE factors:

$$H_{E,g,i} = C_i \cdot DCF_{g,i} \cdot 0.1\,t \cdot 1000 \cdot 10^{-6}$$

where:

$H_{E,g,i}$ = the internal EDE [mrem for the phase of work] from nuclide i and its progeny, due to ingesting nuclide i in floor surface materials;

C_i = the concentration of nuclide i [pCi/g] in floor surface materials;

$DCF_{g,i}$ = the ingestion EDE conversion factor [rem/μCi ingested] for nuclide i, from (DOE 1988);

0.1 = the quantity of floor surface materials ingested [g/d];

t = the length of the phase of work [d];

1000 = the number of mrem per rem; and

10^{-6} = the number of μCi per pCi.

The maximum credible ingestion EDE is the sum of $H_{E,g,i}$ across all nuclides i. For initial evaluation of each phase of the work: C_i was chosen to be the highest concentration of nuclide i detected as statistically significant above background in any floor material sample applicable to the given phase; and the highest ingestion DCF for any form of a given radionuclide was used.

Dust Inhalation Pathway

Following Appendix B of the RESRAD Manual, a conservative approach is to postulate an airborne dust loading (in RESRAD, 0.2 mg/m³ is used by default), and calculate a relationship between the activity concentration of the airborne dust and that of the material being disturbed to produce the dust.

In the BLS case, this was applied as follows: using the soil/surface results (in pCi/g) of the sample producing the highest dose, assume that a worker inhales 9.6 m³/d of air that is

contaminated with this sample to the extent of 0.2 mg/m^3 (*i.e.*, the airborne dust was assumed to be composed entirely of the material in this worst sample). The specific equation used was:

$$H_{E:h,i} = C_i \cdot DCF_{h,i} \cdot 9.6t \cdot 0.2 \cdot 10^{-3} \cdot 1000 \cdot 10^{-6}$$

where:

$H_{E:h,i}$ = the internal EDE [mrem for the phase of work] from nuclide i and its progeny, due to inhaling nuclide i in dust composed of floor surface materials;

C_i = the concentration of nuclide i [pCi/g] in floor surface materials;

$DCF_{h,i}$ = the inhalation EDE conversion factor [rem/μCi inhaled] for nuclide i, from (DOE 1988);

9.6 = the worker's light-activity breathing rate [m^3/d];

t = the length of the phase of work [d];

0.2 = the airborne dust loading [mg/m^3];

10^{-3} = the number of g per mg;

1000 = the number of mrem per rem; and

10^{-6} = the number of μCi per pCi.

The maximum credible inhalation EDE is the sum of $H_{E:h,i}$ across all nuclides i. For initial evaluation of each phase of the work: C_i was chosen to be the highest concentration of nuclide i detected as statistically significant above background in any floor material sample applicable to the given phase; and the highest inhalation DCF for any form of a given radionuclide was used.

Maximum Credible Dose Assessment

Results

The tables below summarize the most conservative total effective dose equivalent (TEDE) assessments performed in accordance with the pathway models presented above. Table II presents the results for the highest concentrations of each nuclide in the two highest-activity samples, BLS017 and BLS018; they were taken within about 3.5 meters of each other, in the area at the east end of the finishing machine in the center of the Special Finishing Area. Table I presents the results based on the highest concentrations of each nuclide in *all other* samples. The contents of these tables are described further in the following paragraphs.

Nuclide Concentrations. Table I uses the highest concentration of each nuclide detected as significantly above background in any of the material samples analyzed, *other than* BLS017 and BLS018. In fact, four different samples contribute to this nuclide distribution: BLS004 for U-235, BLS008 for U-234 and U-238, BLS009 for Th-232, and BLS011 for Ra-226. Ra-228 and Th-228 were not detected as significantly above background in any of the samples.

Table II uses the highest concentration of each nuclide detected as significantly above background in either of the highest-activity material samples analyzed, BLS017 and BLS018. The uranium isotope results come from sample BLS017; the Ra-226 and Th-232 results come from sample BLS018. Ra-228 and Th-228 were not detected as significantly above background in either of these samples.

In the dose assessments summarized in both tables, short-lived progeny were included as follows. Th-234 and Pa-234m, short-lived progeny of U-238, were not measured separately but were assumed for dose assessment purposes to be present at the same concentration as U-238. Th-231, short-lived decay product of U-235, was not measured separately but was assumed for dose assessment purposes to be present at the same concentration as U-235. Ac-228 and Ra-224 are respectively short-lived progeny of Ra-228 and Th-228; the parents were not detectable as significantly above background in any of the samples, so Ac-228 and Ra-224 were not included in the dose assessment.

Inhalation and Ingestion Dose Conversion Factors. As discussed above, these EDE conversion factors are taken from a standard DOE report (DOE 1988). This reference does not provide dose conversion factors for Pa-234m, which has a 1.17-minute half-life and decays directly to U-234. Because of Pa-234m's short half-life and the fact that its U-234 decay product was measured directly and included in the calculations, the minor EDE contribution of Pa-234 itself was ignored.

External Dose Conversion Factors. As discussed above, these factors were taken from (ANL 1993). In this reference, the U-238 and U-235 factors include progeny contributions under the assumption that the decay products are in secular equilibrium. Therefore, Th-231, Pa-234m, and Th-234 do not require separate external dose conversion factors.

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Table I
Dose Assessment for General Cleanup Phase
(Basis: 50-day Job, Samples *Other Than* BLS017 and BLS018)

	C_i (pCi/g)	DCF_h,i (rem/μCi)	DCF_g,i (rem/μCi)	DCF_e,i (mrem/y)/ (pCi/cm³)	Ingestion Dose (mrem)	Inhalation Dose (mrem)	External Dose (mrem)
Ra-226	1.8	7.9	1.1	8.56	9.90e-03	1.37e-03	1.27e+00
Ra-228	0	4.2	1.2	4.51	0.00e+00	0.00e+00	0.00e+00
Th-228	0	310	0.38	7.36	0.00e+00	0.00e+00	0.00e+00
Th-232	1.2	1600	2.8	0.000604	1.68e-02	1.84e-01	5.96e-05
U-234	96.6	130	0.26	0.000697	1.26e-01	1.21e+00	5.53e-03
U-235	6.2	120	0.25	0.49	7.75e-03	7.14e-02	2.50e-01
U-238	101.3	120	0.23	0.0697	1.16e-01	1.17e+00	5.80e-01
Ac-228	0	0.29	0.0021	0	0.00e+00	0.00e+00	0.00e+00
Ra-224	0	2.9	0.33	0	0.00e+00	0.00e+00	0.00e+00
Th-234	101.3	0.033	0.013	0	6.58e-03	3.21e-04	0.00e+00
Pa-234m	101.3	0	0	0	0.00e+00	0.00e+00	0.00e+00
Th-231	6.2	0.00081	0.0013	0	4.03e-05	4.82e-07	0.00e+00
Pathway EDE (mrem)					0.3	2.6	2.1
Total EDE (mrem)					5		

Table II
Dose Assessment for High Activity Phase
(Basis: 5-day Job, Samples BLS017 and BLS018)

	C_i (pCi/g)	DCF_h,i (rem/μCi)	DCF_g,i (rem/μCi)	DCF_e,i (mrem/y)/ (pCi/cm³)	Ingestion Dose (mrem)	Inhalation Dose (mrem)	External Dose (mrem)
Ra-226	3.8	7.9	1.1	8.56	2.09e-03	2.88e-04	2.67e-01
Ra-228	0	4.2	1.2	4.51	0.00e+00	0.00e+00	0.00e+00
Th-228	0	310	0.38	7.36	0.00e+00	0.00e+00	0.00e+00
Th-232	3.8	1600	2.8	0.000604	5.32e-03	5.84e-02	1.89e-05
U-234	24290	130	0.26	0.000697	3.16e+00	3.03e+01	1.39e-01
U-235	1026	120	0.25	0.49	1.28e-01	1.18e+00	4.13e+00
U-238	23570	120	0.23	0.0697	2.71e+00	2.72e+01	1.35e+01
Ac-228	0	0.29	0.0021	0	0.00e+00	0.00e+00	0.00e+00
Ra-224	0	2.9	0.33	0	0.00e+00	0.00e+00	0.00e+00
Th-234	23570	0.033	0.013	0	1.53e-01	7.47e-03	0.00e+00
Pa-234m	23570	0	0	0	0.00e+00	0.00e+00	0.00e+00
Th-231	1026	0.00081	0.0013	0	6.67e-04	7.98e-06	0.00e+00
Pathway EDE (mrem)					6.2	58.7	18.0
Total EDE (mrem)					83		

Discussion

General Cleanup Phase. The total effective dose equivalent (TEDE) across all nuclides and pathways in this ultra-conservative calculation (about 5 mrem) is well below the level (100 mrem/y) at which workers could be treated as general employees (*i.e.*, as not radiological workers). This means that, outside the area of which BLS017 and BLS018 are representative, intensive radiological controls and individual worker monitoring would not be required to protect such persons from the hazards actually present at the site.

Initial High-Activity Phase. The TEDE across all nuclides and pathways in this ultra-conservative calculation (about 80 mrem/y) is somewhat below the level at which relaxation of radiological controls can be considered. Some sources of conservatism that were introduced into this calculation have insignificant bearing on the outcome in practice:

- Concentrations from two samples were combined to obtain the working nuclide distribution. However, the TEDE is >99.5% determined by the three uranium isotopes, and those results all come from a single sample (BLS017, a floor surface sample).

- Uranium progeny not directly measured were assumed to be present. These progeny as a group contribute less than 0.2% of the calculated TEDE.

- It was assumed that each element occurs in its most disadvantageous chemical form. This means that the uranium that dominates the total dose was treated as Class Y for inhalation and soluble for ingestion. The uranium contamination was created over 40 years ago as finely divided metal, so it is probably now present mostly as a low-fired oxide with some admixture of metal. 10 CFR 835 (DOE 1993) classifies U_3O_8 as Class Y for inhalation and insoluble for ingestion; the *Uranium Good Practices Manual* (INEL 1988) treats it as Class W for inhalation and soluble for ingestion. Class W uranium would have a lower inhalation dose by factor of 15-20; insoluble uranium would have a lower ingestion dose by a factor 10. However, neither reference places these two characteristics (Class W and insoluble) together. Taking credit for a specific chemical form would require a lengthy and expensive site-specific solubility study.

- The external dose calculation assumes the contaminated layer to be infinite in extent and thickness. However, because the gamma emissions of the uranium isotopes and their progeny are rather low in energy, this is not a crucial assumption. For example, according to Table A.3 in (ANL 1993), the dose rate difference is less than 10% between infinite thickness and six-inch thickness for a uniformly-contaminated deposit of density 1.8, given a mixture of U–234, U–235, and U–238.

In general, then, the detailed assumptions in the pathway dose calculations are much less important to the final result than the decision to use sample BLS017 to represent all the uranium contamination in the portion of the floor surface that is to be treated in the initial phase. For example, BLS018 contains one-twentieth as much uranium as BLS017.

However, it must be borne in mind that the assumption that the zone at the east end of the finishing machine is contaminated in the same way as the worst sample is not intended to reflect reality. Rather, as discussed above, it serves to compensate for uncertainties in the exact distribution of activity in between the sampled locations, and for lack of knowledge of how much

remediation time would be spent on which spots. Therefore, within the area of which BLS017 and BLS018 are representative, the relaxation of radiological controls and the omission of individual worker monitoring are only marginally supported by the present analysis.

Conclusions

General Cleanup of Special Finishing Area. Outside the small zone where high-activity samples were found, the Special Finishing Area **may** be remediated by general employees rather than radiological workers. DOE regulations would not require individual worker radiological controls to be imposed on this portion of the job, *provided that* issues related to the posting of these low-contamination areas (with a few spots slightly above the 5000 dpm/100 cm^2 level) were addressed successfully.

High-Activity Zone Near East End of Finishing Machine. The ultra-conservative potential total effective dose equivalent calculated for remediating the most-contaminated portion of the BLS Site approaches but does not exceed the 100-mrem criterion for removing radiological controls. Therefore, this portion of the remediation **could** be remediated by general employees rather than radiological workers. However, the posting issues are more acute in this zone because of the presence of several spots with fixed contamination substantially higher than the limits for uncontrolled areas. This posting problem, along with a purely subjective level of prudence, may dictate that this brief but intensive remediation be conducted with full radiological controls.

With minimal care to minimize dust ingestion and inhalation, and given that significant sources of direct external exposure are in fact highly localized, the actual TEDE to any real worker likely will be considerably below 100 mrem, even in the high-activity zone; in fact, the maximum TEDE may not be measurably different from zero under those minimal controls. However, there are some areas with appreciable uranium contamination. *Ensuring* a low-dose outcome will thus require some level of worker and supervisor knowledge and sensitivity, as well as some surveillance of the conduct of the work.

Recommendations

Based on the analysis and conclusions presented above, there are two defensible approaches for radiological control of the remediation of the Special Finishing Area of the BLS Site:

- Perform the entire job under full radiological controls. That is, treat all workers as radiological workers, require radiological worker training, provide individual external dosimetry and bioassay, maintain records as required by DOE regulations, etc.

- Perform the job under phased radiological controls. This approach would include the following features:

  - Staff the job for its entire duration with a trained Radiological Control Technician (RCT) who meets all DOE requirements. Provide the RCT with individual internal and external monitoring.

  - Bring in one trained radiological worker to remediate the high-activity zone under full radiological controls. Provide this worker also with individual internal and external monitoring. In less than five days, this worker (assisted by the RCT as necessary) could finish this section before the rest of the job starts.

  - For the general cleanup, augment the work team with other personnel without regard to their qualifications as radiological workers. Do not provide them with dosimetry or radiological worker training and omit all the individual record keeping and reporting associated with monitoring of radiological workers. If these general-employee workers enter areas that must be posted under DOE regulations, they must be accompanied at all times by trained radiological workers.

  - Throughout the job, have the RCT perform workplace surveys to ensure that the radiological conditions are as expected, and that areas are posted when and if necessary. Perform all such measurements with appropriately selected and calibrated instruments, and maintain the records permanently.

Bechtel may choose between these two approaches based solely on the economic incentives. Factors outside the scope of this assessment, such as the projected cost of the job, the number of workers required, and the availability of radiological workers and non-radiological workers with the requisite skills, will determine whether there are real savings to be obtained through the phased radiological controls approach.

Further savings may be attainable through an application for an exemption to relevant portions of Subpart G of 10 CFR 835. The purpose of such an exemption would be to remove the necessity for creating and posting Contamination Areas at the BLS Site, outside the highest-contamination zone. The grounds for the exemption would be that, based on the results of the present assessment, posting of such areas is not required to help individuals (including members of

the public) protect themselves against the hazards engendered by the type and magnitude of radioactive material actually present at the BLS Site.

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