UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

MAY 27 1994

No. 40-8902
SUA-1470, Amendment No. 22

Atlantic Richfield Company
ATTN: Ron S. Ziegler
Post Office Box 638
Grants, New Mexico 87020

Dear Mr. Ziegler:

Pursuant to Title 10 of the Code of Federal Regulations, Part 40, and in accordance with your submittal dated December 13, 1993, Source Material License SUA-1470 is hereby amended to revise the radon barrier design for the tailings reclamation plan by revising Condition No. 36 as detailed in the enclosed Technical Evaluation Report. All other conditions of this license shall remain the same. The license is being reissued to incorporate the revision specified above.

An environmental assessment for this action is not required since this action is categorically excluded under 10 CFR 51.22(c)(11), and an environmental report from the licensee is not required by 10 CFR 51.60(b)(2).

The issuance of this amendment was discussed via telecon between Mr. Pete Garcia of my staff and Mr. Natver Patel of ARCO on May 4, 1994.

Sincerely,

Joseph J. Holonich
Chief, High Level Waste
& Uranium Recovery Projects
Branch, DWM

Enclosures:
Technical Evaluation Report
Source Material License SUA-1470

cc:
P. D. Bergstrom, ARCO
B. Floyd, RCPD, NM
B. Garcia, NMED

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TECHNICAL EVALUATION REPORT

DOCKET NO. 40-8902 LICENSE NO. SUA-1470

LICENSEE: Atlantic Richfield Company

FACILITY: Bluewater Mill

PROJECT MANAGER: Pete J. Garcia, Jr.

TECHNICAL REVIEWER(S): Elaine Brummett

SUMMARY AND CONCLUSIONS:

By letter dated December 13, 1993, Atlantic Richfield Company (ARCO) requested an amendment of Source Material License SUA-1470 to revise the design of the main tailings pile radon barrier for the approved tailings reclamation plan for the Bluewater Mill. The proposed action is to amend the license to incorporate a revised design for the radon barrier.

The NRC staff reviewed the licensee's December 13, 1993 submittal as well as subsequent submittals dated March 2, 10, and 29, 1994. As a result of the review, the staff concludes that the radon barrier thicknesses proposed by the licensee will attenuate radon emanation from the cover of the reclaimed tailings to less than 20 $pCi/m^2/s$, as required by Criterion 6 of Appendix A to 10 CFR 40. The staff therefore concludes that the license should be amended to authorize the licensee to place the radon barrier layer to proposed thicknesses.

DESCRIPTION OF LICENSEE'S AMENDMENT REQUEST:

The reclamation plan for ARCO's Bluewater Mill Site dated March 1990, was approved by Amendment No. 11 dated August 10, 1990. Amendment No. 16, dated January 30, 1992, approved modification of the reclamation plan and required, under License Condition 36(A), submittal of the reevaluation of the radon barrier design within 60 days of completion of the contaminated fill placement on the main tailings disposal area.

By letter dated December 13, 1993, ARCO submitted the report "Final Radon Barrier Design, ARCO Bluewater Main Tailings Pile." ARCO requested approval of this design for the main tailings pile, and the use of a sampling and radon barrier model analysis protocol (outlined in the report) for the Acid Tailings Pile and the extension to the Carbonate Tailings Pile. According to the March 10, 1994, submittal, additional off-pile tailings and ore residues were placed on the main pile in 1993, with the last compaction test record dated November 11, 1993. Therefore, ARCO met the stipulation in License Condition 36(A) to provide a reevaluation of the radon barrier design within 60 days of completion of the contaminated fill placement on the main tailings disposal area, by providing the December 13, 1993, final design report.

ARCO responded to NRC staff verbal questions on the report by several letters. The first was dated March 2, 1994. This submittal provided information on:

(1) the off-pile material radon emanation fraction, (2) the slime tailings long-term moisture, (3) the effects of freeze-thaw and biointrusion on the radon barrier, (4) the conservatism of the RAECOM model and design, (5) the reliability of the one-time radon flux measurement, (6) the rationale for the Ra-226 characterization depth of 8 feet, (7) barometric pressure data for the site, and (8) a new RAECOM analysis for the Slimes Area. A phone conversation on March 8, 1994, clarified that ARCO had used a correction factor of 0.7 for the slimes diffusion coefficient (to correct an error in Appendix K of the report) and a volume-weighted average density value for the off-pile material in the RAECOM analysis of March 2, 1994.

ARCO's letter of March 10, 1994, expanded on the freeze-thaw and biointrusion discussion, responded to NRC staff concerns on the location of the evaporation pond sludges in the cell (because of elevated Th-230), and addressed why the sideslopes were not modeled for radon flux. ARCO's submittal of March 29, 1994, supported their conclusion on the sideslopes, and presented a slight modification to the protocol for characterization of the Acid Tailings Pile and the Carbonate Tailings Pile Extension.

TECHNICAL EVALUATION:

Modeling the Long-Term Radon Flux

In the reclamation plan and in the 1993 design, ARCO has used the RAECOM computer code to estimate the radon flux from the top of the radon barrier layer of the main tailings pile cover. Use of this code with appropriate input values, representing the long-term physical and radiological characteristics of the contaminated material and the radon barrier soil, provides a design flux estimate to compare to the standard in Criterion 6 of 10 CFR Part 40, Appendix A. ARCO has modeled three separate areas on the main tailings pile, based on the predominant type of tailings; sands, mixed, or slimes, and derived an overall average radon flux by area-weighting the individual flux estimates.

Redesign

ARCO has completed regrading the sideslopes and consolidation of off-pile materials onto the main pile, primarily in the Slimes Area. The off-pile materials include windblown material, evaporation pond sludge, berms, and sub-pond material. Placement of radon barrier on the Sands Area has also been completed. Measurements taken during and after these activities indicate:

1. 705,000 cubic yards more off-pile material than estimated;

2. lower Ra-226 concentration in upper layers than previously modeled;

3. higher compaction of off-pile and barrier material than specifications required; and

4. lower measured radon flux than predicted by the RAECOM analysis.

As a result of these measurements, and a proposed calibration of the RAECOM code that results in a correction factor for the radon diffusion coefficient (D) of the various materials, the final design contains less radon barrier material than proposed in the original reclamation plan. ARCO also indicated in the 1993 final design report that, for various reasons, more radon barrier material would be placed on all three areas than required by their design.

Thickness of Radon Barrier in feet (cm):

Area	Acres	1990 Rec. Plan	1993 design	existing or to be placed
Sands	102	3.4 (104)	1.3 (39)	2.4 (73)
Mixed	68	5.0 (150.5)	0.9 (27)	1.0 (30.5)
Slimes	80	1.8 (55)	0	0.5 (15)
ARCO Estimated flux: (area-weighted)		20.0	16.8	11.6

ARCO did not model the sideslopes (according to their March 10, 1994, letter) because that area contains uncontaminated soil as well as coarse tailings (sands), and will have a minimum of 2.4 feet of radon barrier cover. They determined that a sideslopes model would only lower the pile average radon flux, and they chose not to include this additional conservatism. The March 29, 1994, submittal provided data, RAECOM analyses, and discussion that indicates that the approximately 34 acres of sideslopes with 2.4 feet of radon barrier will have a radon flux of 13.3 $pCi/m^2/s$. The remaining 34 acres of sideslopes do not have tailings material within 10 feet of the surface, so the radon flux from these surfaces due to mill-related material should be near zero.

Proposed Calibration of the RAECOM Model

In the 1993 final design report, ARCO presents a procedure to calibrate the RAECOM model so that the diffusion coefficient, an important parameter in the radon flux calculation, is adjusted to site and material specific conditions. During September 1993, ARCO performed 113 radon flux measurements (20 on bare tailings of the Sands Area, 30 on Slimes Area, 30 on Mixed Area, and 33 on radon barrier of Sands Area), and determined an average flux for each of the four material-areas. ARCO then used the RAECOM code to calculate the radon flux for each of these four areas using actual measured moisture values. For all four areas, the calculated flux was higher than the measured flux value. ARCO adjusted the calculated diffusion coefficient (D) for each material so that the code-calculated flux approximated the measured flux. This correction factor (sands 0.47, slimes 0.70, mixed tailings 0.27, radon barrier 0.87) was then applied to each average measured D value, and used in the model with long-term moisture values. The change for the barrier layer was from a measured D value of 0.0086 to a less conservative 0.0075 cm^2/s.

ARCO indicated that "calibrating the RAECOM model to the site" eliminates the major source of uncertainty in predicting the radon flux. However, the many uncertainties related to cell performance for 1000 years and to the

representativeness of the input values are not eliminated. The regulations require reasonable assurance that the design standards will be met for 1000 years, to the extent reasonably achievable, and in any case 200 years when averaged over the disposal area over at least a 1-year period. Computer codes provide only estimates; conservatism must be assured to justify that the design will meet the standards. Conservatism is applied to the parameters used in the code to account for the uncertainties of cell performance over the design life.

Revised RAECOM Input Values

ARCO determined the new Ra-226 concentration values by performing 93 corings in the upper 8 feet of contaminated material in the main tailings pile. Each coring was divided at 2-foot intervals (372 samples) for Ra-226 analysis. These values were used to model the three different areas of the pile in 2-foot layers. Such modeling in thin layers increases the precision of the flux estimate because the code reflects the decreasing influence on the exit radon flux with the increasing depth of contaminated material.

ARCO measured dry density for more than a hundred samples each of as-placed radon barrier, evaporation pond, berm, and windblown material. Volume-weighted average values were used in the model when material in a layer was derived from more than one source. The large number of measurements substantiates the use of the average values in the 1993 design for the already placed contaminated material and radon barrier soil. ARCO also used the higher density value (less conservative) for the radon barrier in the Mixed and Slimes Areas. This is not acceptable for material that has not been placed and tested because the construction specification requires 95 percent compaction that results in the lower density value of 1.78 g/cm^2.

The D values for the Slimes Area contaminated layers and the radon barrier of all three areas were derived by applying the correction factor to measured values. NRC staff noted that the code-calculated D values for the various contaminated materials and the barrier soil were often less conservative (smaller number) than the measured D values. For example, the barrier soil code-calculated D value was 0.0071, and the one measured value (at current density and long-term moisture) was 0.0086 cm^2/s. Generally, NRC staff would expect site-specific measured values to be used in the RAECOM analysis, based on a sufficient number of valid measurements. When previously measured D values for the radon barrier soil (22 samples, 1990 reclamation plan) are normalized for the higher compaction and the long-term moisture value previously approved, a value of approximately 0.0086 cm^2/s can be justified. The "corrected" D value is not considered conservative by the NRC staff because of the long-term uncertainties, as discussed previously. This does not create a problem because the use of measured D values in place of the "corrected" values still allows the main pile to meet the long-term radon flux limit when the radon barrier thickness that was placed in the Sands Area is considered.

Other parameter values were unchanged from the reclamation plan, but some were derived by volume-weighted averages when different types of materials were

mixed together in one layer. NRC staff summarized the ARCO input values for the RAECOM analysis by combining similar adjacent layers, as indicated in Attachment 1.

Modeling - Layer Sequence

An acceptable RAECOM analysis should model not only the expected long-term material characteristics, but also the correct sequence and thickness of the various layers. ARCO proposed to model only the upper 8 feet of contaminated material because they calculated that modeling the deeper layers on the main pile increased the estimated radon flux by only 6 percent. However, NRC Regulatory Guide 3.64 considers 16.4 feet (500 cm) to represent an equivalent infinitely thick tailings source of radon that may be used in the absence of specific smaller values. The degree of influence of the material deeper than 8 feet depends primarily on its Ra-226 content and D value. NRC staff considers that, in some cases, the deeper contaminated material could contribute to the radon flux and therefore Ra-226 concentrations should be obtained and modeled for this material. ARCO used Ra-226 data from their 1990 reclamation plan for the deeper material of the main tailings pile which is acceptable to the NRC staff.

ARCO's model for the Slimes Area does not appear to represent the various off-pile material layers correctly. NRC staff noted that ARCO's October 30, 1992, report indicated that 623,000 cubic yards of windblown material were placed on the Slimes Area of the main tailings pile and constitute a layer 3.2 feet thick over an area of 120 acres. The reclamation plan states there is approximately 1.4 million cubic yards of evaporation pond material. The cross-section of the as-built pile (see Attachment 2) in the 1993 final design report, indicates this material is about 8 feet thick over the Slimes Area while the windblown material is 1 to 4 feet thick. Therefore, over 4 feet of evaporation pond material must be in the upper 8 feet of contaminated material, but it was modelled only in the 8 to 10-foot-deep layer.

ARCO stated in the letter of March 10, 1994, that the evaporation pond sludge mixed with clean borrow and berm soil was placed on the pile between January 1991 and May 1992. Windblown material was placed between April and August of 1992. This supports the as-built cross-section of the pile indicating the sequence of the various off-pile materials on the Slimes and Mixed Areas (see Attachment 2). However, the appropriate Ra-226 value to use for the 4-8-foot interval in the Slimes Area is still in question. Since uncontaminated soil was mixed with the evaporation pond sludges to reduce the moisture content so that the material could be moved to the main pile, the 1000-year Ra-226 value would be lower than that used in the 1990 reclamation plan, but higher than the Ra-226 concentration used in the 1993 final design because of the high Th-230 (which decays to Ra-226) content of the evaporation pond sludges.

ARCO estimated the radon flux from the contaminated material of the Slimes Area to be 10.4 $pCi/m^2/s$, and determined that a radon barrier layer is not needed. However, they do propose to place at least a 6-inch (15 cm) transition layer of barrier soil (95 percent compaction) to act as a working surface for placing the erosion protection layer. This transition layer will

not affect the radon flux significantly, but will be required by license condition to assist with stabilizing moisture in the upper layers of contaminated material, and to reduce the effects of frost penetration.

Staff Evaluation of the Main Tailings Pile Radon Flux Estimate

NRC staff modeled the three areas of the main pile with more conservative values for some of the parameters. This was done to conservatively reflect the long-term Ra-226 concentration in the layers where evaporation pond material was present, volume-weighted emanation fraction for layers containing a combination of materials, measured D values, and the radon barrier thickness the licensee indicated would be placed. In addition, the barrier layer that has not been placed yet was modeled at 1.78 g/cm² (design) dry density and the corresponding D value at 0.0139 cm²/s. The design density is the value in the reclamation plan, and is reflected in the construction specification for 95 percent compaction.

The resulting area-weighted flux value for the top of the main pile was conservatively estimated at 18.5 pCi/m²/s. The low radon flux expected from the sideslopes has not been considered in this value, providing additional conservatism to the design. Therefore, there is reasonable assurance that the main pile radon flux will meet the 20 pCi/m²/s standard if the proposed radon barrier thicknesses which the licensee indicates will be placed, are used. Therefore, the staff recommends that the revisions to the radon barrier thicknesses, as presented in the December 13, 1993, and March 29, 1994, submittals, be approved.

Long-Term Stability of the Radon Barrier

ARCO stated in their letter of December 13, 1993, that the erosion protection design will remain unchanged. Slight variations were anticipated and proposed modifications are now under discussion with NRC staff. Resolution of any remaining issues will insure that the erosion protection design provides for long-term protection of the radon barrier.

ARCO addressed the possibility of freeze-thaw damage to the barrier layer and concluded (letter of March 10, 1994) that the risk of such damage was low, and any damage would not significantly affect the radon attenuation capacity of the barrier. NRC staff agrees with ARCO's evaluation based on consideration that the low moisture content and soils types in this pile and cover should prevent significant freeze-thaw damage to the radon barrier layer.

ARCO also concluded that there was minimal concern for deep-rooted plants on the pile due to the semi-arid climate and the type of indigenous plants. In conversations, ARCO staff indicated that the local burrowing animals are unlikely to choose the rock mulch covered pile for habitat. NRC staff agrees that root or animal intrusion into the radon barrier layer should not be extensive enough to significantly affect the radon attenuation capabilities of the barrier. If conditions change such that extensive damage is done, the staff recognizes that the long-term surveillance plan would detect the damage and corrective actions could be taken.

Proposed Protocol for the Acid Tailings Pile and Carbonate Tailings Pile Extension

ARCO proposes to take samples at 2-foot intervals in the upper 8 feet for Ra-226 characterization at ten locations (appropriately spaced) on the 22-acre Acid Tailings Pile, when complete, and at three locations on the 4-acre Carbonate Tailings Pile extension. Apparently the contaminated material in the acid pile is less than 8-feet thick in some areas, and in the carbonate pile extension is only about 1-foot thick. The extension area was designated for cleanup in the reclamation plan, but this was not feasible due to the nature of the underlying lava rock.

NRC staff determined that the sampling and testing plan for the Acid Tailings Pile should be adequate to supplement data in the 1990 reclamation plan, except that some Th-230 analysis may be needed because ARCO indicated that the Acid Tailings Pile will contain material from evaporation ponds 3A, 3B, and 3C. Pond 3A will remain open until all other contaminated material is consolidated with the Acid Tailings. This pond material, mixed with berm or other soil, will constitute the layer next to the radon barrier. Data in the reclamation plan indicates that pond 3A material contains 139 pCi/g Ra-226 and 577 pCi/g Th-230. In 1000 years, the decay of both of these radionuclides will result in 293 pCi/g Ra-226. Therefore, the contribution to the Ra-226 concentration from Th-230 decay over 1000 years should be considered in the final design.

The adequacy of the sampling plan for the Carbonate Pile Extension depends on the variation of the material parameters. Assuming that this material is fairly homogeneous and similar to the rest of the Carbonate Pile contaminated material, the sampling plan is acceptable.

The ARCO report also states that the dry density input for RAECOM analysis will be based on measured as-built values, and RAECOM model calibration data (D correction factors) will be used. Staff agrees that an average measured density value is acceptable if an adequate number of measurements are presented; however, modeling should use the appropriate measured values for the D input to add conservatism to the estimates.

RECOMMENDED LICENSE CHANGE:

Based on the staff review of the licensee's submittals, the staff recommends that Source Material License SUA-1470 be amended to revise License Condition 36(A) and add License Condition 36(C) such that License Condition No. 36 reads as follows:

36. The licensee shall reclaim the tailings disposal area as stated in their March 21, 1990 reclamation plan submittal as revised by submittals dated July 12, July 19, July 23, August 2, and August 8, 1990, and November 25, 1991, with the exception of Section 7.0. In addition, the licensee shall:

A. Construct the radon barrier for the main tailings pile to minimum average thicknesses of 73 cm. for the sands area,

30.5 cm. for the mixed tailings area, and 73 cm. for contaminated outslopes. The radon barrier will be a minimum thickness of 15 cm. for the slimes area.

B. Submit for NRC review and approval the correlation of nuclear gauge to sand cone results prior to using the nuclear gauge for field construction control.

C. Submit for NRC review and approval radon barrier designs for the acid tailings pile and the northwest carbonate pile extension before radon barrier placement on those piles is complete. The radium source term for the piles shall be determined using as a minimum the sampling program described in Section 5 of the December 13, 1993, submittal, as modified by the March 29, 1994, submittal.

[Applicable Amendments: 11, 16, 22]

ENVIRONMENTAL IMPACT EVALUATION:

In accordance with the categorical exclusion contained in paragraph (c)(11) of 10 CFR 51.22, an environmental assessment is not required for this licensing action. That paragraph states that the categorical exclusion applies to the issuance of amendments to licenses for uranium mills provided that (1) there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, (2) there is no significant increase in individual or cumulative occupational radiation exposure, (3) there is no significant construction impact, and (4) there is no significant increase in the potential for or consequences from radiological accidents.

The licensing action discussed in this memorandum modifies the radon barrier design in accordance with criterion 6 of 10 CFR Part 40 Appendix A. An environmental report is not required from the licensee since the amendment does not meet the criteria of 10 CFR 51.60 (b)(2).

REFERENCE:

U.S. Nuclear Regulatory Commission Regulatory Guide 3.64, "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers," June 1989.

ATTACHMENT 1

ARCO Main Pile RAECOM INPUT SUMMARY

based on Dec. 1993 and March 1994 models spec. gravity 2.7 assumed

AREA/ MATERIAL	THICK (cm.)	POROS ITY	DENSITY (g/cm^2)	Ra-226 (pCi/g)	Rn EM.	MOIST. % by wt.	DIF. COEF (cm^2/s)
Sands							
1. deep	366	.40	1.61	213	.20	8.0	.024
2.	122	.40	1.61	125	.20	8.0	.024
3.	122	.40	1.61	68	.20	8.0	.024
barrier	39	.31	1.85	1	.20	9.5	.0075
Slimes							
1. deep	275	.42	1.56	463	.20	22	.0008
2. evap, berm	77	.40	1.62	114	.22	22	.0067
3. mixed	244	.38	1.68	12	.22	9.5	.0126
barrier	15	.31	1.85	1	.20	9.5	.0075
Mixed							
1. deep	213	.41	1.59	279	.24	15	.0085
2. evap	61	.41	1.59	122	.20	9.5	.0211
3. mixed	183	.41	1.59	51	.20	9.5	.0211
barrier	30	.31	1.85	1	.20	9.5	.0075

ATTACHMENT 2

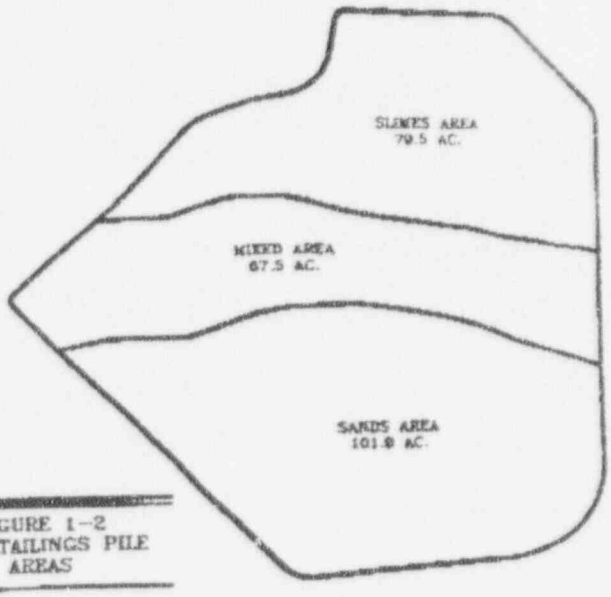

FIGURE 1-2
MAIN TAILINGS PILE
AREAS

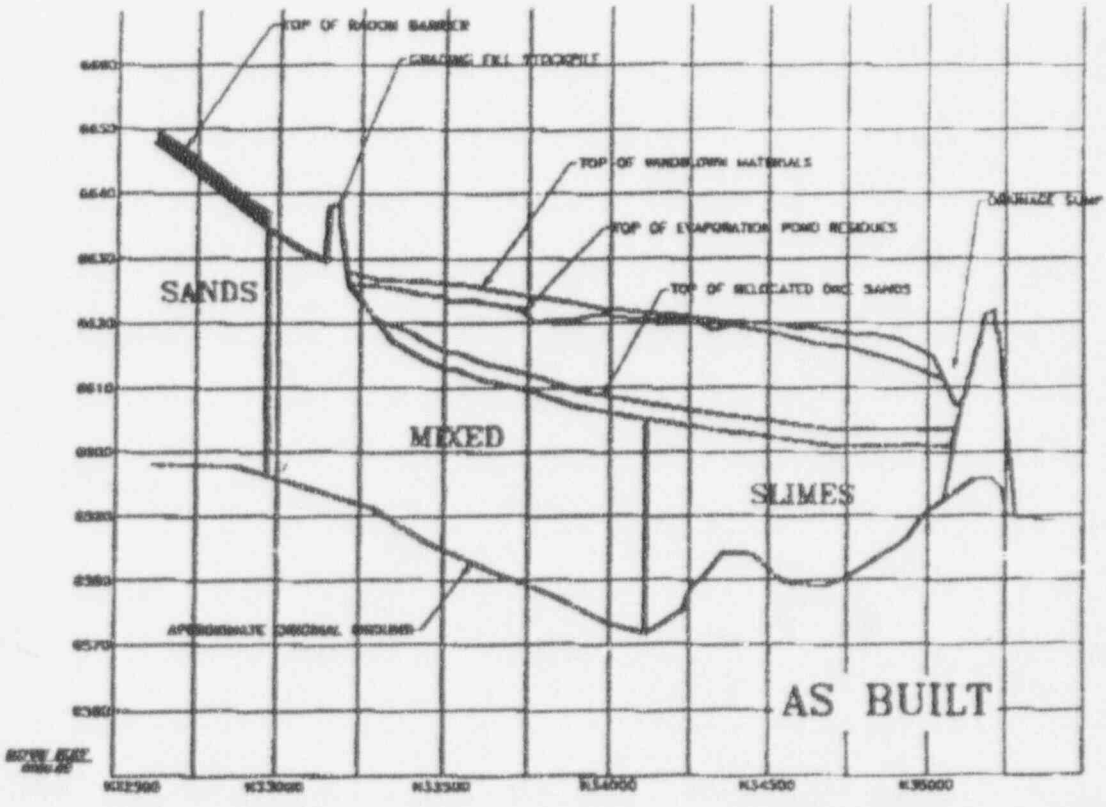

FIGURE 2-1
MAIN TAILINGS PILE
TYPICAL SECTION

ATLANTIC [illegible] COMPANY