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University of Idaho
College of Mines
Department of Geology
Moscow, Idaho/83843
March 1, 1978

Mr. Fred Vaslow
Division of Environmental Studies
Argonne National Laboratories
9700 South Cass Ave.
Argonne, Ill. 60439

Dear Fred:

This letter constitutes my response to your request for information on the cost of the liner installed in the tailings pond at Western Nuclear's Sherwood Project, northwest of Spokane, Washington. Western Nuclear evaluated two materials for use as the liner in their tailings pond. The Materials evaluated were American Colloid Company's "salene seal 100" bentonite clay and DuPont's "hypalon." Hypalon is distributed by B. F. Goodrich and others. Hypalon belongs to a class of elastomers often referred to as EPDM (ethylene, propylene, diene monomer). Salene seal 100 can be expected to have a permeability of 10^{-8} to 10^{-9} cm/sec and hypalon can be expected to have a permeability of 6×10^{-10} cm/sec. Western Nuclear finally settled on hypalon for use at the Sherwood Project.

The cost of the American Colloid Company's "salene seal 100" would have been approximately 7¢/lb. delivered to the Sherwood Project. Approximately 8.5 lbs./square foot would have been required. This would have brought the material cost to 60¢/square foot delivered. Site preparation cost was estimated at .5¢/square foot. Installation costs were estimated at 3¢/square foot. Covering costs were estimated at 8.5¢/square foot. This would have brought the total cost of the salene seal 100 to 72¢/square foot.

For the DuPont hypalon liner supplied by B. F. Goodrich, site preparation costs were .5¢/square foot. The cost of the hypalon delivered to the Sherwood Project was 32.25¢/square foot. Installation cost was only 1.5¢/square foot and covering cost was 8.5¢/square foot. However it is necessary to sterilize the soil beneath hypalon in order to prevent emanation of gases which would cause the liner to "bubble." This sterilization cost was .33¢/square foot. This brought the total cost of the hypalon option to approximately 45¢/square foot.

The principal reason for the higher cost of the "salene seal 100" option was the amount of material required per square foot. I do not know how the required thickness of the salene seal 100 was determined. However it is obvious that this thickness is significant in the economic competitive position of hypalon versus "salene seal 100." Neither do I know the reasoning behing the selection of the particular variety of hypalon which brought its delivery cost to 34.5¢/square foot. Hypalon is available in a variety of thicknesses, layers, and with a variety of strengths and spacings of a reinforcing material known as scrim.

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The specs issued by DRAVO in their bid requests were as follows:

Liner Material

.1 The liner sheet shall be manufactured from materials which shall contain at least 45% by weight Hypalon synthetic rubber as the sole elastomer (as manufactured by DuPont). The Hypalon sheet shall be compounded for use in sealing a slurry of uranium mill tailings.

.2 Sheeting shall be free of gels, air bubbles, undispersed raw materials, or other manufacturing defects that may affect its serviceability.

.3 Sheeting shall be free of defects such as holes, tears, modules, delaminations or blisters. The edges shall be straight and free of nicks and cuts visible to the naked eye.

.4 Sheeting shall be free of pinholes. Pinhole inspection shall be made before shipment to the field by running the sheets over a light sour · or by the use of a spark tester.

.5 Hypalon sheet shall meet the following physical properties. Certification tests showing that the Hypalon sheet meets the specification shall be supplied.

Property	Test Method	Requirement
Tensile Strength	ASTM D-412	1000 psi, min.
Elongation at Break	ASTM D-412	250% min.
Water Absorption	ASTM D-471 (7 days at 70°F)	5% (wt.) max.
Cold Bend	ASTM D-2136 (1/8" Mandrel)	-30°F, no cracks
Brittleness Temperature	ASTM D-746 Procedure "B"	-45°F, no failures
Ozone Resistance	ASTM D-1149 (3 ppm at 30% strain at 104°F for 70 hrs.) Procedure "A"	No cracks visible under 7x magnification
Heat Aging	ASTM D-573 & D-412	
Tensile Strength	14 days at 212°F	1000 psi, min.
Elong. @ Break		150% min.
Color		Black

Srim Material

.1 The scrim material shall be polyester fiber.

.2 The prime criteria for the scrim is total encapsulation of the scrim in the Hypalon sheets to practically eliminate the possibility of delamination while meeting the strength, tear and puncture test requirements.

.3 The scrim should have double thread lino weave.

.4 The scrim count should be not less than 6 x 6 or more than 12 x 12.

.5 The denier of the thread shall be consistent with the count.

Manufacturing

.1 Pond liner material shall be of 2-ply construction consisting of two (nominal) 15 mil thicknesses of "Hypalon" synthetic rubber sheeting laminated to one layer of reinforcing fabric (scrim) to produce a single 30 mil thickness.

.2 Each ply shall provide a minimum cover thickness over the scrim of 12 mils.

.3 Each Hypalon ply shall have a minimum thickness of 14 mils.

.4 The completed roll goods shall have a minimum thickness of 28 mils.

.5 The completed sheet shall conform to the following physical property requirements:

Property	Test Method	Requirement
Strength - wrap	ASTM D-751	80 lbs. min.
- fill	Grab Method	80 lbs. min.
Tear - wrap	ASTM D-751	20 lbs. min.
- fill	Tongue Method	20 lbs. min.
Mullins Burst	ASTM D-751	90 psi min.
Puncture Resistance	FTMS-101-B Method 2031	115 psi min.

.6 The scrim shall be a maximum of 1" from the edge of the sheet and the selvage edge shall not be less than ½" (this prevents waste water from entering and decomposing the scrim).

.7 There shall be no exposed fabric or indication of delaminating.

Fabrication

.1 Finished roll goods shall be fabricated into the maximum size panels which can be handled in the field. The size of the panels and an installation plan shall be submitted to Dravo.

.2 All factory seams must be made by heat welding and shall provide a bond strong enough to tear the parent material in peel.

.3 All seams, for either fabrication or repairs, shall provide a minimum overlap of 2 inches reinforced material when made under "shop" conditions. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an "overlay" which provides the minimum specified overlap, or the material will be rejected.

.4 Exposed fabric edges shall be sealed with a "flood" coat of adhesive along the edge or by use of 2-inch wide non-reinforced tape (or both).

.5 All shop seaming shall be done on level, firm and clean surfaces. Where "fish-mouths" occur, they shall be repaired by cutting and seaming with an overlap. The specified minimum seam overlaps will be required.

.6 All patches shall be cut with rounded corners.

.7 All seams shall be made such that the bond extends fully to the edge of the sheets so that no loose edges are present.

.8 All sheets and seams shall be inspected visually during fabrication for compliance with the foregoing and all indicated repairs shall be made by the supplier before the panel is packaged for shipment.

Solvent

Commercial grade trichloroethylene shall be used for cleaning the Hypalon unless field conditions dictate use of other solvents. The installation procedures shall indicate what alternate solvents would be used and under what conditions.

Adhesives

The adhesive used to make the field seams shall meet the film tearing bond requirement. Physical properties including set time as a function of temperature shall be submitted to DRAVO.

Soil Stabilizer

Soil stabilizer shall be Aerospray 52 as manufactured by American Cynamid or approved equal.

Soil Sterilant

The soil sterilant shall be Hyvar X Bromacil Weed Killer as manufactured by E. I. DuPont de Nemours & Co. or approved equal.

Select Soil for Fill Over Liner

The soil for covering the liner shall be free of rocks or other materials which could puncture, cut or damage the liner. Rocks larger than 1½" in diameter shall be removed by screening or other approved method as determined by Dravo's Construction Superintendent.

Site Preparation

.1 The side slopes and all major excavation will be completed by DRAVO's excavation contractor.

.2 Removal of rocks and other objects which could cause puncture or tearing of the liner is the responsibility of the liner installation contractor.

.3 The liner installation contractor shall apply the soil sterilant according to the manufacturer's directions.

.4 The liner installation contractor shall excavate and backfill anchor trenches as shown on the installation drawings.

Liner Installation

.1 The liner manufacturer and fabricator shall have a supervisor on site during installation as requested by DRAVO CORPORATION's construction superintendent.

.2 An installation plan shall be submitted for approval to DRAVO's Engineering Department. The plan shall include procedures for delivery, unrolling, positioning blankets, field seaming, and protection of the blankets.

.3 A sample of a typical field seam shall be submitted to DRAVO's Engineering Department.

.4 Field seams shall be strong enough to tear the Hypalon sheet in peel.

.5 All seams shall be made so that the sealant extends fully to the edge of the sheets so that no loose edges or voids are present.

.6 If liner repairs are required, all patches shall have round corners and extend beyond the flaw or cut a minimum of 6".

.7 Field seaming shall not be performed when the ambient temperature is below 60°F, unless prior approval is obtained.

.8 Field seaming shall be performed only during daylight hours.

.9 Upon completion of the inspection and repairs, the liner will be covered with select soil.

.1 The select soil shall be placed to a minimum depth of one (1) foot over the liner. The fill material shall be free of debris, rocks, or any other coarse material which could penetrate, pierce, or damage the liner during placement.

.2 Prior to placement of the select soil over the liner in the impoundment area and the embankment area, the subcontractor shall field test a representative area as directed by Dravo's Construction Superintendent to determine:

.1 The method of hauling, dumping, and spreading of the select soil over the liner.

.2 The actual thickness of the select soil required in traffic areas to withstand the impact of tracked vehicles, and rubber-tired vehicles and equipment to avoid any damage of the liner.

.3 No compaction of the earth fill will be required in the impoundment area.

.4 Compaction to 90% proctor will be required on the face of the dam.

.10 Provisions shall be made for adding to the liner two or three years after the initial installation.

.11 After the select soil has been placed on the liner, soil sterilant shall be applied according to the manufacturer's instructions.

.12 The soil stabilizer shall be applied to the upstream face of the dam according to the manufacturer's directions.

Inspection

.1 DRAVO reserves the right to inspect the liner installation and reject work not meeting high quality workmanship according to current best practice.

As you know, Western Nuclear opted to line only a portion of the tailings pond treated by the embankment. If I understand the situation correctly, the area of the bottom portion of the basin which was lined totalled 25 acres in area. With this information you can break the previous cost data down into any increments you choose. All costs, by the way, are in 1976 dollars and a correction factor should be utilized if you plan to present the information in 1978 dollars. I suggest using the construction index as the correction factor for all but the liner. You may wish to phone Mr. R.D. Cunningham, sales manager for B. F. Goodrich at 500 South Main Street, Akron, Ohio 44318, for a corrected price index on hypalon.

I hope this information will be of assistance to you. If I can be of further help, please call.

Sincerely,

Roy E. Williams

Roy E. Williams
Professor of Hydrogeology

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