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Subject: K-65 removal

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INNOVATIVE SYSTEMS FOR MIXED WASTE RETRIEVAL AND/OR TREATMENT IN CONFINED SPACES

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presented by
A.E. Ghusn*
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INTRODUCTION

The United States Department of Energy (DOE) Fernald Environmental Management Project (FEMP) is located approximately 32 kilometers (20 miles) northwest of Cincinnati, Ohio. The FEMP established operations in 1951 under orders of the Atomic Energy Commission and produced uranium and other metals for use at other DOE facilities. Production at the FEMP has ceased, and the environmental remediation of the entire site is ongoing. A part of the sitewide remediation effort is the removal, treatment, and disposal of the K-65 wastes from Silos 1 and 2. These silos contain radium-bearing residues from the processing of pitchblende ore (high grade uranium mineral) at Mallinckrodt Chemical Works and Lake Ontario Ordinance Works (currently known as Niagara Falls Storage Facility).

The silos are constructed of steel-reinforced concrete and are approximately 24.4 meters (80 feet) in diameter, with 8 meter (27-foot) high walls, and are 11 meters (36 feet) high at the top of the dome.

Age has taken its toll on those silos. The structures have cracked, and some of the concrete has peeled off, exposing rusted and deteriorated reinforcing steel. These conditions have so weakened the silo domes that any contact with the domes, especially the center 9 meters (30 feet), is strictly prohibited.

The radioactive constituents of concern in the silos are Uranium-238 and 234, Radium-226, and Thorium-230. The radium-bearing residues emit radiation in the form of alpha, beta, and, in small amounts, gamma rays; radon gas is also emitted. Most of the radon generated was contained within the enclosed silos. About 6 curies of radon were generated and released into the head space of each silo per day, based on a radon emission flux rate of 1.5×10^5 pCi/m² sec. Due to the age and condition of the silos, the radon emission from the silos exceeded the United States Environmental Protection Agency (US EPA) limits.

These silos were included in one of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Studies (RI/FSs) identified as Operable Unit 4 (OU-4), now called CERCLA Resource Conservation and Recovery Act (RCRA) Unit 4 (CRU-4) at the FEMP. While pursuing final remediation, it has been determined by the DOE that a non-time-critical removal action is necessary. The scope of this removal action can be broadly defined as reducing the chronic radon gas emissions to the atmosphere from Silos 1 and 2. This removal action was being conducted pursuant to the Consent Agreement between the DOE and the US EPA as Silos 1 and 2 Removal Action. An Engineering Evaluation/Cost Analysis (EE/CA) was prepared to evaluate the removal action alternatives using the preliminary characterization data and select a preferred alternative. The selected alternative consisted of covering the K-65 residues with a gas barrier material that will retard the emanation of radon gas into the space between the residues and the silo dome.

Bentonite was selected as cover material due to its good emanation coefficient, its favorable plasticity, its capability to retain water, and the relative ease by which it can be placed into the silos. PARSONS was retained as design engineers, under DOE Contract, to supply the design/construction packages to carry out the above removal action. Design packages were developed by PARSONS; while procurement, construction, and application were performed by Westinghouse Environmental Management Company of Ohio (WEMCO), then current site manager. All activities were performed and executed successfully in accordance with the requirements of the work plan compiled by PARSONS and WEMCO, and approved by the US EPA.

The removal action outlined above can only be described as a stop-gap measure. It was intended to reduce radon gas emission to the atmosphere to a minimum during the long time period required to effect remediation.

The remediation of the K-65 wastes consists of the retrieval and treatment of the wastes prior to final disposal, which has not yet been determined. Treatment will be performed in a new facility to be built

adjacent to the silos. The wastes must be retrieved from silos in an efficient and reliable way and delivered to the treatment facility. This proved to be no simple chore, given the condition of the silos and associated constraints. Also, there are approximately 10,000 dry tons of waste in the silos with variable moisture levels, averaging about 30 percent by weight (25% to 65% range).

The first challenge of covering the wastes with bentonite has been successfully met. The second phase of retrieving the wastes from the silos is not due for a few years. However, conceptual design and configuration of the retrieval system have been developed as part of the Conceptual Design Report (CDR) prepared by PARSONS to remediate the K-65 wastes. The system is based on the utilization of hydraulic mining techniques, and is based on similar successful applications.

TREATMENT OF MIXED WASTES IN CONFINED SPACES

BENTOGROUT EMPLACEMENT

An application demonstration program was developed and carried out by PARSONS to confirm the applicability of the alternative selected by EE/CA and to provide the basis for the full-scale implementation of the removal action concept.

During the demonstration test, the optimum and other applicable mix formulae were developed. Optimum mix was determined based on the slurry physical characteristics, area coverage by flow versus time, setting time, pumping requirements, adhesion, dehydration, and reslurrying characteristics after setting. Based on the results of this demonstration test, design/operational requirements for the full-scale implementation were developed as presented in Table 1.

The schematic of the full scale system designed by PARSONS is depicted in Figure 1. The BentoGrout material (a bentonite base material by American Colloid Corp.) was delivered by a pneumatic tanker to a receiving area near the K-65 silos. The dry feed material was pneumatically unloaded from the tanker and transferred into a 2-hour capacity feed bin. BentoGrout was withdrawn from the bin by an inclined screw auger feeder and discharged into a weigh hopper. The predetermined dry BentoGrout batch weight was fed into one of two mixing units. Air vented from the bin through a dust collector to control dust emissions. Similar to the demonstration plan, each mixing unit consisted of one 760-liter (200-gallon) capacity mix tank equipped with side-mounted high shear-type ribbon blender driven by electric motor. The two mixing units (by ChemGrout Corp.) in parallel were served by a common discharge hopper equipped with one high pressure Moyno transfer pump. The entire mixing unit was mounted on an easily movable skid. From the mixing unit, the BentoGrout slurry was pumped into the silos through a distributor/sprayhead assembly unit suspended from the main basket positioned over the center manway and suspended from a mobile crane boom. The system was designed to produce BentoGrout mixes in 380- and 760-liter (100- and 200-gallon) batches and distribute the mixes into the silo by the distributor/sprayhead at a continuous rate of 76- and 152-liters per minute (20 and 40 gpm) respectively. Continuous operation was achieved by alternating between the two mixing tanks. The system was designed to allow for flushing the entire system with water at the end of daily operations, at shutdown, and/or at job completion.

Table 1. Design/Operational Requirements.

Mix Formulas

Description	Optimum	Intermediate	Heavy
BentoGrout % Weight	25*	30*	40**
Water per 23 kg (50 lbs.) BentogROUT - Liters (Gal.)	68 (18)	53 (14)	34 (9)
Specific Gravity (Slurry)	1.18	1.22	1.31

Batch Values

Description	Optimum	Intermediate	Heavy
Water Liters (Gal.)	668 (176.4)	646 (170.8)	299 (79)
BentoGrout Kilograms (Lbs.)	222 (490)	277 (610)	199 (439)
Batch Volume Liters (Gal.)	757 (200)	757 (200)	378 (100)

Mix Preparation

Optimum & Intermediate Mix Time	0	1	2	3	4	5
Water Addition	3 minutes					
BentoGrout Addition			3 minutes			
Final Mixing						1 minute

Heavy Mix Time	0	1	2	3	4	5
Water Addition	1.5 minutes					
BentoGrout Addition			2.5 minutes			
Final Mixing						1 minute

* Weight percent may vary by ± 2 .

** Weight percent may vary by -2.

The instrumentation and controls for the BentoGrout covering system, for the most part, were conventional electronic products with very few special devices. Figures 1 and 2 show the types of instrumentation and controls. BentoGrout handling and mixing measurement and controls included level, flow, pressure, speed, and power. The closed circuit television (CCTV) system to monitor the depositing of BentoGrout consisted of two cameras and two lighting bars of four lights each. These were introduced into the silos through the 500 millimeter peripheral manways. Cameras installed were provided with the capabilities to zoom, pan, and tilt. For the headspace within the domes of the silos, the dynamic measurements included temperature, differential pressure, relative humidity, and radon gas concentration for the purpose of providing logged information to prepare monthly and yearly monitoring reports.

With the exception of the distributor/sprayhead, all components of the system were commercially available. The distributor sprayhead was required to supply and distribute the slurry for even and controlled coverage of the silo contents. No readily-available equipment was found on the market that met the functional requirements. Potential equipment suppliers were contacted, but they could not meet the tight schedule (6 months) to develop and supply the necessary equipment. Some suppliers proposed extremely complex systems that would have taken even longer to develop and would have been prohibitively expensive. Now PARSONS was left with only one choice--to design the applicator system. The main criteria that had to be met by the design included:

- 1) Equipment to be lowered into the silos through the center manway (460-millimeter diameter available opening). The inserted sprayhead must be statically and dynamically balanced. No load is allowed on the silo dome within a restricted, capped center area of 9-meter diameter. During installation or operation, no live load exceeding 318 kilograms (700 pounds) is allowed at any point on the dome surface outside of the capped area.
- 2) Sprayhead discharge rate and flow direction must be controlled. The entire surface of the waste in the 24.4 meter diameter silo must be covered, preferably from the center manway only. The equipment must have the capability to cover "waste piles" located on the surface under all the manways by properly positioning sprayhead discharge and using intermediate or heavy BentoGrout slurry mixes.
- 3) Design shall accommodate the removal of manway covers from the positioned main basket in an airtight glove bag and shall accommodate the installation and operation of the equipment without permitting radon emissions to the atmosphere.

The distributor/sprayhead assembly is presented in Figure 3 and the installed equipment in operation is shown in Figure 4. The assembly consists of the following main components:

- 1) The **Quill Assembly** consists of the inner tube (1 inch) in a vertical position connected to the slurry feed line at the upper end through a rotating joint. At the lower end, it is connected to the two symmetrically-located distributor arms through a distributor assembly. To ensure that all equipment is dynamically and statically balanced, all rotating parts are symmetrically located. The inner tube is fitted, through the upper and lower sleeve bearings, into a center lift tube designed to be lowered and raised to vertically adjust the position of the arms infinitely through mechanical connectors. The center tube, together with the lift tube, are fitted into the drive tube, which is housed in an 8-1/2 inch support tube. The drive tube is supported by ball bearings at the upper and lower ends. The lift tube is equipped with a lift disc at its upper end to accommodate the positioning hydraulic cylinders. The support tube is anchored to the basket weldment floor plate, which supports the entire Quill Assembly.
- 2) The **Basket Weldment** assembly is a steel frame with welded construction. It is designed to support the quill assembly anchored in the center of the floor plate, the gear motor, the hydraulic

cylinders, and the hydraulic power unit. The basket weldment supporting the entire distributor/sprayhead assembly is fitted into a fabricated steel main basket where it is suspended from a chain hoist, and lowered and raised within predetermined limits. Guided movement of the basket weldment is provided by the traveling guides attached to the main basket. In addition, the entire basket assembly was balanced to maintain a true vertical. The drive tube is rotated at 0.5 rpm through a drive train consisting of a gear motor and chain drive.

- 3) A Hydraulic Power Unit, located in the basket weldment, provides motive power to the cylinders for the positioning of the spray arms.

Operation

Prior to the start of operation, the existing radon treatment system (RTS) was activated to reduce radioactivity dose to allowable reasonable levels on the dome surface. Air from the silo free board was removed by the RTS at a rate of 1,000 CFM and radon was removed on carbon canisters, then the air was recycled to the silo.

When the system was ready, the main basket containing the installed distributor/sprayhead assembly was attached to a mobile crane boom. Next, the suspended main basket was carried, then positioned over the center manway of the silo, and securely anchored to the ground. At this time, properly trained and suited operators attached the access ramp and entered the main basket. They connected the slurry supply and flush water lines, as well as electrical and instrumentation cabling. Furthermore, the manway cover was opened and removed in an airtight glove bag provided between the basket weldment assembly and the manway.

After overall system readiness was verified and acknowledged, the distributor/sprayhead was lowered into the silo. Insertion of the equipment was remotely carried out in the control room. The motion was closely monitored by CCTV cameras. Operators remained in the main basket, ready to override operations should that be required. The sprayhead was further lowered to a final position of about 500 millimeter over the center waste pile. The two spray arms were lifted up from vertical to 75 degrees. The sprayhead assembly rotation was started (0.5 rpm) and the operators were instructed to leave the main basket. Instruction was given to start the BentoGrout mix/supply system. Optimum mix (25% wt. solids) was prepared and, with a continuous rate of 152 liters per minute, was jetted into the silo by the distributor/sprayhead. The entire surface area was covered by spraying the BentoGrout slurry from the two arms on the rotating sprayhead. BentoGrout was applied starting at the silo wall and advancing concentrically toward the center.

Coverage was controlled by adjusting the angle of the arms and the height of the sprayhead above the surface and the slurry pressure to the sprayhead. Waste pile coverage was accomplished by applying heavy and intermediate mixes around the pile in layers. BentoGrout was applied in consecutive thin layers until a minimum thickness of 300 millimeters (1 foot) was achieved at any point. At this time, operation ceased. Lines and sprayheads were flushed and drained. Operators re-entered the main basket. Equipment was removed in reverse order of installation and the center manway cover was replaced in an airtight glove bag. After removing and safely discarding the glove bag, the operators left the main basket and readied it for removal. The main basket was transferred by the crane to its standby position on the ground. Operations were identical for both silos.

Coverage of the surfaces in both silos was completed in 1 week. Operations were smooth, with a minimum of downtime. The distributor/sprayhead system proved to be highly reliable in fully remote operation.

After emplacement of BentoGrout slurry into Silos 1 and 2, the total waste volume has been increased by 355 and 310 cubic meters, respectively. The depth of the BentoGrout layer over the residue surface

averaged 500 millimeters in Silo 1 and 670 millimeters in Silo 2. Radon gas concentration in the silo free board has been reduced from $25 - 30 \times 10^6$ pCi/l to 45,000 - 220,000 pCi/l, resulting in an overall reduction efficiency of 99.8 percent.

RETRIEVAL OF MIXED WASTES FROM CONFINED SPACES

SLURRY RETRIEVAL SYSTEM

Many of the same constraints on the application of the BentoGrout to cover the silo contents also apply to the retrieval of those contents. The severity of these constraints is more acute in the case of retrieval, as discussed later.

An integral part of remediating the Fernald site is the retrieval and treatment of the waste from the silos for stabilization prior to disposal. Several alternates for treatment and final disposal have been considered including vitrification, chemical separation, solidification, shallow burial, and deep geologic disposal. Common to all of these methods is the necessity of retrieval of the waste from the silos. The retrieval action is governed by the following parameters and/or constraints:

- 1) Access to silo contents is limited to five manways, 500 millimeters diameter (inside) each. The vertical projection of the four peripheral manways is equivalent to only 360 millimeters.
- 2) The system must be large enough to retrieve 15 tons of dry solids per day and must operate without imposing any loads on the silo structure. This requirement is extremely critical since the system operates 24 hours per day, 7 days per week, in all types of weather including high winds, tornadoes, heavy rain, and snow.
- 3) The system must be capable of mobilizing all the waste in the silo, conveying it outside the silo, and delivering it to the treatment facility. All this must be accomplished without breaching the integrity of the silo radon gas abatement system.
- 4) Foreign solid materials are present in the silos. These include pipe pieces, wrenches, wire, plastic sheets, cans, bottles, etc. which could have an impact on the method and equipment selected.
- 5) The system must be remotely operated and automatable. The ability to remove large quantities of waste from a single position (without being moved) is highly desirable. It must also be easy to maintain and decontaminate.
- 6) The system must be retrievable from the silo in case of failure.

As you can see, it should now be apparent that the retrieval of the silo contents in a safe and reliable way presented a major challenge. Several methods for removing the waste from the silos were considered. These included bucket elevator, auger screw, other mechanical systems, and the slurry method. This paper addresses only the slurry, or hydraulic mining, method.

Two slurry systems were evaluated. The first one consisted of a slurry pump supported by a cable, two independent and extendable water supply pipes, each with a nozzle at the end, supported from a telescoping pipe for rigidity. This option presented many problems:

- 1) It could not be reliably automated.
- 2) Certain modes of failure could make it impossible to retrieve the system from the silo.

- 3) Frequent movement of the assembly between manways would be required. This would result in prolonged work interruptions and would increase the danger of contact between the assembly and the silo dome, as well as increase the possibility of radon gas escaping to the atmosphere and the probability of worker exposure.
- 4) The necessity for frequent movement makes the installation less permanent and, therefore, more susceptible to the dangers of inclement weather.

The second slurry system evaluated, and selected, is a specially designed integrated slurry pump/water jets system that we call the "caisson." The caisson meets or exceeds all the constraints and criteria listed above.

The caisson system is based on proven technology and uses commercially available components. The caisson consists of a submersible slurry pump with a jet ring, two oscillating high-pressure water main jets, piping, cables, etc. that are integrated and mounted to a rigid pipe to form a compact and portable assembly.

The slurry pump is a high head, low speed centrifugal type. It was very important to select a pump with the highest ratio of impeller diameter to overall outside dimension that would fit through a hole of about 460 millimeters in diameter. Also, the pump must have a fairly flat performance curve to prevent upset conditions. The pump is driven by an electric motor.

The rigid pipe assembly consists basically of 8-inch stainless steel pipe that attaches securely to the top of the pump and extends through the manway when the pump is at the bottom of the silo. To the top of this pipe is welded a length of 4-inch stainless steel pipe to complete the caisson support system. This assembly provides the necessary rigidity and support and the ability to position the caisson vertically through the center dome manway. Split sleeves and easily removable roller bushings provide for vertical alignment of the rigid pipe and caisson without contact with the dome or manway. The rigid pipe also provides the conduit and/or support for the slurry and water pipes, hoses, and cables.

The two high-pressure water main jets are installed near the pump suction, 180 degrees apart. Each jet is at the end of its own water supply pipe that terminates in a rotary joint and hydraulic actuator outside the silo. The jets are oscillated about 240 degrees by the hydraulic actuators. The jet nozzle directs a stream of high pressure water at the consolidated material, at a slight upward angle. The slurried material then flows by gravity towards the pump suction, following the channel created by the jet stream. The angle of the nozzle is a function of the particle size distribution, viscosity, specific gravity, and distance.

The jet ring consists of a pipe ring mounted around the pump suction with small holes (or nozzles) directed in a generally downward direction below the pump. The jet ring is supplied independently from the same high pressure water source as the main jets. The jet ring serves to slurry the material immediately under and around the pump, thus allowing the caisson to sink into the material. Additionally, the jet ring provides water to prevent the pump from starving, when needed, and will be used for slurry density control.

The caisson is designed to retrieve 15 dry tons of K-65 material in 24 hours, based on a slurry density of 20 percent solids by weight. This very conservative approach was selected due to lack of characterization of the K-65 material at this time. However, analyses of the available particle size distribution and historical data indicate that the K-65 material could be retrieved at much higher slurry densities, which would ease the operational requirements of the caisson.

Installation

The entire caisson system is assembled outside the silo. A specially designed platform is rigidly installed over the silo manway. The caisson assembly is then lowered into the silo through the manway by a mobile crane. Moveable plates and roller guides on the platform are used to prevent any contact between the caisson and the silo dome or manway. The caisson is lowered until it reaches the consolidated material. The water and slurry lines and the electric cables are connected. The system is started (as described later) and the caisson is lowered to the desired position. The caisson is then anchored to the platform above the silo with lateral and vertical supports before becoming fully operational.

Expandable isolation bags will be used and strict procedures will be implemented to capture any radon gas escaping from the silo during deployment and operation of the caisson and to facilitate removal and replacement of the manway cover.

Operation

Once the pump inlet screen reaches the top of the waste material or the BentoGrout, water is supplied to the jet ring. The jet ring directs the water under and around the pump assembly, in a predetermined pattern, so as to slurry the material and allow the caisson to sink by gravity. Once the caisson is down to the desired or predetermined position and anchored in place, the main jets are started. After a slight delay to create a slurry pool, the pump is started. The density of the slurry discharge is then monitored and the flow of water from the jet ring and the main jets is varied until the desired slurry flow and density are achieved. When the system is thus balanced, it is placed in the automatic mode.

The automation system maintains the desired conditions by monitoring and controlling slurry discharge, water pressure, water flow, main jet oscillation speed, and flow through the jet ring. Additional control or fine tuning may be accomplished by varying the pump speed. The system will also record flow rates, pressures, slurry density and speeds that will form the basis for adjustments, if needed.

The caisson system operates fully submerged. It is anticipated that the caisson will be lowered to the bottom of the silo as quickly as possible and left to operate there for very extended periods of time. As the main jets oscillate through overlapping 240 degree arcs, they will slurry the waste around the pump, which discharges the slurry outside the silo. This action creates a cavity into which more material slides and is then slurried. This process continues until all the waste material above the plane of the main jets is removed.

Removal of the waste material remaining below the plane of the main jets will be considered the "cleanup" action. During this stage, accurate control of slurry density becomes difficult and the density could drop substantially. However, what is important at this stage is the removal of the material, not the rate of removal. The cleanup can be accomplished by manipulating the position of the caisson, replacing the main jet nozzles with specially designed "cleanup" nozzles, providing auxiliary lancing at the outer reaches of the silo, or any combination thereof. In all cases, variable or intermittent slurry pump operation may also be required.

The entire system is operated in balance. The water supply is monitored and compared to the slurry discharge. The flow rates are automatically adjusted to minimize the chance of increasing the water content of the waste in silo. Given the fact that the moisture content in the silos presently varies from about 25 percent to 65 percent, and based on our experience with this type of operation, we believe that the probability of a significant increase in the resident water content of the waste is very small. Water used in the slurry operation is recycled from the treatment facility. Additional water is made up from the process water system. Process water will be used to flush the system for shutdown or maintenance.

It is expected that the vast majority of the silo contents will be retrievable with this system (as a stand-alone from the center manway). Residue characterization may result in a need for auxiliary lancing of the residue along the heel of the silo during the final cleanup. This lancing will be performed with a simple pipe and nozzle arrangement through the peripheral manways without disrupting the operation. The slurried material will flow along the sloping floor of the silo to the low point where the slurry pump is located. If necessary, the pump system could be moved from one manway to another; however, conceptually, it will be located in the center manway. Retrieved waste, in slurry form, will be delivered to the processing facility without any additional handling except, perhaps, a booster pump. The slurried material will be double contained to minimize the possibility of spills, leaks, or contamination of the environment.

Any solid object encountered will simply sink straight down or even be pushed away from the caisson by the action of the main jets. These will remain in the silo to be retrieved later as part of the decontamination and decommissioning operation. However, the waste will be washed from these objects and be discharged by the pump. The impinging of the high pressure water stream on the silo wall will in no way affect the integrity of the silo. However, any loose material on the wall could be scabbled by the jet action and removed with the waste.

The environmental integrity of the silo is maintained through the use of isolation bags and enclosures around the support platform. The entire operation within the silo will be monitored by the CCTV cameras described earlier.

Conclusion

There are many sites that have mixed wastes in confined spaces that must be remediated. However, some immediate action may be necessary to minimize environmental impact while awaiting final remediation.

At Fernald, the short-term objective of mitigating radon gas emissions from the K-65 silos to the atmosphere has been successfully met through the application of Bentogrout slurry. We are confident that the other objective of retrieving the wastes from the silos for treatment and disposal will be similarly accomplished using the slurry retrieval system.

It is also important to note that relatively simple equipment can be quickly designed and built, based on proven technology and commercially available components, to satisfy sensitive and complex environmental functional requirements.

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REFERENCES

1. Westinghouse Materials Company of Ohio, November 1990. *Silo 1 and 2 (K-65 Silos) Removal Action Work Plan, Feed Materials Production Center* for the United States Department of Energy, Oak Ridge Operations Office.
2. Bechtel National Inc., July 1990. *Engineering Evaluation/Cost Analysis for the K-65 Silos Removal Action at the Feed Material Production Center, Fernald, OH* for the United States Department of Energy.
3. PARSONS, December 30, 1992. *Operable Unit 4 Remedial Action Conceptual Design Report* for FERMCO.

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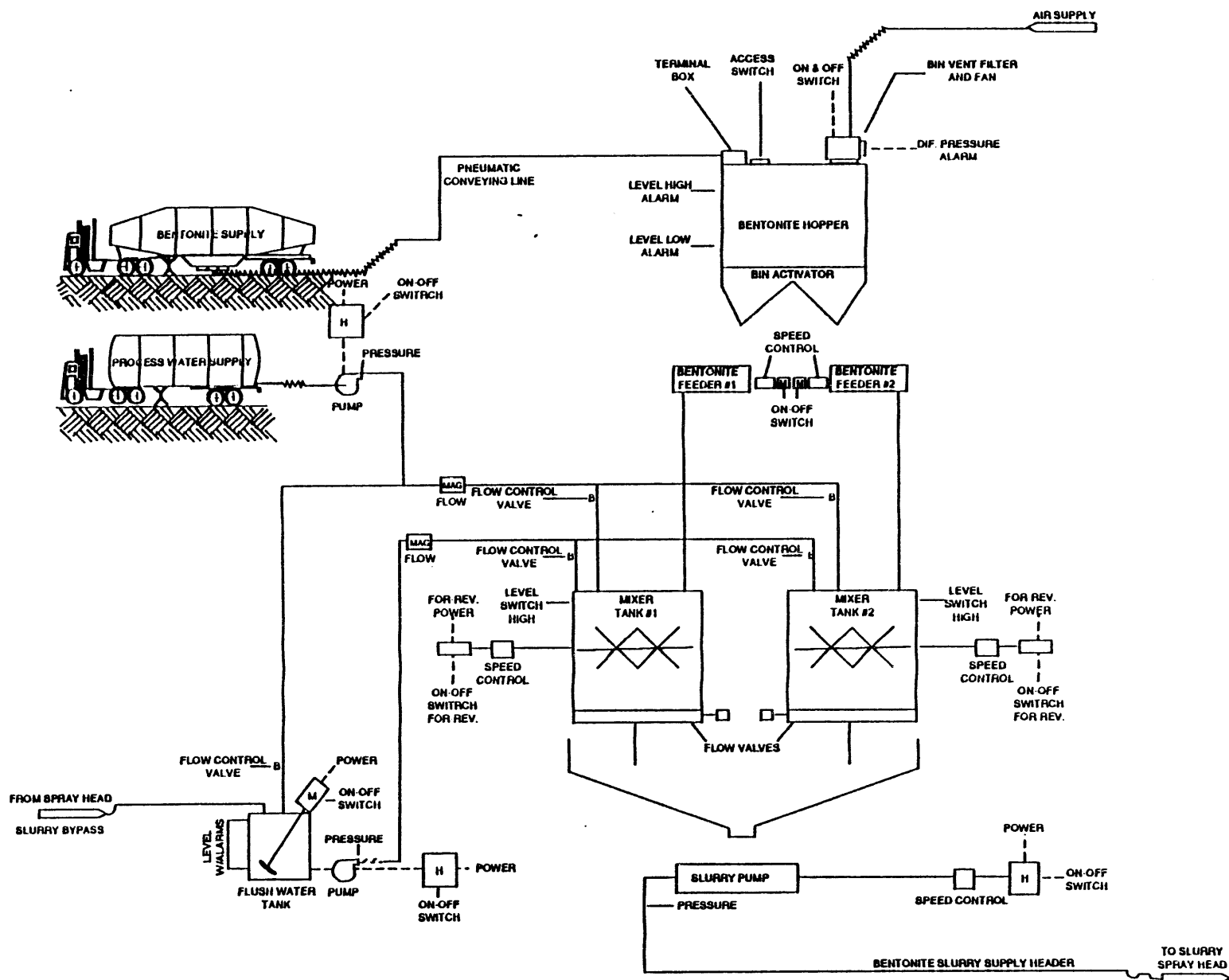


FIGURE 1
K-65 SILOS BENTOGROUT COVERING SYSTEM
MIX AND TRANSFER OPERATION

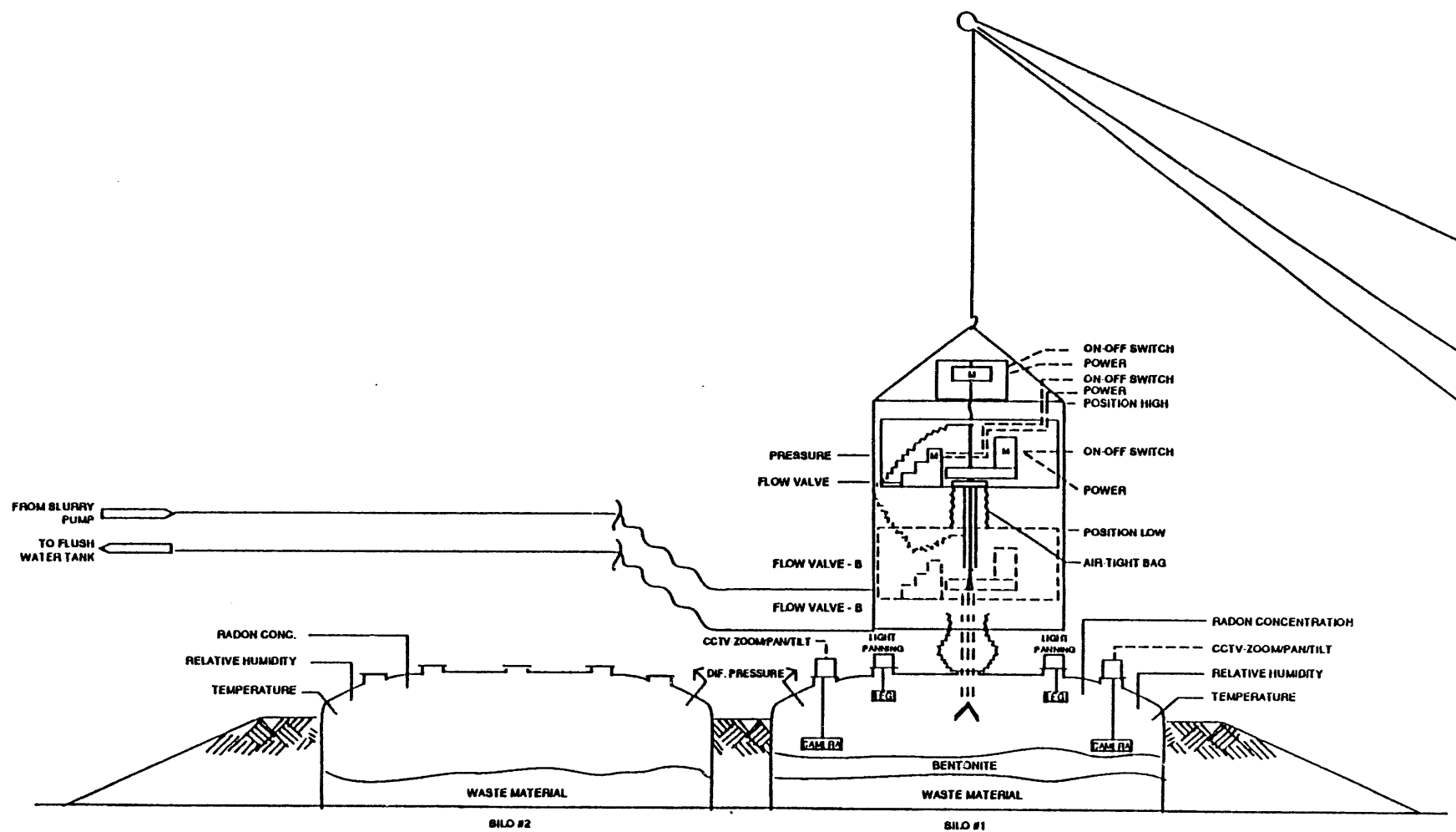
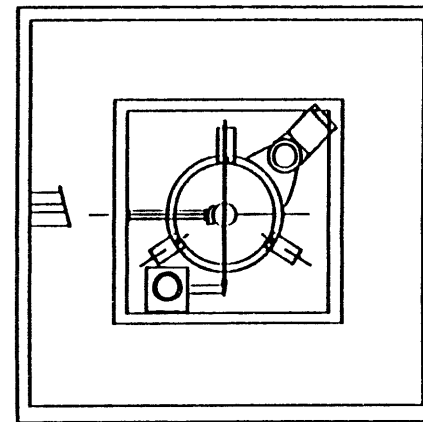
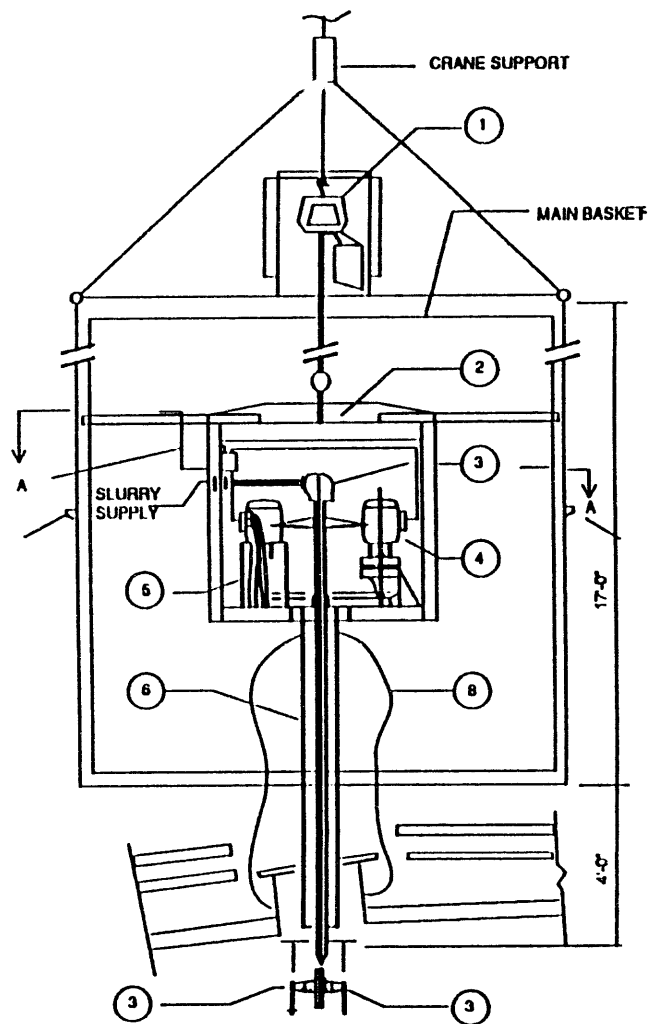


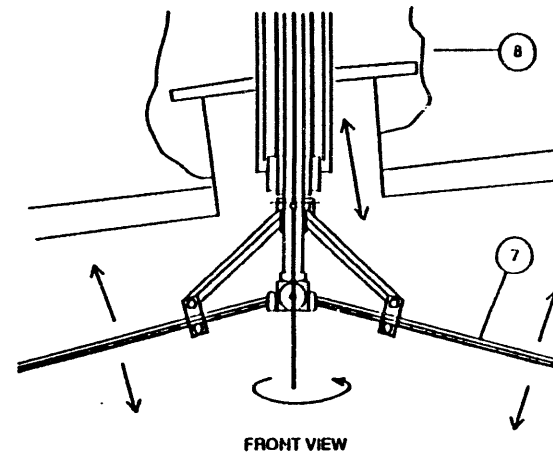
FIGURE 2
K-65 SILOS BENTOGROUT COVERING SYSTEM
DISTRIBUTOR/SPRAYHEAD OPERATION



SECTION A-A

MAIN ASSY.

- HOIST
- 2 BASKET
- 3 ROTATION JOINT
- 4 GEAR ROTOR DRIVE
- 5 HYDRAULIC ASSY.
- 6 QUILL ASSY.
- 7 DISTRIBUTOR ASSY.
- 8 GLOVE - BAG



FRONT VIEW

FIGURE 3
K-65 SILOS BENTOGROUT COVERING SYSTEM
DISTRIBUTOR/SPRAYHEAD

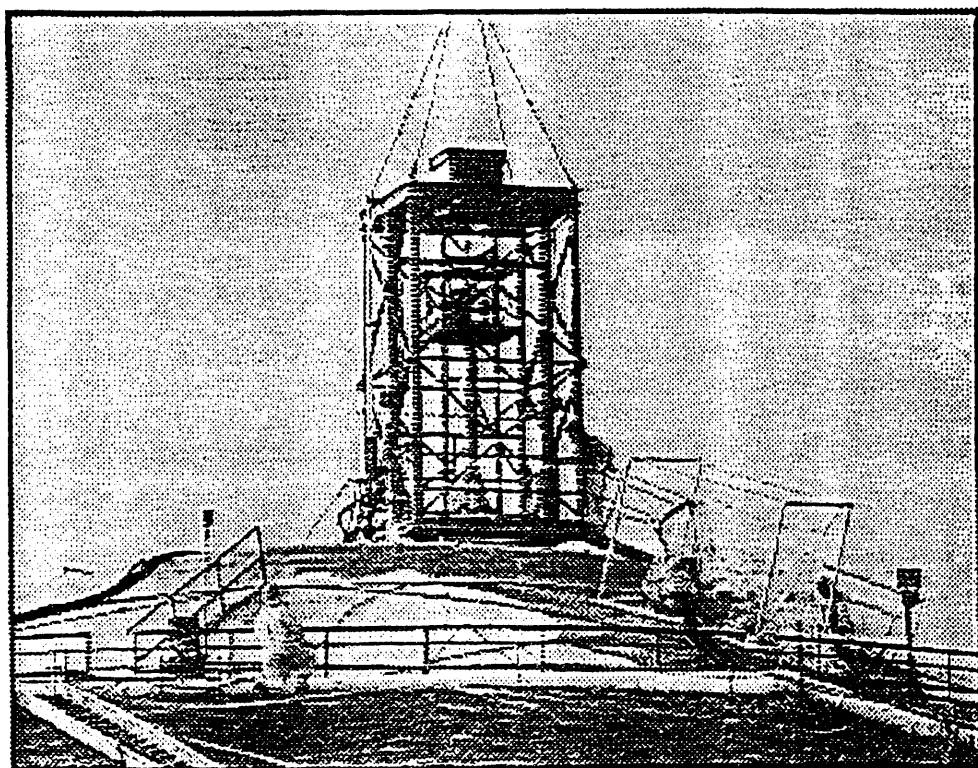
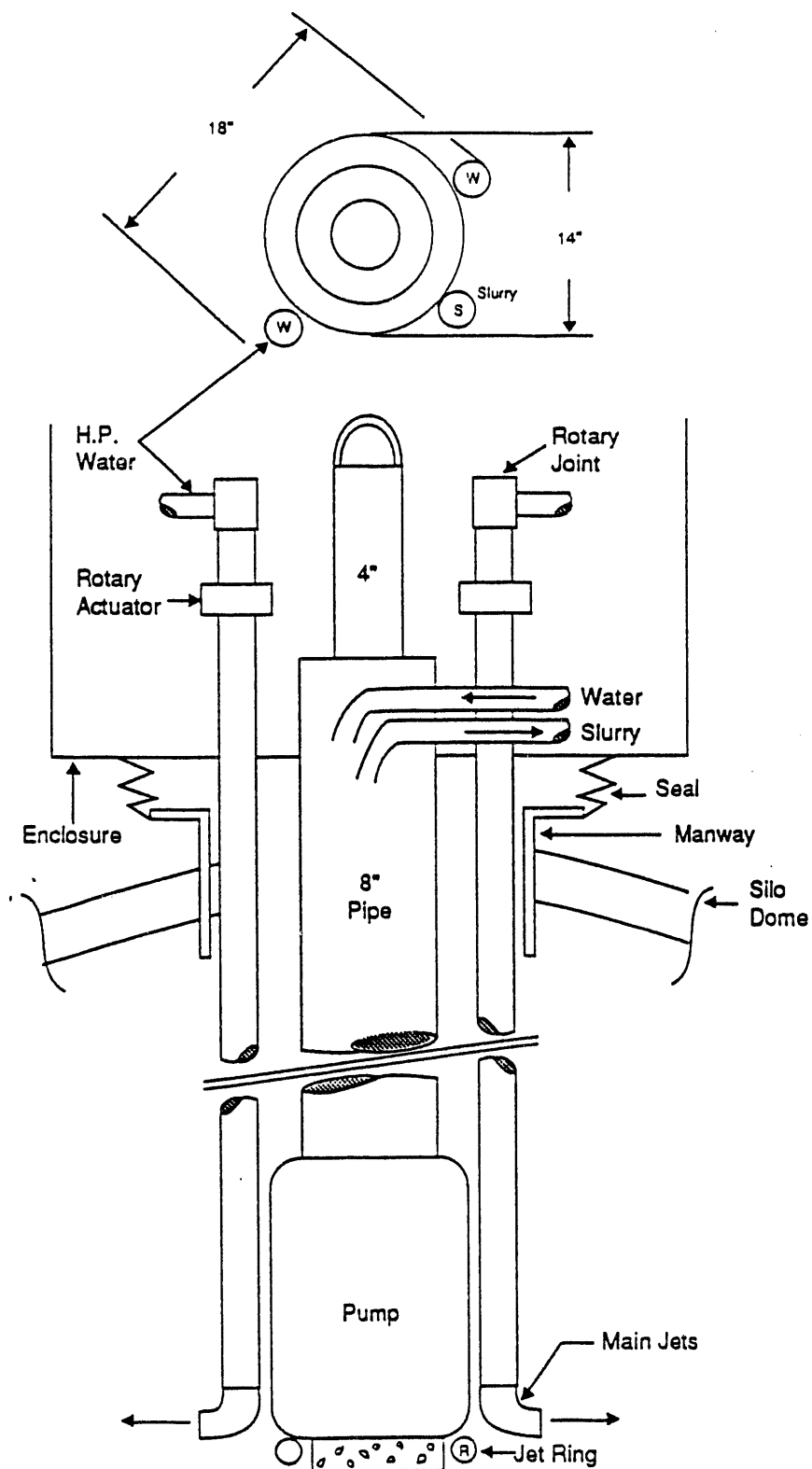


FIGURE 4

PLAN



ELEVATION

FIGURE 5
CAISSON ASSEMBLY
FUNCTIONAL

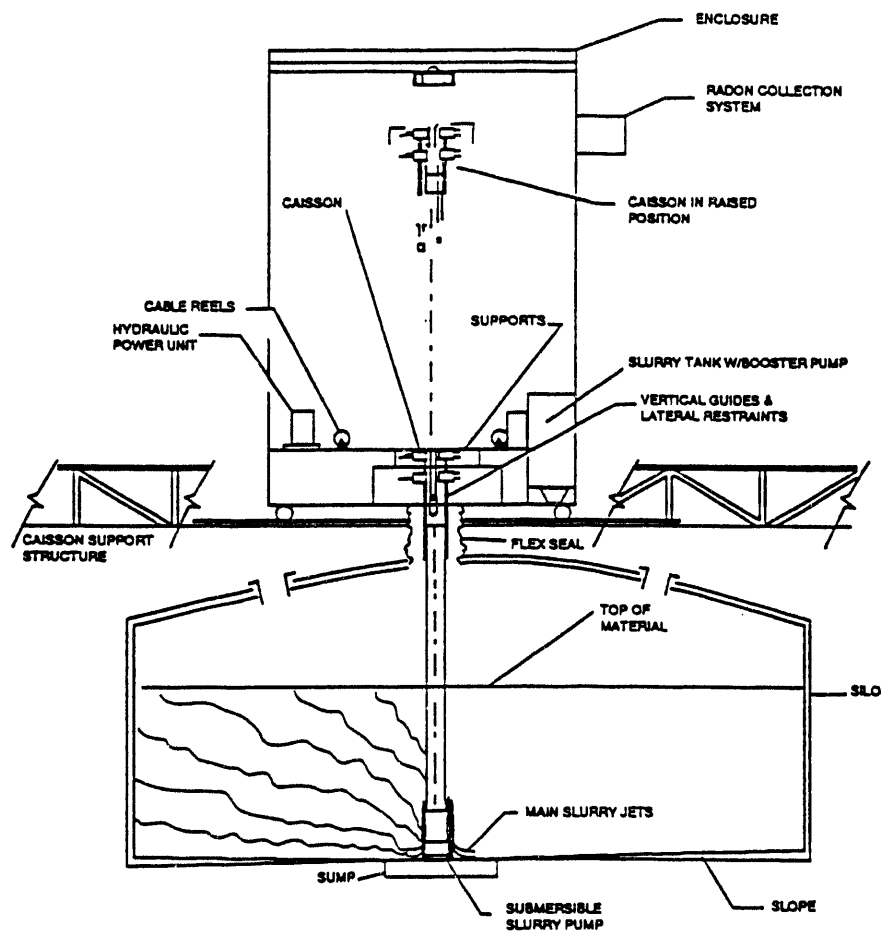


FIGURE 6
CAISSON DEPLOYMENT

END

**DATE
FILMED**

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