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SYSTEM DESIGN FOR RETRIEVAL OF SOLIDIFIED HIGH-LEVEL WASTES AT HANFORD

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DISCLAIMER

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ABSTRACT

A Waste Retrieval System has been conceptually designed as a step in the process toward the demonstration of the capability to retrieve the projected 36,000,000 gallons of radioactive salt cake and sludge wastes from underground storage tanks at Hanford. This functionally complete, totally remotely operable system consists of a large mobile platform containing all of the tools and equipment necessary to recover, remove and package the wastes for transfer to an onsite processing facility.

INTRODUCTION

High-level radioactive defense wastes resulting from the chemical processing of spent nuclear fuel for recovery of plutonium, uranium, and neptunium have been generated at Hanford since 1944 when the first facilities on the Hanford site were operated to produce and recover plutonium for the Manhattan Project. A total of eight graphite-moderated plutonium production reactors and one dual purpose reactor, producing both plutonium and steam, were eventually built at Hanford. At this time, however, only the dual purpose N Reactor remains in operation, with one fuel processing plant (Purex) being maintained in standby condition for intermittent operation as required by N Reactor plutonium production. At various times since 1944, four major chemical processing operations have been conducted. The Bismuth Phosphate, Redox and Purex processes were specifically designed for the recovery of plutonium. The Tributyl Phosphate process was designed for the recovery of relatively large amounts of uranium which remained in the Bismuth Phosphate waste. The more advanced Redox and Purex processes recovered the uranium as well as the plutonium on a current basis.

These processing wastes, containing most of the fission products and comparatively small quantities of uranium, plutonium and other actinides, were originally stored as liquid wastes (with significant amounts of solids in the form of precipitated sludge) in 149 underground, single-shell storage tanks.

There has been a continuous and evolving program for management and safe containment of these wastes. In 1957, steps were taken to develop a more definitive program to assure continued safe containment for greatly extended periods of time. This program, which is still being implemented, converts the high-level radioactive liquid wastes to less mobile forms which can be safely stored in existing tanks for at least decades. This current waste management (solidification) program will:

- Continue to store the water insoluble chemical fraction (sludge), which precipitated from the original liquid waste, in the existing single-shell tanks.
- Continue waste fractionization to remove, solidify, and store in double-walled metal capsules most of the ^{90}Sr and ^{137}Cs (the major heat generators).
- Pump drainable interstitial liquid from the solidified wastes contained in single-shell tanks (stabilization).
- Concentrate existing liquid wastes via evaporation to produce damp salt crystals (salt cake) for storage in existing single-shell tanks.
- Store the remaining nonevaporable liquid (residual liquor) in double-shell tanks.
- Continue storage of stabilized solidified wastes in single-shell tanks modified by sealing the tank against liquid intrusion from any credible source and confining the atmosphere in the tank, except for filtered airways for normal tank breathing and ventilation for temperature control where necessary (isolation).

High-level wastes have not been generated since the Purex Plant was placed in standby status in September 1972. Recovery of ^{90}Sr and ^{137}Cs from currently stored wastes (fractionization) is scheduled for completion by early 1980. Concentration of currently stored liquid wastes, and isolation and stabilization of single-shell tanks are scheduled for completion by late 1982.

Upon completion of the current fractionization and solidification programs in the early 1980's, the defense high-level waste inventory will consist of approximately:

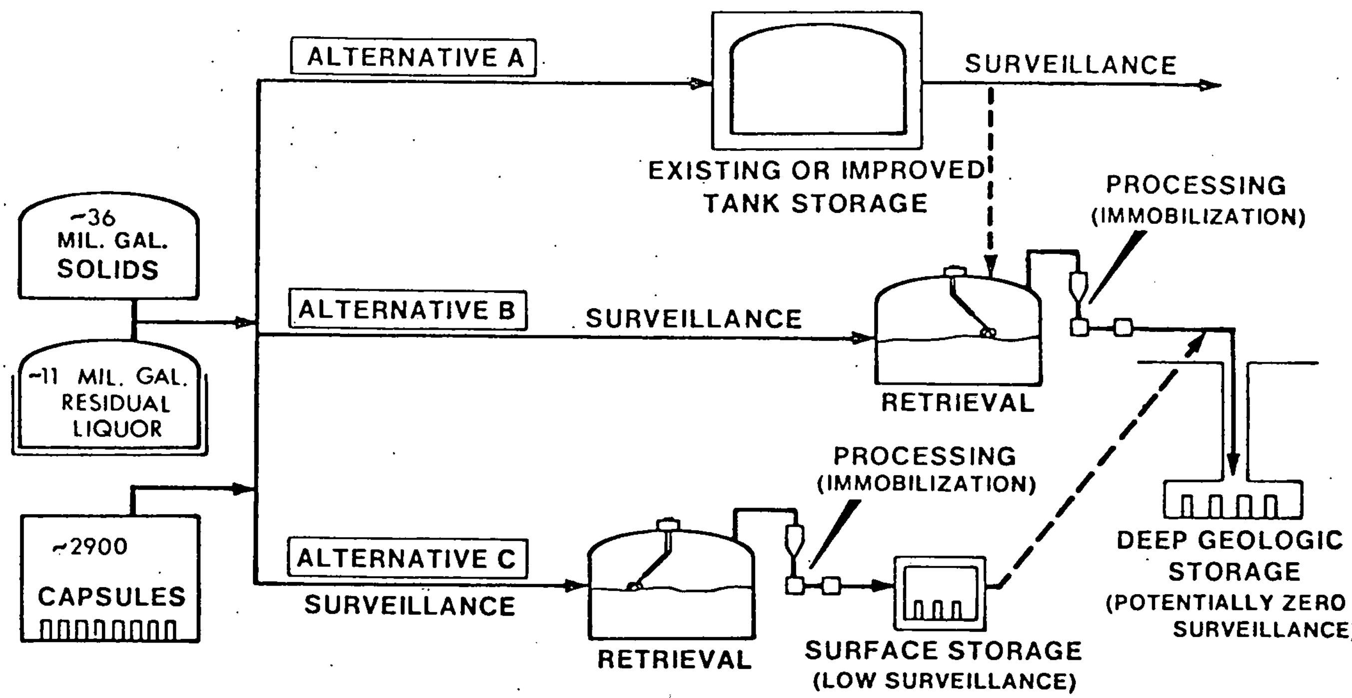
- 25,000,000 gallons* (bulk) of damp salt cake
- 11,000,000 gallons (bulk) of damp sludge
- 3,000,000 gallons of liquid wastes awaiting solidification
- 11,000,000 gallons* of residual liquor
- 2,900 capsules containing compounds of ^{90}Sr or ^{137}Cs.

*The quantity of residual liquor may be reduced and that of salt cake increased by the application of waste treatment techniques currently under study.

Resumption of Purex Plant operation, presently scheduled for September 1978, will result in the generation of a comparatively small volume of additional high-level wastes.

LONG-TERM WASTE MANAGEMENT PLAN

The objective of the Hanford Long-Term High-Level Waste Management Program is to develop, evaluate, and demonstrate the technology for long-term storage or final disposition of the high-level waste existing at the end of the current waste solidification program. The plan of this program includes three basic alternatives. First is the continuation of existing or improved tank storage, with assurance of waste isolation from man through continuing maintenance and surveillance. The second approach involves the retrieval of the wastes from the storage tanks, the processing of these wastes to a less mobile form, and storage in a deep geologic site (e.g., basalt) which has potentially zero surveillance requirements. The third alternative includes retrieval and processing (immobilization), but with storage in a surface facility requiring minimum surveillance. Before an alternative can be selected and put into operation, the various technologies must be developed and demonstrated, the alternatives assessed (cost and risk), and one or more environmental statements prepared and evaluated. This program is being carried forward under the direction of the Energy Research and Development Administration as an integral part of the expanded national program leading to safe, terminal storage of nuclear wastes.[3]



The present discussion addresses only the problem of the retrieval of solidified wastes from underground storage for subsequent processing — a task common to two of the three alternatives presented in the plan for the disposition of Hanford high-level wastes. The following paragraphs represent the plans and accomplishments to date for the technology development phase of the Waste Retrieval Task.[4] Work under this task will include conceptual designs and engineering studies leading to the design, construction, testing and demonstration of a functionally complete Prototype Retrieval System. Under current plans the capability of this sytem will be demonstrated first with nonradioactive tests in a Prototype Test Facility and, second, by retrieving wastes from one or more of the Hanford waste tanks. Items specifically excluded from consideration in this task are packaging of waste for offsite transportation, processing (including blending of waste types which may be necessary to provide suitable feed to the processing facility), and specific procedures for handling residual liquor and the stored capsules of concentrated ^{90}Sr and ^{137}Cs. Residual liquor, for example, can be handled using existing techniques of pumping and transport via underground piping.

WASTE STORAGE SYSTEM

In the beginning, to prepare storage for the waste streams from fuel processing using the Bismuth Phosphate process, the Manhattan Project plans called for the construction of 48 tanks of 533,000-gallon capacity and 16 of 55,000-gallon capacity. These tanks were constructed during 1943 - 1944 with the small tanks (55,000 gallons) designed specifically to receive plutonium concentration process waste. Additional underground storage tanks were built over the years to contain wastes generated by continued processing and, later, from newer and improved processing schemes. Following the original 64 tanks, 12 more 533,000-gallon tanks were built in 1946 - 1947. During the period from 1947 to 1952, a total of forty-eight 758,000-gallon tanks were constructed and, from 1953 to 1964, twenty-five 1,000,000-gallon tanks were constructed. All of these tanks were of the single-shell variety, with waste containment being provided by a carbon steel vessel surrounded by a reinforced concrete, domed structure. These tanks ~~and the later double-shell~~

~~tanks~~ are illustrated in Figure 1, and the distribution of tanks by area and size is shown in Table I. Of the total 149 single-shell tanks, 68 are presently on inactive status; and of the remaining 81, only 19 are scheduled to receive additional solidified wastes (i.e., salt cake).

TABLE I

Starting in 1968, double-shell tanks were built to contain aging waste, residual liquor, and drainable interstitial liquid pumped from the solidified wastes stored in single-shell tanks. This action was required because some of the tanks had developed leaks. These double-shell tanks (a total of 19 built or under construction), consist of a complete free standing, carbon steel primary tank within a carbon steel secondary shell, which is in turn contained within a reinforced concrete structure.

The basic shape of the tank interior and typical location relative to the ground level is shown in Figures 2 ~~and 3~~ for each size ~~for type~~ of underground storage tank. Depths from ground level dimensions are approximate, since tanks are typically emplaced in farms in rows with 1-foot steps in elevation so that fluid will overflow (cascade) to a tank in the adjacent row.

Typically, tank domes contain a large number and variety of penetrations, not all of which are connected to the surface via risers. Following the ground rule that full use of existing penetrations will be made so that a minimum of risers need be added, the following illustration (Figure 3) shows all dome penetrations 30-inches wide or greater. Equally significant to the design of the Waste Retrieval System, however, is the precise location of dome penetrations, both radially from the tank center as well as orientation with respect to the rows and columns of tanks. The 12 tank farms with large single-shell tanks shown in Figure 3 represent seven distinct arrangements of large penetrations. All manholes appear to be capped and/or plugged at the dome; some risers stop a short distance above the domes while others end at the bottom of concrete sluice pits.

An additional factor bearing on the Waste Retrieval System configuration is the arrangement of tank farms in rectangular patterns of rows and columns. The 533,000-gallon tanks (B, BX, C, T, and U) are emplaced at intervals of 100-feet; while the 758,000 and 1,000,000-gallon (single-shell) tanks are at 102-feet spacing (A, AX, BY, SX, and TY). The newer 1,000,000-gallon double-shell units are on a center-to-center spacing of 107-feet. ~~The 55,000-gallon tanks are emplaced at 50-foot intervals in a row 100 feet from the adjacent row of larger tanks.~~

The bulk of the solidified wastes (more than 99%) is contained in the large (75-foot diameter) single-shell tanks. These tanks are located in two general areas of a high-standing terrace (200 Areas plateau) separated by about 5 miles. Within each of these areas the tanks have been built in individual arrays (farms) of 4 to 18 tanks (see Table I) with the tank farms extending over a distance of approximately 1 1/2 miles in each area.

WASTE TANK CONTENTS

Because different nuclear fuel processing schemes were used over the years, as well as a variety of blending, evaporation and admixture schemes, the waste is extremely varied from tank to tank in chemical and radionuclide content and/or physical characteristics.

To proceed as quickly and as efficiently as possible with the design of a complete Waste Retrieval System, substantial knowledge of the quantity and quality of each waste type (especially physical characteristics) would be required. Both of these features, however, are a function of time due to ongoing use of vacuum-evaporator crystallizers, salt-well pumps, the encapsulation process, addition of desiccants, etc. Additional information as to the physical, chemical, and radionuclide characteristics of the waste material will be forthcoming from the Waste Characterization Program and will be incorporated into the present effort as it becomes available.

The distribution of solidified wastes by Area and by tank size is shown in Table II. Further description of the high-level wastes has been obtained from process flow sheet compositions, essential material consumption records, and recorded waste volumes sent to underground storage. The most significant characteristics of the wastes are listed in TABLE III, Average Chemical Composition; TABLE IV, Most Abundant Radionuclides; and, TABLE V, Estimated Actinide Contents.

DESIGN CONSIDERATIONS

The objective of this task is to develop and demonstrate the performance of a retrieval system which has the functional capability to retrieve material from Hanford waste tanks in a safe, efficient, and cost-effective manner. (Phase I: Technology Development). This Prototype Retrieval System would provide the basis for the construction of systems which could be required to perform the ultimate task of the removal of all Hanford high-level wastes for processing and terminal storage (Phase II: Operational) should the decision be made to do so.

Assumptions and conditions affecting the design of the retrieval system include the following:

- direct, additional loads shall not be imposed on the tank domes or risers,
- requirements for additional risers and site preparation shall be minimized,
- the uncontrolled addition of water may not be desirable,
- in-tank equipment (principally air-lift circulators and debris must be separately removed,
- the design of waste material handling equipment will be affected by lack of specific knowledge of physical and chemical properties, and radionuclide content of the waste,
- uncertainties exist in the feed quantity and quality requirements of the Waste Processing Task, and
- environmental, safety and quality assurance considerations will be significant factors in the Waste Retrieval System design and transport mode selection.

With consideration of the above factors and the size, shape, and location of the larger of the dome penetrations, a retrieval system configuration based on a large mobile platform appears worthy of further engineering study. This platform, sized to the approximate 100-foot tank spacing, will support the waste handling apparatus and contain all auxiliary systems necessary for the safe, cost-effective, remote recovery, removal and containerization of the wastes. To gain entry through a central 42-inch riser, reach allpoints within the largest of the 75-foot diameter tanks and maneuver around in-tank obstacles, a hydraulically actuated, articulated arm will be used. This mechanical arm will serve to support and position a variety of waste handling tools. This Prototype Retrieval System will be completely equipped for remotely controlled retrieval operations and will require only electric power and water. "On-board" equipment and functions will include: tool racks and tool change capability, a maintenance and repair cell with appropriate shielding and electromechanical manipulators, a waste packaging and handling section, the means for disposing of debris and obstacles removed from the tanks equipment decontamination facilities. A filtered ventilation system will be coupled to the tank to control radioactive particulate emissions to the environment.

Subsystem and component design will emphasize simplicity and ruggedness, since low maintenance and high reliability are essential for cost-effective, long-term retrieval operations. Because safety and environmental considerations are of paramount importance, substantial effort will be devoted to designs and systems analyses to assure personnel safety and preservation of the environment from radioactive contamination.

SYSTEM CONCEPTUAL DESIGN

The following description of the Prototype Retrieval System's arrangement and components is based on a recently completed, detailed conceptual design in which the assumption was made that the basic mode of retrieval operations will be mechanical mining with containerization and transfer to a processing facility in large (approximately 700 gallon) containers. If further information on waste characteristics and processing methods should indicate otherwise, alternate handling and shipping techniques would be employed. For example, consideration has been given to controlled water addition and transfer of the resulting slurry via tank truck or pipeline.

The plan and profile of the system is illustrated in Figures 4 and 5, respectively. The retrieval equipment is housed in a T-shaped structure (platform) which spans a tank so as not to impose loads on the tank dome. Tracked, powered transporters at each of the three ends of the structure are used to move the waste retriever from tank to tank.

Waste material is removed from a tank by means of an articulated, hydraulically actuated arm which operates through a 42-inch diameter riser in the center of the tank dome. The arm is mounted on an electrically powered telescoping hoist which travels within a tower located in the center of the platform structure. The arm can be withdrawn from the tank for tool changing, maintenance, and moving between the tanks. A variety of remotely interchangeable tools used to remove pipes and other obstacles from the tank, break up hard waste material, move waste material to an elevator and perform the final tank clean-up are located in the platform area adjacent to the arm. The arm with its tools can reach any location within a tank and can be placed into an operating configuration in a fully filled tank.

Tools are removed from a place on the outer end of the arm by a tool change machine. Tools are stored in racks which can be reached by the tool change machine or a two-ton crane. Since the tools are the items which will become the most contaminated, each time a tool is removed from the arm by the tool change machine, it is moved to a wash station. After washing the tool can be returned to its storage rack or into the maintenance room for repair. The maintenance room has an overhead monorail hoist and a floor mounted tool maintenance cart for handling tools during washing and maintenance. With the tools washed, contact maintenance can be performed. The maintenance room has side doors through which tools and other items can be delivered and shipped, and a storage area for spare components.

A personnel room next to the maintenance room has lockers and showers for maintenance personnel. A personnel corridor running the length of the main structure allows viewing and location control of all operations. Shielded windows are provided for viewing.

Waste material picked up by the arm is moved to an elevator which operates through a 42-inch diameter riser located 20 feet 9-inches from the tank centerline. The elevator, mounted in a tower similar to the articulated arm, carries material deposited by the arm up into a shielded filling room within the structure. A bucket on the elevator is pivoted to a position over a shielded shipping container used to transport material to the processing plant. The bottom of the elevator bucket is opened and the waste material placed in the shipping container.

Shipping containers are moved into and out of the filling room by a turntable which passes through two shielded air locks. These provide shielding and air restriction between the filling room and the unshielding shipping and receiving room. Each shipping container, received by trailer from the processing plant, is inside a sealing container which provides double containment during transport. The sealing container never enters a contaminated area. The containers, which are washed prior to leaving the processing plant, are removed from the trailer by a 20-ton crane which services the System shipping and receiving room. The crane removes the lid of the sealing container, lifts out the shipping container and places it onto the turntable. After the shipping container is moved to the filling station next to the elevator, a lid handling machine removes the lid and moves it to a storage position. When the shipping container is filled, the lid handling machine replaces and latches its lid and the turntable moves the filled container into the wash station. After the washed container is moved to the shipping room, the overhead crane places the shipping container into the sealing container, places and latches the lid on the sealing container and places them on the trailer for transport back to the processing plant. The trailer is 10-feet wide and has a latching and energy absorbing mounting to secure the containers to the trailers. The turntable method of moving shipping containers into and out of the filling room provides a production method of operation to provide a maximum continuous amount of waste material throughput. Three shipping containers are in process simultaneously within the Retrieval System platform, one being loaded onto or off of the turntable, one being filled and the third being washed.

An electromechanical manipulator, which runs on the same rails as the two-ton crane, is stored in the maintenance room. By means of remotely operated doors, the manipulator can be moved into the articulated arm area and the filling area to accomplish various maintenance and clean-up tasks. For example, periodically the manipulator is used to remotely operate wash water hoses installed in the filling room and mining boom room for washing down the equipment, walls and floors in these rooms. Floor drains return the water to the wash water system.

Air pressure within the System is maintained at a slight negative gage pressure by a ventilation unit mounted over a small diameter riser in the tank. A standby diesel generator is provided to keep the ventilation system operating in the event of a main power failure. These measures minimize the possibility of radioactive release from the System.

In-tank viewing is provided by television cameras and lights mounted on vertically positionable supports which extend into the tank through small diameter tank risers.

Television cameras also are provided for viewing of remotely-controlled operations performed in the above-ground portion of the System.

The primary control center for the Prototype Waste Retrieval System is in a trailer located near the main structure from which all of the equipment of the System can be controlled remotely. Human engineered controls and displays provide convenient, efficient operation. A mini-computer is used to operate the System in an automatic mode. This assures a maximum continuous operation rate and reduces operator fatigue and chance for error.

A power center room is located in the main structure.

General features incorporated in the Prototype Waste Retrieval System

- Provisions for continuous, all weather operation are included. Working areas are heated, cooled and lighted as required.
- No water is put into waste tanks. All water used in washing boom tools and shipping containers is used to flush the elevator bucket and thus is placed into shipping containers and sent to the processing plant.

- Instrumentation is included as required. Radiation montiors and pressure and temperature sensors are located at appropriate places and displayed in the control center.

The Prototype Waste Retrieval System conceptual design presented in this report meets the requirements for a functional and safe means of removing defense waste material from underground storage tanks and shipping it to a processing plant.

ACKNOWLEDGEMENTS

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References

1. ERDA-1538, December 1975, "Final Environmental Statement - Waste Management Operations, Hanford Reservation, Richland, Washington"

2. ARH-LD-142, June 1976, Compiled by D. D. Wodrich, "Hanford Long-Term High-Level Waste Management Program Plan - Phase I: Technology Development"

3. New Release RLO-76-8, February 19, 1976, "ERDA Administrator Announces Expanded Program in Management of ERDA, Commercial Nuclear Wastes," Richland Operations Office, U. S. Energy Research and Development Administration, Richland, Washington

4. ARH-LD-144, December 1976, Harvey A. Wallskog, "Program of the Hanford High-Level Waste Tetrieval Task - A Narrative Description"

TABLE I

HANFORD HIGH-LEVEL WASTE STORAGE TANKS

		TANK CAPACITY IN GALLONS					
		DOUBLE SHELL[c]	SINGLE SHELL				
AREA		1,000,000	1,000,000	758,000	533,000	55,000	TOTAL
200 EAST	BY FARM	AY 2, AZ 2, AW 6[a], AN 6[b]	A 6, AX 4	BY 12	B 12, BX 12, C 12	B 4, C 4	
	SUBTOTAL	16	10	12	36	8	82
200 WEST	BY FARM	SY 3	SX 15	S 12, TX 18, TY 6	T 12, U 12	T 4, U 4	
	SUBTOTAL	3	15	36	24	8	86
TOTAL		19	25	48	60	16	168

a UNDER CONSTRUCTION   b PLANNED FY 1977   c ADDITIONAL TANKS ARE PLANNED FOR FY 1978

TABLE II

SUMMARY OF WASTE TANK SOLIDS CONTENT [a] PROJECTED TO END OF CY 1980

BULK VOLUME OF SOLIDS [b] (MILLIONS OF GALLONS)

TANK CAPACITY GALLONS	200 WEST AREA	200 EAST AREA	TOTAL
1,000,000	4.8	2.4	7.2
758,000	13.3	4.6	17.9
533,000	5.1	5.1	10.2
55,000	0.2	0.2	0.4
TOTAL	23.4	12.3	35.7

a FOR DETAILS, SEE [redacted]. REF. 4.

b SOLIDS ARE COMPOSED OF SLUDGE AND SALT CAKE

TABLE III Average Chemical Composition of Hanford High-Level Wastes

Chemical	Salt Cake	Sludge	Residual Liquor	Total
	Wt.%	Wt.%	Wt.%	Wt.%
$NaNO_3$	84.5	17.2	12.1	50.9
H_2O	10.3	35.8	47.1	25.1
Na_3PO_4	0.1	22.6	--	5.9
NaOH	1.5	3.2	14.3	4.8
$NaNO_2$	1.7	3.7	12.3	4.6
$NaAlO_2$	1.4	3.1	11.7	4.1
Na_2CO_3	0.5	2.2	0.8	1.0
Na_2SiO_3	--	2.9	--	0.7
Al_2O_3	--	2.3	--	0.6
$Fe(OH)_3$	--	1.8	--	0.5
Na_2SO_4	--	1.1	0.5	0.4
Other	--	4.1	1.2	1.4
Totals	100.0	100.0	100.0	100.0

TABLE IV Most Abundant Radionuclides in Hanford High-Level Wastes — Decayed to 1990

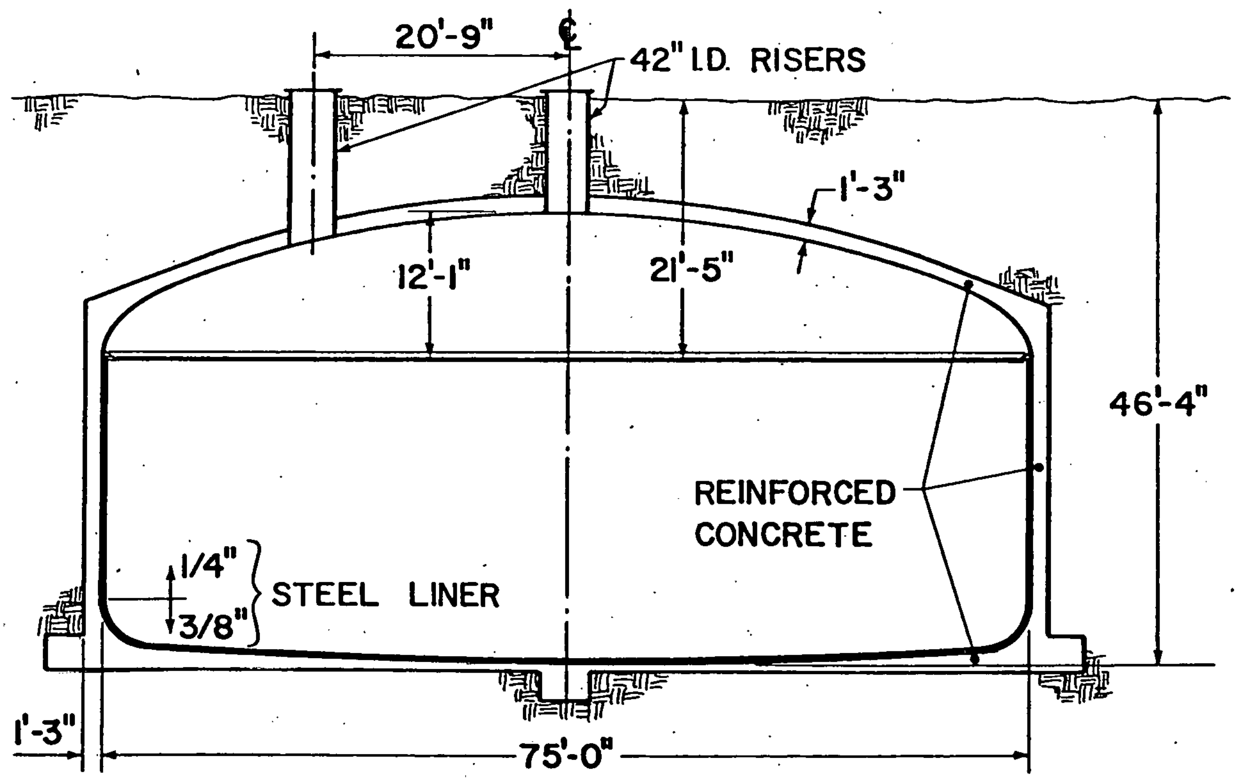
	Curies				
Radionuclides	Salt Cake	Sludge	Residual Liquor	Capsules	Total
^{90}Sr	$2. \times 10^6$	4.5×10^7	6.0×10^5	5.8×10^7	1.06×10^8
^{137}Cs	$5. \times 10^6$	5.0×10^6	1.8×10^7	1.0×10^8	1.3×10^8
^{239}Pu	Trace	2.1×10^4	Trace	--	2.1×10^4
^{240}Pu	Trace	5.2×10^3	Trace	--	5.2×10^3
^{241}Pu	Trace	6.0×10^4	Trace	--	6.0×10^4
^{241}Am	Trace	5.0×10^4	Trace	--	5.0×10^4

TABLE V

TANK FARM ACTINIDE CONTENTS, ESTIMATED, KILOGRAMS

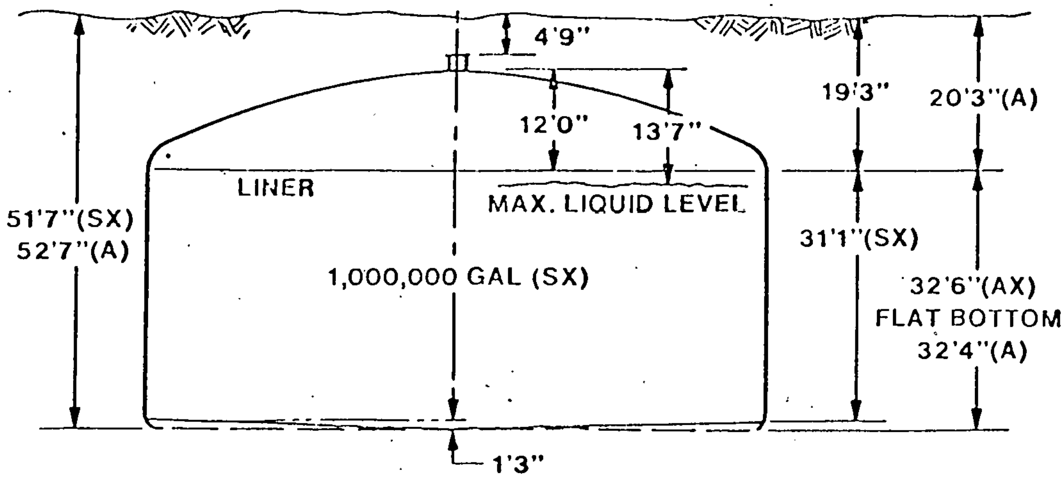
TANK FARM	U TOTAL	^{235}U	^{233}U	$^{239+240}Pu$	^{232}Th	^{237}Np
A	55,000	360	1	99	390	0.4
AX	8,000	60	3	18	1,100	2.2
B	47,000	310	-	20	-	-
BX	67,000	440	-	11	-	-
BY	154,000	1,010	-	25	-	-
C	178,000	1,190	38	69	13,000	5.1
S	40,000	270	-	27	-	-
SX	48,000	320	-	45	-	-
T	52,000	340	-	32	-	-
TX	127,000	840	-	10	-	-
TY	32,000	210	-	7	-	-
U	90,000	590	-	3	-	-
TOTAL	900,000	5,900	42	370	14,500	8

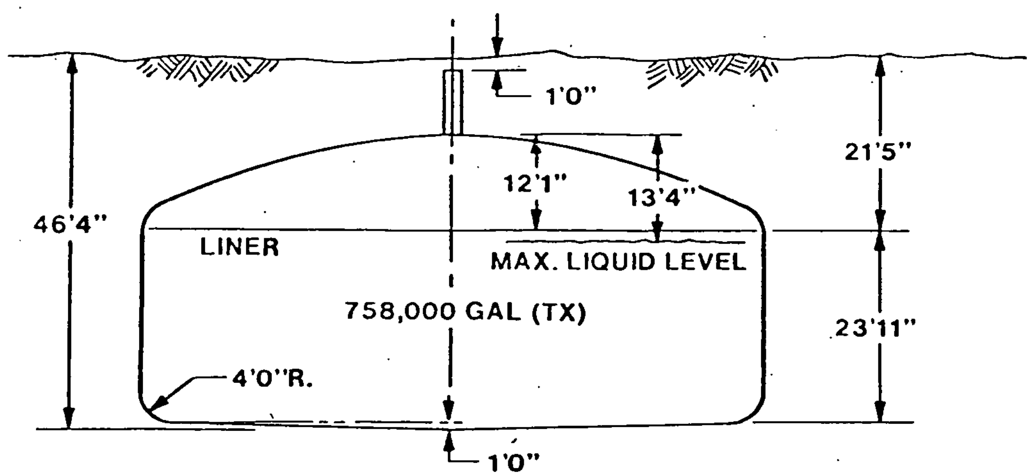
FIGURE TITLES

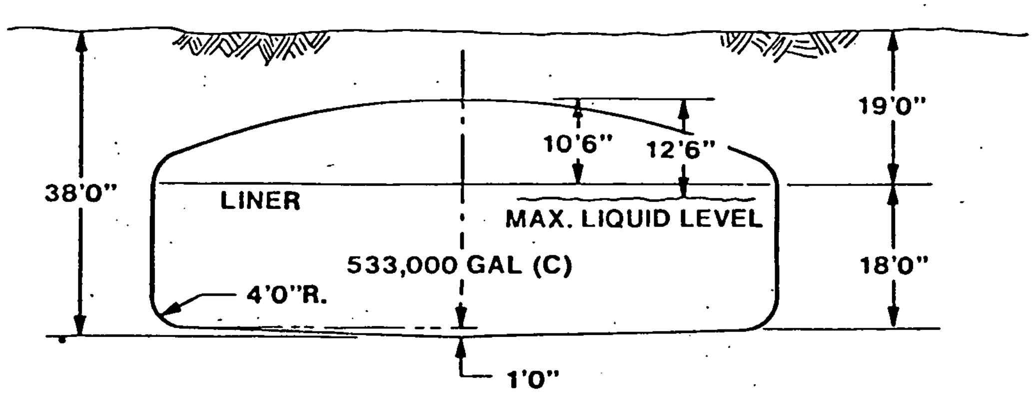


20'-9"
℄
42" I.D. RISERS
1'-3"
12'-1"
21'-5"
46'-4"
REINFORCED
CONCRETE
1/4"
3/8"
STEEL LINER
1'-3"
75'-0"

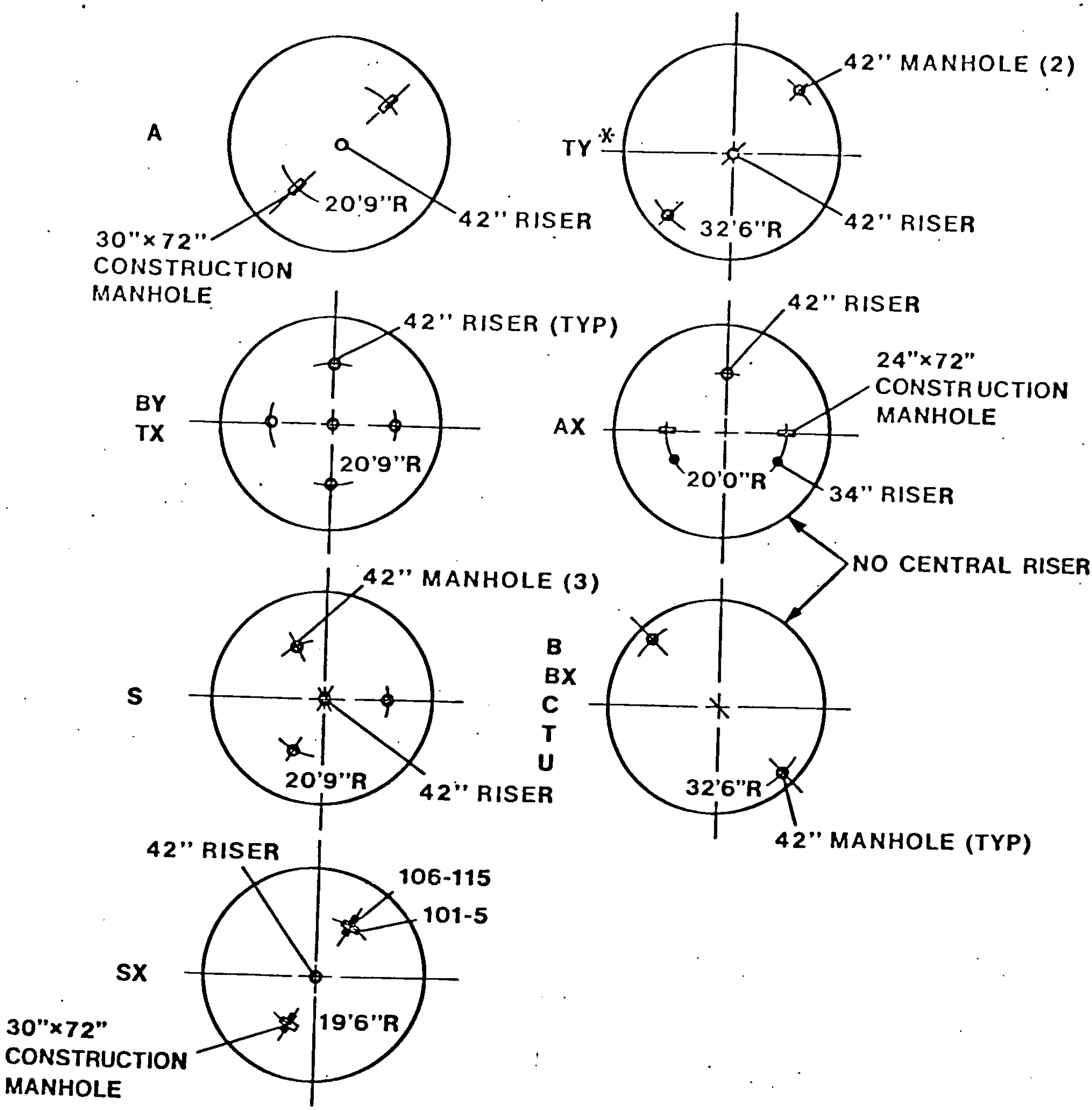
SINGLE SHELL TANKS - 75 FEET DIAMETER



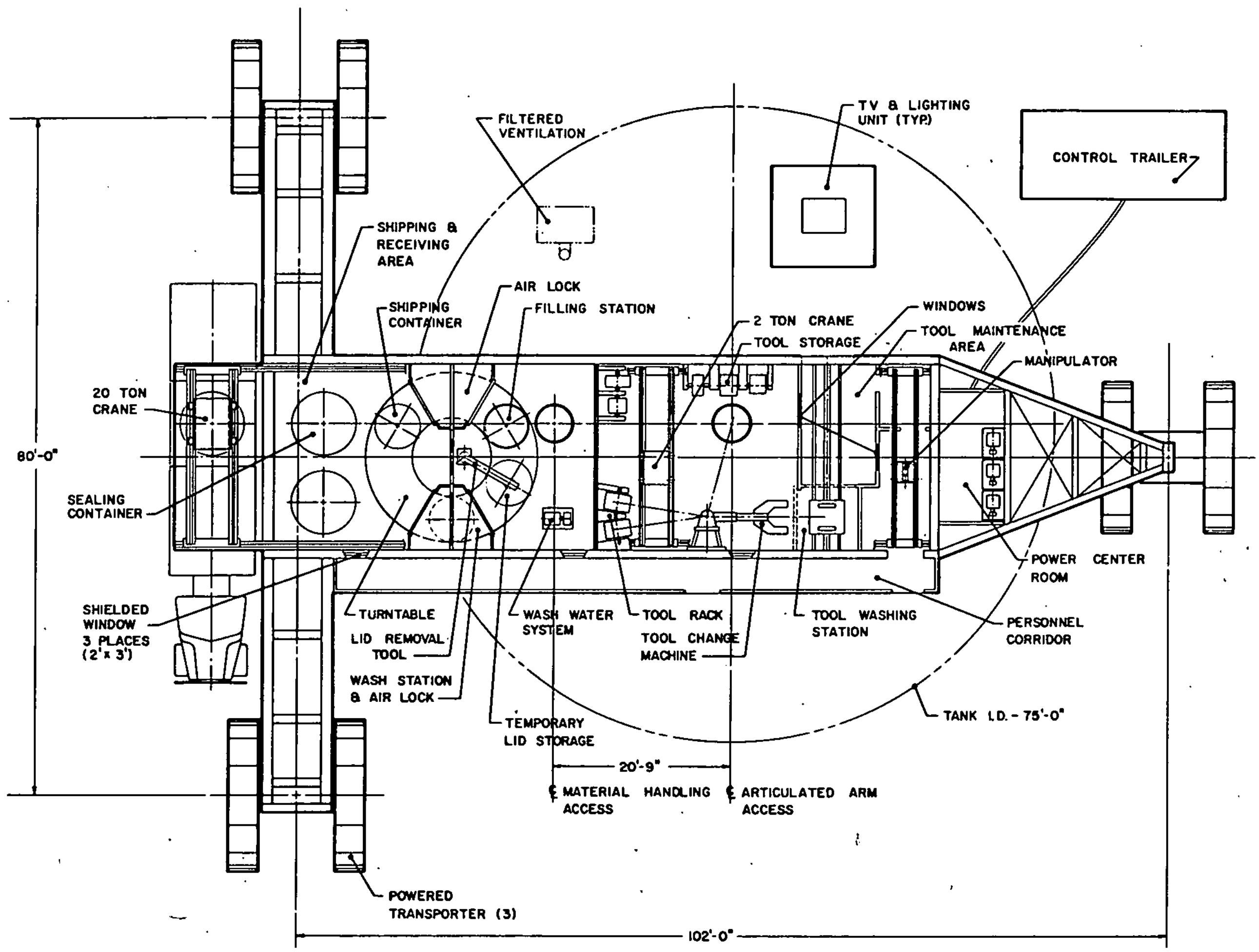




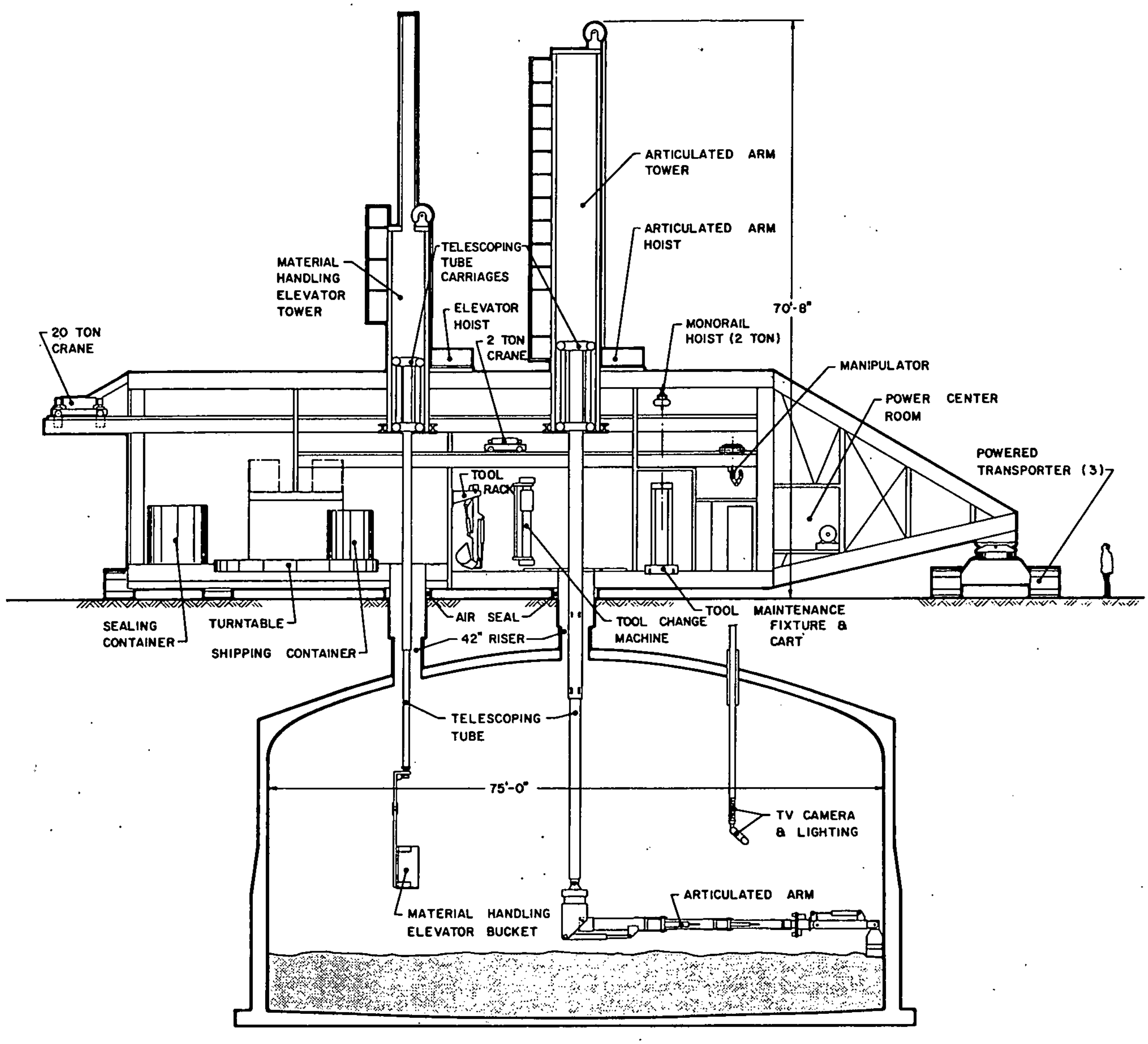
SINGLE SHELL TANKS



* TY TANKS CAN BE GROUPED WITH (B,BX,C,T,U) WITH THE ADDITION OF CENTRAL 42" RISERS TO THE LATTER.



FILTERED VENTILATION
TV & LIGHTING UNIT (TYP.)
CONTROL TRAILER
SHIPPING & RECEIVING AREA
AIR LOCK
SHIPPING CONTAINER
FILLING STATION
2 TON CRANE
TOOL STORAGE
WINDOWS
TOOL MAINTENANCE AREA
MANIPULATOR
20 TON CRANE
80'-0"
SEALING CONTAINER
POWER CENTER ROOM
PERSONNEL CORRIDOR
SHIELDED WINDOW 3 PLACES (2' x 3')
TURNTABLE
WASH WATER SYSTEM
TOOL RACK
TOOL WASHING STATION
LID REMOVAL TOOL
TOOL CHANGE MACHINE
WASH STATION & AIR LOCK
TEMPORARY LID STORAGE
TANK I.D. - 75'-0"
20'-9"
℄ MATERIAL HANDLING ACCESS
℄ ARTICULATED ARM ACCESS
POWERED TRANSPORTER (3)
102'-0"


ARTICULATED ARM TOWER
ARTICULATED ARM HOIST
MATERIAL HANDLING ELEVATOR TOWER
TELESCOPING TUBE CARRIAGES
ELEVATOR HOIST
2 TON CRANE
70'-8"
MONORAIL HOIST (2 TON)
20 TON CRANE
MANIPULATOR
POWER CENTER ROOM
POWERED TRANSPORTER (3)
TOOL RACK
SEALING CONTAINER
TURNTABLE
AIR SEAL
42" RISER
SHIPPING CONTAINER
TOOL CHANGE MACHINE
TOOL MAINTENANCE FIXTURE & CART
TELESCOPING TUBE
75'-0"
TV CAMERA & LIGHTING
ARTICULATED ARM
MATERIAL HANDLING ELEVATOR BUCKET