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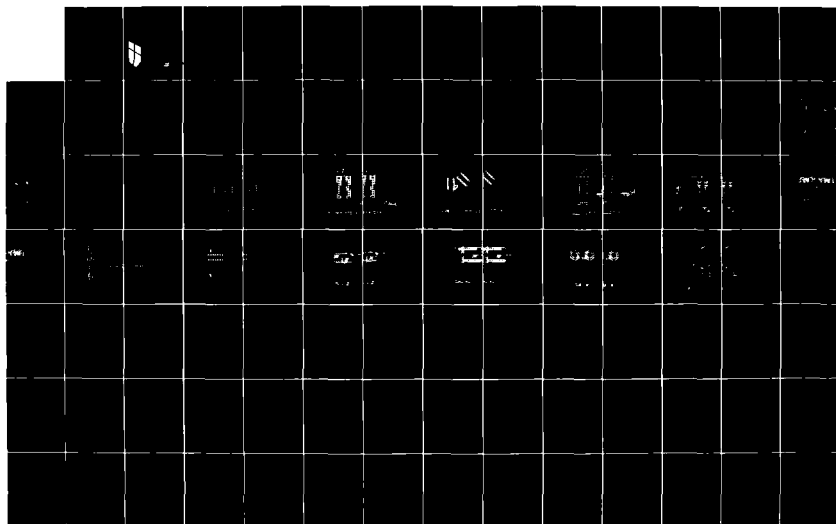
ADVANCED STRUCTURAL CONCEPTS FOR WEAPONS STORAGE - FLAT
AND MOUNTAINOUS TERRAINS(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL JUN 83 CERL-TR-M-330
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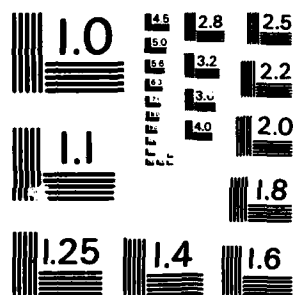
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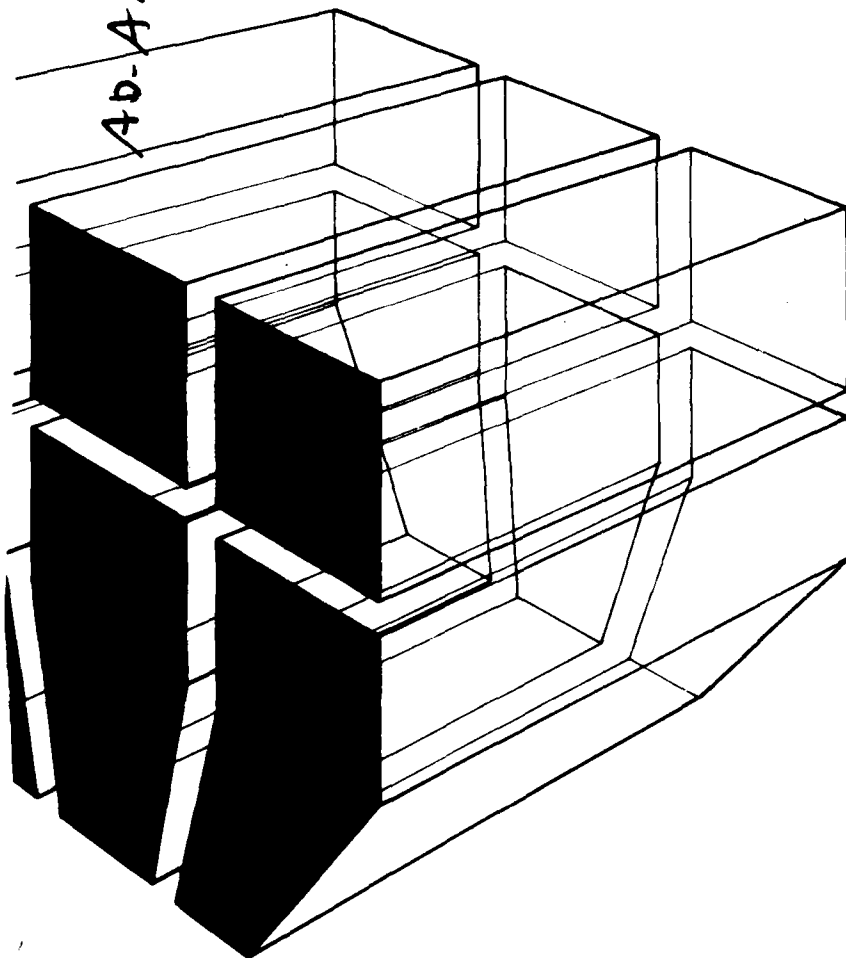
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Technical Report M-330
June 1983

ADVANCED STRUCTURAL CONCEPTS
FOR WEAPONS STORAGE—
FLAT AND MOUNTAINOUS TERRAINS



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> This study has developed 12 concepts for a modern weapons storage area and evaluated them in terms of these essential criteria. From these 12 concepts, six were chosen which rated highest during the evaluation. These concepts are recommended for further development.

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FOREWORD

This research was conducted for the Defense Nuclear Agency (DNA) by the Engineering and Materials Division (EM) of the U.S. Army Construction Engineering Research Laboratory (CERL) under DNA RDT&E Funds for FY1982 Task Code A99QAXFC (MIPR No. 82-529). The study was prepared for CERL by Black and Veatch under DACA 88-82-C-0012.

MAJ L. T. Messenger was the DNA Technical Monitor. Dr. A. M. Kao was the CERL Principal Investigator. Dr. R. Quattrone is Chief of CERL-EM. COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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I. INTRODUCTION

A. Background. In the past, the Department of Defense (DOD) based design of weapons storage facilities primarily on explosive safety. Consideration of other factors, such as security and operational efficiency, was based on much less stringent criteria; today, however, the storage of much more complex modern weapons and the existence of a more sophisticated enemy present problems that did not apply previously. As a result, military planners must now design weapons storage facilities which consider the need for fast mobilization, security against terrorist attacks, sophisticated security, and survivability in the event of a large-scale natural or man-induced disaster. Designs must also be planned for a variety of terrain and must be equipped to deal with emergencies such as loss of commercial power and weapons accidents. DOD must therefore develop concepts that will meet these more modern criteria, yet still have as little effect on the local environment as possible, require minimum personnel and resources, and require minimal construction and maintenance costs.

B. Purpose. The purpose of this study is to develop and evaluate several advanced concepts, adaptable to various locations, for weapons storage facilities.

C. Approach. Weapons storage design criteria were established and divided into categories of operations, security, and safety. These criteria were then used to develop 12 conceptual layouts for a weapons storage facility. The 12 concepts were evaluated in terms of their construction and life cycle costs, number of personnel required to operate the security and safety features, load-out time, and land required. The six best concepts were then chosen and recommended for further development.

II. SUMMARY

A. Problem Definition.

1. Criteria. The number of storage facilities at one location and the number of weapons in each storage facility will vary. However, in all cases the storage facility must meet the following criteria:

- Load-out all weapons onto trucks in no more than 2 hours.
- Withstand the attack of terrorists for at least 30 minutes.
- Survive the crash of a 747 airplane.

2. Components. The basic components of the weapons storage facility are the following:

- Magazine - storage room for one group of weapons, in which each weapon is stored in an individual cell.
- Truck Tunnel - passageway for the trucks which load-out the weapons.
- Maintenance Area - room in which periodic weapons maintenance will occur.
- Security/Personnel Area - a security/command/control room, toilets, and a break room.
- Support Equipment Area - space for emergency power generation, environmental control equipment, and any support equipment required for maintenance, material handling or security barrier systems.

3. Modes of Operation. The use of personnel to secure the storage facility on a day-to-day basis will depend on location and command prerogative. In keeping with current practice, the storage facility will be constantly manned, with the entrances guarded and the surveillance equipment monitored in the security/command/control room by

personnel assigned to 8-hour shifts. However, in keeping with the purposes of this study, which include reducing manpower and increasing reliance on passive security measures, it is assumed the facility would be unmanned most of the time.

a. Storage. Most of the time there would be no activity in the storage facility. Guards could be posted outside the facility at entrances, but no personnel would be stationed inside. Monitoring of surveillance and intrusion detection equipment would be at a remote location.

b. Maintenance. Periodically, weapons inventory and routine weapons and facility maintenance would require personnel access into the facility. Personnel assigned to do the required work (two, minimum) and a small security team (two, minimum) would enter the facility.

c. Alert. During an alert, security personnel and material handlers would enter the facility and prepare it for load-out. Dispersion of the weapons by truck would be their primary defense against enemy attack. A large security force would accompany the trucks to secure the facility while open.

B. Recommendations. In the following analysis the problem is more completely defined and the factors for evaluating the proposed solutions are enumerated. Twelve solutions are proposed and each concept is evaluated on its construction and life cycle costs; load-out time; security, safety, and material handling features; land area required; and number of operating personnel required. Separate evaluations are made for an

assumed flat site and for an assumed mountainous site. The six advanced concepts with the best evaluations are as follows:

<u>Concept</u>	<u>Recommended Terrain</u>
I: Mausoleum (Figure 10)	Flat or Mountainous
K: Carrousel (Figure 12)	Flat or Mountainous
L: Windshield Wiper (Figure 13)	Flat or Mountainous
E: Stacker Crane (Figure 6)	Flat
F: Turntables (Figure 7)	Mountainous
H: Trap Door (Figure 9)	Mountainous

III. ANALYSIS

A. Facility Criteria. Detailed written design criteria were not provided and would not have been appropriate for a conceptual study in which a high degree of creative thought is desired. However, a skeleton of design criteria has been provided by CERL and supplemented by Black & Veatch assumptions. These given and assumed criteria have been divided into three categories - operational, security, and safety.

1. Operational Criteria.

a. Given.

(1) Load-out time. Maximum storage facility load-out time is 2 hours.

(2) Location. The storage facility sites are unknown, although it is known they will be on land already controlled by the Government. Site conditions to which a facility design must be adapted will vary widely. At least six of the 12 study concepts should be adaptable to flat terrain and at least six should be adaptable to mountainous terrain.

(3) Appearance. The storage facility's appearance must not be destabilizing to the local populace.

(4) Personnel. The number of people required to operate the facility should be minimized.

(5) Weapons characteristics. This storage study applies to four types of weapons. The weapons types will not be mixed in one storage magazine. The four weapons types have the following characteristics:

<u>Explosives (kg)</u>	<u>Number/ Group</u>	<u>Weight (lbs)</u>	<u>Container Size</u>		
			<u>Width</u>	<u>Length</u>	<u>Height</u>
4.2	15	420	1'-2"	5'-6"	1'-3"
3.7/7.2	15	266	1'-10"	4'-9"	1'-9"
35.6	12	1,465	3'-1"	9'-8"	3'-3"
17.8/21.5	15	2,877	4'-5"	14'-0"	4'-8"

(6) Weapon position. The weapon containers should be stored and handled in a horizontal position. The containers may not be stored in suspended positions or on moving surfaces.

(7) UPS. A 4-hour uninterruptible power supply (UPS) is required.

(8) Manual load-out. It must be possible to load the containers without power. Manual out-loading has no maximum time duration.

(9) Load-out order. It cannot be assumed that weapons may be removed in the order in which they are stored. It must be possible to select a container with a specific identification number and remove it from the magazine without having to remove weapons stored in front of it.

(10) Material handling. Material handling systems should be simple to operate and require little maintenance.

(11) Truck characteristics. The weapons will be loaded onto 2-1/2- or 5-ton uncovered cargo trucks, which will be part of the Army's general inventory of tactical vehicles. Each truck will hold one or two weapon containers, depending upon container and truck sizes. The backing-up of the truck should not be a necessary part of the loading procedure.

(12) Maintenance room. A maintenance room, 30 ft. by 50 ft., with a 14 ft. ceiling height is required. Routine maintenance schedules vary from 3 month to 5 year intervals for the various types of weapons. The maintenance room must be equipped with an overhead crane. Maintenance will not have to operate without power.

(13) Security room. A 10 ft. by 20 ft. security/command/control room is required, accessible to men's and women's toilets and a break room.

(14) Environmental control. No special environmental control is required for the weapons; environmental control will be what is required for human comfort.

b. Assumed.

(1) Weapons type selection. To provide a basis for valid comparison, the study concepts are all designed for the same weapons type, the one with the largest container. For the same reason, each concept contains two magazines of weapons, with each magazine storing a group of 15 weapons and one dummy container. Based on the selected weapons type, a 5-ton cargo truck with a 21 ft. long bed is required to transport each container, which is 14 ft. long.

(2) Maintenance room requirements. A single maintenance room is adequate to serve two magazines. Means of transporting weapons from the magazines to the maintenance room must be provided. Transportation of large pieces of maintenance equipment between the truck tunnel and the maintenance room is required.

(3) Maintenance personnel needs. Maintenance personnel require access to the toilets and break room.

(4) Equipment room. A room, distinct from the maintenance room, is required for the standby power equipment, environmental control equipment, and any support equipment required to operate maintenance equipment, security barriers, and material handling systems. Access to the truck tunnel is required for moving large equipment.

(5) Standby power. In the event of loss of commercial power, there are two sources of standby power: a motor-generator set and storage batteries. The motor-generator set should be sized to serve the facility's lighting, heating, ventilating and surveillance systems; to operate the material handling system motors; and to open one security barrier at a time. Since the facility must be capable of 2-hour load-out, a 4-hour supply of diesel fuel for the motor-generator set should be adequate. The CERL criteria anticipate the loss of emergency generator power also and require manual load-out capability. In this case, storage batteries would be relied upon to power lighting and surveillance systems. Therefore, the storage battery requirement should be determined by the manual load-out time duration, which may exceed 4 hours. By reliance on storage batteries, most commercial power interruptions could be endured without activating the motor-generator set.

2. Security Criteria.

a. Given.

(1) Terrorist siege endurance. The facility must withstand a 30-minute siege by well-trained, well-equipped, fully

dedicated terrorists. The most serious threat of penetration by terrorists is their use of the shaped and plate charge explosives.

(2) Enemy observation prevention. Enemy air and ground observation of facility activities must be prevented, although the facility's existence and location will be general knowledge.

(3) Passive measures. Passive security measures are preferred to active security measures. Normal security must not depend upon a large force of armed personnel.

(4) Intrusion detection and remote surveillance. It can be assumed the storage facility will be equipped with intrusion detection and remote surveillance systems. The consideration of these systems is not a part of this study.

(5) Barrier redundancy. There should be a series of security barriers at the facility, and any use of deadly force against an intruder should be withheld until the intruder has penetrated the outer barriers, clearly demonstrating his intent and ability to do harm.

(6) Transportation personnel restrictions. During load-out, transportation personnel (two per truck) must not have access to more weapons than they are assigned to transport. Transportation personnel must not have access to control devices which actuate functions within high security areas.

b. Assumed.

(1) Definition of siege endurance. After 30 minutes, terrorists may have penetrated the truck tunnel, the personnel area, or the equipment rooms, but they must not have penetrated the magazine, the maintenance room, or the security room.

(2) Personnel entry. A personnel entry, distinct from the truck tunnel, should be provided for use by personnel performing periodic inventory and maintenance. The personnel entry should terminate in a sally port, controlled by the security room personnel.

(3) Truck tunnel protection. Truck tunnel barriers should be operable from the inside only, by personnel who have entered through the personnel entry. Open truck tunnel entries will be secured by a large security force. The truck entries should be 12 ft. wide by 12 ft. high, large enough for only one vehicle, to reduce vulnerability.

(4) Personnel restrictions. Maintenance personnel should not have to enter the maintenance room through a magazine and should not have to enter the security room for any reason. Transportation personnel should not have to enter the magazine or operate any material handling equipment during load-out. Their only reason to get out of the truck should be to secure the container to the truck bed.

3. Safety Criteria.

a. Given.

(1) Airplane crash survivability. The facility must survive the crash of a 747 airplane, using the Nuclear Regulatory Commission (NRC) requirements for nuclear reactor safety. As indicated in Appendix D, a 3 ft. thick reinforced concrete roof slab buried under 10 ft. of earth is assumed to satisfy this requirement.

(2) Weapon accident survivability. The facility must survive the accidental explosion of the high explosive (HE) in a weapon, although clean-up of contaminated debris will be required afterward.

(3) Natural disaster survivability. The facility must function after an earthquake, a tornado, or a flood.

(4) Blast protection. Blast protection is required between the containers in case of accidental detonation of the HE in a warhead. Calculations in Appendix D indicate that approximately 18 in. thick reinforced concrete will withstand such a blast. There should be no line-of-sight between containers or between a container and a magazine door. Accidental HE explosions may not be vented to the outside.

(5) Electromagnetic Pulse/Electromagnetic Radiation (EMP/EMR) protection. EMP/EMR protection is required in the maintenance room, but not in the magazines.

(6) Material handling. Material handling systems must be approved by the NRC. Preferably, containers should not drop more than 6 in. in case of accidental mishandling.

(7) Fire protection. An automatic, non-water (Halon) fire protection system is required in the maintenance room, but not in the magazines.

(8) Redundant exiting. The truck tunnel must have at least two remotely located entrances and must include truck turn-around space.

b. Assumed.

(1) Survivability. A structural design which will withstand a 747 airplane crash will withstand an earthquake or a tornado. Floodproofing of a facility is best accomplished by locating where it will not be flooded.

(2) Blast dispersion. Based on a container size of 4 ft. 5 in. wide by 4 ft. 8 in. high by 14 ft. long, the minimum dimensions of an individual container cell within a magazine could be approximately 6 ft. wide by 6 ft. high by 16 ft. long. However, the individual cell volume should be larger than this minimum or the cell should be open to a larger volume to vent gases and to reduce the intensity of blast pressures that would develop against structural containment surfaces in the event of an accidental detonation of HE.

(3) Location of blast protection. Blast protection should be provided around the maintenance room as well as the magazines.

B. Evaluation Factors. As with design criteria, detailed and numerous evaluation factors were not provided and would not be appropriate for this conceptual study. The following evaluation factors were developed during the study period. As many as possible are objective, but some are rather subjective. Further development of the storage concepts should include the determination of objective means for measuring the subjective factors.

1. Construction Costs. The initial capital cost is often the major evaluation factor for a construction project. All 12 concepts have been estimated for construction on a flat site and for construction in a mountainous terrain. The flat terrain estimates assume very easy soil excavation and the mountainous terrain estimates assume very difficult solid rock excavation.

2. Life Cycle Costs. The full cost of a storage facility includes future operating and maintenance costs as well as the initial

construction costs. Life cycle costs for flat and mountainous terrains have been estimated for all concepts.

3. Load-out Time. The faster the containers can be loaded-out, the better. The time required for loading-out each concept has been estimated, and all load-out times are less than the 2-hour maximum allowed.

4. Security. The more safeguards against terrorist intrusion, the better. The less accessible the weapons containers are to personnel, the better. The more passive the security features, the better.

5. Safety. The more protection of the weapons and facility personnel from outside impact or inside accident, the better.

6. Material Handling. The simpler to operate, more reliable, and easier to maintain the material handling systems, the better. The fewer means of transportation and the less container repositioning required during the load-out, the better. Also, the less care required in truck positioning, the better.

7. Land Requirement. The importance of a concept's land requirement is not based on the cost of purchasing land, since the facility will be located on land already controlled by the government. The importance of the land requirement is that available sites may be limited in size, and there may be other land uses competing for them. Because the assumed excavation conditions are so severe, it is assumed the mountainous site will be remote, expansive, and not valued highly for other land uses. The acreage required at a mountainous site will be so much

less important than at a flat site, land requirement is not an evaluation factor for mountainous terrain. However, for the flat terrain, the less acreage required, the better. The amount of land required for the facility itself is not as extensive as the construction site required. Every concept will require adjacent space for excavated material, if expensive hauling is to be avoided. For the purpose of comparison the land area calculated for each concept is bounded by the toe of the slope of the earth cover.

8. Personnel Requirement. The fewer personnel required to be involved during load-out, the better. The number of personnel required for load-out includes security personnel and material handlers, but does not include any of the deployment force. The estimated number of security personnel is based on the assumption that they work in pairs. The number of places security personnel must be stationed depends upon the configuration of the concept. The estimated number of material handlers accounts for the assumption that a weapon must be observed throughout its loading-out, even though the removal of the weapon from its storage cell may be fully automated and remotely controlled. In several concepts, the lifting of this restriction would result in a reduction in the number of personnel required. It should be noted that the number of material handlers for a concept may not be the most cost- or time-effective, but it is the minimum required for load-out in the time estimated.

9. Other Considerations. The scope of the weapons storage problem exceeds the scope of the solutions proposed in this report. The

study concepts are designed for only one of the four special weapons types, the largest. By arbitrary choice, only two groups of weapons are stored in each facility concept. Adaptability to smaller weapons and expandability could be concept evaluation factors. However, since all concepts would need to be revised for smaller weapons or additional magazines, the subjects of evaluation would be vaguely defined design possibilities and the evaluation would be highly subjective. Therefore, design flexibility is not included as an evaluation factor.

C. Presentation of Schemes.

1. Development Process. Over 20 storage facility concepts were conceived during the study process. Sketches of all these concepts are in Appendix G. The 12 concepts which are evaluated in this report were chosen from the concepts shown in Appendix G and were further refined.

2. Common Features.

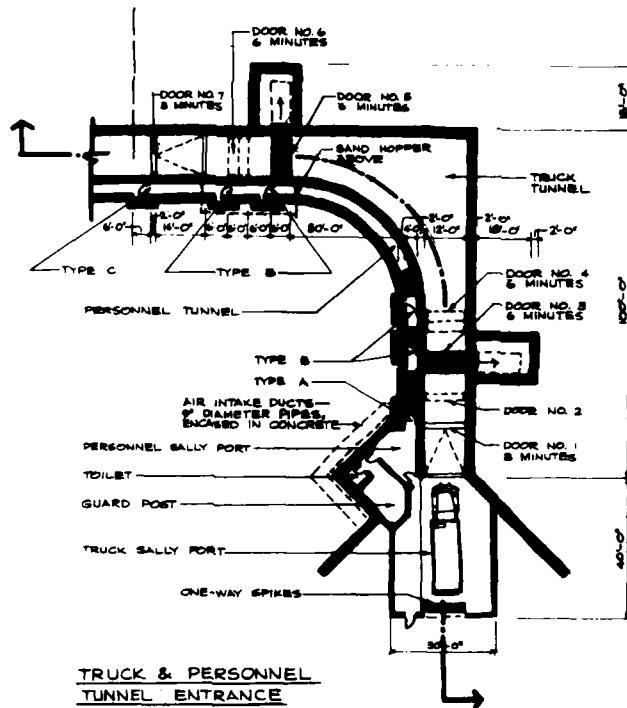
a. Operations Scenarios. To provide a consistent basis of design for alternative concepts, scenarios for normal and alert operations were assumed. These operations scenarios are presented in Appendix A.

b. Security Barriers. There were several ideas proposed during the study period to prevent intrusion for at least 30 minutes. Sketches of these ideas are presented in Appendix C. For consistency, standard truck and personnel tunnel entrance designs were decided upon for all 12 study concepts. The standard designs are presented in Figure 1. Although the standard tunnel entrances are designed

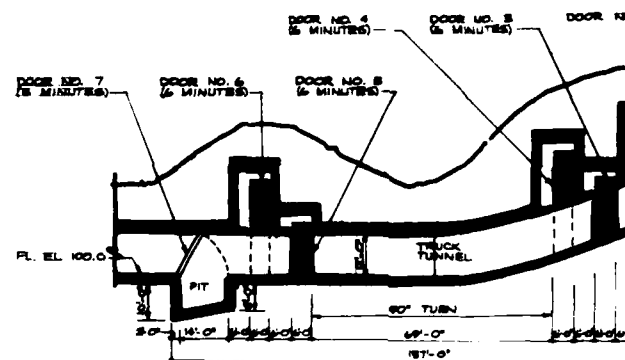
to prevent intrusion for at least 30 minutes, intrusion through the storage facility roof, a 3 ft. thick reinforced concrete slab with 10 ft. of earth cover, is possible in about 10 minutes. (See Appendix C for supporting data.) To increase the roof penetration time, the depth of the earth cover would have to be increased greatly or a burster slab would have to be inserted in the earth cover to provide material discontinuity, which would increase the number of explosive charges required for penetration. Neither of these expensive measures has been incorporated in the study concepts for the following reasons:

- Intrusion through a doorway rather than through a buried building surface, such as the roof, is the natural tendency.
- The earth cover will hinder the intruder's ability to penetrate the facility in the correct location.
- The intruder will be more observable while he is trying to penetrate the roof than he will be while he is trying to penetrate one of the tunnel entrances.

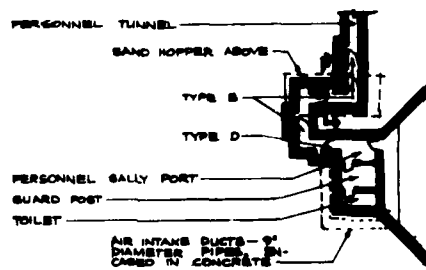
c. Survivability Features and Support Systems. The structural designs required to resist aircraft impact and to contain accidental HE detonation, the estimated utility loads, and the proposed facility support systems are assumed to be standard for all study concepts. Although these features will not actually be the same for all concepts, the differences are too slight and too vaguely defined for their consideration at this conceptual level. Further information, including sketches and calculations, concerning survivability features and support systems is contained in Appendices D and E.



TRUCK & PERSONNEL
TUNNEL ENTRANCE
FLOOR PLAN

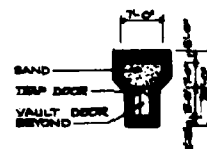


TRUCK TUNNEL SECTION



PERSONNEL TUNNEL ENTRANCE
FLOOR PLAN

NOTE: PLAN ABOVE IS
TYPICAL WHERE
NOT ADJACENT TO
TRUCK TUNNEL



SAND HOPPER
SECTION

NOTE: SECTION AT LEFT
FOR PERSONNEL
TUNNEL SHOWS
FROM TRUCK TUN-
NEL. SAND HOPPER
ADJACENT TO TRUCK
TUNNEL IS
SIMILAR



BASIC HOPPER
NOT TO SCALE

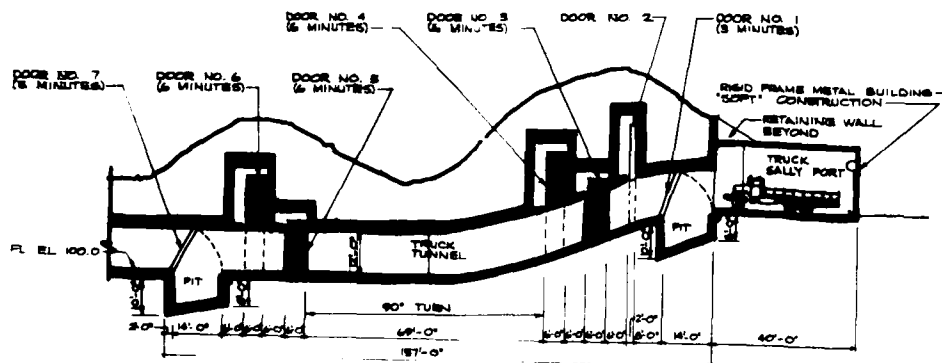
PER

TYPE A

TYPE B

TYPE C

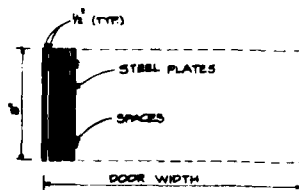
TYPE D



TRUCK TUNNEL SECTION



SAND HOPPER SECTION



BASIC HORIZONTAL CROSS SECTION
NOT TO SCALE

PERSONNEL DOOR

- TYPE A - 5 MINUTE AIRTIGHT BARRIER (SPACES BETWEEN PLATES FILLED WITH FRAMABLE MATERIAL)
- TYPE B - 6 MINUTE BARRIER
- TYPE C - 5 MINUTE BARRIER
- TYPE D - 5 MINUTE AIRTIGHT BARRIER (SPACES BETWEEN PLATES FILLED WITH FRAMABLE MATERIAL)

W E O W E

GENERAL

The sketches on this sheet show typical entrance designs for the 12 storage facility schemes. In all schemes there are two truck entrances and one personnel entrance. In some schemes the personnel entrance parallels the truck entrance, and in other schemes it doesn't. The advantages of the personnel entrance paralleling the truck entrance are that one guard post can be used for both entrances, and the number of facility entrances is limited. The advantages of not locating the personnel tunnel parallel to the truck tunnel are that it can be shorter and more direct, and the distance between barrier doors can be reduced to the detriment of saboteurs' activities.

BARRIERS

The proposed intrusion-resistant doors are described in more detail in Volume II, Appendix F. The main type used in the truck tunnel is a space frame of steel bars and the type used in the personnel tunnel consists of vertical steel plates with spacers between them. The design theory of both door types is to provide a noncontinuous surface which will require multiple shaped charges for penetration.

The defense against a single plate charge penetrating a series of barriers are the changing of tunnel direction between doors and the automatic closing of a door which is normally open and out of the way after the destruction of the door in front of it. A plate charge conceivably could be resisted by forcing placement in a viscous medium such as water. Another possibility would be a barrier of gas confined by air curtains.

The doors are locked by a central hydraulic system actuating bolt mechanisms. Each door can be opened manually by chain hoist or auxiliary hydraulic pump. The manual operation is extremely slow (6 inches in 30 minutes) to defeat unauthorized entry in this manner. Rapid entry for authorized personnel is possible only by overriding the central hydraulic system with controls inside the facility. To enter when no one is inside the facility, a bypass switch is provided with a 30 minute delay before the hydraulic system starts opening the doors. Rapid entry into the facility is impossible unless authorized from inside the facility.

TRUCK TUNNEL

The typical truck tunnel entrance has two drawbridge doors, Nos. 1 and 2, which open deep sills when open. The sills not only slow intruders, they prevent tank entry. Door Nos. 3 through 6 are the space frame type. Door No. 4 falls in place after the destruction of Door No. 3 and Door No. 5 falls in place after the destruction of Door No. 6. Door No. 2 deters intrusion by closing after an intruder has penetrated the tunnel, trapping him in a space too small for him to remain in safely while he sets off an explosive charge at the next door.

The truck sally port is not designed to stop an aircraft impact or explosion. The structure provides a place out of the weather in which a vehicle can be safely and cleared by security personnel before it enters the storage facility. The truck sally port might not be used during load-out, since the deployment force is responsible for external security at that time, but it surely will be used at any other time a vehicle, such as a maintenance truck, must enter the facility. The truck sally port structure conceals the truck tunnel entrance, and it can be designed for compatibility with local architectural styles.

PERSONNEL TUNNEL

In addition to a series of barrier doors, the other intrusion hindrance in the personnel tunnel is the hopper above the middle of the tunnel which automatically fills the tunnel with sand or some other appropriate material when the tunnel is intruded.

The personnel tunnel with its grate-like doors is itself the air supply duct for the storage facility. Air is taken from the outside into the personnel tunnel by pipes too small for a person to crawl through. The first barrier door in the personnel tunnel is airtight to prevent the short circuiting of exhaust air from the truck tunnel. The air intake is located within sight of the guard post which will be occupied whenever the storage facility is staffed.

When people are not inside the facility, ventilation is not required, even for the emergency power generator. The standby motor/generator set should not be started automatically upon power failure. Unessential power requirements, such as for intrusion detection and surveillance, can be satisfied by storage batteries, and the consumption of the generator's fuel supply when operation of doors and material handling system is not required is pointless.

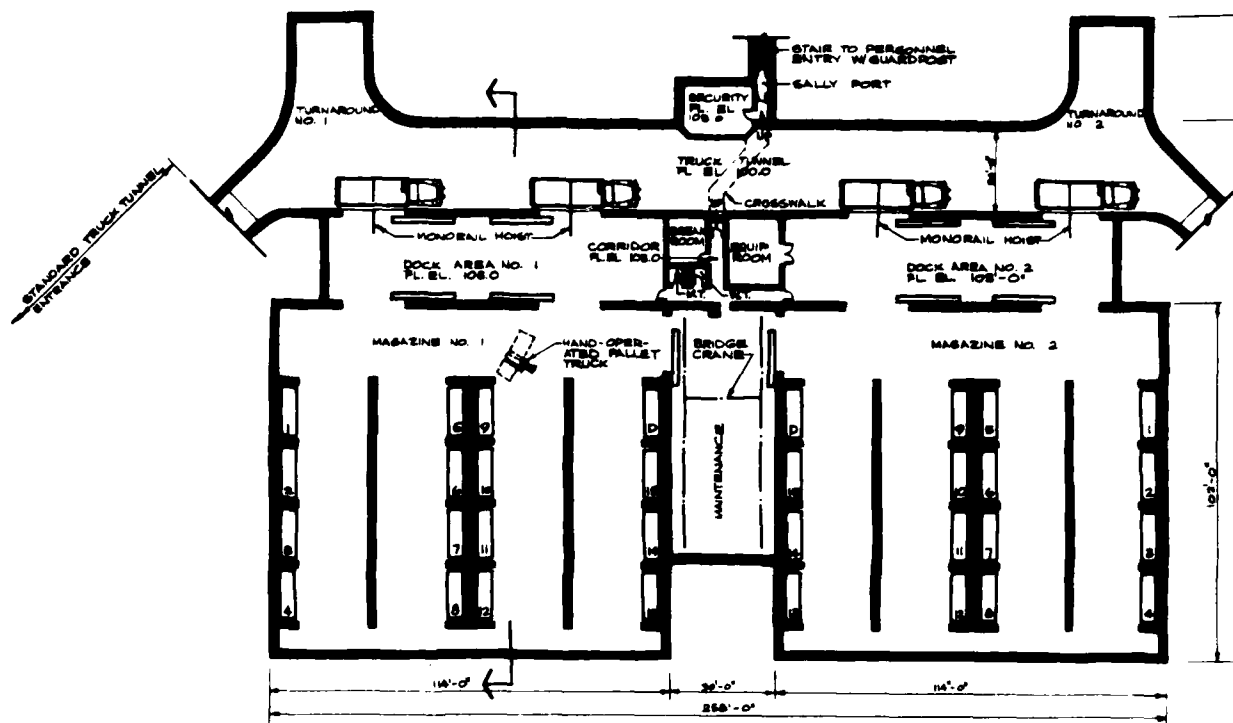
WEAPONS STORAGE CONCEPTS

FIGURE 1 STANDARD TRUCK & PERSONNEL TUNNELS

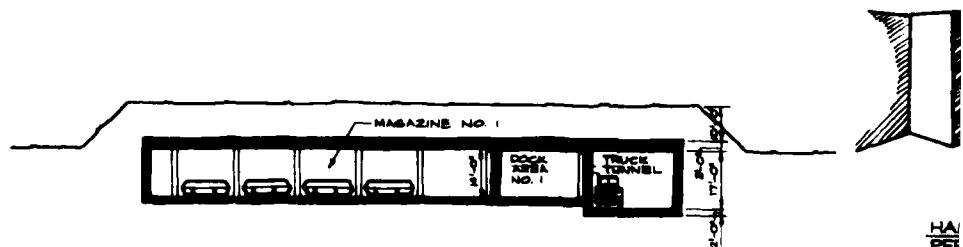
d. Material Handling. Most of the 12 study concepts could be revised slightly to use different material handling systems if required or advantageous. Appendix B provides more detailed information about the material handling systems employed in the concepts and about systems which may be viable alternatives. Appendix B contains for each concept supporting data for its estimated load-out time. The load-out time estimates assume operational efficiency and do not account for human errors or mechanical failures. Manual load-out is also discussed in Appendix B.

e. Cost Estimates. It should be noted that estimated concept costs are for comparison and not intended to be real. The cost estimates are incomplete because they do not include items, such as intrusion detection, which were not part of this study. Also, because construction schedules and locations are unknown, current (third quarter 1982) average U.S. construction costs have been used; the cost estimate for a concept would have to be escalated and revised for any real time and place. The construction costs of each concept have been estimated for two grossly different sites. The flat terrain estimate assumes a perfectly flat site with easy excavation conditions in which no rock is encountered and no dewatering is required. The mountainous terrain estimate assumes the worst excavation conditions requiring hard rock tunneling and blasting. Either of the two extreme conditions is improbable at a real site, but their extremity provides a better basis for evaluating the schemes for different terrains. Construction and life cycle cost estimates, including assumptions, unit prices, bills of materials, and other supporting data, are presented in Volume III.

3. Sketches. The 12 study concepts are presented on Figures 2 through 13. The sketches indicate the concepts in flat terrains, but all are adaptable to mountainous terrains. The brief narrative included with each concept presentation focuses on the unique features of that concept, facilitating the comparison of concepts.

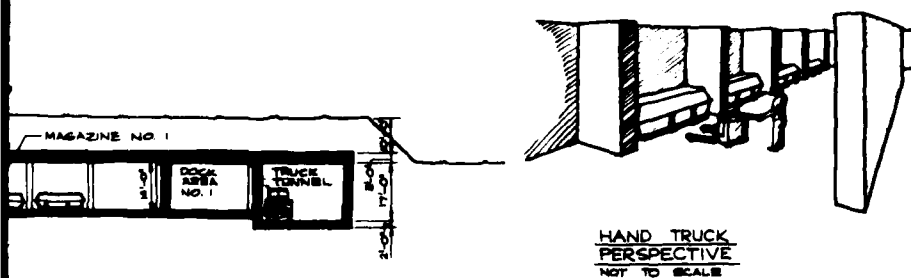


FLOOR PLAN



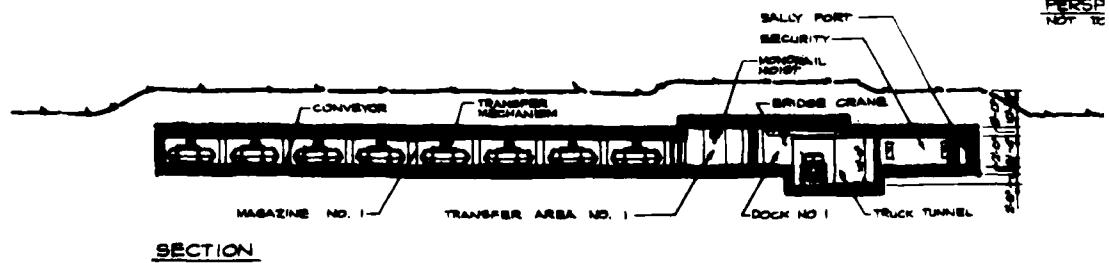
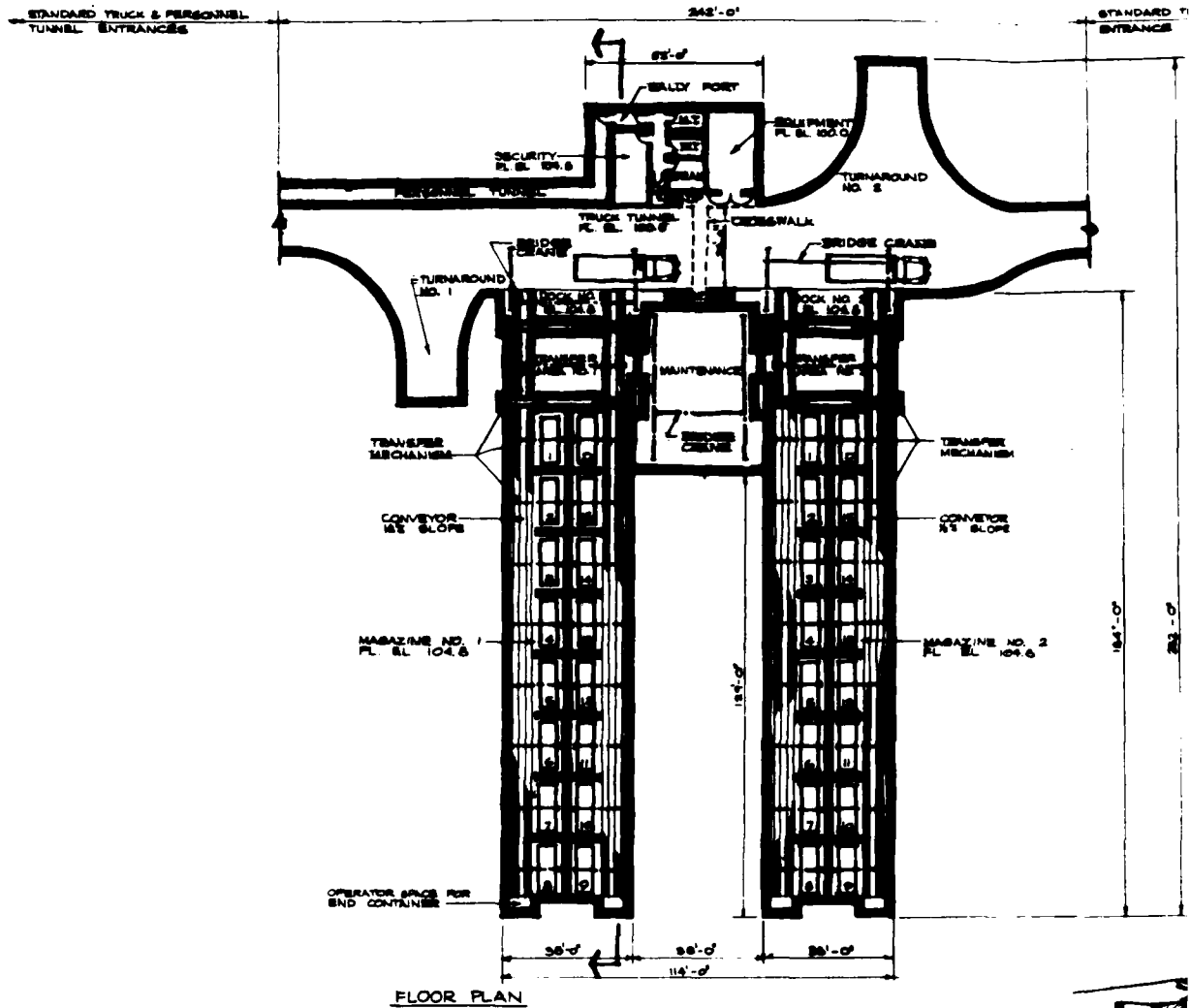
SECTION

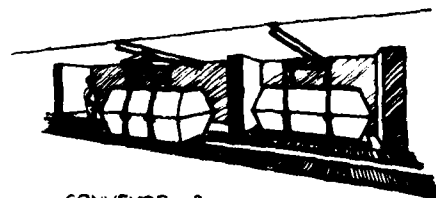
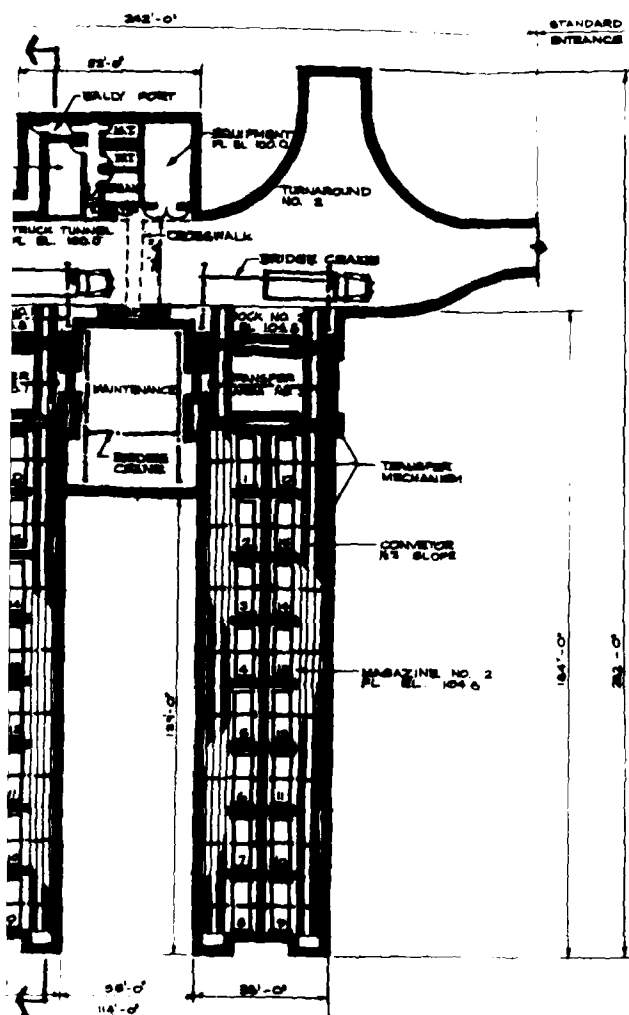
102'-0"



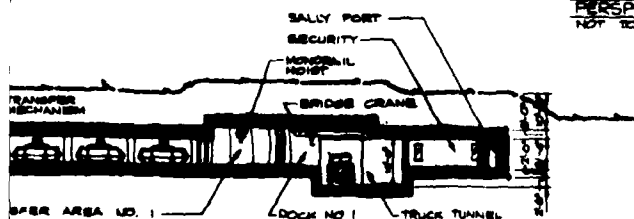
HAND TRUCK
PERSPECTIVE
NOT TO SCALE

W E O W E





CONVEYOR &
TRANSFER MECHANISM
PERSPECTIVE
NOT TO SCALE



SCHEME B: CONVEYOR

FLOOR AREA

Magazines	13,500 sq. ft.
Truck/Personnel Tunnel	19,200 sq. ft.
Maintenance Area	1,950 sq. ft.
Security/Personnel Area	900 sq. ft.
Support Equipment Area	450 sq. ft.
TOTAL	36,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and four material handlers (for each magazine, one at the dock and one in the magazine).

Although there are two loading points from each magazine, they are too close to each other to allow the positioning of more than one truck at each magazine.

ADVANTAGES

The transfer area between the truck tunnel and the magazines/maintenance area provides additional safety and security.

The maintenance room does not have direct access to the magazines, increasing the safety and security of the scheme.

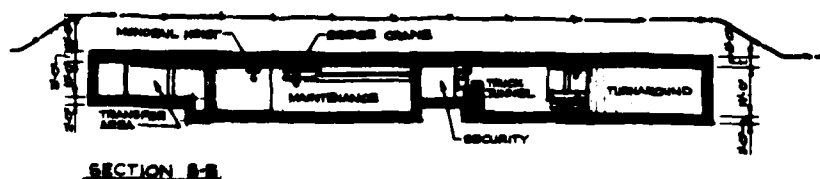
EVALUATION FACTORS

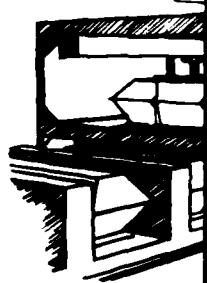
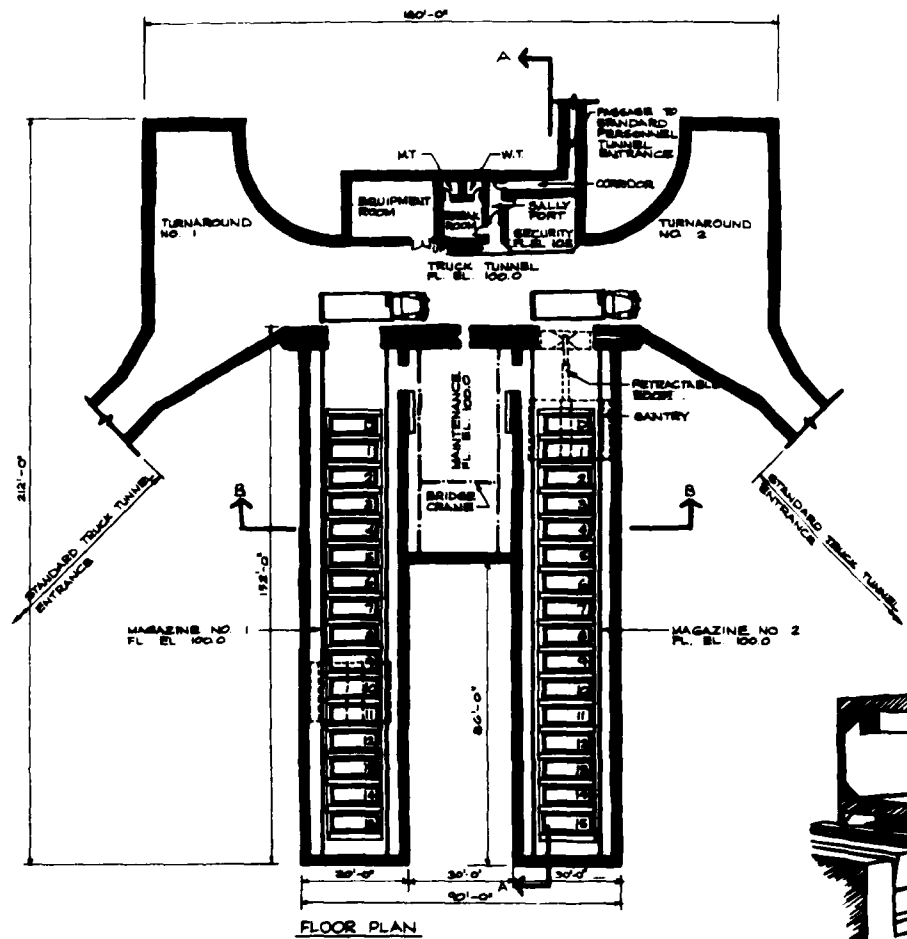
FLAT TERRAIN	
CONSTRUCTION COST:	\$8,100,000
MOUNTAINOUS TERRAIN	
CONSTRUCTION COST:	\$29,450,000
FLAT TERRAIN	
LIFE CYCLE COST:	\$11,420,000
MOUNTAINOUS TERRAIN	
LIFE CYCLE COST:	\$32,750,000
LOAD-OUT TIME:	61 minutes
SECURITY:	Average
SAFETY:	Average
MATERIAL HANDLING:	Average
LAND REQUIREMENT:	3.4 acres
PERSONNEL REQUIREMENT:	8

WEAPONS STORAGE CONCEPTS

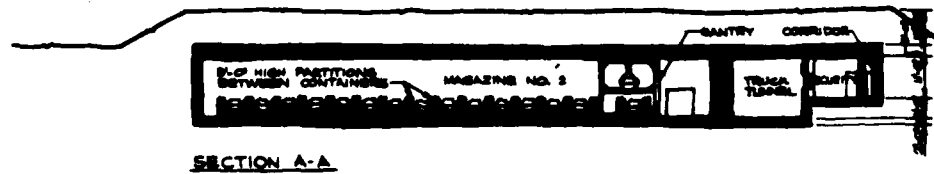
CONVEYOR CONCEPT B

FIGURE 3



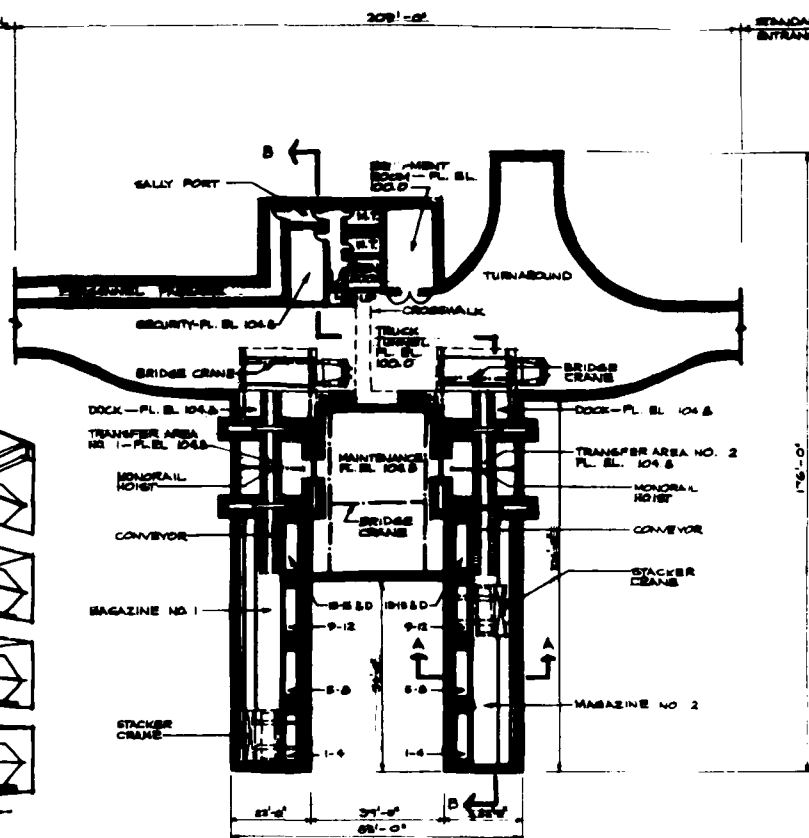


GANTRY CR
NOT TO SCALE

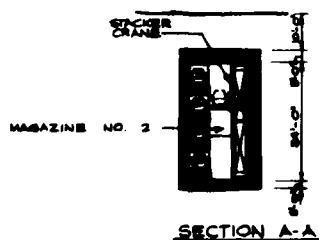




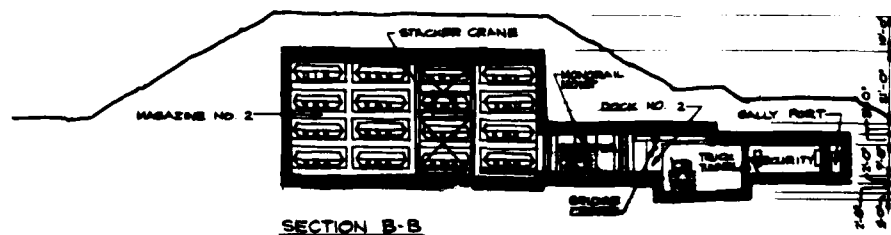
STACKER CRANE PERSPECTIVE
NOT TO SCALE



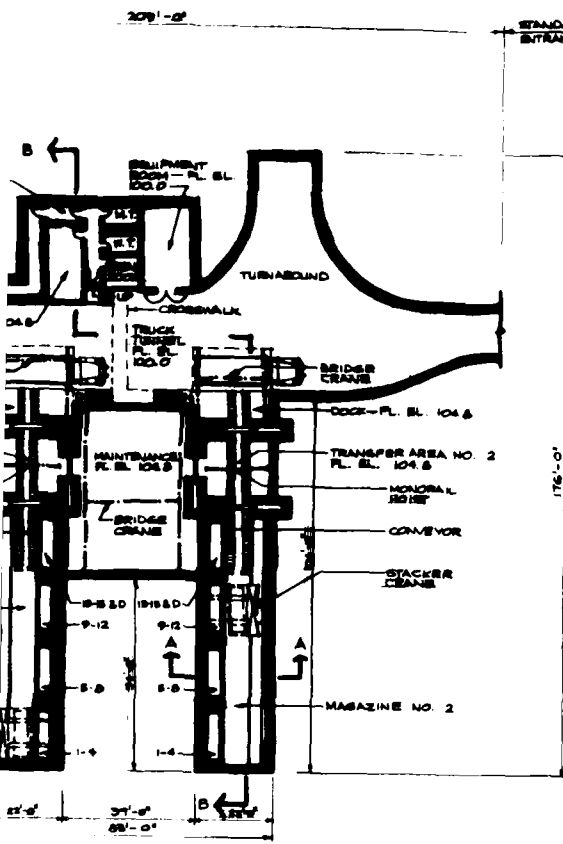
FLOOR PLAN



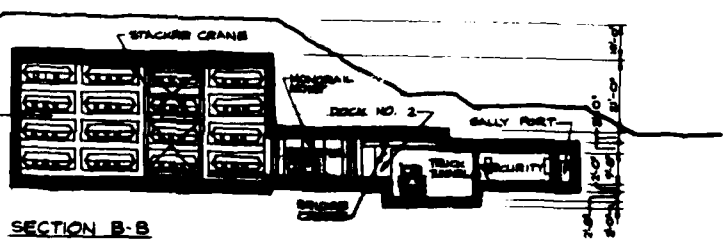
SECTION A-A



SECTION B-B



FLOOR PLAN



SECTION B-B



SCHEME E: STACKER CRANE

FLOOR AREA	
Magazines	5,620 sq. ft.
Truck/Personnel Tunnel	16,440 sq. ft.
Maintenance Area	1,620 sq. ft.
Security/Personnel Area	840 sq. ft.
Support Equipment Area	480 sq. ft.
TOTAL	25,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and four material handlers (for each magazine, one in the transfer/dock area and one on the stacker crane).
 The scheme is excellent for adapting to smaller weapons and for increasing the number of magazines due to the compact storage configuration.

ADVANTAGES

The transfer areas between the truck tunnel and the magazines/maintenance area provide additional safety and security.
 The maintenance room does not have direct access to the magazines, increasing the safety and security of the scheme.

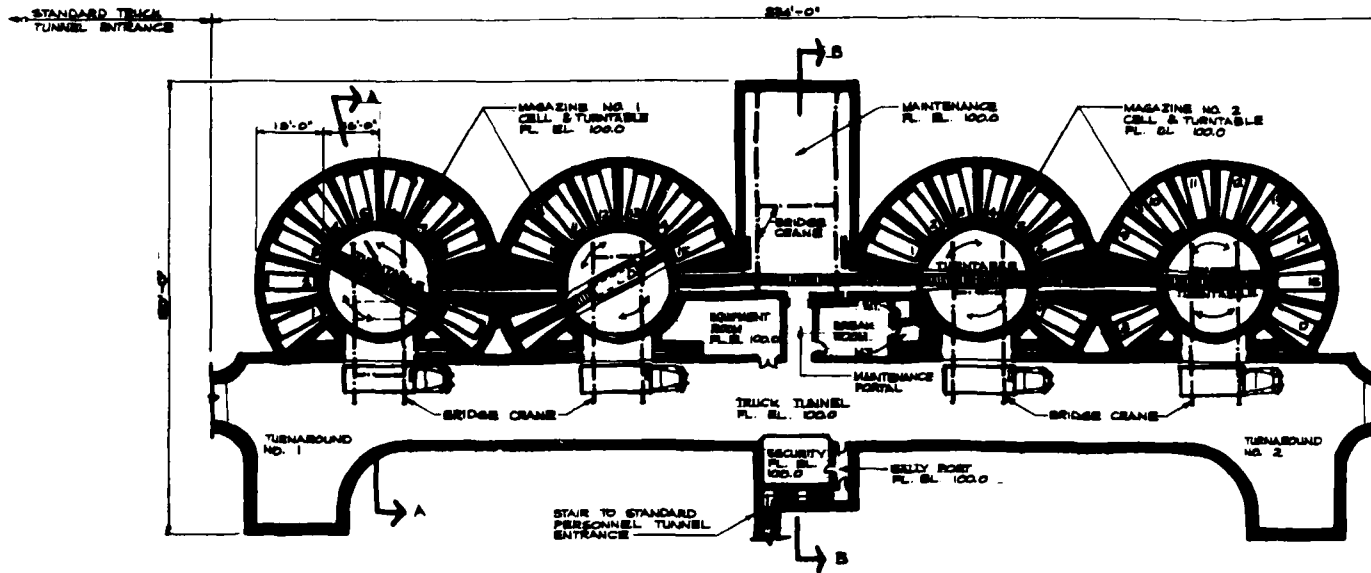
DISADVANTAGES

Vertical stacking of the weapons on open shelves could be dangerous. Accidental blast, an earthquake, or other impact could cause a weapon to fall off its shelf.

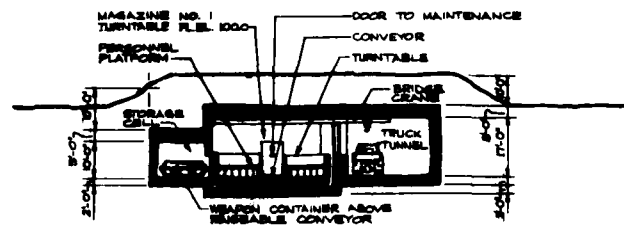
EVALUATION FACTORS

FLAT TERRAIN CONSTRUCTION COST:	\$6,450,000
MOUNTAINOUS TERRAIN CONSTRUCTION COST:	\$14,900,000
FLAT TERRAIN LIFE CYCLE COST:	\$9,480,000
MOUNTAINOUS TERRAIN LIFE CYCLE COST:	\$17,930,000
LOAD-OUT TIME:	55 minutes
SECURITY:	Average
SAFETY:	Minimal
MATERIAL HANDLING:	Average
LAND REQUIREMENT:	2.4 acres
PERSONNEL REQUIREMENT:	8

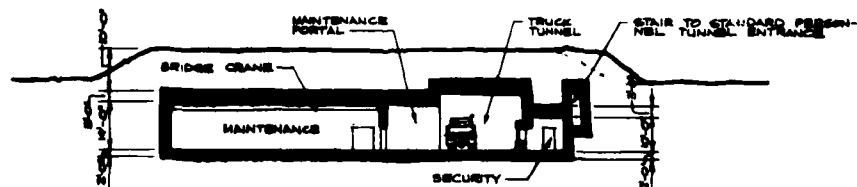
WEAPONS STORAGE CONCEPTS STACKER CRANE CONCEPT E FIGURE 6



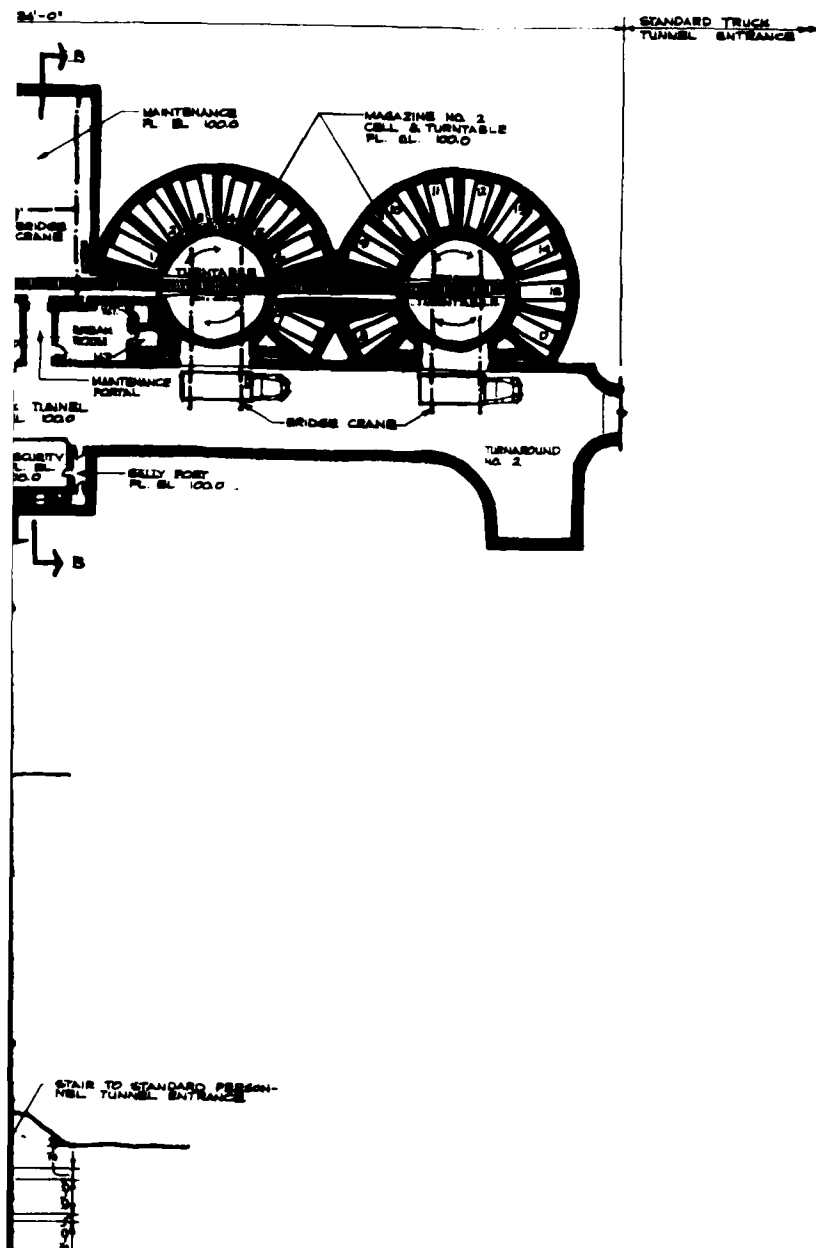
FLOOR PLAN



SECTION A-A



SECTION B-B



SCHEME F: TURNABLES

FLOOR AREA

Magazines	12,530 sq. ft.
Truck Tunnel	18,510 sq. ft.
Personnel Tunnel	1,140 sq. ft.
Maintenance Area	2,040 sq. ft.
Security/Personnel Area	1,120 sq. ft.
Support Equipment Area	640 sq. ft.

TOTAL 34,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and four material handlers (one at each turntable).

In this scheme, there are not individual cell blast doors; the walls of the turntables provide blast protection between weapons.

A possible revision to this scheme which might make manual material handling easier would be to unload each turntable through the opening in the turntable wall to a loading platform; the truck tunnel floor would be lowered to align the loading platform with the side of the truck bed.

Although the scheme configuration allows the simultaneous loading of four trucks, doing so would be a logistics problem. The trucks would have to enter the facility so that two trucks in a row do not require weapons stored around the same turntable. If the trucks did not enter in the proper order, the weapons could be moved between turntables via conveyor, when necessary, but load-out time would be increased. The estimated load-out time for this scheme is based on loading one truck per magazine at a time, because of this logistics problem.

The scheme is easily adaptable to smaller weapons. The number of weapons per turntable could be increased, or the turntable diameter could be decreased.

ADVANTAGES

Only one weapon per turntable is accessible at a time.

Even under no-power conditions, load-out would be fairly easy and quick.

The turntable walls provide two barriers beyond the barrier between the magazine and the truck tunnel for improved blast and intrusion protection.

DISADVANTAGES

Security's view of the loading points end of the truck tunnel entrances is limited.

The weapons would be irretrievable if the turntable was inoperable.

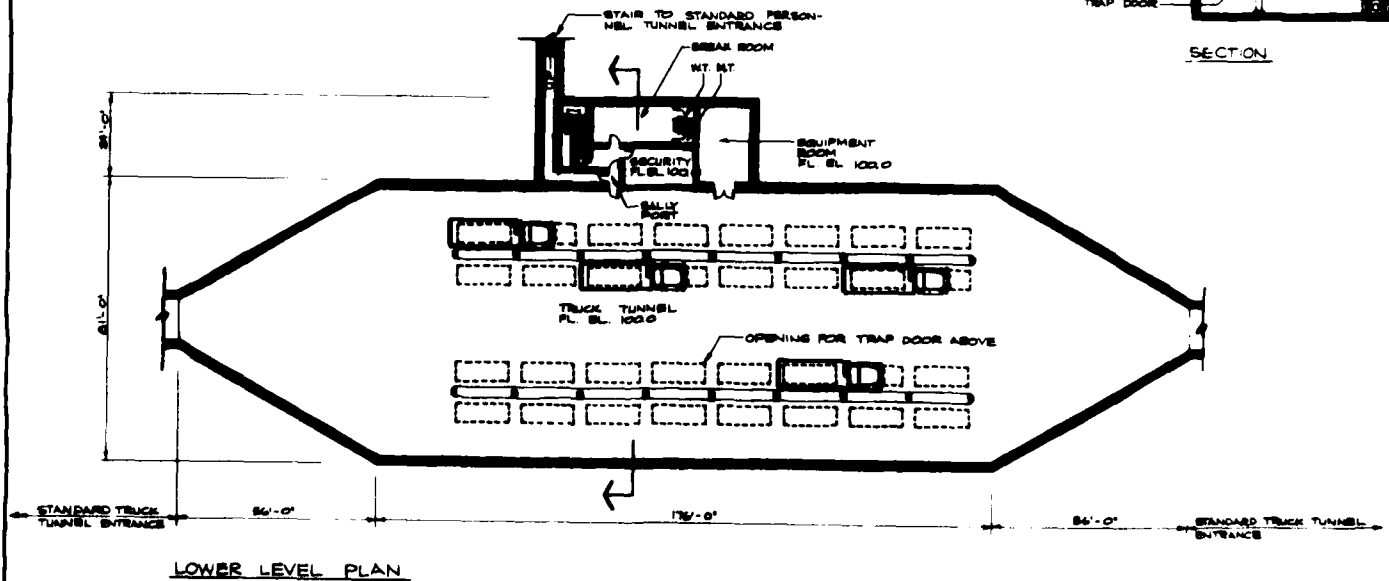
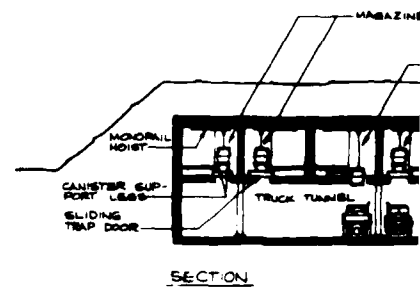
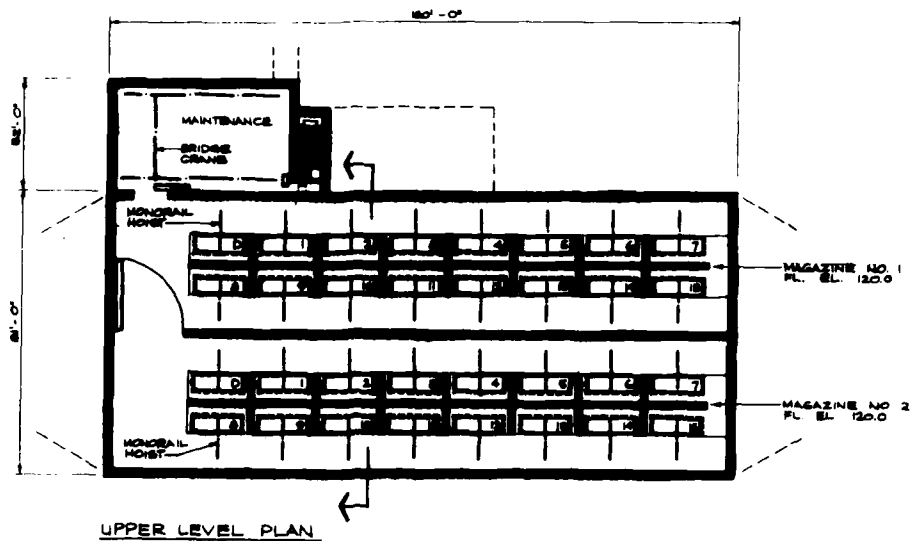
EVALUATION FACTORS

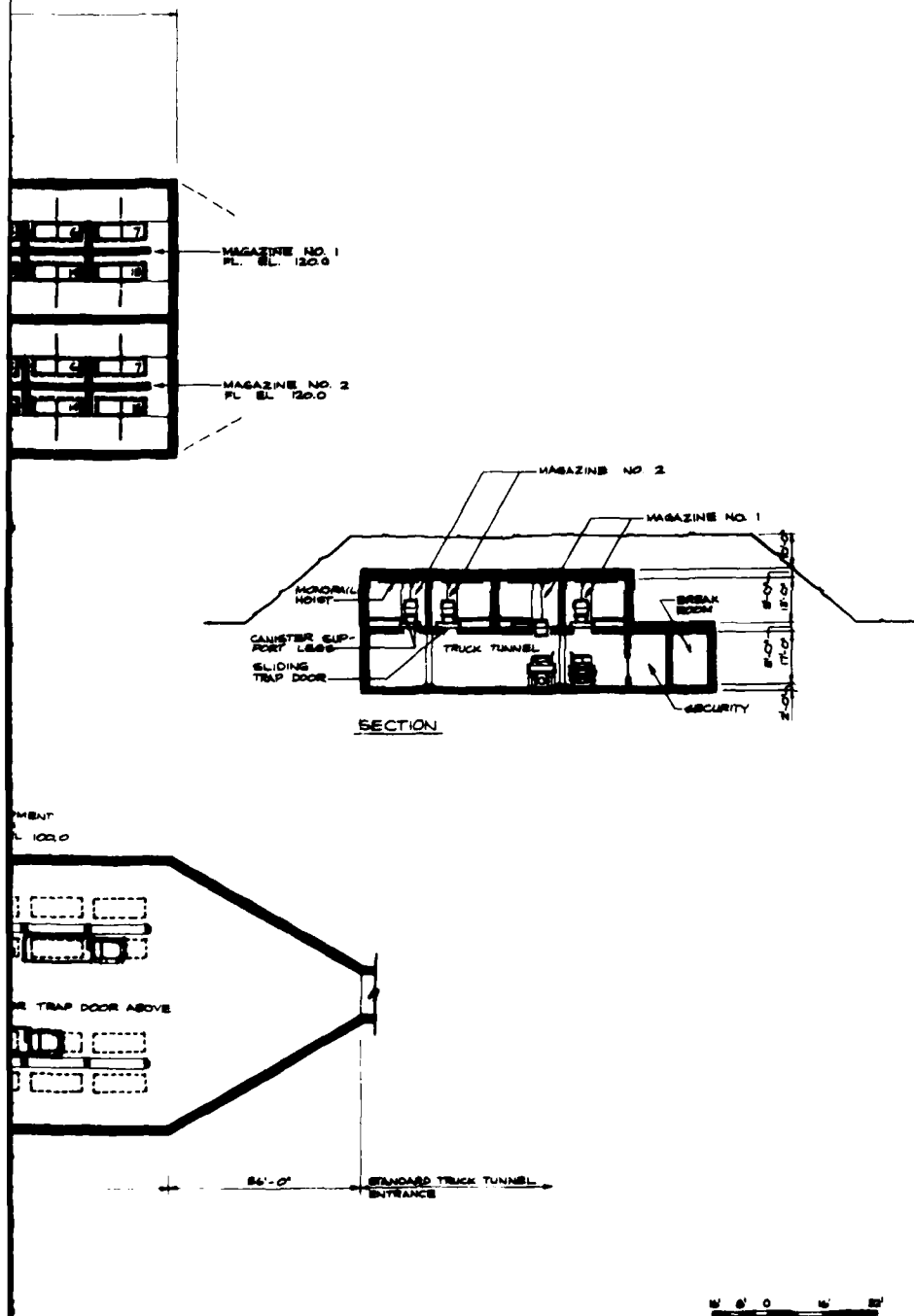
FLAT TERRAIN CONSTRUCTION COST:	\$8,600,000
MOUNTAINOUS TERRAIN CONSTRUCTION COST:	\$15,450,000
FLAT TERRAIN LIFE CYCLE COST:	\$12,130,000
MOUNTAINOUS TERRAIN LIFE CYCLE COST:	\$19,000,000
LOAD-OUT TIME:	15 minutes
SECURITY:	Average
SAFETY:	Minimal
MATERIAL HANDLING:	Average
LAND REQUIREMENT:	1.2 acres
PERSONNEL REQUIREMENT:	8

WEAPONS STORAGE CONCEPTS

TURNABLES CONCEPT F

FIGURE 7





SCHEME H: TRAP DOOR

FLOOR AREA

Magazines	14,500 sq. ft.
Truck Tunnel	20,200 sq. ft.
Personnel Tunnel	1,120 sq. ft.
Maintenance Area	1,630 sq. ft.
Security/Personnel Area	900 sq. ft.
Support Equipment Area	420 sq. ft.
TOTAL	40,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and one in the truck tunnel entrance guard post) and four material handlers (for each magazine, one in the truck tunnel and one in the magazine).

The estimated load-out time is based on loading two trucks per magazine at one time.

A weapon is taken to the maintenance area by using it sideways by means of a hoist and lowering it onto a dolly.

The trap doors below the magazines are not intended to contain accidental SE detonation. They are intended to vent blast pressure into the huge volume of the truck tunnel below. Although they must be explosive vents, the trap doors must have structurally sound frames to support the weapons and to hinder intrusion, and they should be spaced so that the weapons cannot be seen from the truck tunnel.

This scheme is very adaptable to the smaller weapon types and it is easily expandable to accommodate more magazines.

ADVANTAGES

Only one type of material handling is required during load-out.

Even under no-power conditions, load-out would be easy and quick.

The vertical separation of the magazine/maintenance areas from the truck tunnel is a good security feature. Not only is it difficult for terrorists to reach the weapons, but the transportation personnel cannot enter the magazines.

The truck tunnel allows the separation of the truck traffic for the two magazines.

Security has a good view of the whole truck tunnel.

The large volume of the truck tunnel would reduce blast pressure intensity in case of an accidental explosion.

If a cell trap door or manhole hoist was imperable, the weapon in that cell could easily be loaded out through another cell.

DISADVANTAGES

The distance the containers must be lowered may be excessive for safety considerations and SEC approval.

Each weapon is located directly behind a door. This is disadvantageous for security.

Proper truck positioning is extremely critical.

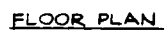
EVALUATION FACTORS

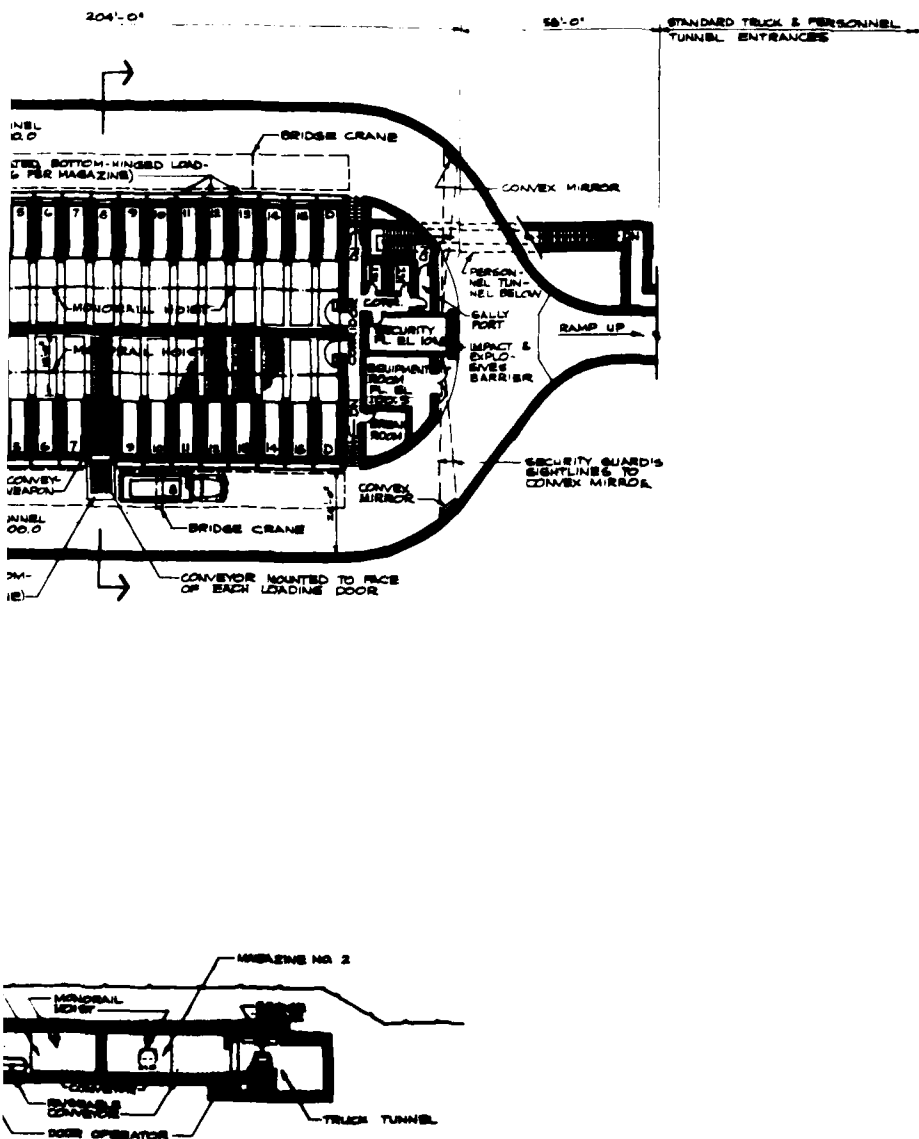
FLAT TERRAIN CONSTRUCTION COST:	\$8,950,000
MOUNTAINOUS TERRAIN CONSTRUCTION COST:	\$12,650,000
FLAT TERRAIN LIFE CYCLE COST:	\$12,210,000
MOUNTAINOUS TERRAIN LIFE CYCLE COST:	\$15,720,000
LOAD-OUT TIME:	72 minutes
SECURITY:	Minimal
SAFETY:	Minimal
MATERIAL HANDLING:	Superior
LAND REQUIREMENT:	3.4 acres
PERSONNEL REQUIREMENT:	8

WEAPONS STORAGE CONCEPTS

TRAP DOOR CONCEPT H

FIGURE 9





CONCEPT I: MAUSOLEUM

FLOOR AREA

Magazines	10,800 sq. ft.
Truck Tunnel	23,690 sq. ft.
Personnel Tunnel	1,170 sq. ft.
Maintenance Area	2,270 sq. ft.
Security/Personnel Area	1,680 sq. ft.
Support Equipment Area	390 sq. ft.
TOTAL	40,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and two material handlers (one outside each magazine).

The load-out time is based on loading one truck per magazine at a time. Load-out time would be even faster if the trucks entered in the order which would allow the maximum number of simultaneous loadings. However, the number of material handlers and bridge cranes required would have to increase.

Large equipment is moved to and from the maintenance area by moving one of the weapons out of its cell and using the empty cell for a passageway. If this scheme is revised for smaller weapon types, direct access should be provided between the truck tunnel and the maintenance area for large equipment.

ADVANTAGES

The large volume of the magazine would reduce blast pressure intensity in case of an accidental explosion.

Material handling personnel do not need to enter the magazines during load-out.

Even under no-power conditions, load-out would be fairly easy and quick.

The truck tunnel arrangement eliminates the need to back-up a truck to turn it around and separate the traffic to the two magazines.

The location of the security room protects it from an accidental explosion in the tunnel during load-out.

If a cell door was inoperable, the weapon in that cell could easily be loaded out through another cell.

DISADVANTAGES

Security does not have a good view of the loading area and has no view of one of the truck tunnel entrances.

Each weapon is located directly behind a door. This is disadvantageous for both safety and security.

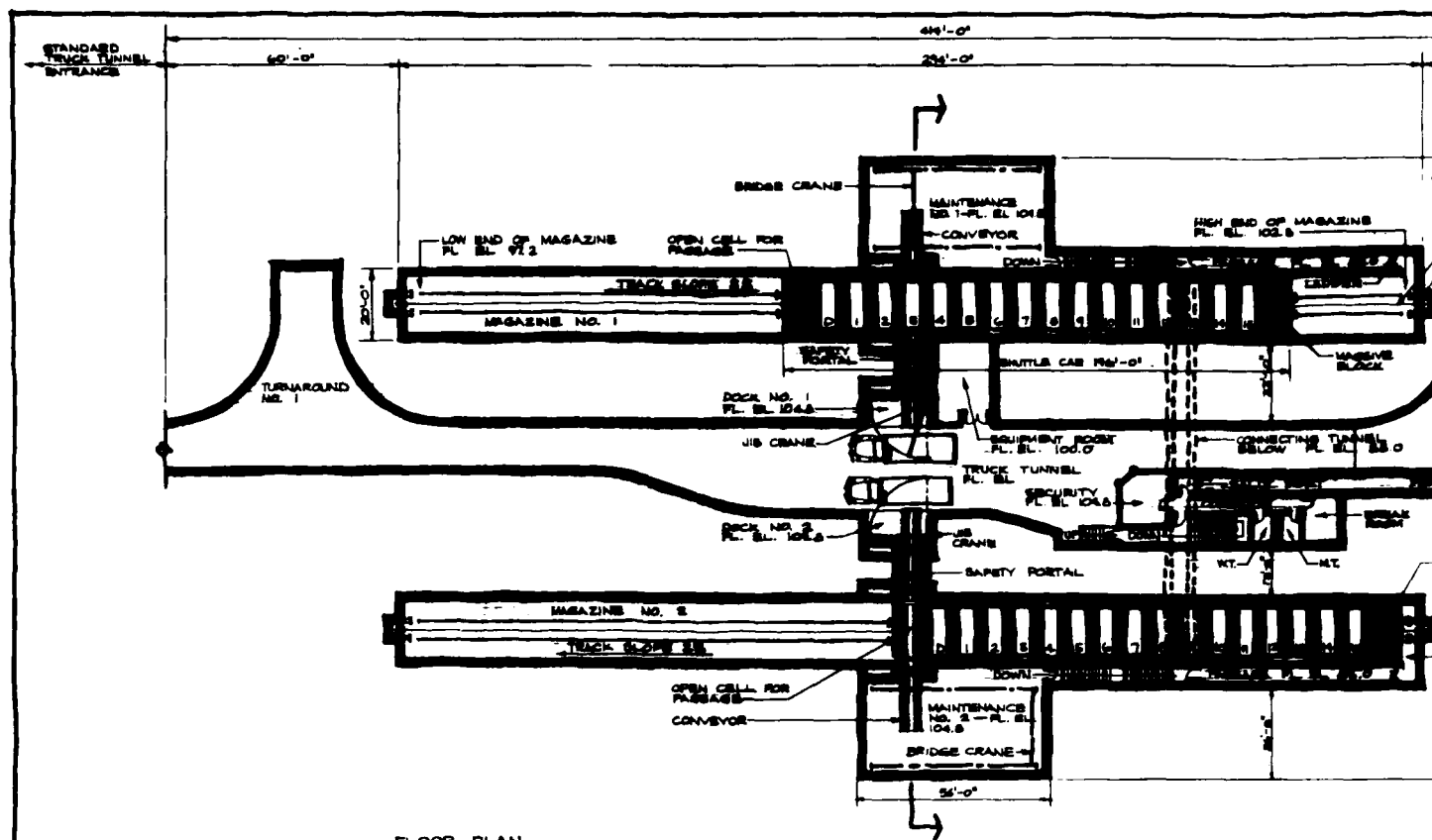
EVALUATION FACTORS

FLAT TERRAIN	
CONSTRUCTION COST:	\$9,200,000
MOUNTAINOUS TERRAIN	
CONSTRUCTION COST:	\$15,330,000
FLAT TERRAIN	
LIFE CYCLE COST:	\$12,810,000
MOUNTAINOUS	
LIFE CYCLE COST:	\$18,940,000
LOAD-OUT TIME:	35 minutes
SECURITY:	Minimal
SAFETY:	Average
MATERIAL HANDLING:	Superior
LAND REQUIREMENT:	2.9 acres
PERSONNEL REQUIREMENT:	6

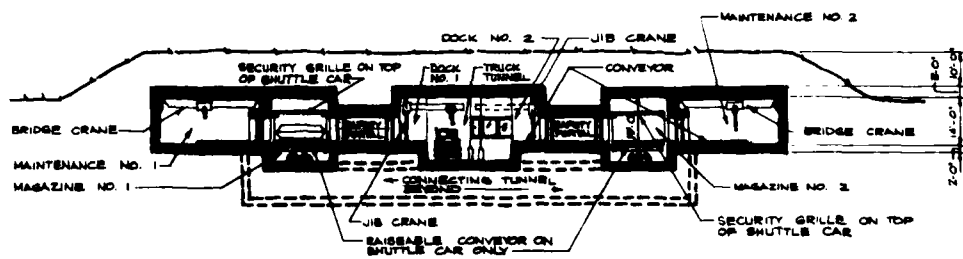
WEAPONS STORAGE CONCEPTS

MAUSOLEUM CONCEPT I

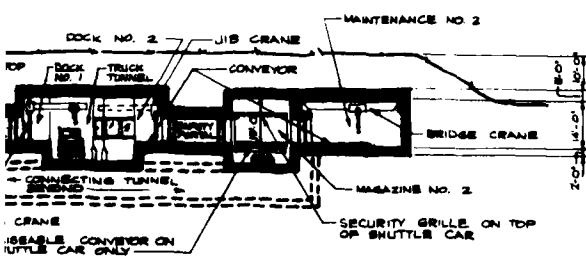
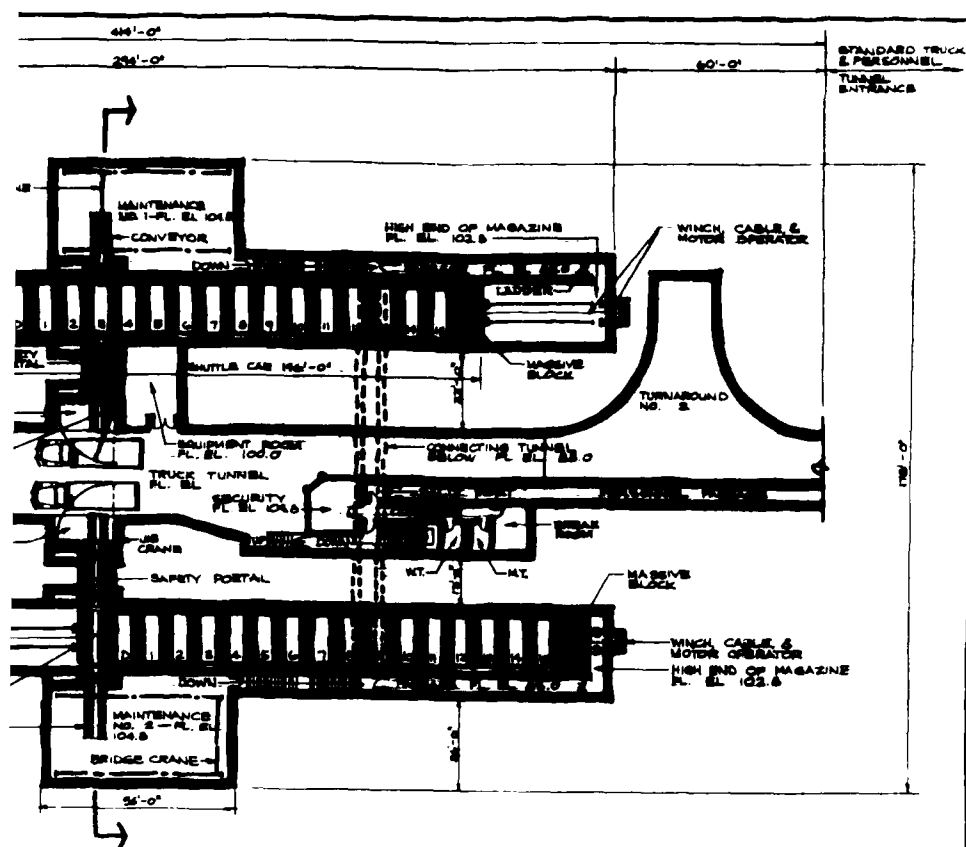
FIGURE 10



FLOOR PLAN



SECTION



SHUTTLE CAR

FLOOR AREA

Maintenance	14,150 sq. ft.
Tr. & Personnel Tunnel	21,800 sq. ft.
Maintenance Area	3,180 sq. ft.
Security/Personnel Area	1,340 sq. ft.
Support Equipment Area	430 sq. ft.
TOTAL	42,000 sq. ft.

TOTAL 42,000 sq. ft.

NOTES

Load-out requires two security personnel in the security room and two material handlers (one at each magazine).

The cars on which the weapons are stored are normally stopped at the high end of their tracks. In case of intrusion, the cars would be released to coast to the bottom of the tracks and some to the watches would be cut. Thus, the portals to the magazines would be blocked by massive blocks of concrete, and the cars would be inoperable.

An alternative magazine configuration would be placement of the massive block in the center of the shuttle car and placement of the lowest point in the center of the tracks.

This scheme would adapt to smaller weapon types, although the magazine doors and the empty cell passageway could not be reduced in size if they are still relied upon for large equipment movement to and from the maintenance room.

Additional magazines could not easily be added to this scheme because additional truck tunnel and other support areas would be required.

ADVANTAGES

The vestibule and empty cell provided between the weapons in each magazine and the truck tunnel provide extra safety and security.

Only one weapon in the magazine is accessible at a time.

The procedure of shutting off each magazine entrance with a massive block provides increased security.

Material handling personnel do not need to enter the magazines during load-out.

Security has a good view of the loading points without being directly in line with the magazine doors, where it would be most vulnerable in case of an accidental explosion during load-out.

DISADVANTAGES

The scheme does not permit the sharing of a maintenance area; two maintenance areas are required.

Manual load-out will be difficult because of the weight of each shuttle car.

The weapons would be irretrievable if the shuttle car was inoperable.

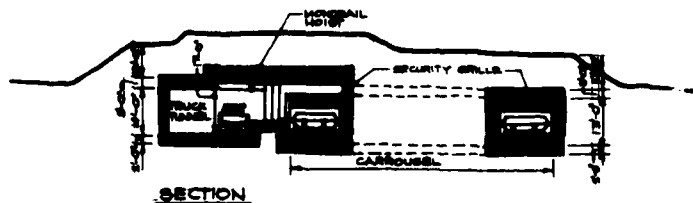
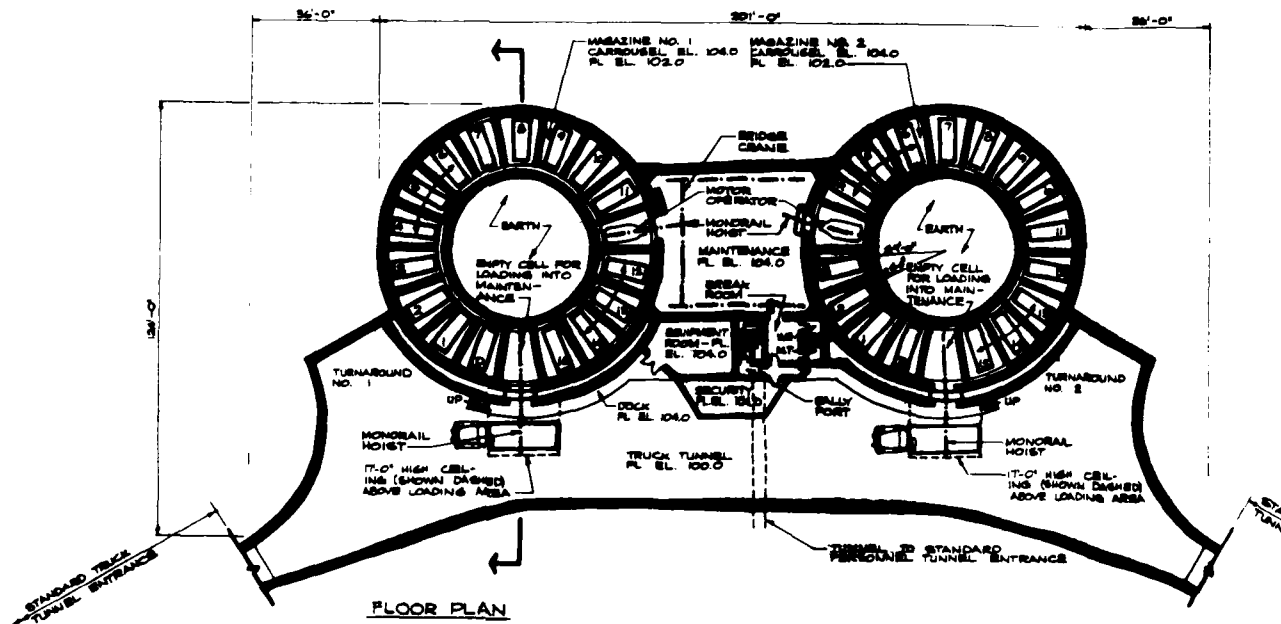
EVALUATION FACTORS

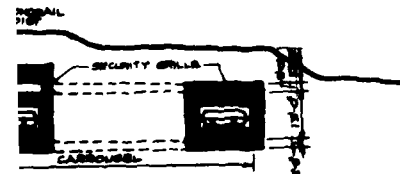
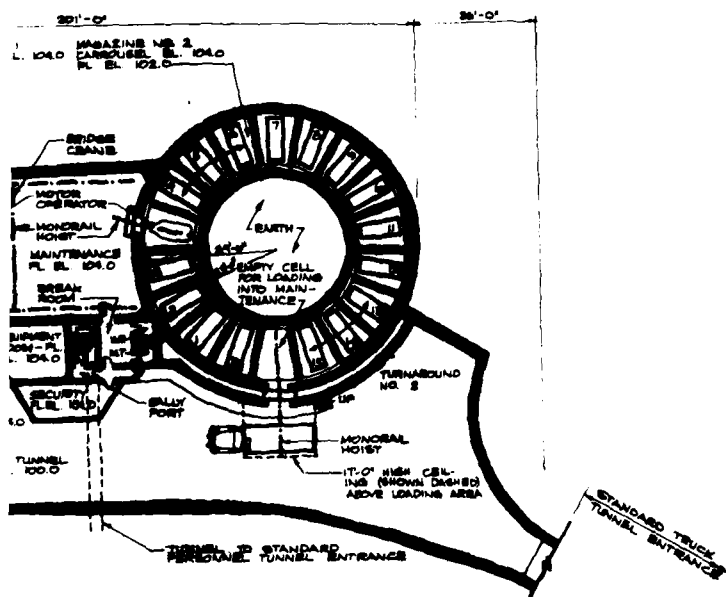
FLAT TERRAIN	
CONSTRUCTION COST:	\$10,750,000
MOUNTAINOUS TERRAIN	
CONSTRUCTION COST:	\$25,050,000
FLAT TERRAIN	
LIFE CYCLE COST:	\$13,700,000
MOUNTAINOUS TERRAIN	
LIFE CYCLE COST:	\$27,950,000
LOAD-OUT TIME:	55 minutes
SECURITY:	Superior
SAFETY:	Average
MATERIAL HANDLING:	Minimal
LAND REQUIREMENT:	3.7 acres
PERSONNEL REQUIREMENT:	4

WEAPONS STORAGE CONCEPTS

SHUTTLE CAR CONCEPT J

FIGURE 11





SCHEME K: CARROUSEL

FLOOR AREA

Magazines	9,100 sq. ft.
Truck Tunnel	15,340 sq. ft.
Personal Tunnel	1,480 sq. ft.
Maintenance Area	1,900 sq. ft.
Security/Personnel Area	650 sq. ft.
Support Equipment Area	420 sq. ft.
TOTAL	28,000 sq. ft.

NOTE

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and two material handlers (one at the door of each magazine).

The scheme is easily adaptable to smaller weapons, although an alternative method of storing large equipment to and from the maintenance area would be required. The number of weapons per carousel could be increased, or the carousel diameter could be decreased.

ADVANTAGES

Security has good views of the loading positions and the truck tunnel entrance, without being directly in line with the magazine doors, where it would be most vulnerable in case of an accidental explosion during load-out.

Only one weapon per magazine is available at a time.

The empty cell stored at the magazine door provides an extra barrier between the truck tunnel and a weapon for improved blast and intrusion protection.

Material handling personnel do not need to enter the magazines during load-out.

DISADVANTAGES

The truck must be positioned properly under the monorail.

Manual load-out will be difficult because of the weight of each carousel.

The weapons would be retrievable if the carousel was inoperable.

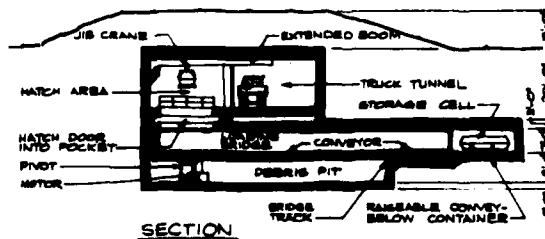
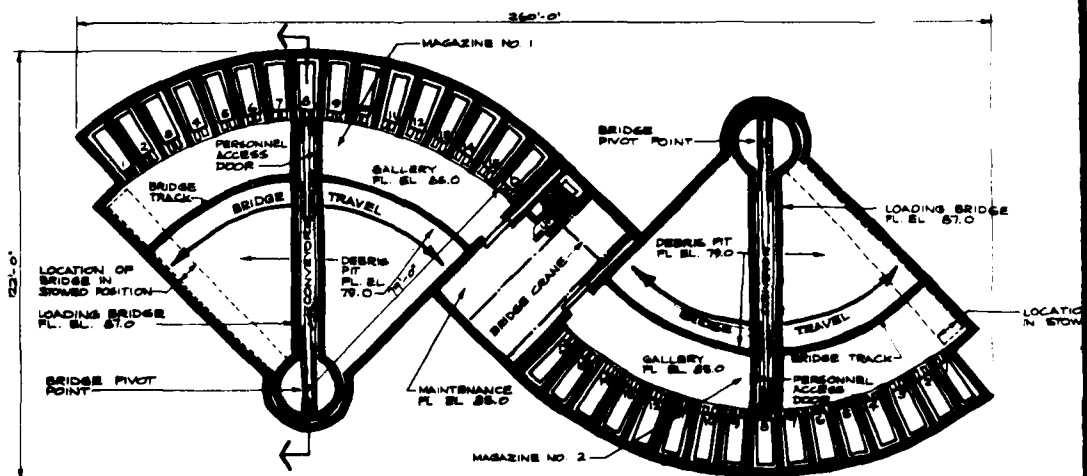
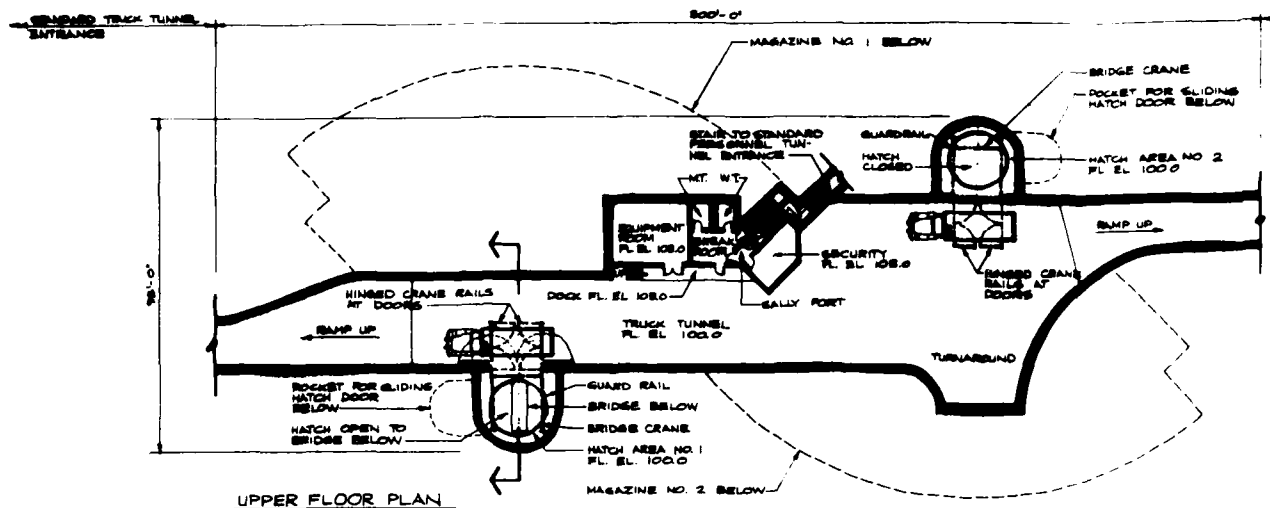
EVALUATION FACTORS

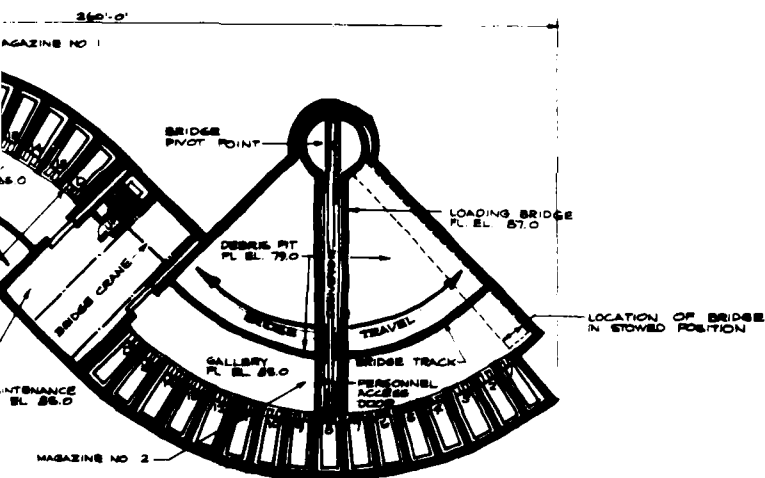
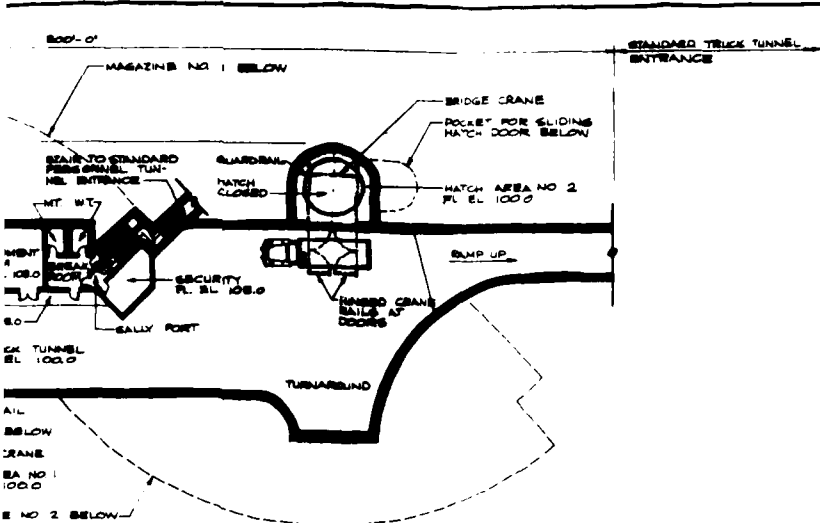
FLAT THERMAL CONSTRUCTION COST:	\$8,000,000
MONORAIL THERMAL CONSTRUCTION COST:	\$13,150,000
FLAT THERMAL LIFE CYCLE COST:	\$11,000,000
MONORAIL THERMAL LIFE CYCLE COST:	\$16,150,000
LOAD-OUT TIME:	48 minutes
SECURITY:	Superior
SAFETY:	Average
MATERIAL HANDLING:	Minimal
LAND REQUIREMENT:	3.2 acres
PERSONNEL REQUIREMENT:	6

WEAPONS STORAGE CONCEPTS

CARROUSEL CONCEPT K

FIGURE 12





SCHEME - WINDSHIELD WIPER

FLOOR AREA

Magazines	15,390 sq. ft.
Truck Tunnel	21,440 sq. ft.
Personnel Tunnel	990 sq. ft.
Maintenance Area	1,840 sq. ft.
Security/Personnel Area	160 sq. ft.
Support Equipment Area	180 sq. ft.
TOTAL	41,000 sq. ft.

NOTES

Load-out requires four security personnel (two in the security room and two in the truck tunnel entrance guard post) and four material handlers (for each magazine, one in the loading bridge and one above the hatch).

Weapons are moved from the magazines to the maintenance room by dollies.

It will be difficult to deliver large equipment to the maintenance room. The container, preferably the dummy, must be removed from its cell by dolly and stowed out of the way. Then the equipment must be delivered through the hatch and bridge into the empty cell. The equipment must be moved from the cell to the maintenance room by dolly, and the weapon container must be returned to the cell. Although the procedure is difficult, a very high level of security is maintained.

The scheme is applicable to smaller weapons, although the bridge would still have to be large enough for a person and an alternative method of delivering large equipment to the maintenance room might be required.

ADVANTAGES

The vertical separation of the magazine/maintenance areas from truck tunnel is a good security feature. But only is it difficult for terrorists to reach the weapons, but the transportation personnel cannot enter the magazines.

Weapons are buried deep in the earth for greater security and safety.

Use of the loading bridge limits access to one weapon at a time.

Security has views of both truck loading areas and both truck tunnel entrances without being directly in line with the magazine doors, where it would be most vulnerable in case of an accidental explosion during load-out.

The debris pit not only aids in fast clean-up, but it acts as a most barrier for intruders.

The rooms between the truck tunnels and the magazine hatches provide additional safety and security.

The large volume of the magazine would reduce blast pressure intensity in case of an accidental explosion.

DISADVANTAGES

The distance the crane must lift containers may be excessive for safety considerations and MEC approval.

The weapons would be irretrievable if the loading bridge was inoperable.

EVALUATION FACTORS

FLAT TERRAIN CONSTRUCTION COST:	\$9,250,000
MOUNTAINOUS TERRAIN CONSTRUCTION COST:	\$13,200,000
FLAT TERRAIN LIFE CYCLE COST:	\$12,410,000
MOUNTAINOUS TERRAIN LIFE CYCLE COST:	\$16,370,000
LOAD-OUT TIME:	65 minutes
SECURITY:	Superior
SAFETY:	Superior
MATERIAL HANDLING:	Average
LAND REQUIREMENT:	1.3 acres
PERSONNEL REQUIREMENT:	0

WEAPONS STORAGE CONCEPTS

WINDSHIELD WIPER CONCEPT L FIGURE 13

D. Evaluation of Concepts. The evaluation procedure used to select the six best from the 12 study concepts is a very simple one and is appropriate for the conceptual level of this study. For an expanded discussion of evaluation and an example of step-by-step evaluation procedure for potential weapons storage facility users, see Appendix F.

1. Evaluation Matrices. The following matrices assign scores of - (minimal), 0 (average), or + (superior) for each evaluation factor to each concept. Separate evaluations are made for flat and mountainous terrains.

2. Six Recommended Concepts. The six concepts listed below score highest in the evaluation matrices and are recommended for further development.

<u>Concepts</u>	<u>Recommended Terrain</u>
I: Mausoleum	Flat or Mountainous
K: Carrousel	Flat or Mountainous
L: Windshield Wiper	Flat or Mountainous
E: Stacker Crane	Flat
F: Turntables	Mountainous
H: Trap Door	Mountainous

EVALUATION MATRIX - FLAT TERRAIN

CONCEPT	CONSTRUCTION COST (\$000's)	LIFE CYCLE COST (\$000's)	LOAD-OUT TIME (minutes)	SECURITY	SAFETY	MATERIAL HANDLING	LAND REQUIREMENT (acres)	PERSONNEL REQUIREMENT	TOTAL SCORE
A: Hand Truck	0 9,500	0 12,089	0 44	0 Average	0 Average	0 Superior	0 4.2	0 12	-1
B: Conveyor	0 8,100	0 10,689	0 61	0 Average	0 Average	0 Average	0 3.4	0 8	+2
C: Monorail	0 7,500	0 9,976	0 71	0 Minimal	0 Average	0 Average	0 3.0	0 8	+1
D: Gantry Crane	0 7,000	0 9,443	0 60	0 Minimal	0 Minimal	0 Average	0 3.1	0 8	+1
E: Stacker Crane	0 6,450	0 8,801	0 55	0 Average	0 Minimal	0 Average	0 2.9	0 8	+2
F: Turntables	0 8,600	0 11,353	0 36	0 Average	0 Minimal	0 Average	0 3.2	0 8	+1
G: Hayloft	0 11,400	0 13,735	0 53	0 Average	0 Minimal	0 Average	0 3.4	0 8	-2
H: Trap Door	0 8,950	0 11,889	0 22	0 Minimal	0 Minimal	0 Superior	0 3.4	0 8	+1
I: Mausoleum	0 9,200	0 12,018	0 35	0 Minimal	0 Average	0 Superior	0 2.9	0 6	+3
J: Shuttle Car	0 10,750	0 13,050	0 53	0 Superior	0 Average	0 Minimal	0 3.7	0 4	-1
K: Carrousel	0 8,050	0 10,419	0 48	0 Superior	0 Average	0 Minimal	0 3.2	0 6	+3
L: Windshield Wiper	0 9,250	0 11,711	0 68	0 Superior	0 Superior	0 Average	0 3.3	0 8	+2

EVALUATION MATRIX - MOUNTAINOUS TERRAIN

CONCEPT	CONSTRUCTION COST (\$000's)	LIFE CYCLE COST (\$000's)	LOAD-OUT TIME (minutes)	SECURITY	SAFETY	MATERIAL HANDLING	PERSONNEL REQUIREMENT	TOTAL SCORE
A: Hand Truck	0 20,100	0 22,727	0 44	0 Average	0 Average	+	12	0
B: Conveyor	29,450	32,016	61	0 Average	0 Average	0 Average	8	-2
C: Monorail	27,600	30,077	71	- Minimal	0 Average	0 Average	8	-4
D: Gantry Crane	20,200	22,615	60	- Minimal	- Minimal	0 Average	8	-2
E: Stack Crane	14,900	17,257	55	0 Average	- Minimal	0 Average	8	+1
F: Turntables	15,450	18,219	36	0 Average	- Minimal	0 Average	8	+2
G: Hayloft	14,850	17,171	53	0 Average	- Minimal	0 Average	8	+1
H: Trap Door	12,450	15,002	22	- Minimal	- Minimal	+	8	+2
I: Mausoleum	15,350	18,145	35	- Minimal	0 Average	+	6	+4
J: Shuttle Car	25,050	27,303	53	+	0 Average	- Minimal	4	-1
K: Carrousel	13,150	15,485	48	+	0 Average	- Minimal	6	+3
L: Windshield Wiper	13,200	15,668	68	+	+	0 Average	8	+3

APPENDIX A
OPERATIONS SCENARIOS

INTRODUCTION

The weapons storage facility referred to in these scenarios is assumed to contain two groups of the largest weapons under consideration. There are 15 weapons per group. No more than one of these weapons can be transported in a 5-ton cargo truck.

1. NORMAL OPERATIONS

1.1 General Assumptions

1.1.1 The storage facilities will be located on existing Government installations where security forces and weapon maintenance personnel already exist. Thus, conceptual concepts do not include facilities for permanent personnel.

1.1.2 The number of storage facilities will vary depending upon the missions of nearby military installations to be supplied. There will probably be more than one facility at a site.

1.1.3 The individual storage facilities at a site will be unmanned most of the time, and passive barriers which will exclude unauthorized entry for at least 30 minutes and intrusion detection systems will be relied upon for security. There will be a central, constantly manned monitoring point at the site which may be the security room inside one of the storage facilities or may be some other location. Although not constantly manned, there will be redundant monitoring of surveillance and intrusion detection systems at each storage facility's security room. When personnel entry into the buttoned-up facility is required for non-alert activities, the following scenario applies.

1.2 Security

1.2.1 The security room will be staffed with security personnel whenever work is being done inside the storage facility.

1.2.2 The weapons storage areas (magazines) will not be staffed with security personnel.

1.2.3 Personnel entry will be provided through a tunnel separate from the truck tunnel, giving access to the security room through a hallway with limited passage.

1.2.4 Each entry portal will be provided with a guard post connected to the central security system.

1.2.5 No guard post or security room will be staffed with less than two men, when staffed.

1.3 Maintenance

1.3.1 Periodically (about once a week), at least two people will enter the storage facility to verify that the weapons containers are in place and to monitor the contents. The material handling equipment will be exercised, and doors and other equipment will be operated not less than once per month.

1.3.2 Weapons which require maintenance will be moved to the maintenance area using the material handling equipment for that respective weapons group.

1.3.3 Security personnel will monitor and control access to the weapons during maintenance and inventory operations.

1.3.4 Interior facility maintenance will be minimal but will be necessary during the 25 year life of the facility. Presumably

facility maintenance will not be done by weapons maintenance personnel. Facility maintenance personnel will be accompanied by security personnel, and their access to the magazines and to the security room will be severely restricted.

2. ALERT OPERATIONS

2.1 General Assumptions

2.1.1 The loading-out of weapons will occur after an alert has been declared, allowing time for full staffing. Alerts will not always result in load-out.

2.1.2 Once an alert has been declared, the facility will be fully and constantly manned with at least four personnel: two security personnel and two material handlers. The actual number of personnel will depend on the concept design.

2.1.3 The deployment forces will consist of a command structure, a suitable security force and the 30 trucks which will transport the weapons out of the storage facility. Only the trucks, with one driver and one passenger per truck, will enter the storage facility.

2.2 Truck Entry. After the deployment force arrives at the storage facility and secures the site, the security personnel within the storage facility will open the truck tunnel barriers. The barriers will remain open during load-out to speed the movement of trucks. Security personnel at the entrance end of the truck tunnel will identify to personnel inside the facility which weapon is required by a particular truck. Each truck driver will be directed to the proper loading area which will be identified by signs, paint color, or lights. The proper parking position will be depicted on the area required for loading.

2.3 Truck Loading. The material handlers will direct the truck into the correct loading position, if required, and will verify the weapon to be loaded. The material handlers will load the weapon container on the truck and supervise securing the container within the truck. Transportation personnel will secure the container within the truck, but they will not be involved with moving it from the magazine to the truck. The advantage of using transportation personnel to load-out the weapons would be that material handlers would be unnecessary. However, the use of material handlers is justified by the following:

- The handling of containers in the simplest manner conceivable by personnel unfamiliar with the operation will be unpredictable.
- Material handling in a predictable manner is the basis of the facility design.
- The efficient and rapid deployment of containers is the justification for building the facility.
- The training of a material handling crew of two to eight per storage facility will be cheaper than training transportation personnel (60 per storage facility) to do the job of loading.

2.4 Truck Exit. After the container is secured in the truck, the truck will be dispatched upon advice from security to proceed. The truck will not exit by the same tunnel it entered to avoid the crossing of truck traffic. The barriers will have been opened by the internal security personnel, and the tunnel opening will be secured by the deployment security force. After all trucks have left the storage facility, but before the deployment security force leaves with the trucks, the facility will be reclosed and secured.

APPENDIX B
MATERIAL HANDLING

MATERIAL HANDLING EQUIPMENT

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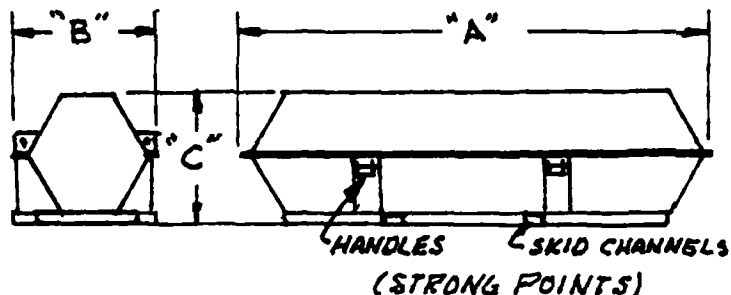
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1. Container:



CONTAINER	A	B	C	WEIGHT
1	5'-6"	1'-2"	1'-3"	420#
2	4'-9"	1'-9"	1'-10"	266#
3	9'-8"	3'-1"	3'-3"	1465#
4	14'-0"	4'-5"	4'-8"	2877#

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2. Moving Devices:

- A. Wheeled Dollies
- B. Monorail
- C. Conveyors
- D. Cranes
- E. Forklift Trucks
- F. Pallets
- G. Dock Levelers

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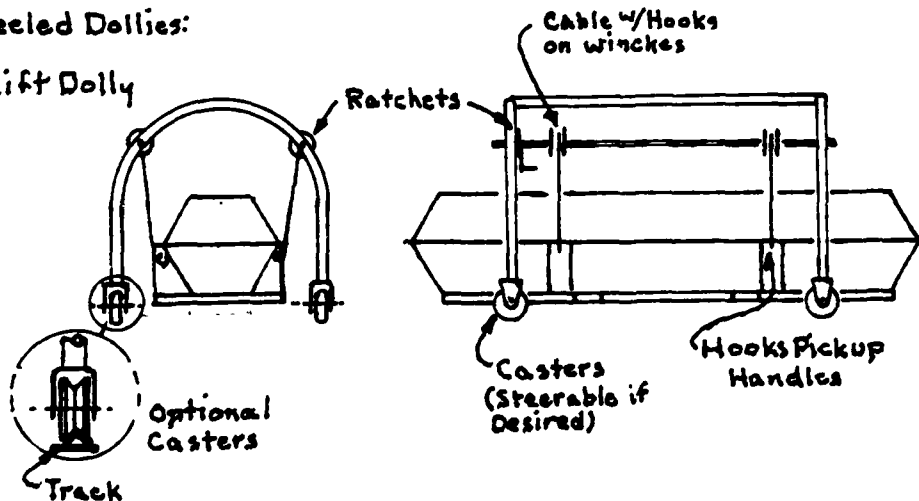
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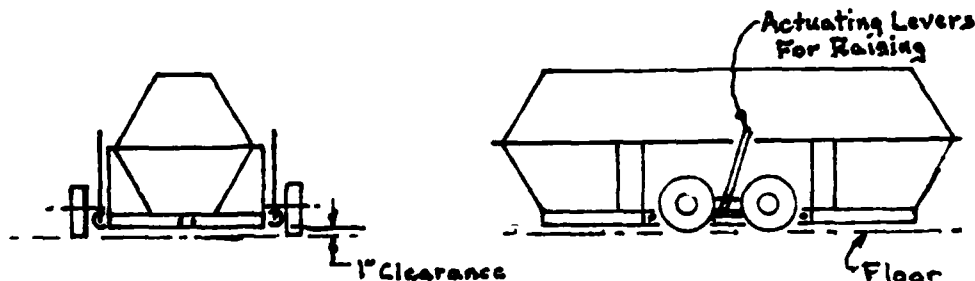
A. Wheeled Dollies:

(1) Lift Dolly



Note: Dolly can be made to only slightly larger than the container for transporting easily.

(2) Dolly Wheels



Note: Wheels are mounted in forklift slots from each side and locked in place. The actuating levers operate eccentric axles which lift container and lock over center. Container can be steered like a four wheel trailer.

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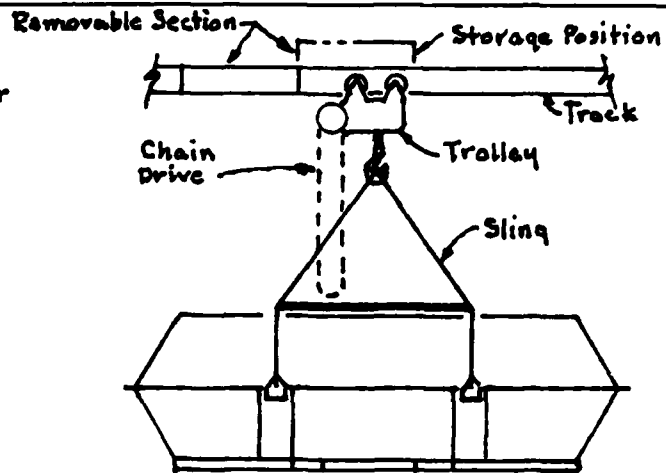
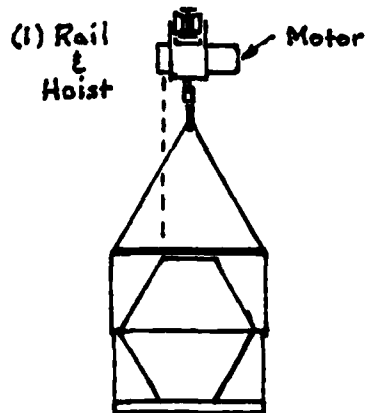
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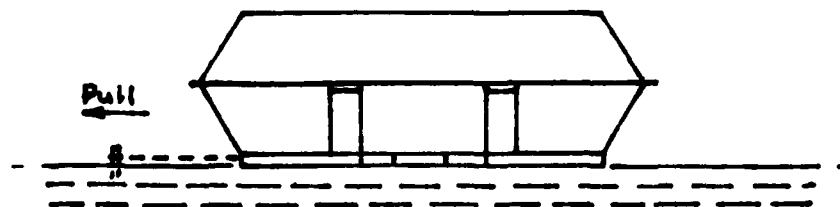
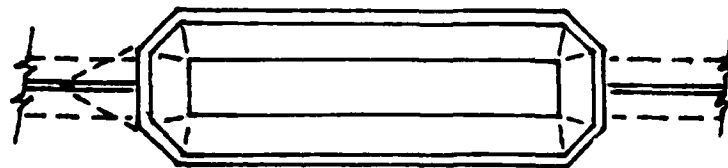
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B. Monorail



Note: Hoist selection is all electric, electric lift and manual traverse, all manual, or manual lift and electric/manual traverse. Track can be any of several proprietary systems which have switches, branches, and programed control for automatic distribution.

(2) Under Floor Rail



Note: Powered chain drags load in three dimensions, up or down medium grades, around corners, etc.

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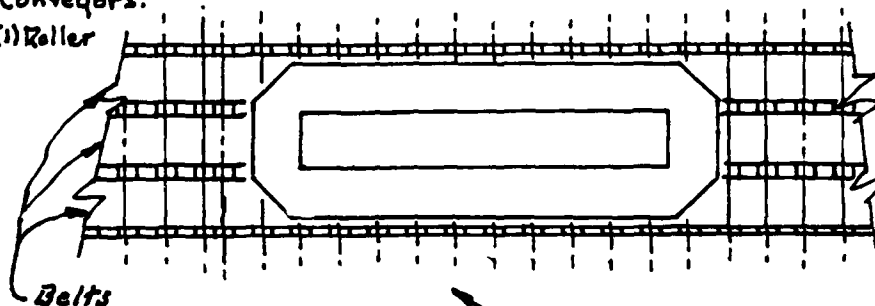
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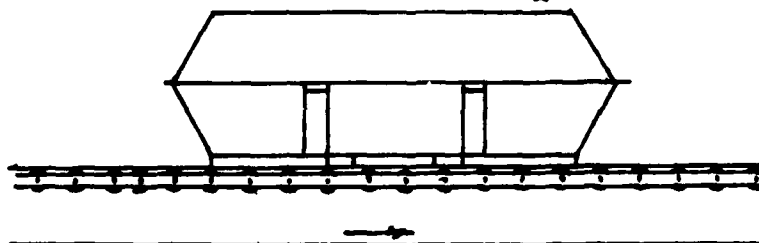
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C. Conveyors:

(1) Roller

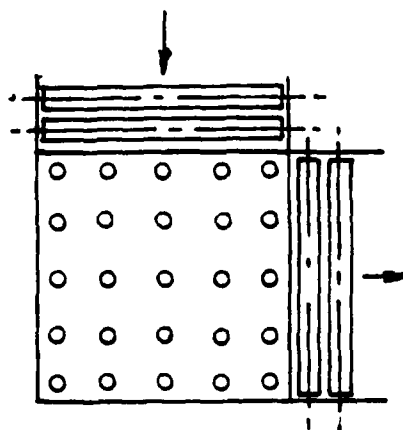


Conveyor can
traverse 30°
incline max.
if required

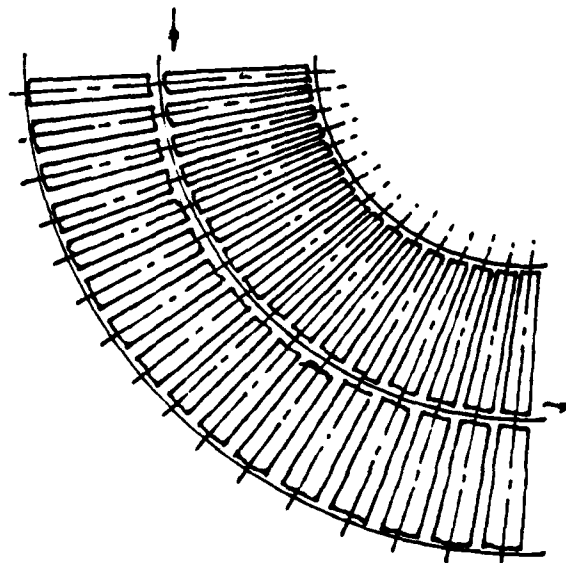


Allow space for belt return

(2) Ball Transfer Table



(3) Roller (Direction Change)



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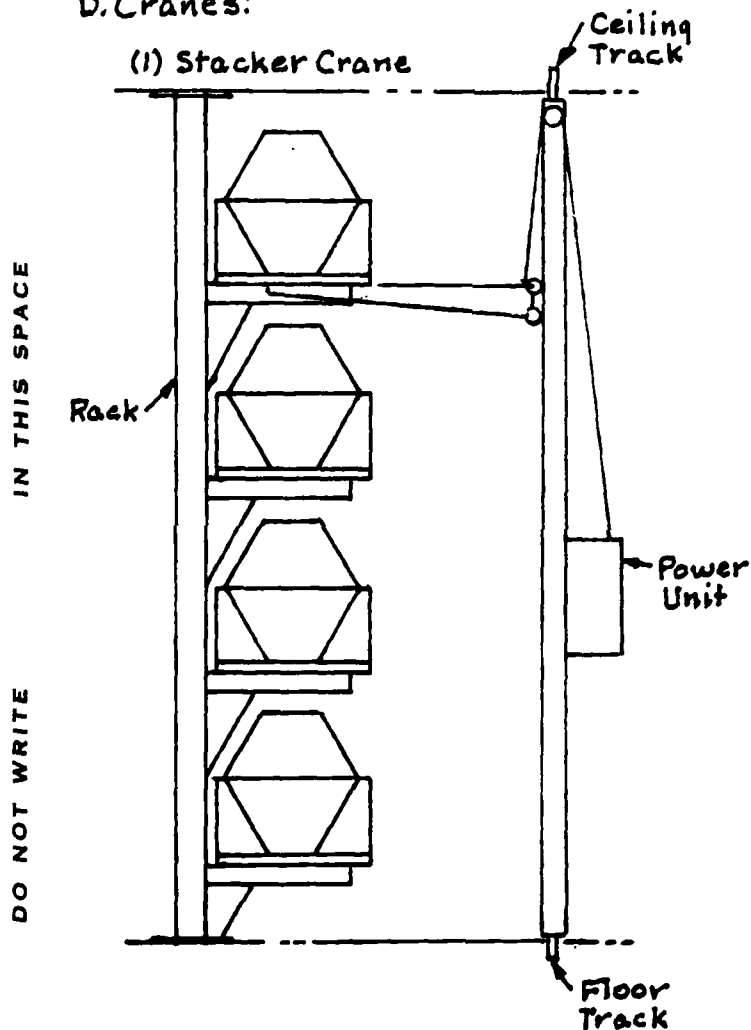
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D. Cranes:

(1) Stacker Crane



Note: Stacker cranes stack and retrieve automatically if desired and can be arranged to suit any floor layout.

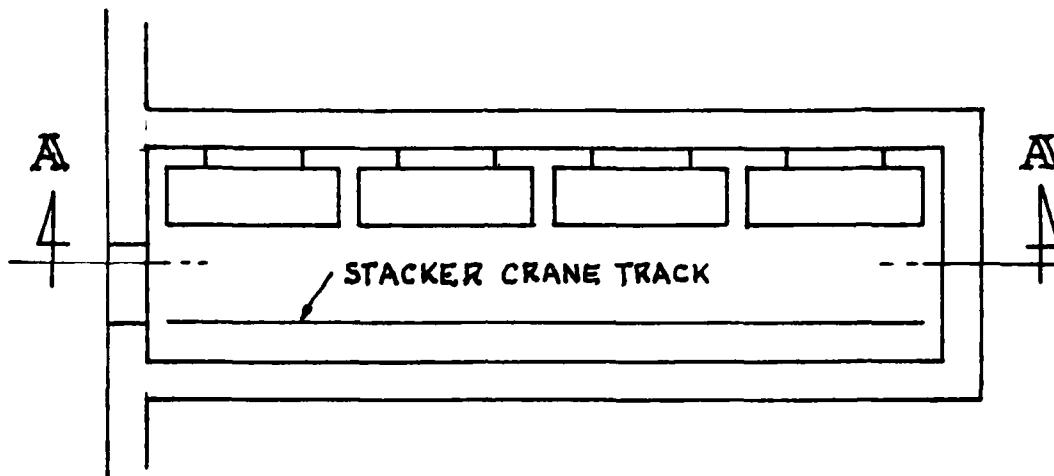
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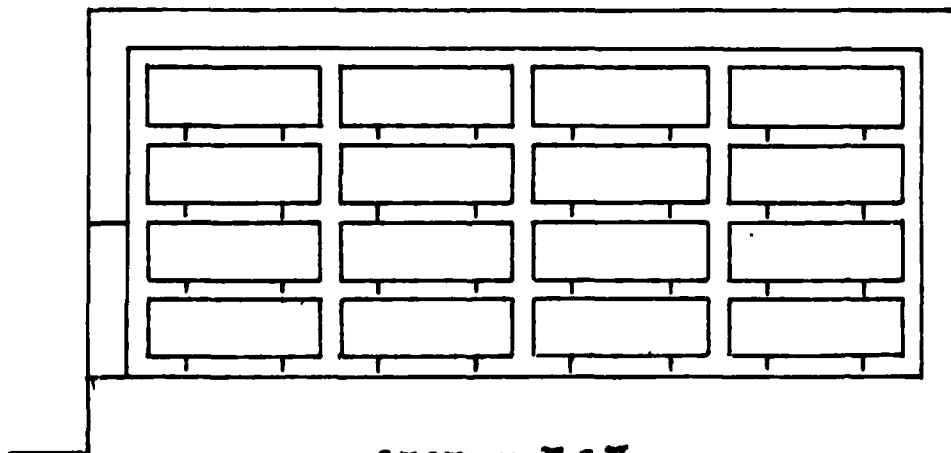
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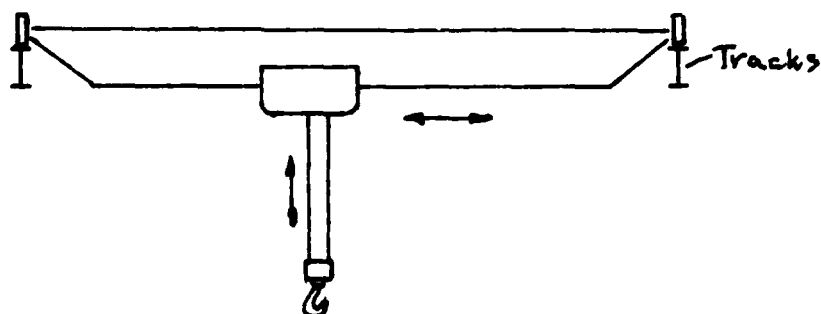
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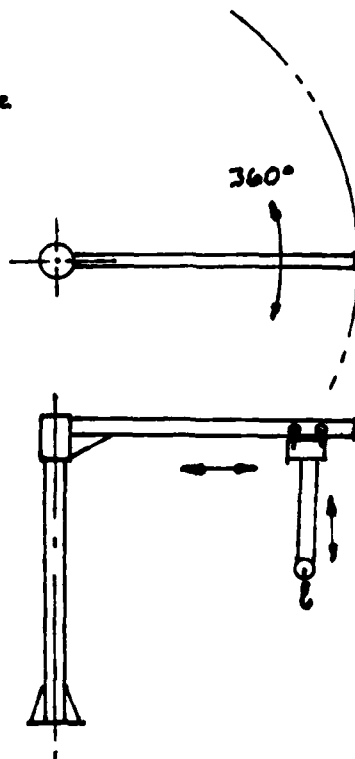
D. Cranes (Cont'd)

(2) Overhead Crane



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(3) Jib Crane



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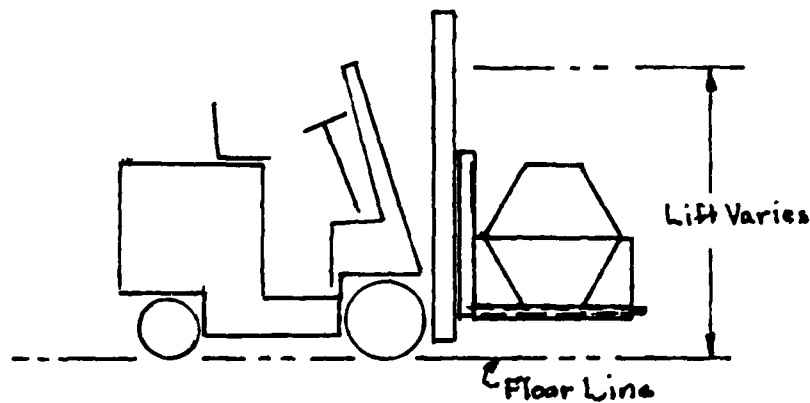
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E Forklifts:

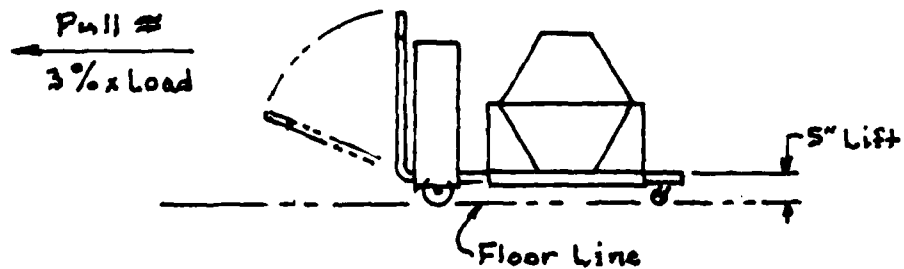
(1) Electric or Catalytic Exhaust System

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(2) Manual Lift/Hydraulic Pallet Truck

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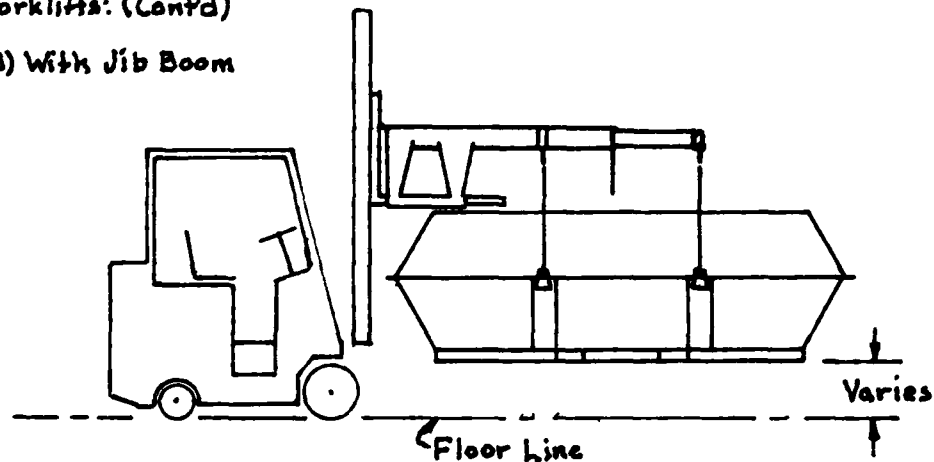
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E. Forklifts: (Cont'd)

(3) With Jib Boom

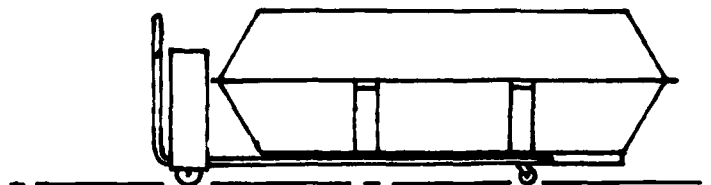
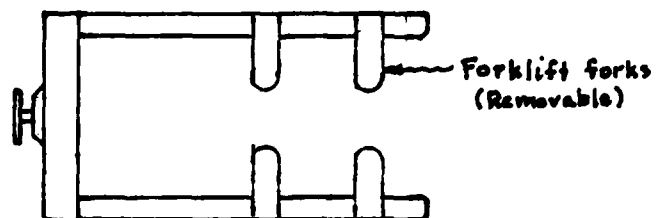
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Note: Jib mounts on standard forks and is raised by raising forks.

(4) Special Pallet Truck

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Note: Pallet truck is wider and longer than standard. A pallet under the container would allow using a pallet truck with only special length forks.

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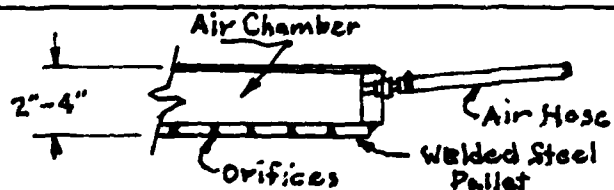
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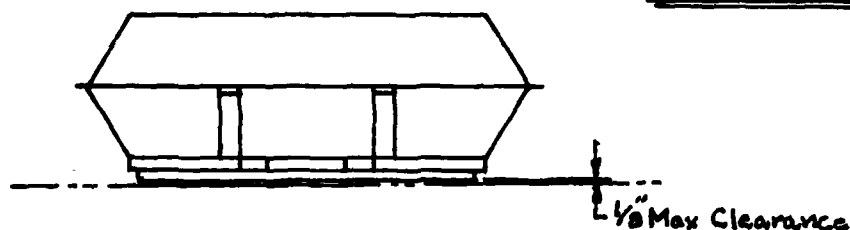
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F. Pallets:

(1) Air Pallet

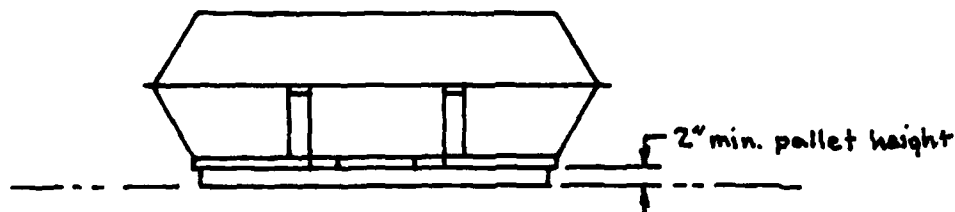
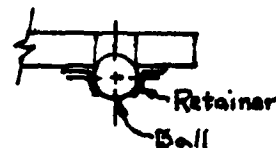


Air Pressure 1-2 psi



Note: Air pallets are virtually friction-free and can be pushed and steered effortlessly. Shutting off air will stop the device.

(2) Ball-Roller Pallet



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DATE 17 June 1982

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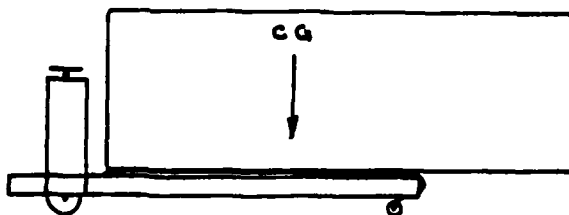
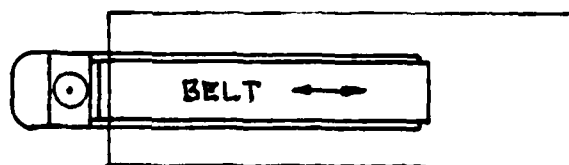
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RIDING TYPE PALLET TRUCK WITH POWER DRIVEN
CONVEYOR BELT PLATFORM

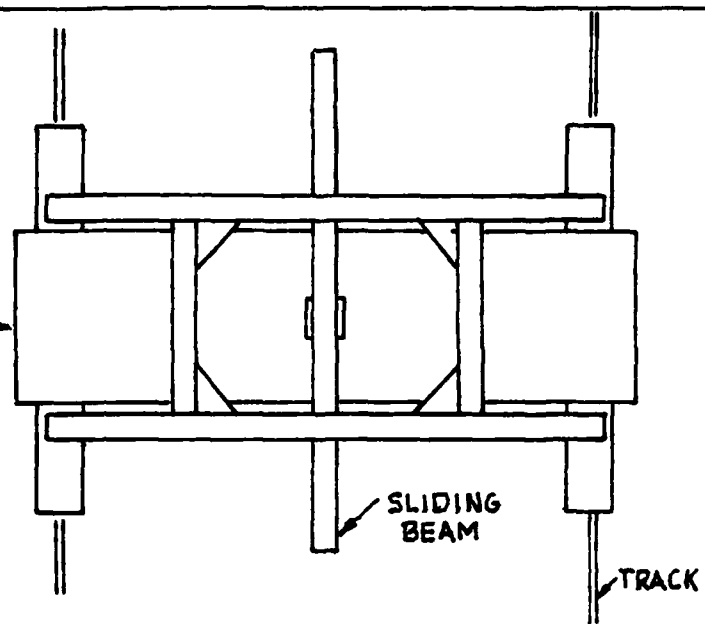
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+ BLACK &
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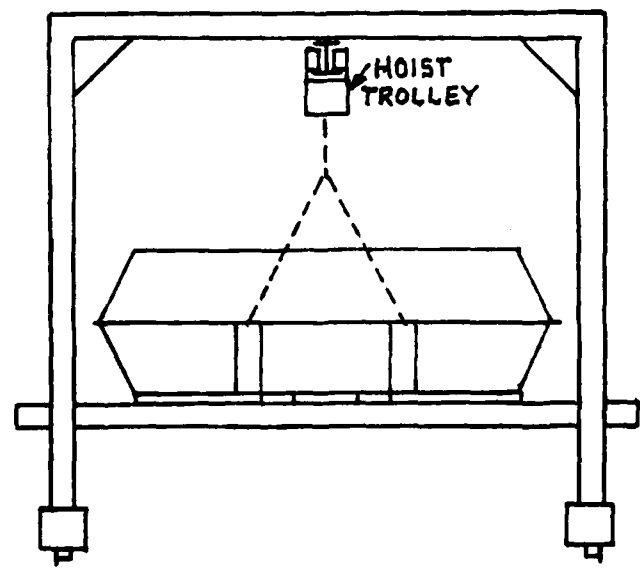
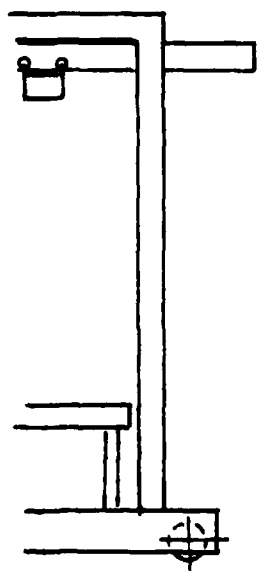
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CONVEYOR →



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TRANSPORTING & LOADING DOLLY

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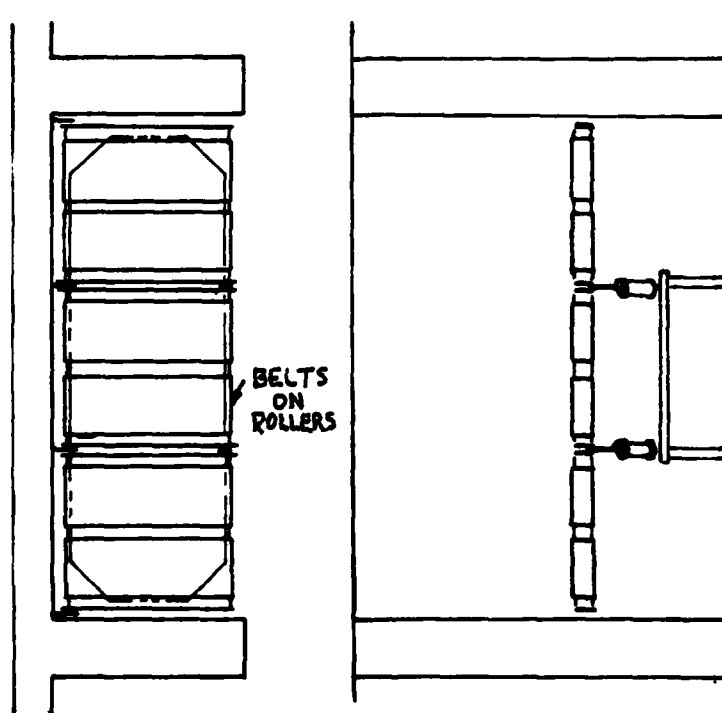
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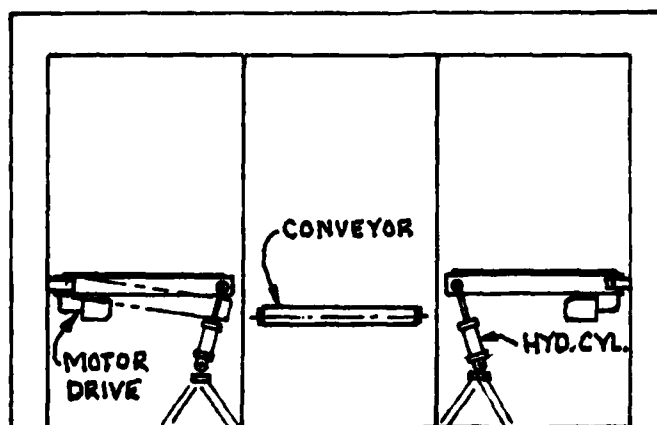
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PLAN VIEW

FRONT ELEVATION



SIDE ELEVATION

CONVEYOR TYPE
STORAGE SHELF

$$\frac{3000^{**}}{14\text{ ft.}} = 214^{**}/\text{ft.}$$

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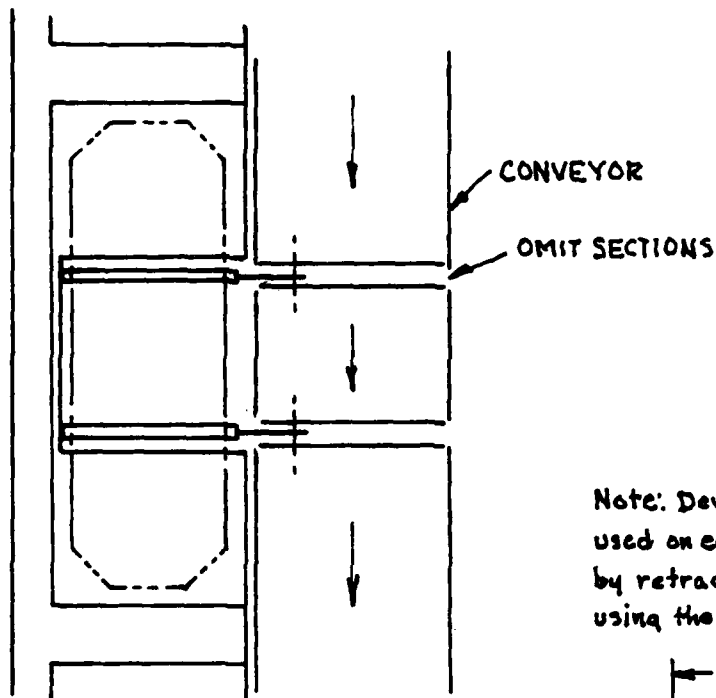
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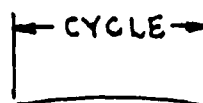
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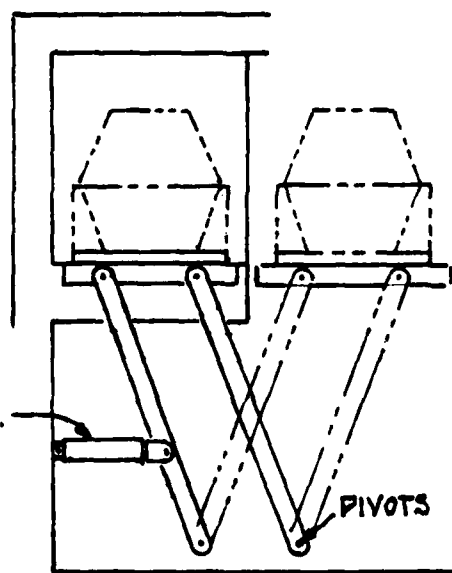
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Note: Device shown can be used on each side of conveyor by retracting one before using the other



TRANSFER
MOTION



SHELF UNLOADING/LOADING
TO CONVEYOR

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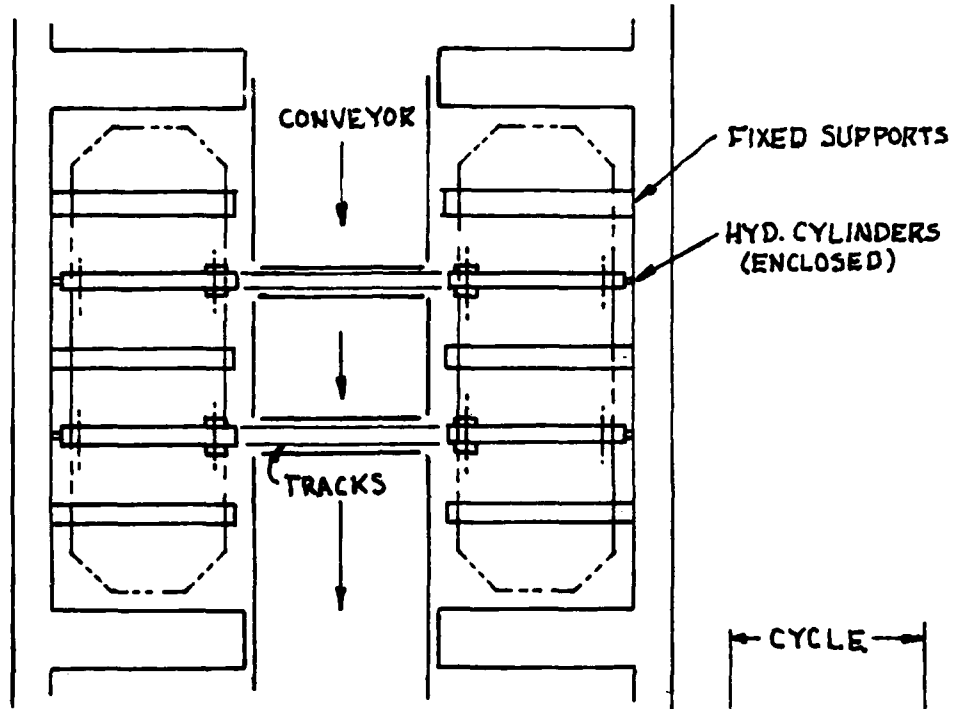
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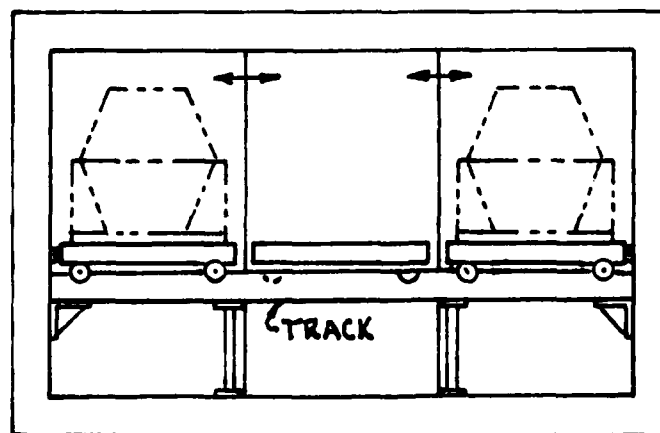
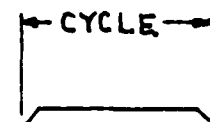
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PLAN VIEW



ELEVATION

SHELF UNLOADING/LOADING
 TO CONVEYOR

P.GN-025-A

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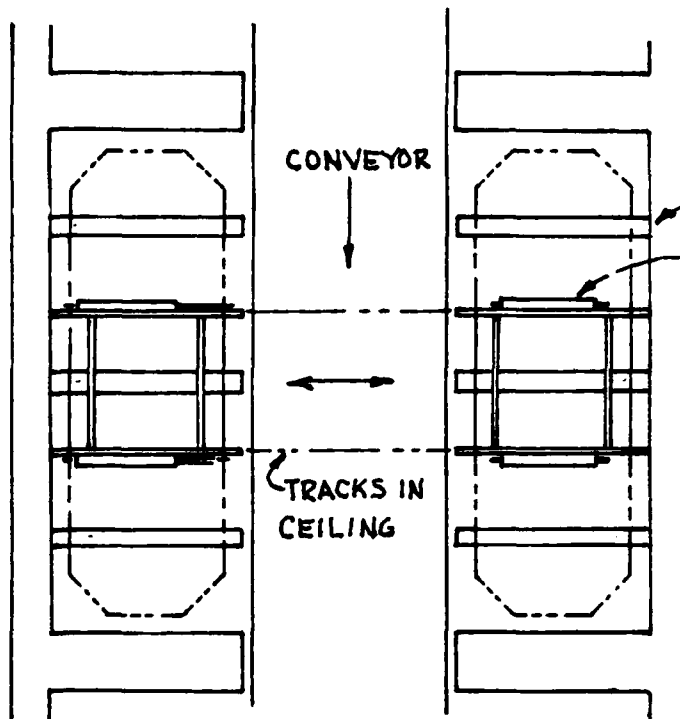
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PROJECT NO. 10304

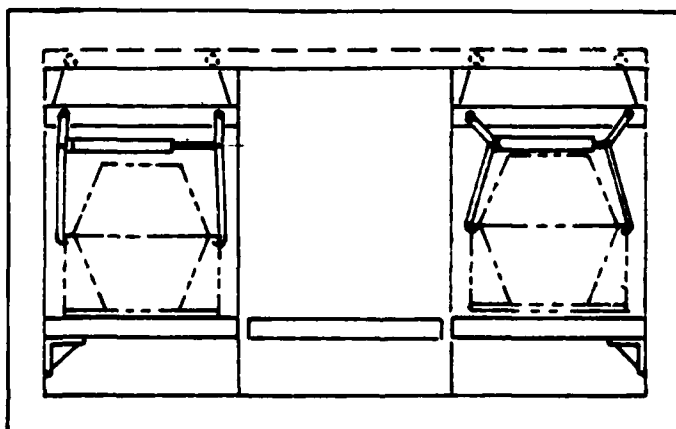
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PLAN VIEW



ELEVATION

P. (N-025)-4

STORAGE ARRANGEMENTS

**PREVIOUS PAGE
IS BLANK**

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DATE 26 May 1982

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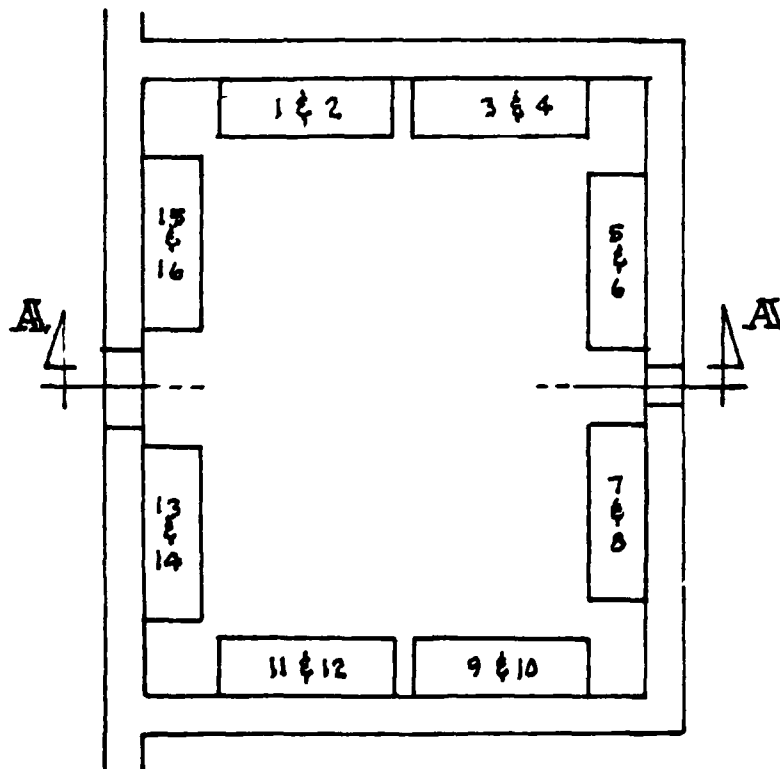
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PROJECT NO. 10304

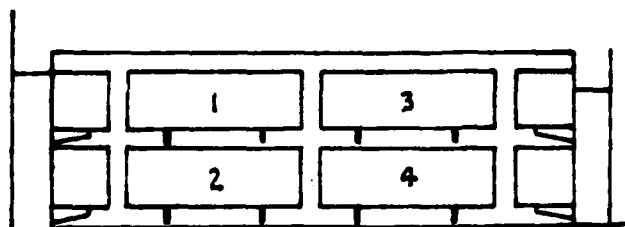
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STORE AROUND THE WALLS



SECTION A-A

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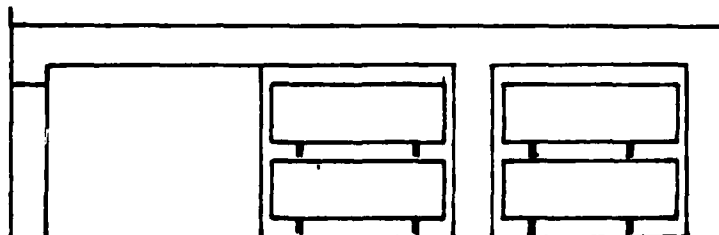
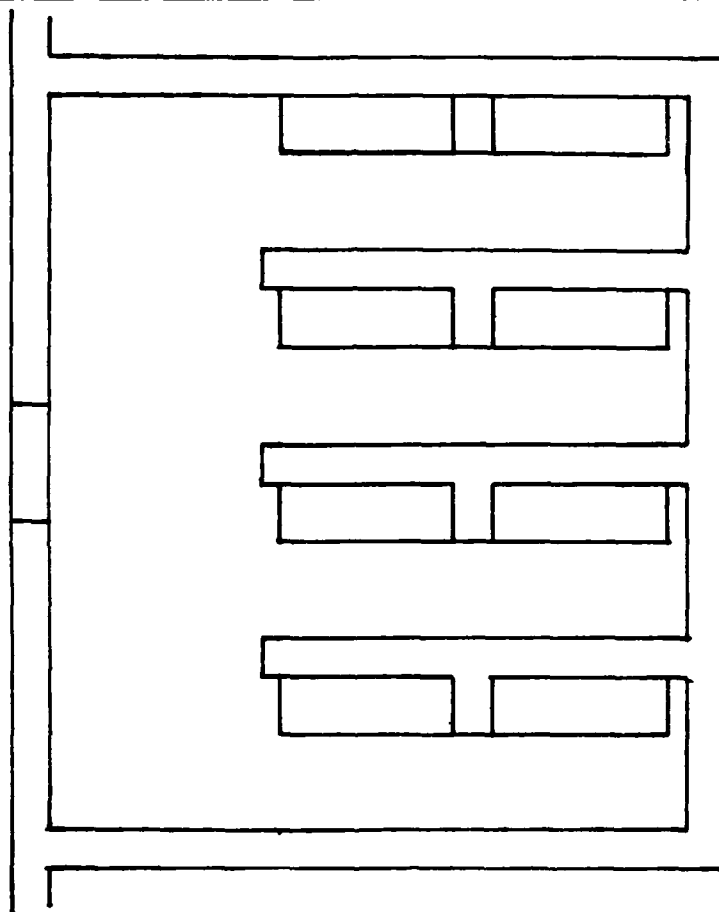
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STORE ON SHELVES w/ BARRIERS

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ORLANDO

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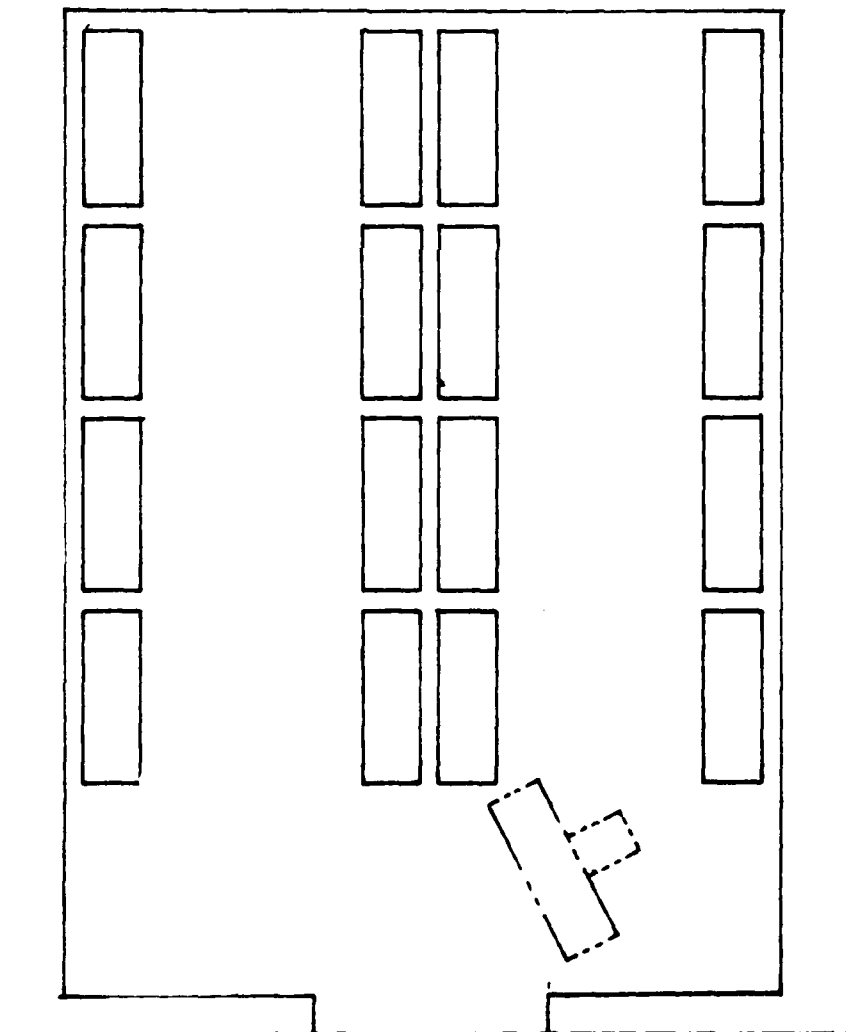
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FORKLIFT HANDLING

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P. W. 025-4

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VEATCH
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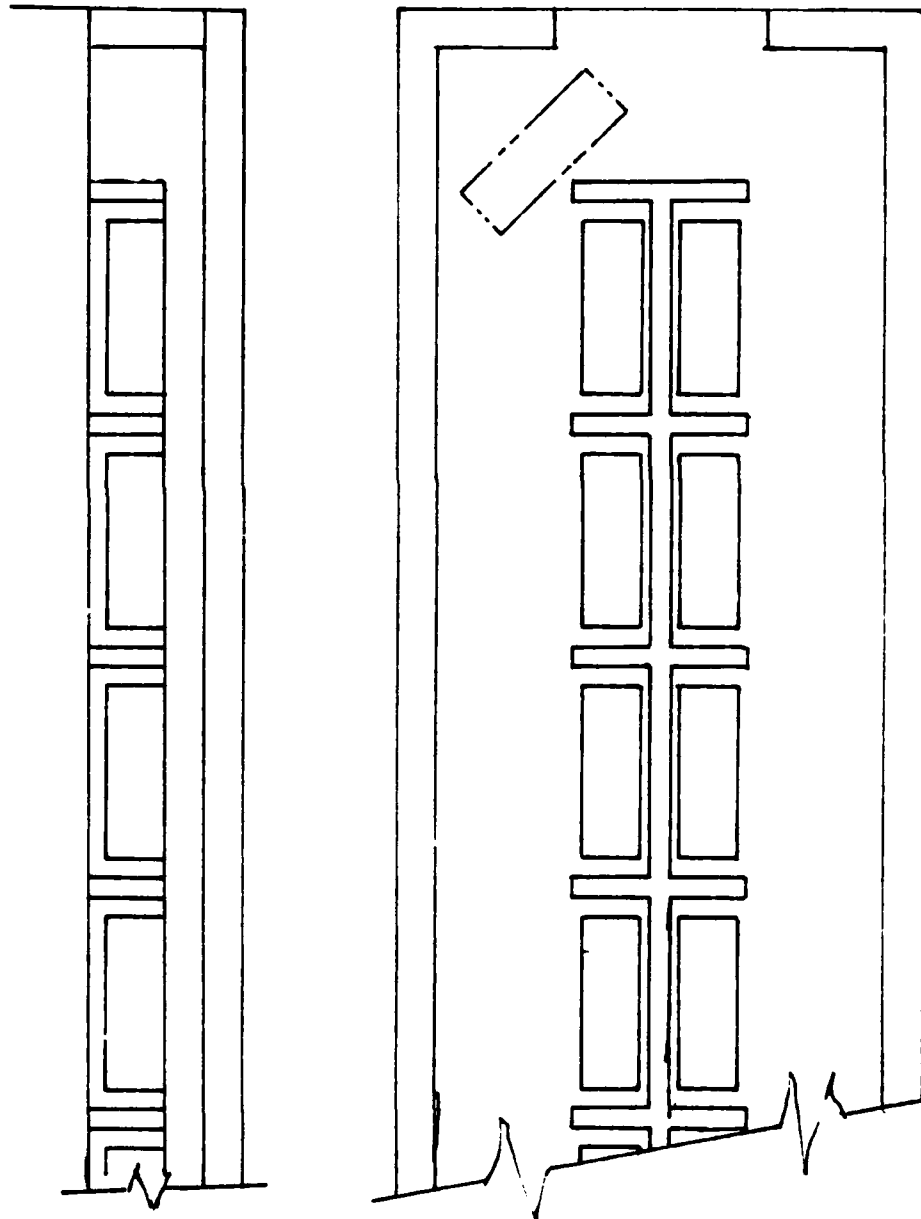
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PALLET STORAGE W/ BARRIERS

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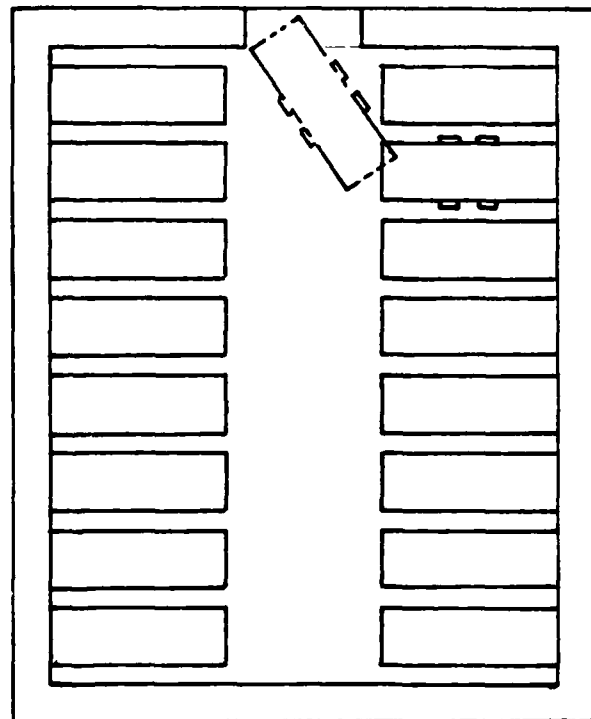
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WHEELED DOLLY STORAGE

P. ON-025-A

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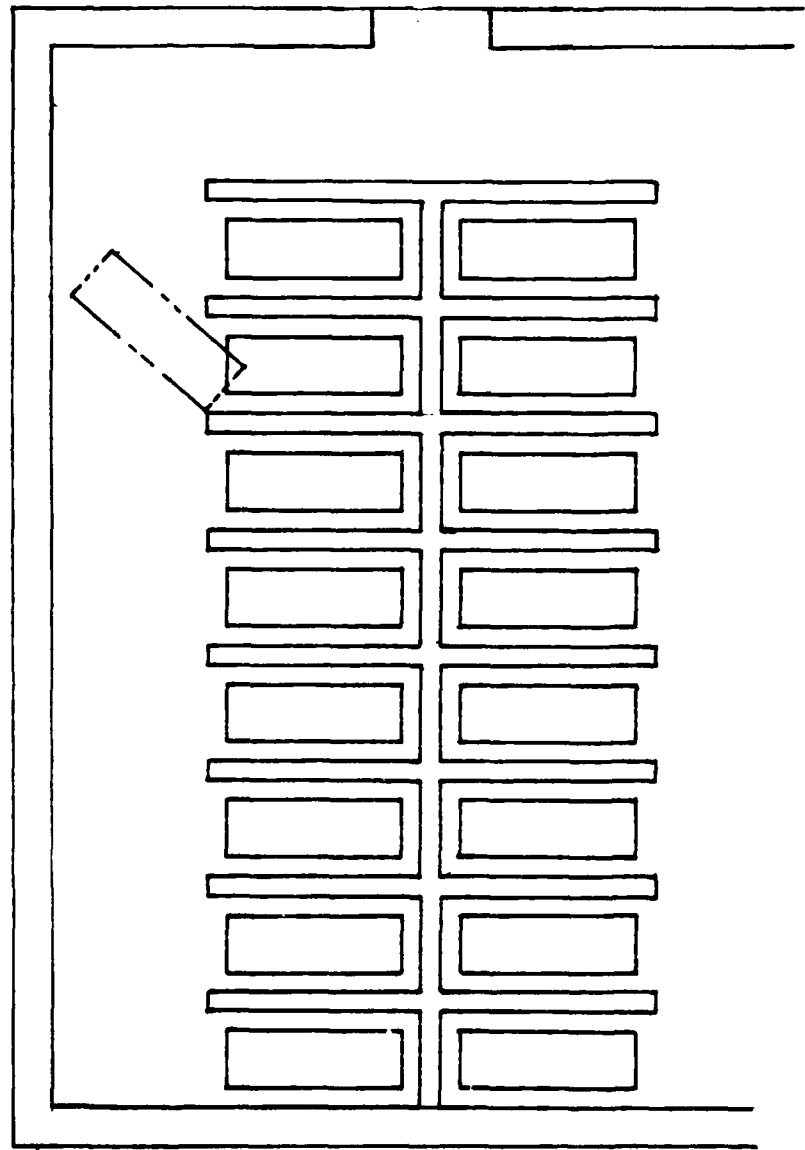
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WHEELED DOLLY STORAGE w/BARRIERS

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Reflected Ceiling Plan

DO NOT WRITE

Lower with Forklift

P.GN-025-A

STORE IN THE CEILING

+

+ BLACK &
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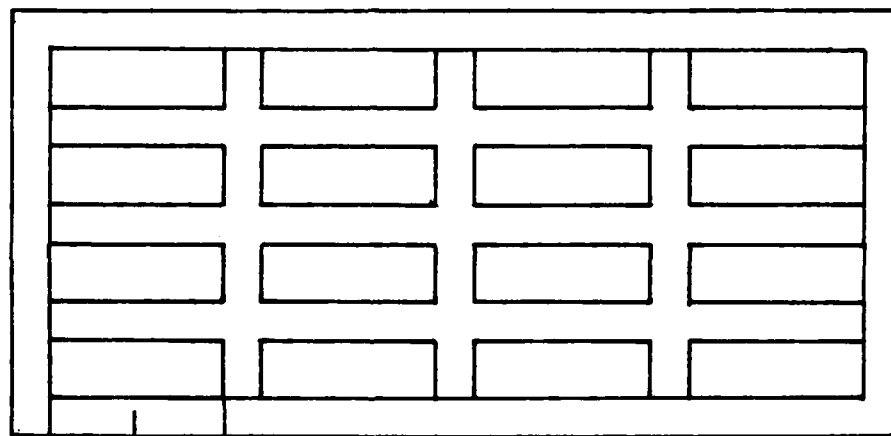
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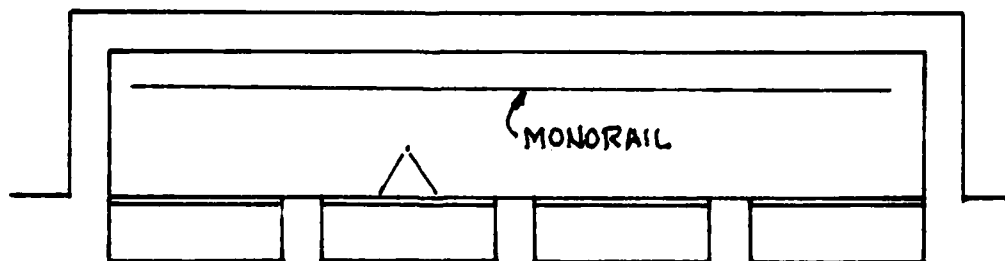
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STORE IN THE FLOOR

P. 6W. 025-A

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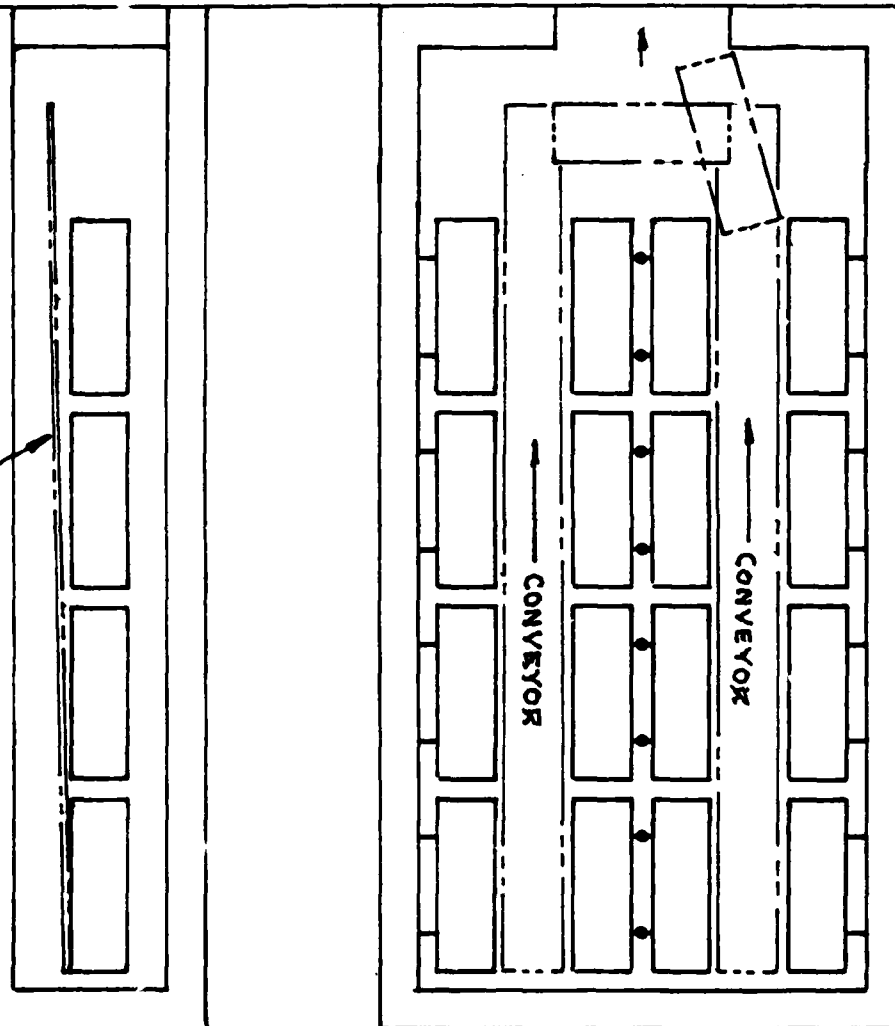
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2%
SLOPE



CONTAINER STORAGE

P. CN. 025-A

+ **BLACK &
VEATCH**
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DO NOT WRITE

P.G.W.-025-A

NOTE: SET MONORAIL
AT 2% SLOPE

+ TROLLEY
STORAGE

MONORAIL

SWITCHES

+ BLACK &
VEATCH
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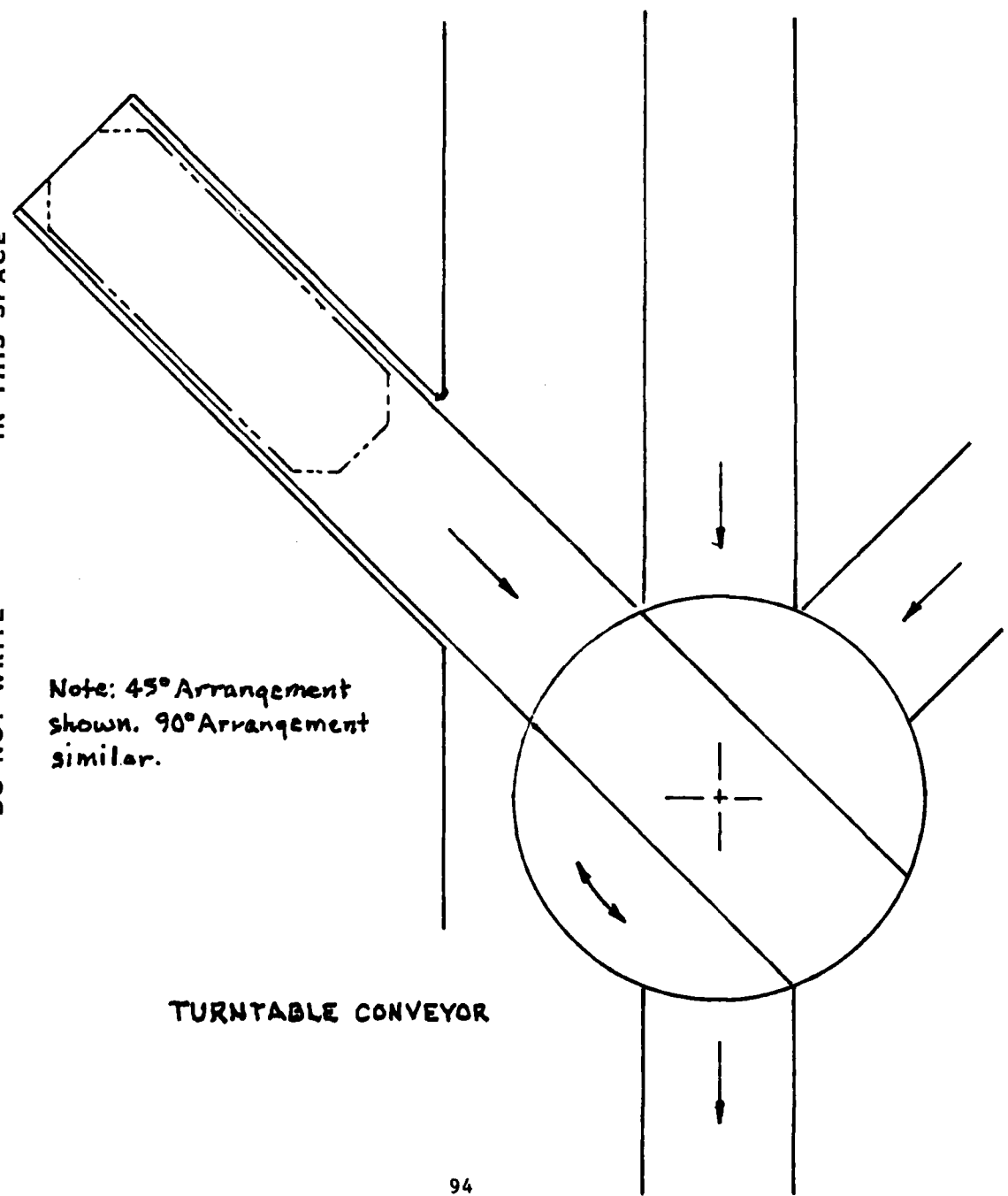
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Note: 45° Arrangement
shown. 90° Arrangement
similar.

TURNTABLE CONVEYOR

P. GN. 025-A

+



+ BLACK &
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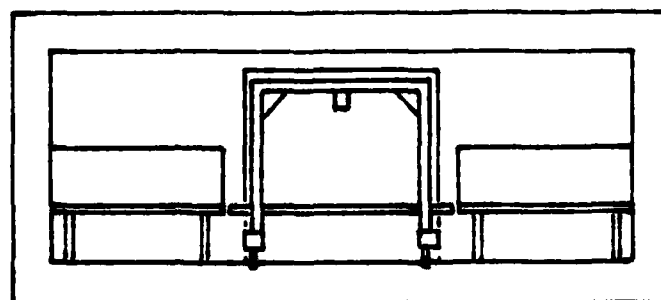
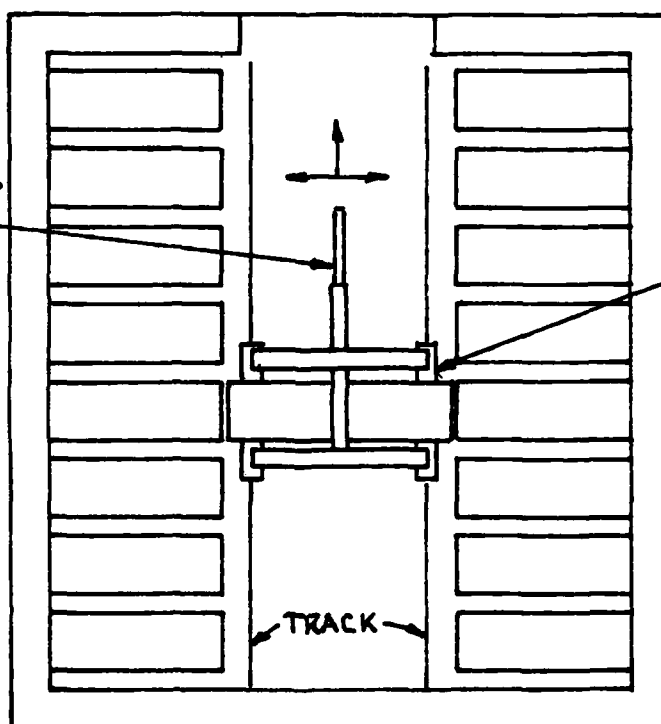
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RETRACTABLE
BOOM

TRANSPORTING
&
LOADING
DOLLY

TRACK



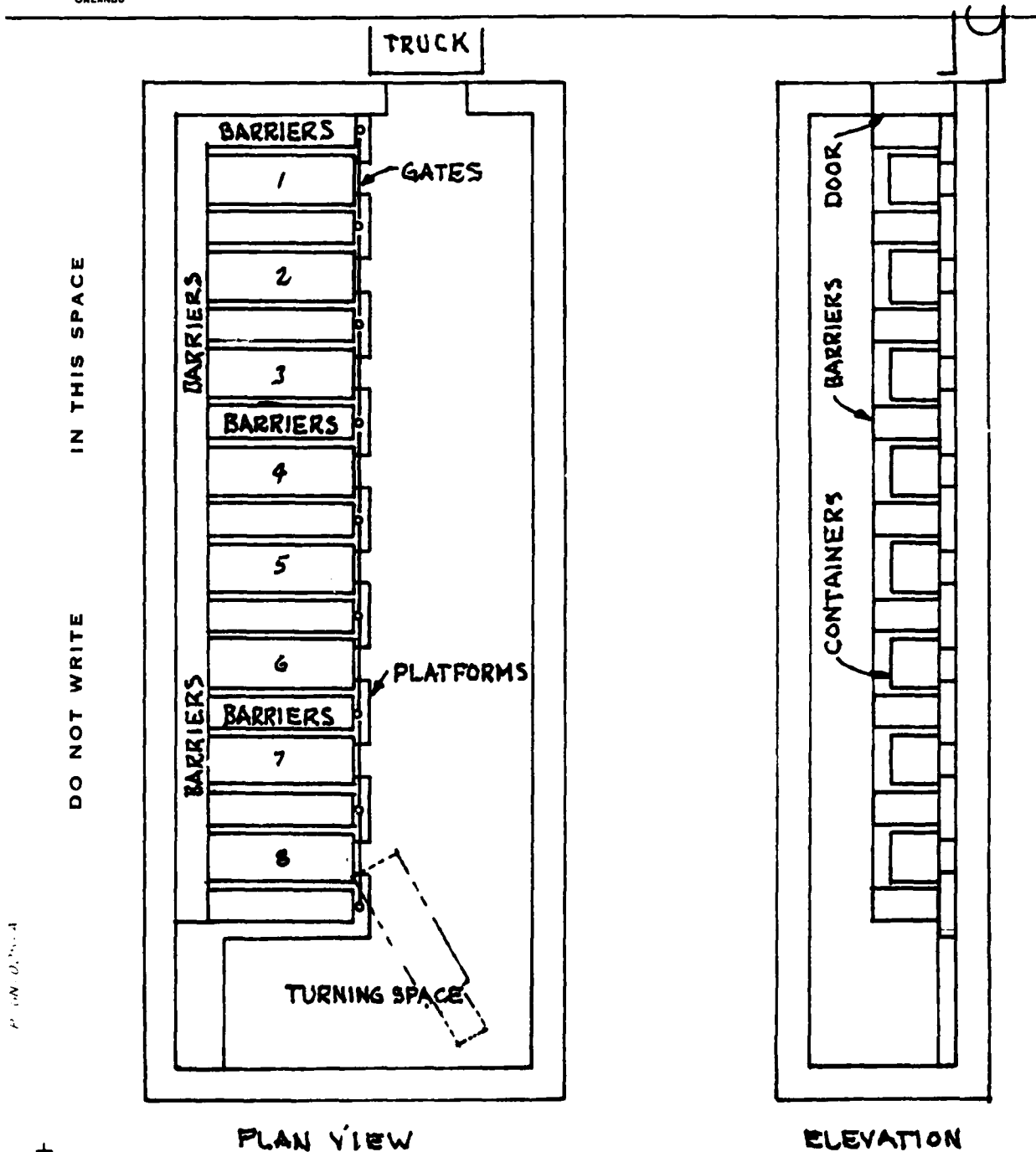
ELEVATION

P. GN. 025-A

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WORK "Motorized Pallet" Pallet Truck ARRANGMT
PROJECT NO. 10304

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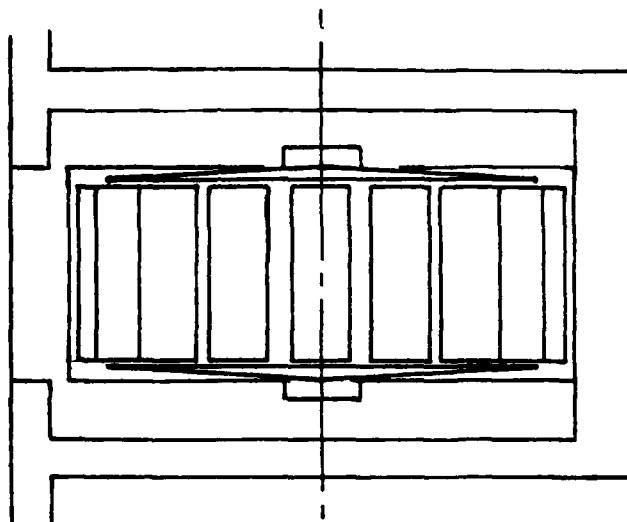
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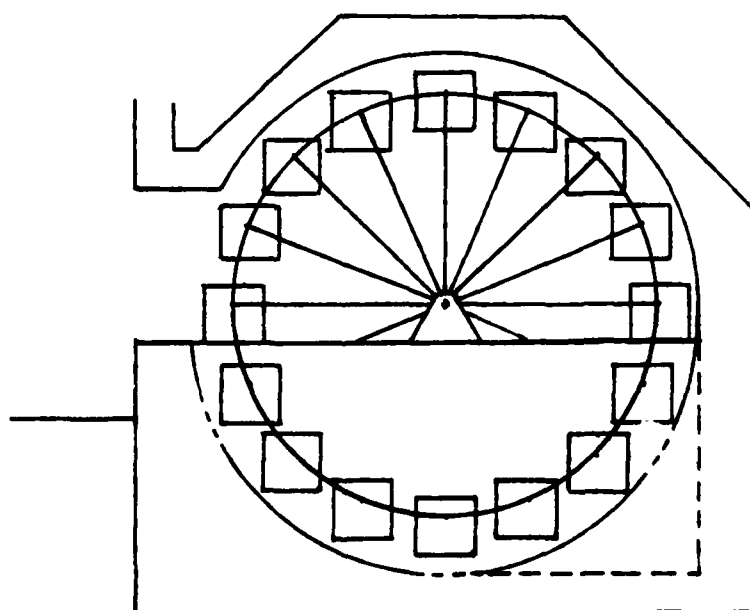
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FERRIS WHEEL

+ BLACK &
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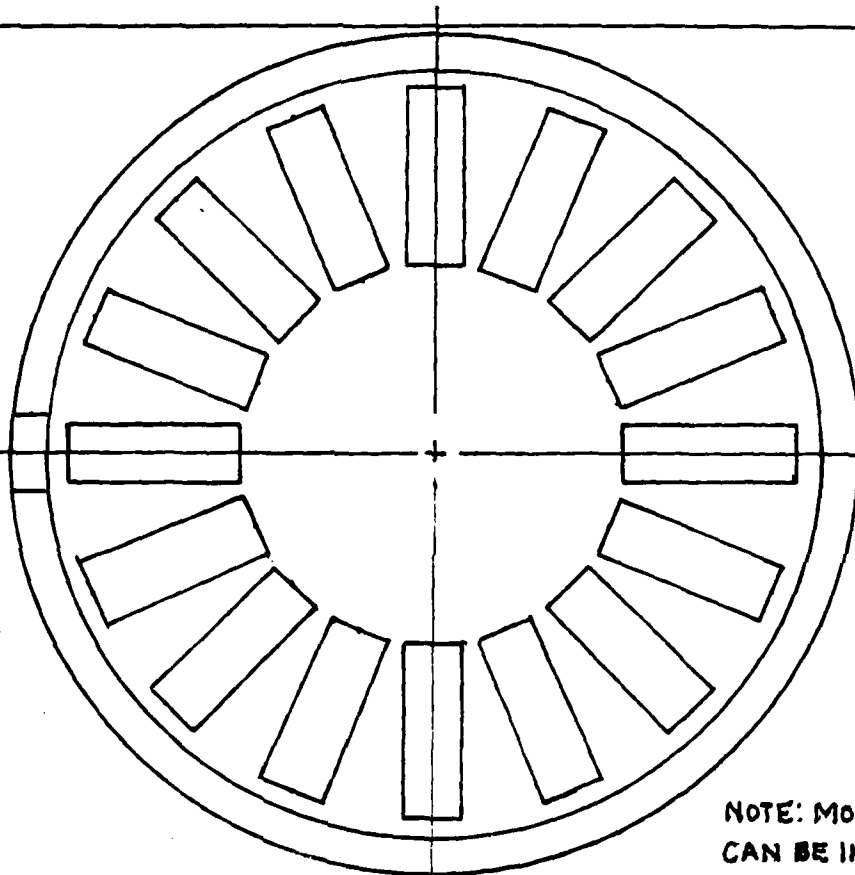
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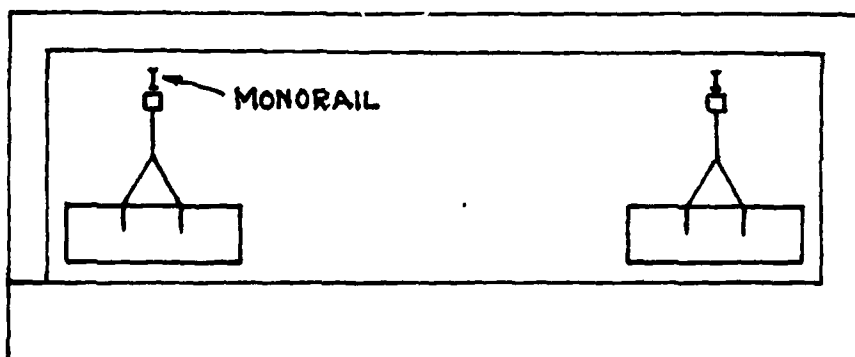
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4

A
4



NOTE: MONORAIL
CAN BE IN FLOOR

P. (N-025)-4



CARROUSEL STORAGE

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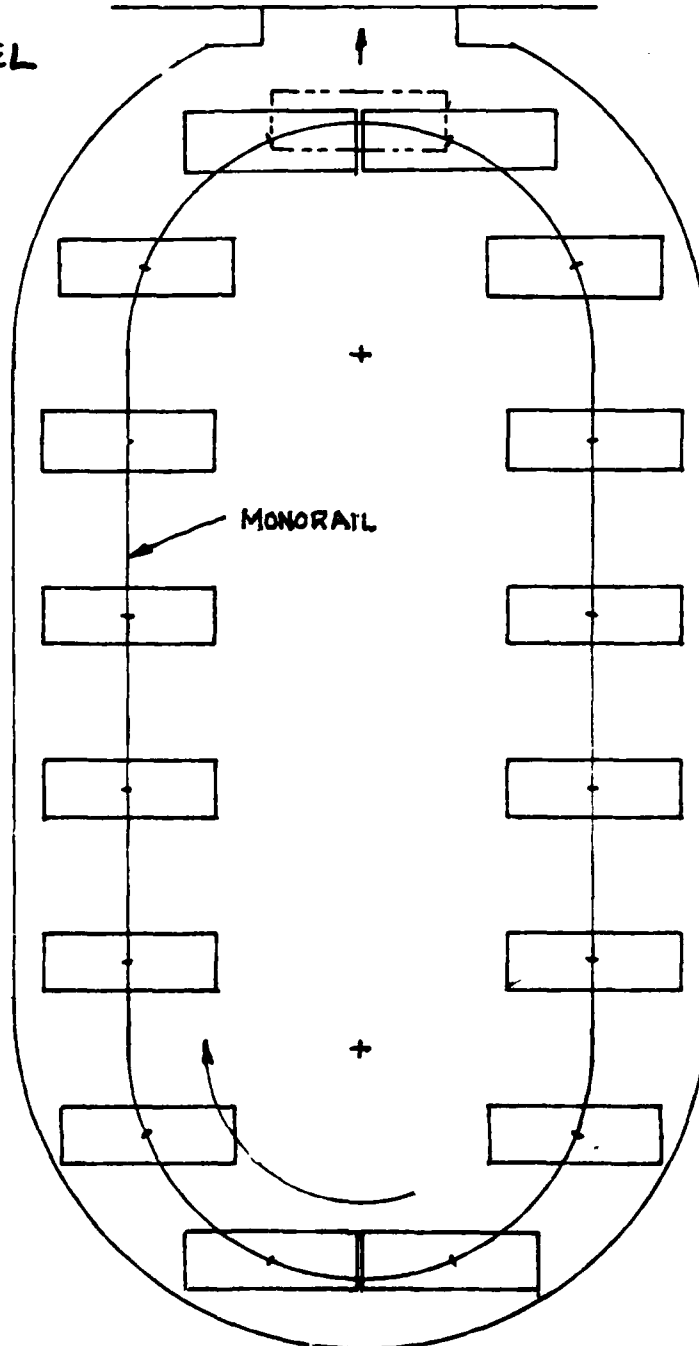
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**CAROUSEL
STORAGE**



P. (N-025). 4

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ADVANCED STRUCTURAL CONCEPTS FOR WEAPONS STORAGE - FLAT
AND MOUNTAINOUS TERRAINS(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL JUN 83 CERL-TR-M-330

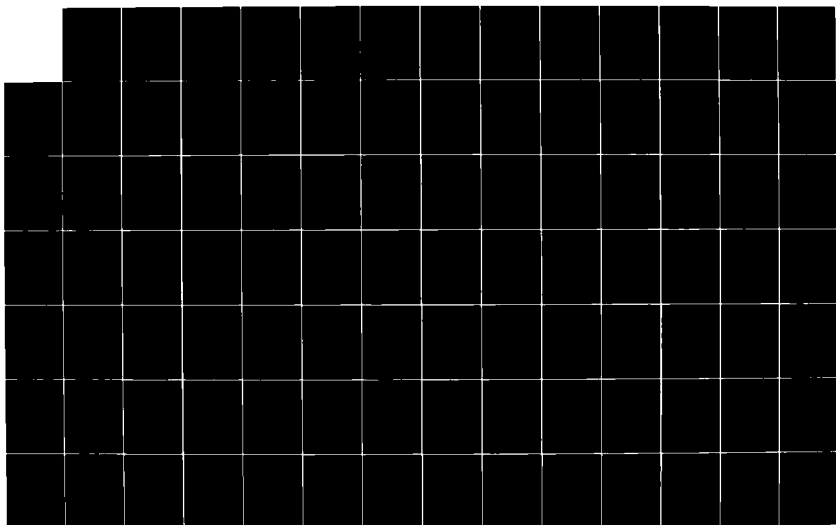
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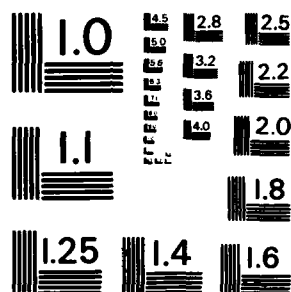
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

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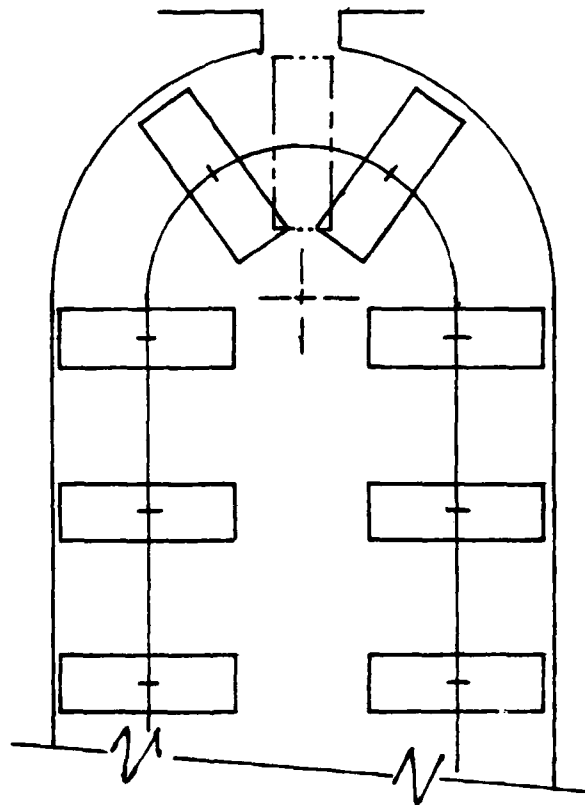
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CARROUSEL STORAGE

P.C.N. 025-A

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TRUCK LOADING CONCEPTS

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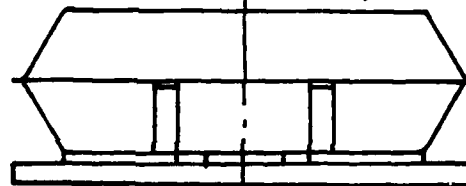
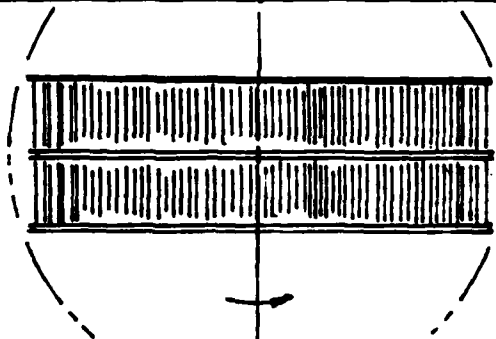
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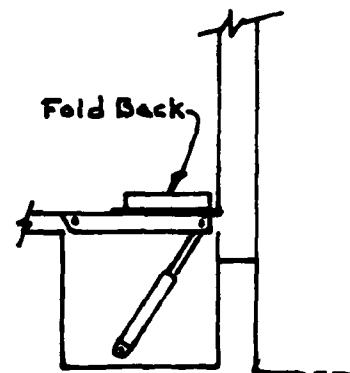
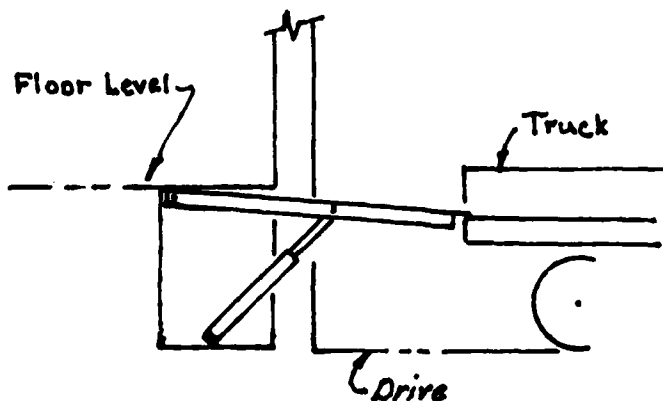
Dock Levelers:

Hydraulic
Lift



Height
Varies

Hydraulic
Ramp



IN THIS SPACE

DO NOT WRITE

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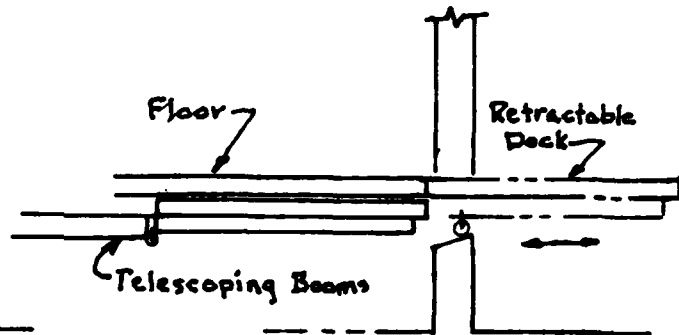
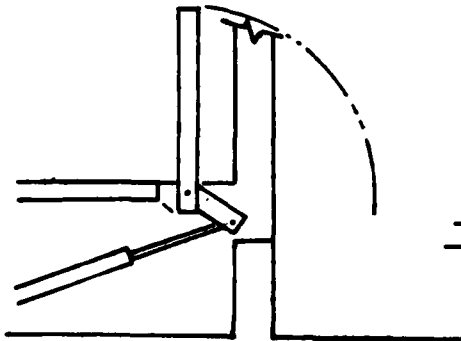
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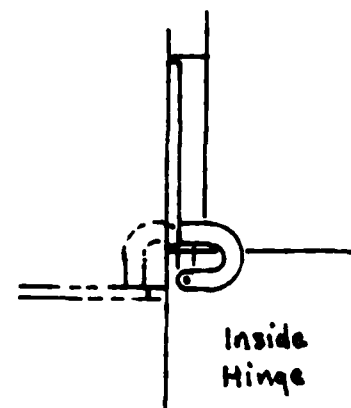
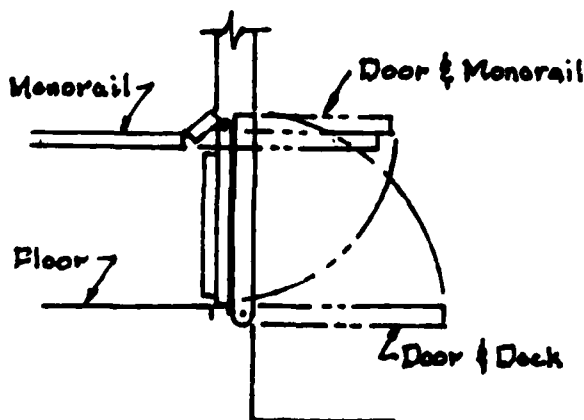
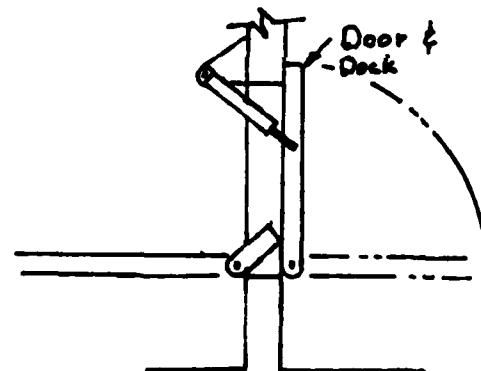
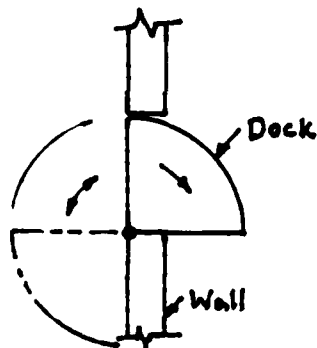
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Note: Dock must extend fully before it locks in place.



+ **BLACK &
VEATCH**
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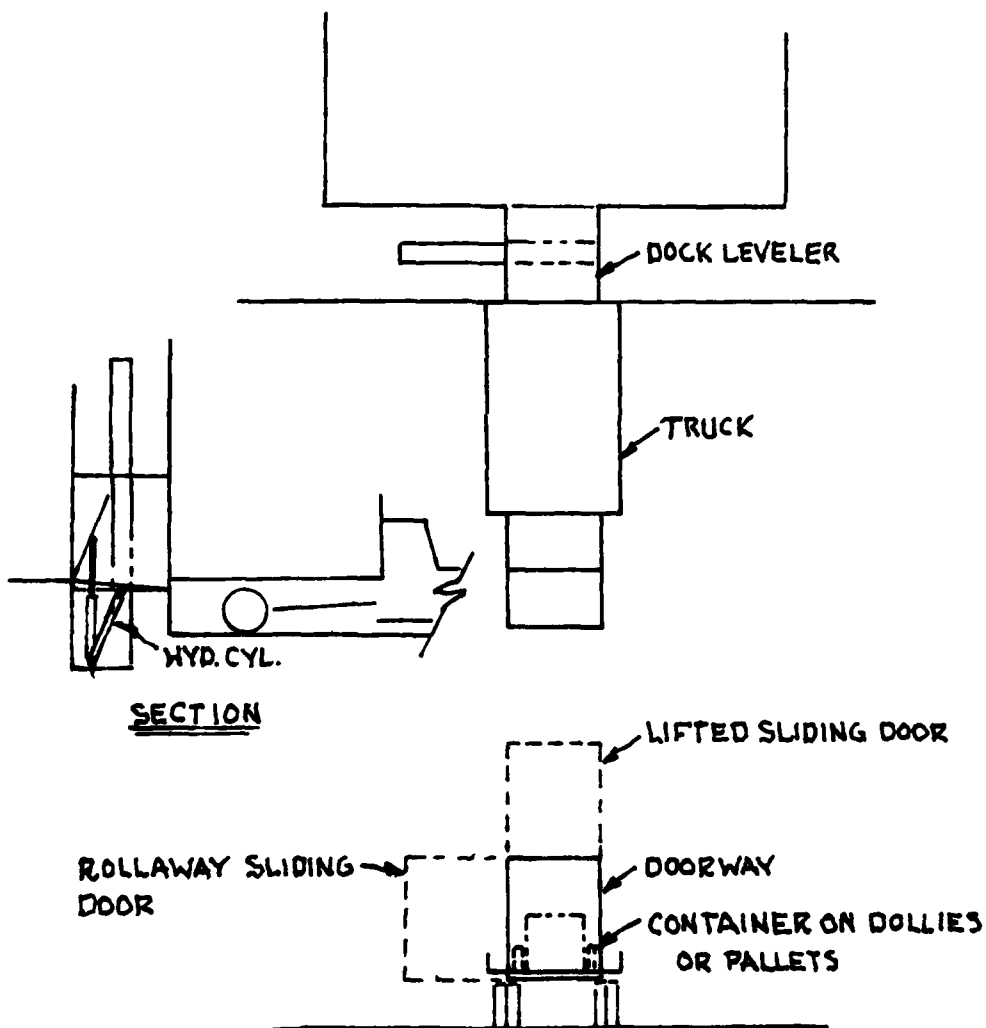
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NOTE: DOCK LEVELER MUST BE FLAT
FOR LOWEST TRUCK POSSIBLE AND RAISE
FOR ALL OTHERS.

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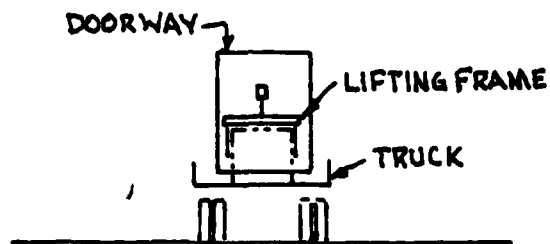
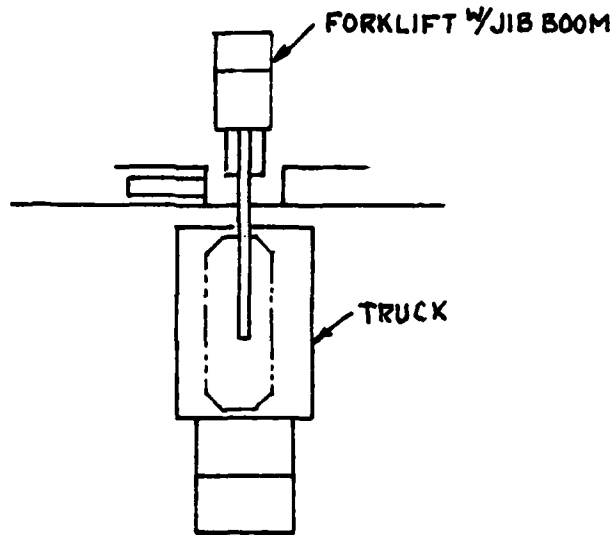
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SUBJECT CERL STUDY

WORK _____

PROJECT No. 10304

DATE 10 June 1982

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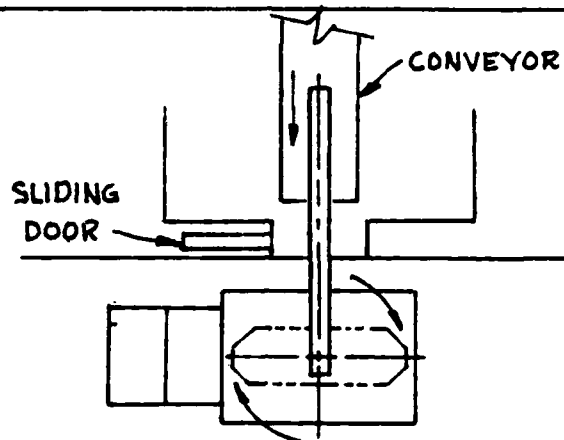
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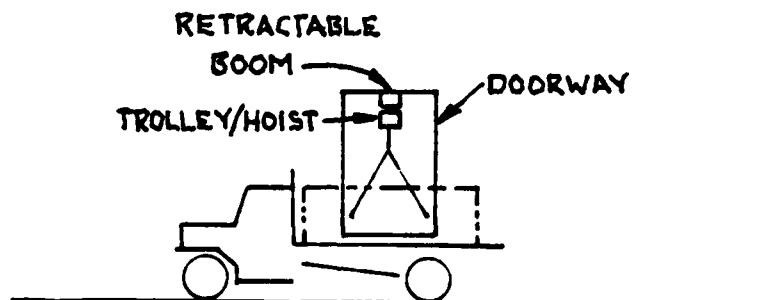
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TURN CONTAINER USING
SWIVEL SLING



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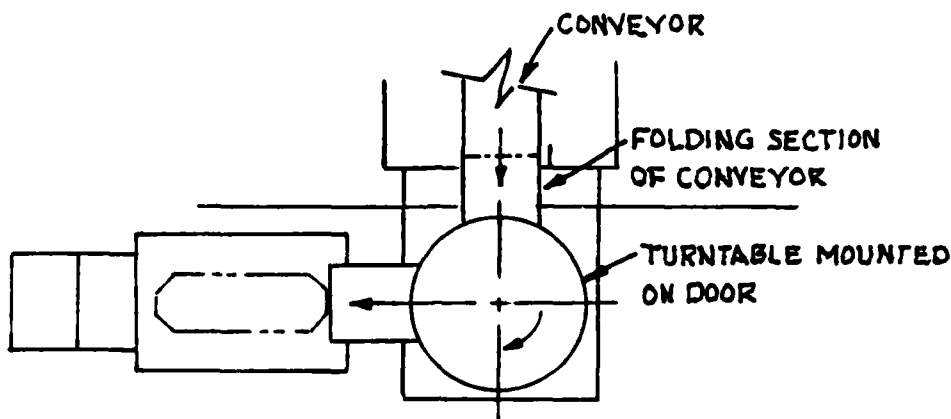
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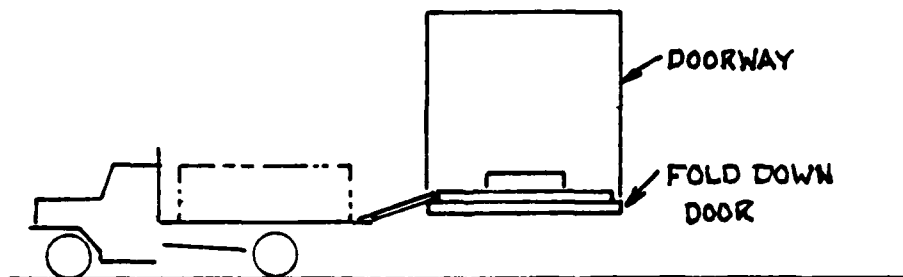
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NOTE: THIS SCHEME REQUIRES A PULLER
TO MOVE THE CONTAINER INTO THE TRUCK.

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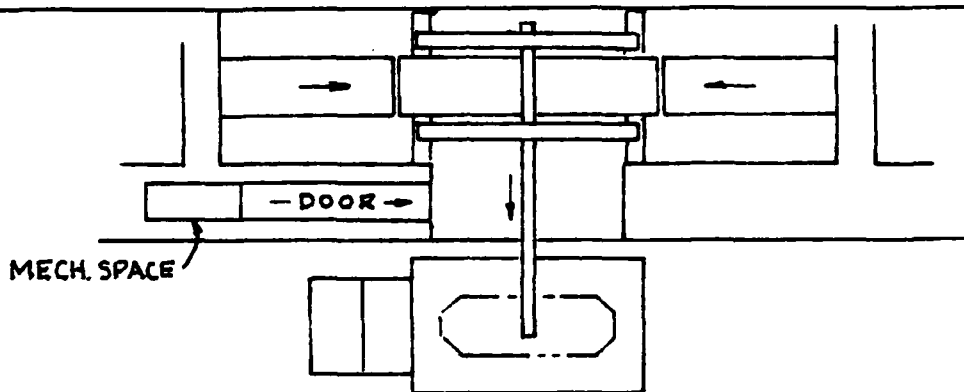
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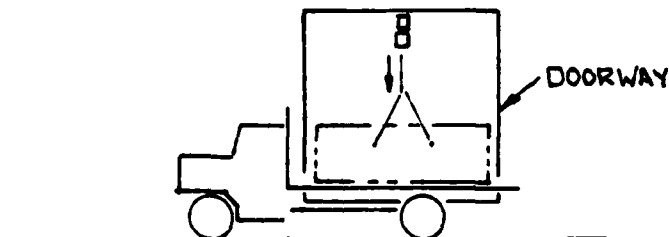
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PROJECT NO. 10304

FILE NO. _____



PLAN VIEW



FRONT ELEVATION

TRANSPORTING &
 LOADING DOLLY
 CONCEPT

P.GN. 025-A

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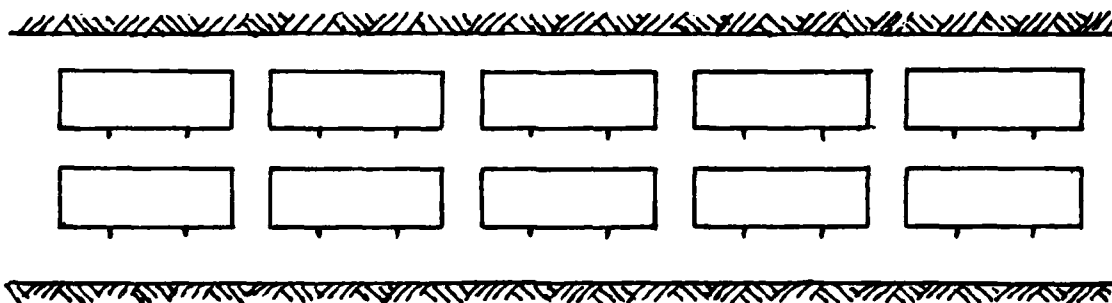
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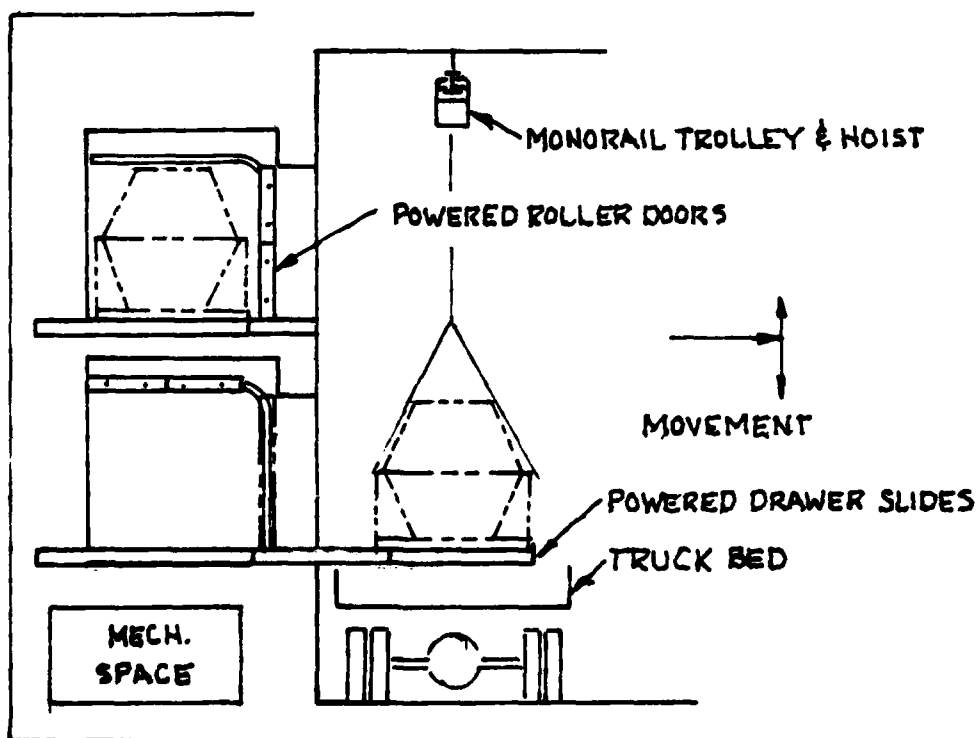
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FRONT ELEVATION
MAUSOLEUM CONCEPT



SECTION THRU CRYPT
ENLARGED VIEW

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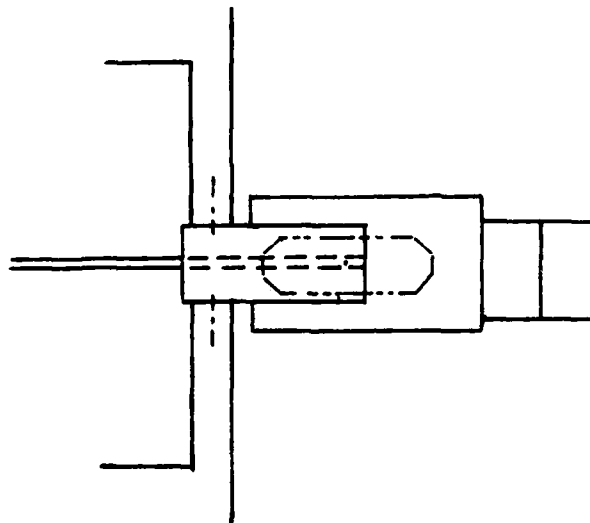
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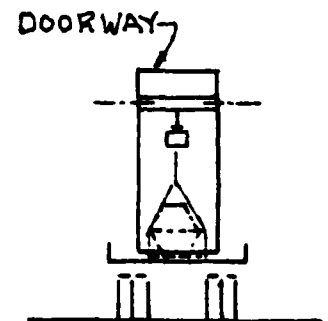
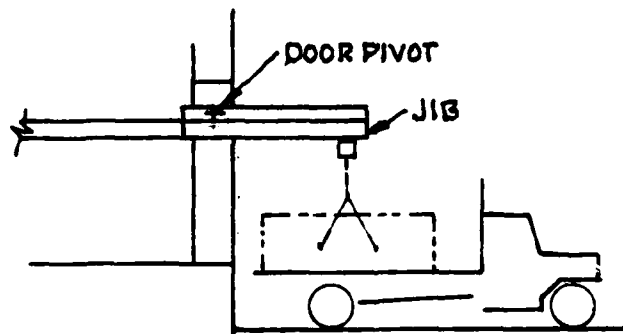
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NOTE: JIB CRANE FORMED BY
DOOR SWINGING UP. JIB TO
EXTEND FAR ENOUGH FROM
WALL SO CONTAINER CAN BE
ROTATED TO PARALLEL AXIS
OF TRUCK.

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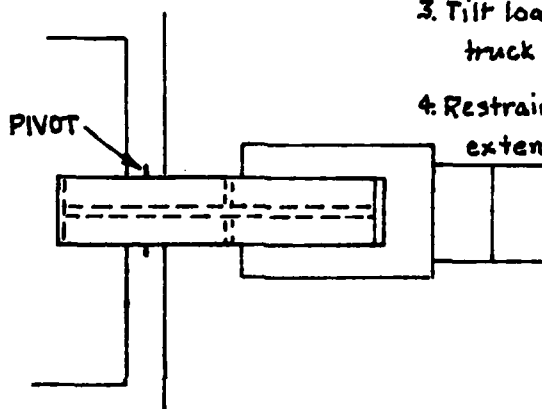
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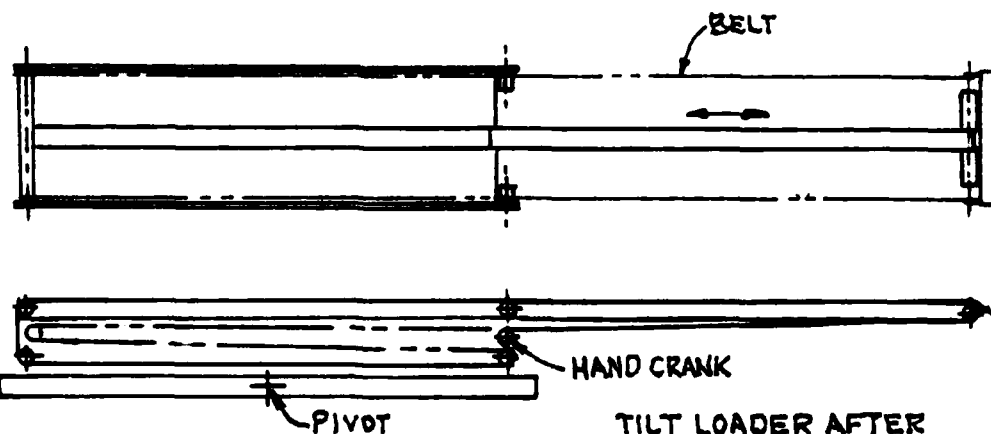
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1. Load container on loader.
2. Crank extension into truck.
3. Tilt loader until extension rests on truck bed and crank contain into truck
4. Restrain container in truck and crank extension from under container.



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Note: Restraining belt and cranking moves extension. Restraining extension and cranking moves belt.



TILT LOADER AFTER
EXTENDING TO LENGTH
REQUIRED

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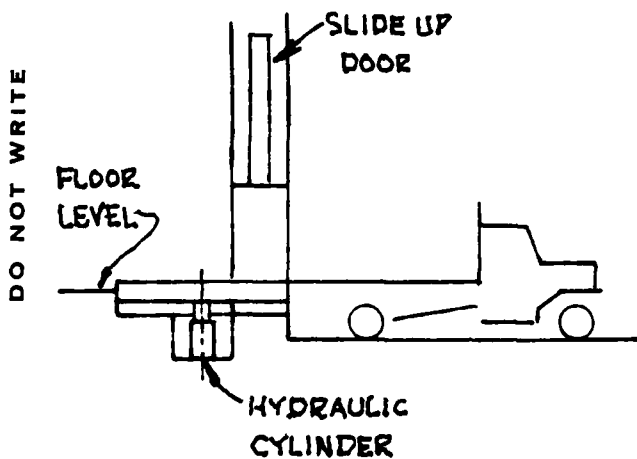
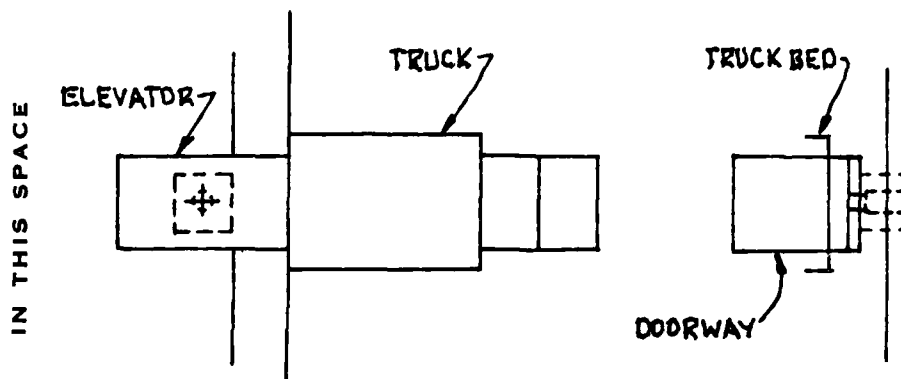
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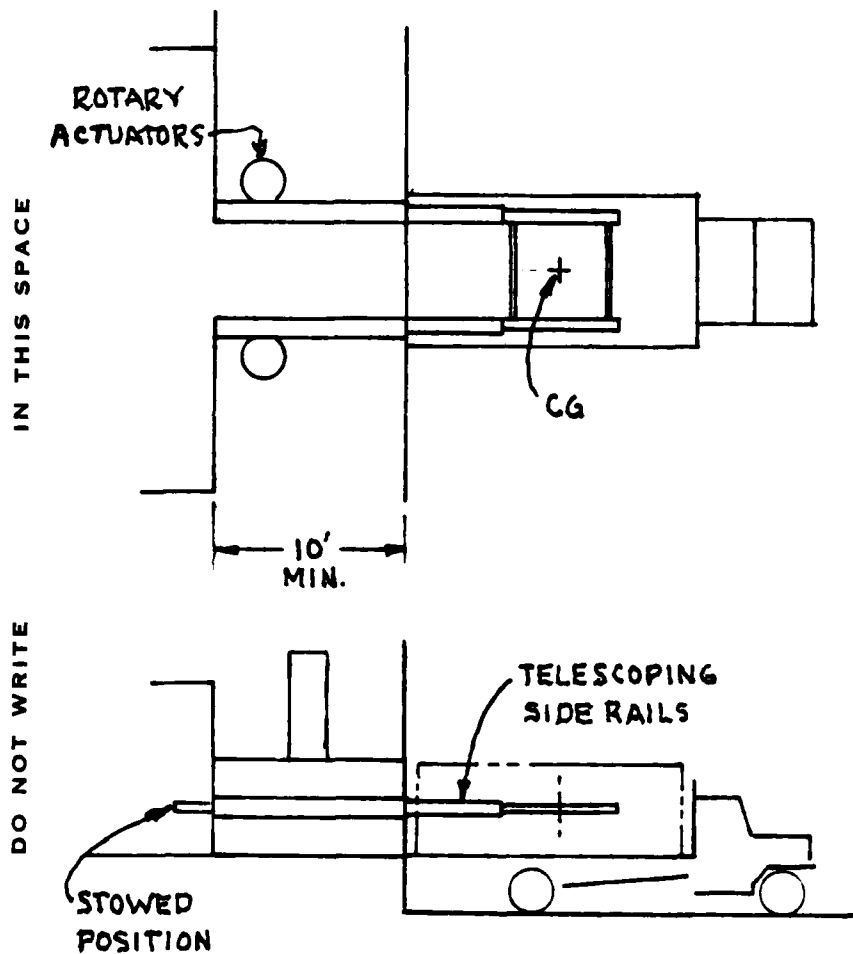
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Note: Truck can be raised or lowered simpler than raising or lowering side rails.

TRUCK POSITIONING

TRUCK POSITIONING

It is important that possible truck driver error or incompetence not be allowed to hinder rapid load-out. Therefore, the storage facility design should ensure that the truck stops in the right position for loading. Most of the concept load-out times do not include time for truck positioning; those concepts which employ a material handling system with only two movement directions do allow a small amount of time for positioning.

Truck positioning should be by passive means and should be verified by a material handler prior to loading. Passive means of lateral positioning include curbs and ruts which would be large enough to be felt by the truck drivers but which would not be obstacles to the tactical vehicles. The truck drivers would learn to stop when they intersect a light beam, a flexible wand suspended from the ceiling or wall, a bump on the road, or some similar device.

CONCEPT LOAD-OUT TIME ESTIMATES

LOAD-OUT TIME SUMMARY

<u>CONCEPT</u>	<u>NAME</u>	<u>MINUTES</u>
A	HAND TRUCK	44
B	CONVEYOR	61
C	MONORAIL	71
D	GANTRY CRANE	60
E	STACKER CRANE	55
F	TURNTABLES	36
G	HAYLOFT	53
H	TRAP DOOR	22
I	MAUSOLEUM	35
J	SHUTTLE CAR	53
K	CARROUSEL	48
L	WINDSHIELD WIPER	68

$$\text{Total Facility Load-out Time} = \frac{((X - Y)15) + Y}{Z}$$

Where

X = Load-out time for one weapon

Y = Non-sequential operations time for one weapon

Z = Number of trucks per magazine loaded simultaneously

15 = Number of weapons per magazine

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading.	*.50
30	Material handler uses pallet truck to move container to loading dock.	3.25
40	Attach sling to container and raise to loading height.	.50
50	Move bridge crane to truck and lower container to bed of truck.	1.50
60	Remove sling and secure container in truck	.45
	Total Minutes	6.95
Note: Pallet trucks or fork lift trucks can be used with this arrangement. Two pallet trucks will operate simultaneously in each weapons unit. * Non-sequential operations		

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Upon identification of the proper container, the material handler locally operates the container transfer to the "live" conveyor.	.54
30	Container is transported along conveyor to dock area where the bridge crane is positioned to receive it.	1.80
40	The handling sling is attached	.25
50	The bridge crane lifts the container and moves it into loading position as the container is turned with the axis parallel with the truck axis.	.55
60	Container is lowered to bed of truck and sling removed.	.50
70	Container is secured in truck and the truck dispatched	.35
Total Minutes		4.74
* Non-sequential		

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal	*.75
20	Position truck for proper loading	.50
30	Upon identification of the proper container the material handler raises the container and moves it along the monorail, under power, to the truck loading area.	2.55
40	Lower the container to the truck bed, remove sling and secure the container, and dispatch the truck.	.65
50	Move trolley hoist and sling to storage area	1.00
	Total Minutes	5.45
	*Non-sequential	

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading	.50
30	Upon identification of the proper container the material handler attaches the gantry crane hook to the container sling.	.35
40	Container is lifted, transported, and lowered to the bed of the truck.	1.50
50	Sling is removed from the container, container is secured, and truck is dispatched.	.60
60	Sling is returned to empty stall.	1.00
Total Minutes		4.70
*Non-sequential		

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Upon identification of the proper container the material handler transfers the container to the transfer area (Local Control).	1.75
30	Material handlers secure sling and position container under crane.	.40
40	Lift container, turn, position over truck and lower to bed of truck	.85
50	Remove sling, secure container in truck, and dispatch truck.	.60
Total Minutes		4.35
Note: Sling is returned to transfer area while next container is being brought to the area.		
* Non-sequential		

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Turntable is positioned at proper container. Raise conveyor and move container to turntable.	.30
30	Attach sling and rotate turntable to proper position for loading	.84
40	Move container over the truck bed and lower to position.	.60
50	Remove sling and secure container. Dispatch truck.	.60
Total Minutes		3.09
*Non-sequential		

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading.	.50
30	Material handler raises container (7 ft) from stall with bridge crane and moves to open hatch. (An average distance of 46 ft)	1.43
40	Lower container to truck bed and disengage sling. (23 ft down)	1.17
50	Secure container and dispatch truck.	.35
Total Minutes		4.20
*Non-sequential		

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading.	*.50
30	Material handler raises container from stowed position.	.25
40	Open hatch cover.	.15
50	Material handler lowers container to material handler below to position container on truck. (Control pendant passed down also - 15 ft)	1.25
60	Material handler below lowers container to the truck bed and removes lifting sling. Material handler operates "retract" button for hoist.	.75
70	Container is secured in truck and truck is dispatched.	.35
Total Minutes		4.00
Note: Trucks can be loaded as fast as material handler above can lower containers except when two adjacent containers are required.		
* Non-sequential		

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading.	.50
30	Lower blast door and pull container under bridge crane.	.50
40	Attach sling to container	.25
50	Raise container to height of truck bed and move container with bridge crane into loading position.	.35
60	Lower container onto truck and disengage sling.	.35
70	Secure container and dispatch truck.	.35
	Total Minutes	3.05

* Non-sequential

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal. (Portal is open & sling in place.)	*.75
20	Material handler pulls container into position under hoist.	.30
30	Secure hoist to sling, raise container, turn 90°, and position container over truck for loading.	2.25
40	Lower container to truck bed and disengage sling.	.50
50	Secure container and dispatch truck.	.35
	Total Minutes	4.15
		+.10
	** Note: Shuttle cars require 3.2 minutes for positioning to off load. Therefore off-loading is limited by shuttle car speed.	** 4.25
	* Non-sequential	

CONCEPT CARROUSEL CONCEPT K

PAGE NO. 1 OF 1

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Position truck for proper loading	.50
30	Attach sling to container and raise to loading height	.45
40	Move container over truck and rotate 90°	1.25
50	Lower container to bed of truck	.40
60	Remove sling and secure container in truck	.45
70	Dispatch truck	.10
Total Minutes		3.90
Note: Time required to position carousel upon notice of which container is to be off loaded is 4 minutes maximum * Non-sequential		

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Driver clears security and proceeds with truck to designated portal.	*.75
20	Selected container is automatically dispatched to conveyor bridge and moved to loading hatch.	2.50
30	Hoisting sling is placed on container and is raised and positioned over truck. Conveyor bridge is free to go to next container.	1.25
40	Container is lowered to truck bed, hoisting sling removed, and container secured in truck. Truck is dispatched.	.75
Total Minutes		5.25
* Non-sequential		

MANUAL LOAD-OUT

MANUAL LOAD-OUT

One of the design criteria is that the storage facility be capable of manual load-out. There is no maximum time duration for manual load-out, but the time required is significant.

On the following pages are manual load-out time estimates for three of the twelve study concepts, representing the range of durations. The estimates assume that personnel additional to the number estimated for powered load-out would be available for manual load-out. The horsepower required to operate some of the concepts is substantial. It is estimated that one man could exert $3/8$ horsepower for no more than 30 minutes at a time.

The manual load-out time estimates do not include the manual opening of security barriers, which would require at least 30 minutes to meet the design criterion of delaying unauthorized entry.

OFF LOADING TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
	~ POWER OFF ~	
10	Driver clears security and proceeds with truck to "emergency powered" designated portal.	*.75
20	Position truck for proper loading.	*.50
30	Material handler uses pallet truck to move container to loading dock.	5.0
40	Attach sling to container and manually operate hoist to raise to loading height.	.75
50	Manually operate bridge crane into position over truck and lower container to bed of truck.	3.0
60	Remove sling and secure container in truck.	.45
	Total Minutes	10.45
	Total time to empty 15 containers from 1 unit: $(15 \times 9.2) + 1.25 = 139.25 \text{ min. or } 2.3 \text{ hours}$	
	* Non-sequential operations	

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
	- POWER OFF -	
10	Driver clears security and proceeds with truck to "emergency powered" designated portal.	*.75
20	Position truck for proper loading.	.50
30	Upon identification of the proper container the material handler attaches the gantry crane hook to the container sling.	.35
40	Container is lifted manually from the stowed position.	1.2
50	Gantry crane is manually moved to truck area.	4.0
60	Extend boom of crane and lower hoist manually to place container in truck.	2.8
70	Sling is removed from the container, secured, and truck is dispatched.	.60
80	Sling is returned to empty stall.	4.0
* Non-sequential operation. Total Minutes Time to empty 15 containers from 1 unit: $(15 \times 13.45) + .75 = 202.5 \text{ min. or } 3.4 \text{ hours}$		14.2

OFF LOADING TIME ESTIMATE

OPER.	DESCRIPTION	TIME
	— POWER OFF —	
10	Position container at unloading portal.	14.9
20	Material handler pulls container into position under hoist.	.30
30	Secure hoist to sling, raise container manually, turn 90°, and position container over truck for loading	3.0
40	Lower container to truck bed and disengage sling.	.75
50	Secure container and dispatch truck	.35
	Total Minutes	19.3
	Note: Two men working constantly at "hard" work (total $\frac{3}{4}$ hp) would be required to position containers. Time to empty 15 containers from 1 Unit: $15 \times 19.3 = 289.5$ min. or 4.8 hours	

APPENDIX C
SECURITY FEATURES

INTRUSION BARRIER CONCEPTS

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SUBJECT CERL STUDY

DATE 22 June 1982

WORK Barrier Construction - Bar Type

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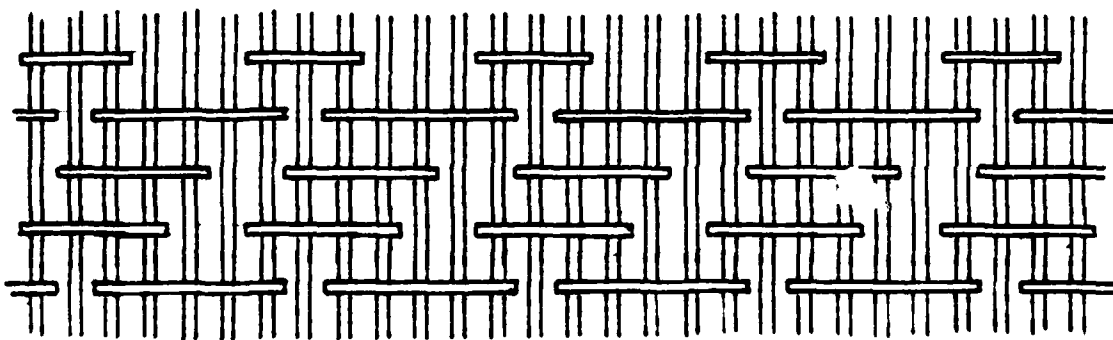
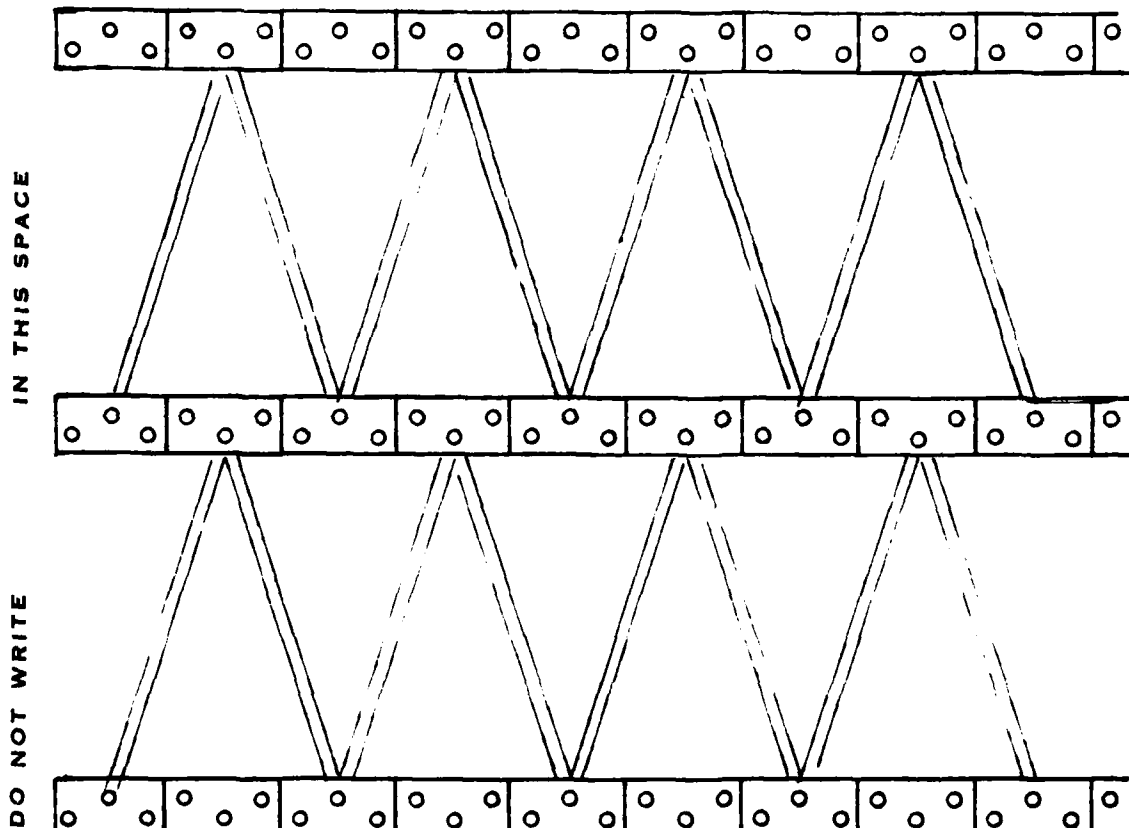
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STANDARD TRUCK TUNNEL BARRIER



PLAN 025-4

+

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SUBJECT CERL STUDY

WORK Barrier Cutting 2' x 2' Opening

PROJECT No. 10304

DATE 25 June 1982

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12 Diamond Charges
Alternate Direction of Pattern
(Decreases Hole Sizes)

DO NOT WRITE

12 Diamond & 2 Ribbon Charges

12 Diamond & 6 Ribbon Charges

P. 6N 024.4

+

DEMOLITION: TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Place precut diamond shaped charges - 12 places	.35
20	Secure detonating cord to charges	.80
30	Move to safe distance & detonate	.15
40	Move to barrier	.25
50	Place precut charges	.35
60	Secure detonating cord	.80
70	Move to safe distance & detonate	.30
80	Move to barrier	.50
90	Place precut charges	.35
100	Secure detonating cord	.80
110	Move to safe distance & detonate	.55
120	Move through barrier	.60
Total Min.		5.80

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SUBJECT CERL STUDY

WORK Webb's Plate Barrier

PROJECT NO 10304

DATE 7 July 1982

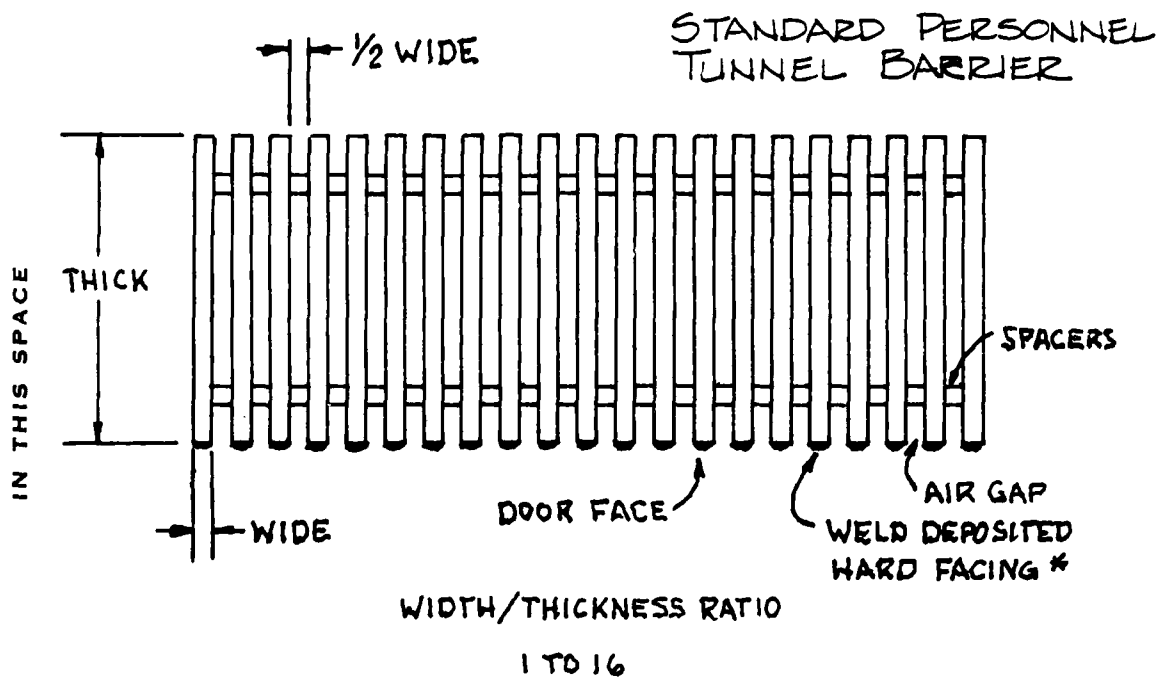
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Note: Doors built up in this manner would not offer enough surface to do much damage. The plates should be deep enough that they couldn't be cut with a shaped charge and the spacers must resist blast impulse to prevent door cave-in. A friable material, such as plastic foam, would provide an additional barrier for weather when placed in the air gaps.

* Hard facing material is reportedly flame cut resistant.

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SUBJECT CERL STUDY

WORK Webbs Plate Barrier

PROJECT NO. 10704

DATE 21 July 1987

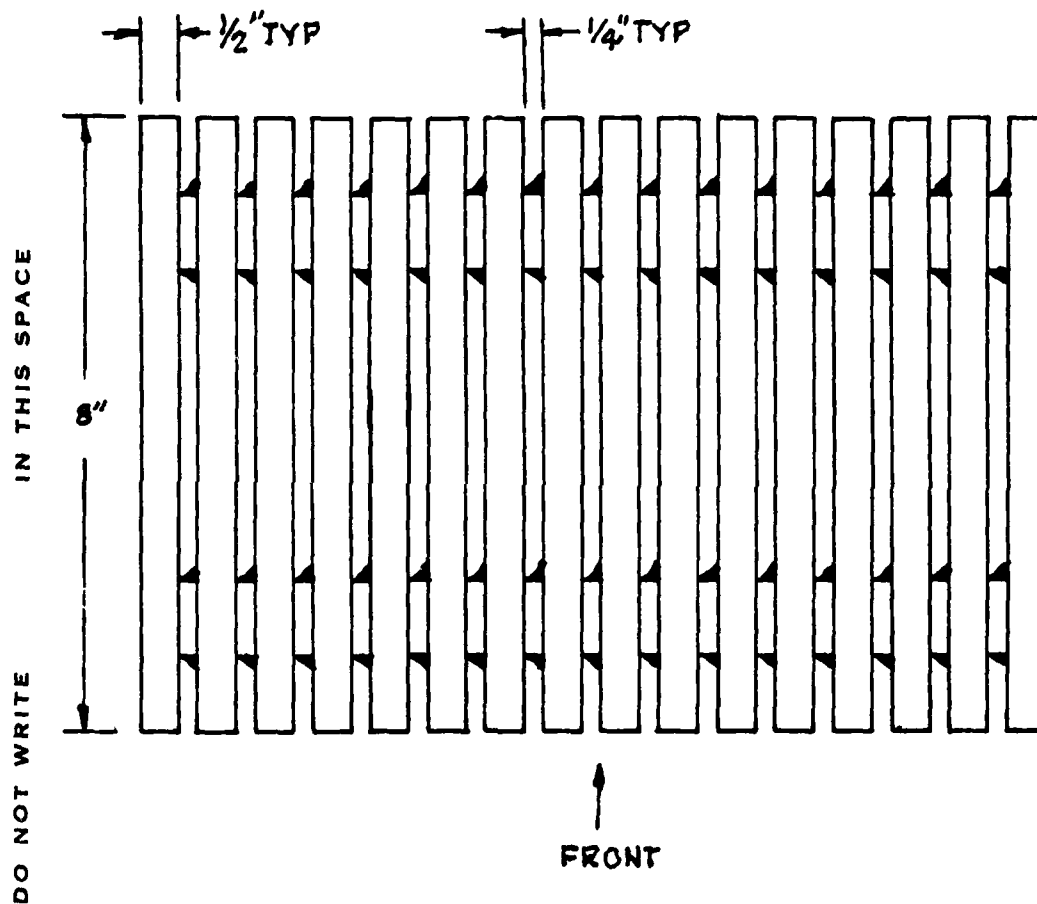
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SECTION THRU DOOR OR BARRIER

DEMOLITION: TIME ESTIMATE

OPER.	DESCRIPTION	TIME

This design is outside the realm of our ability to predict the demolition time. It will be considered a 6-minute barrier for conceptual purposes.

A plate charge would clear this door away and probably any door within the line of the blast.

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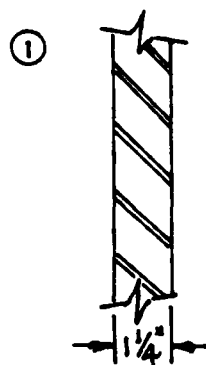
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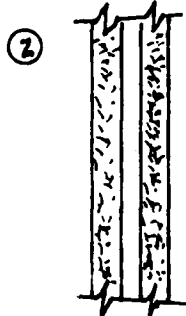
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Doors or barriers should be resistant to shaped charges as well as conventional cutting or forcing. This can be accomplished by several means as shown below:

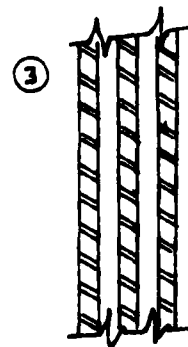
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Thickness

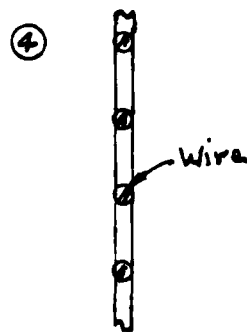


Air Space

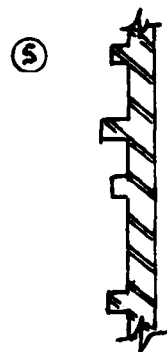


Multiple Surfaces

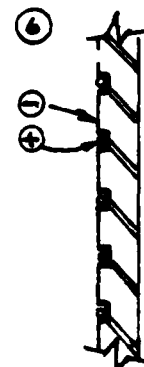
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"No" Surface

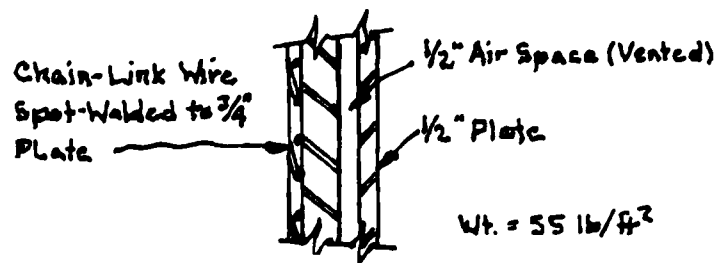


Irregular Surface



Electric Potential

The method proposed is a combination of these ideas:



Wt. = 55 lb/ft²

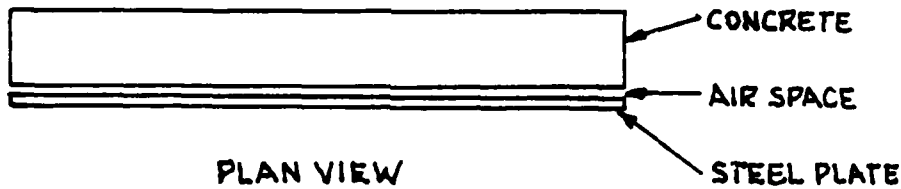
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INTRUSION BARRIER
(SERIES OF DOORS)

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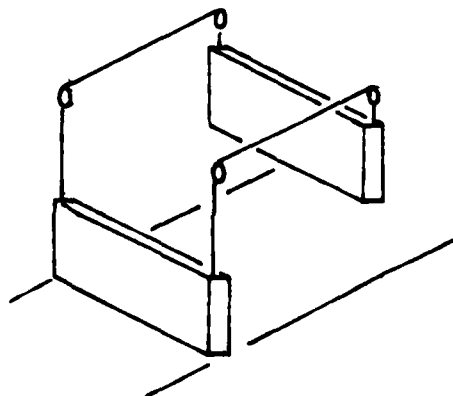


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PLAN VIEW

Note: Doors can be
arranged to c'balance
each other.



P. GN. 025. A

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DATE 3 June 1982

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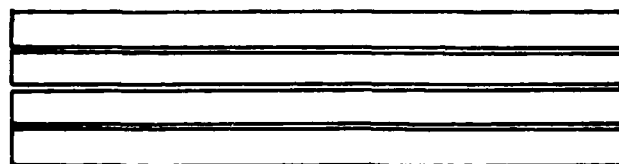
PROJECT NO. 10304

FILE NO. _____

PAGE NO. _____ OF _____

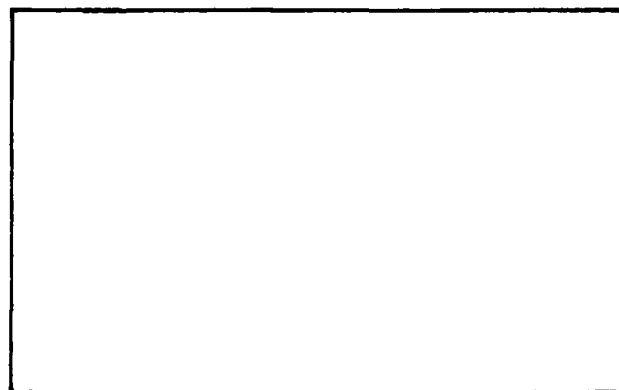
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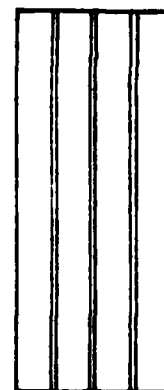


PLAN VIEW

DO NOT WRITE



FRONT ELEVATION



SIDE VIEW

DENSITY = 4000 lb/Yd³

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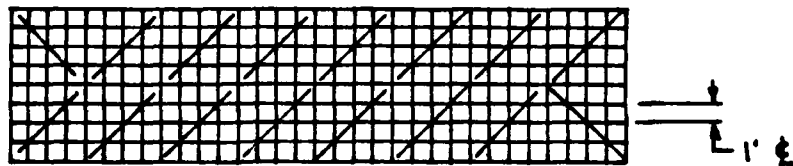
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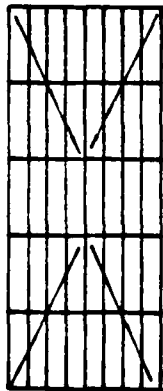
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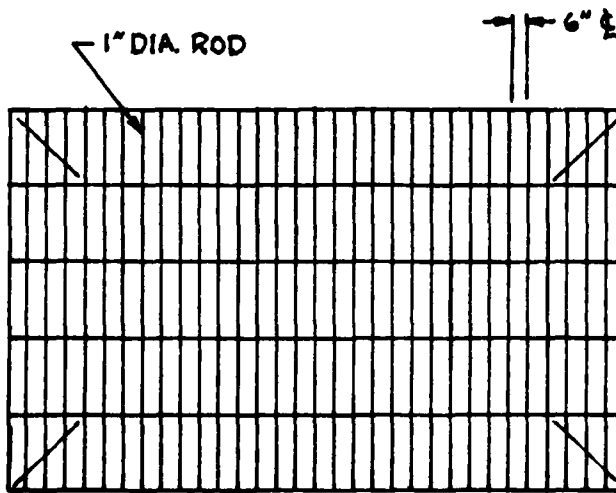


PLAN VIEW

DO NOT WRITE



SIDE VIEW



FRONT ELEVATION

DENSITY = 500 lb/yd³

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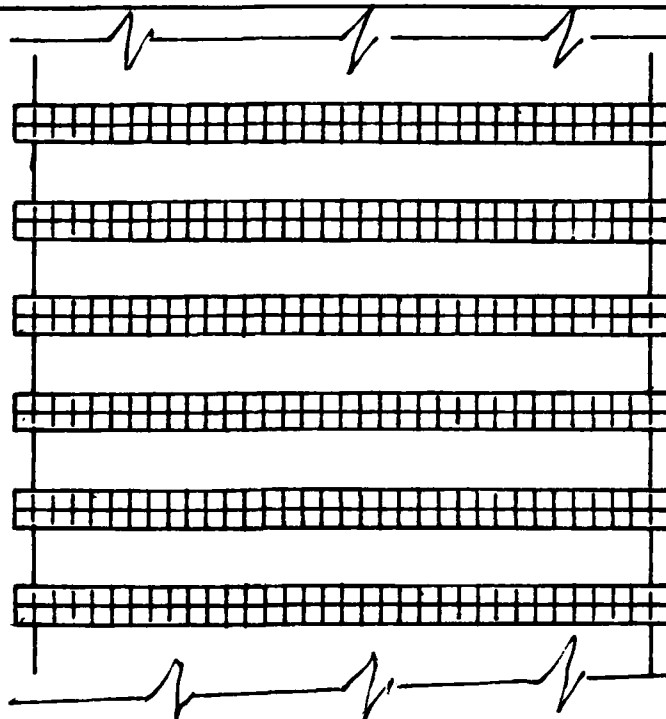
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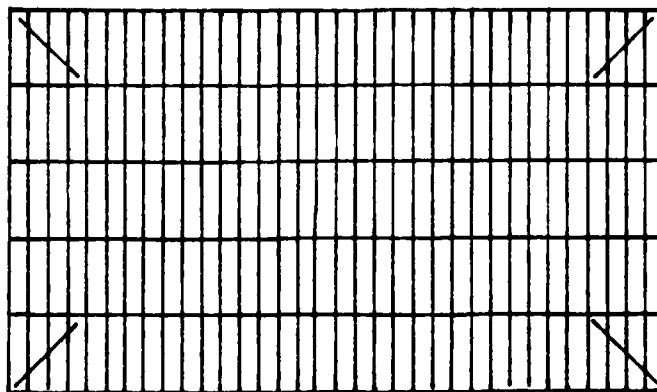
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INTRUSION
BARRIER
—
SERIES
ARRANGEMENT

PLAN VIEW



FRONT ELEVATION

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WORK Resist Platter Charges

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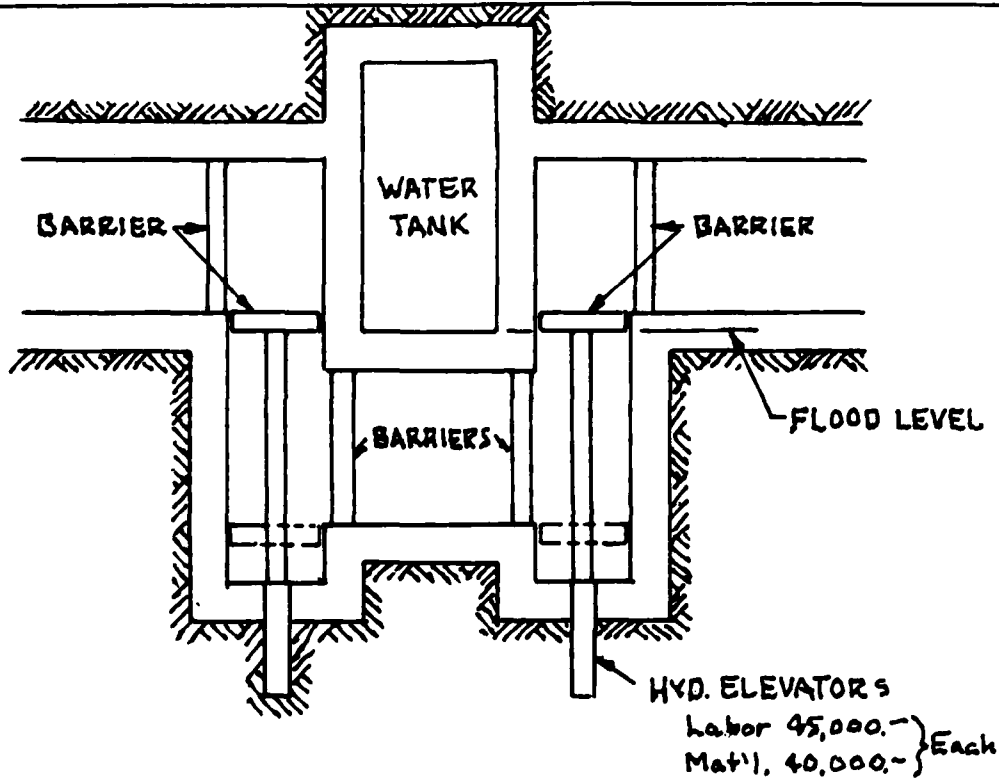


PLATE CHARGE
 WATER BARRIER

PLAN 0.0.4

+

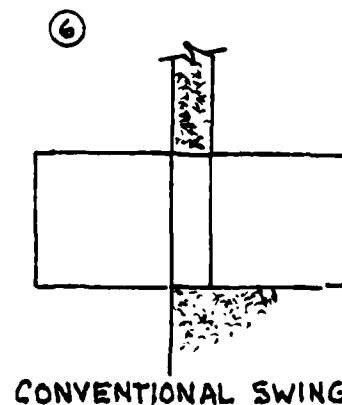
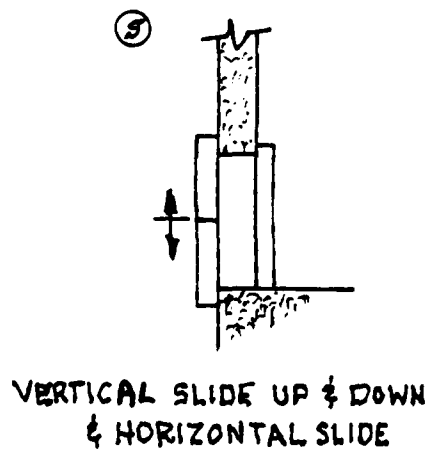
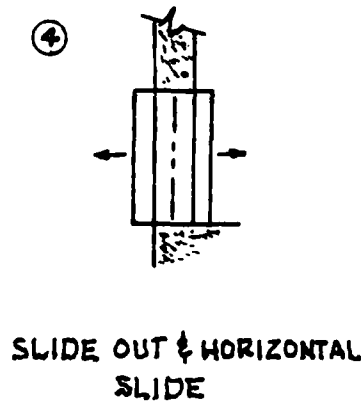
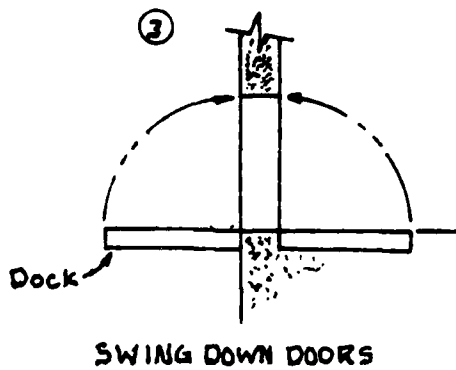
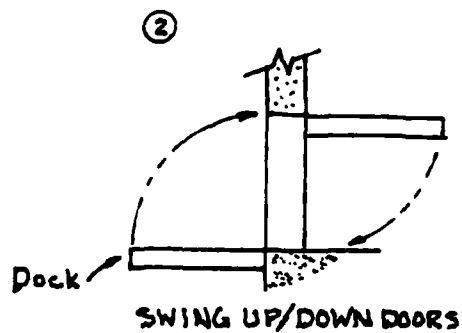
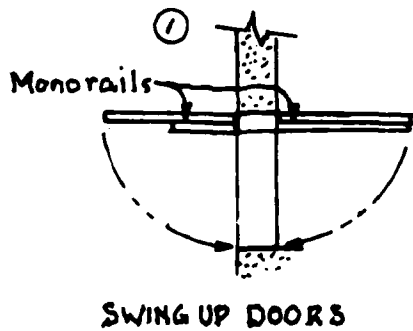
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SUBJECT CERL STUDY
WORK Door Arrangements
PROJECT NO. 10304

DATE 1 June 1982
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DO NOT WRITE



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DATE 2 June 1982

WORK _____

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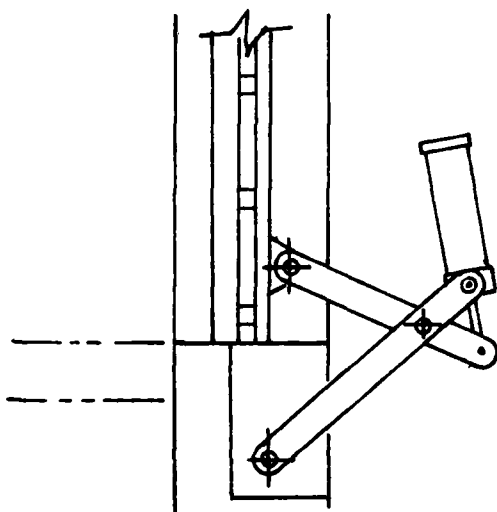
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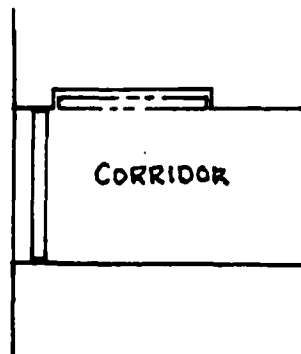
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Compound Swing
(To Any Position)

DO NOT WRITE



Fully Retracted Door

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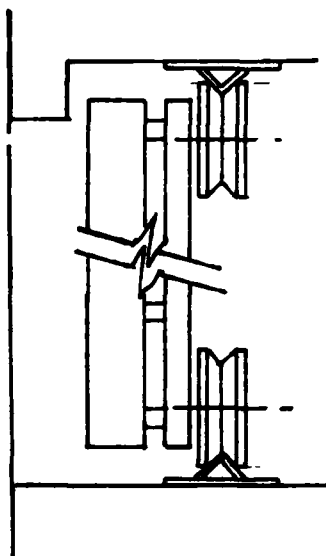
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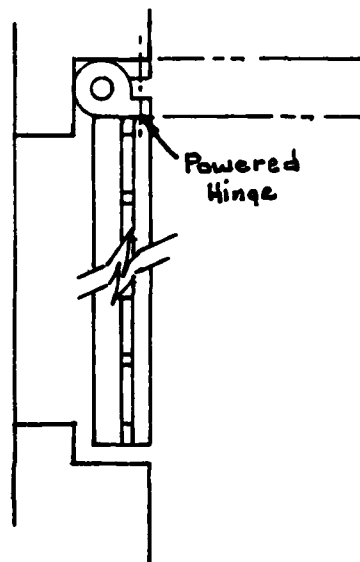
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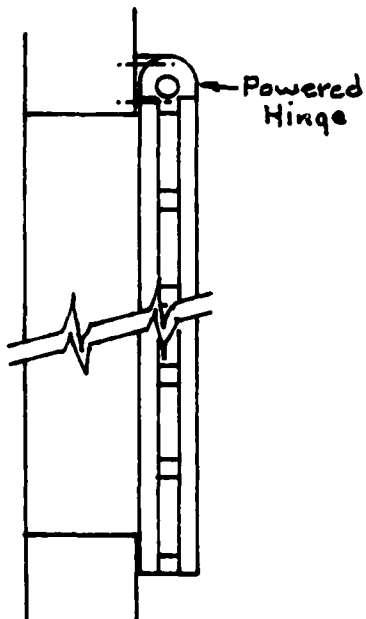


Sliding Door Detail

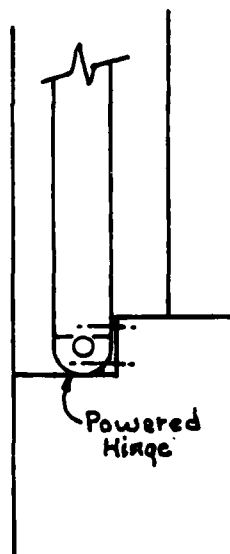


90° Swing Door Detail

DO NOT WRITE



180° Swing Door Detail



90° Swing Down
Door Detail

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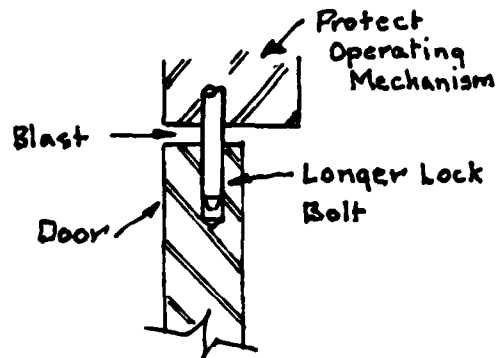
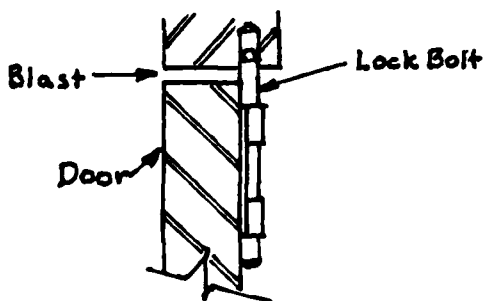
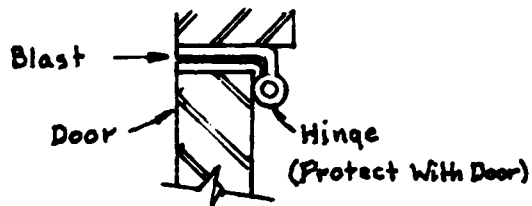
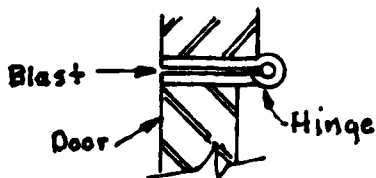
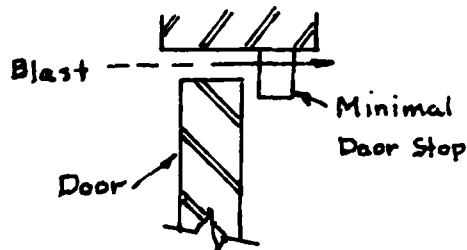
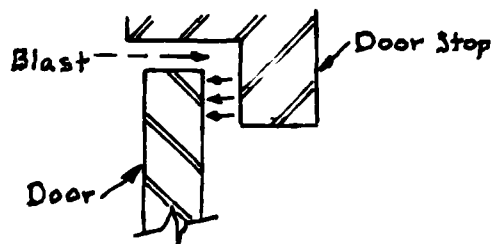
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The mounting of doors or barriers should be considered as subject to demolition:

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PROJECT NO. 10304

DATE 4 June 1982

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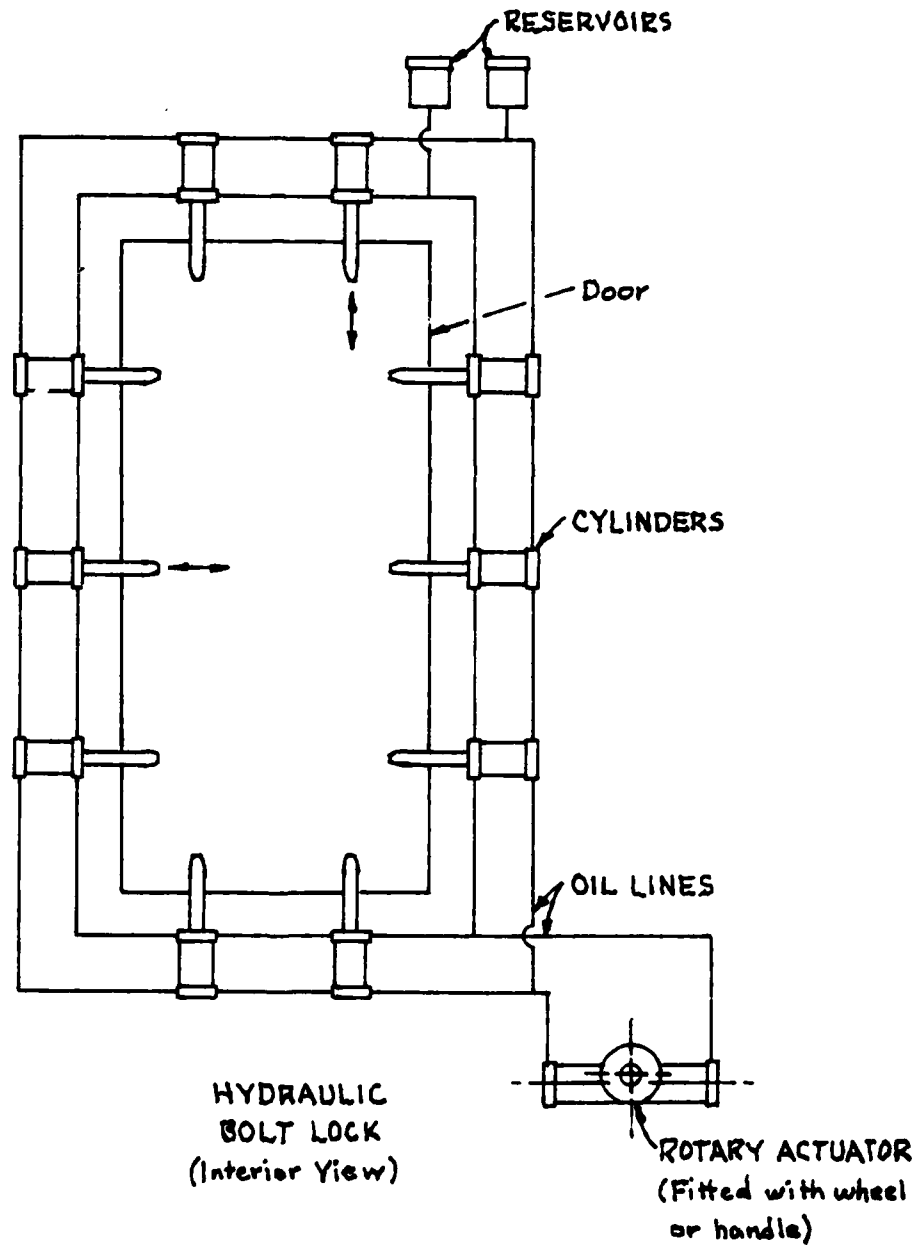
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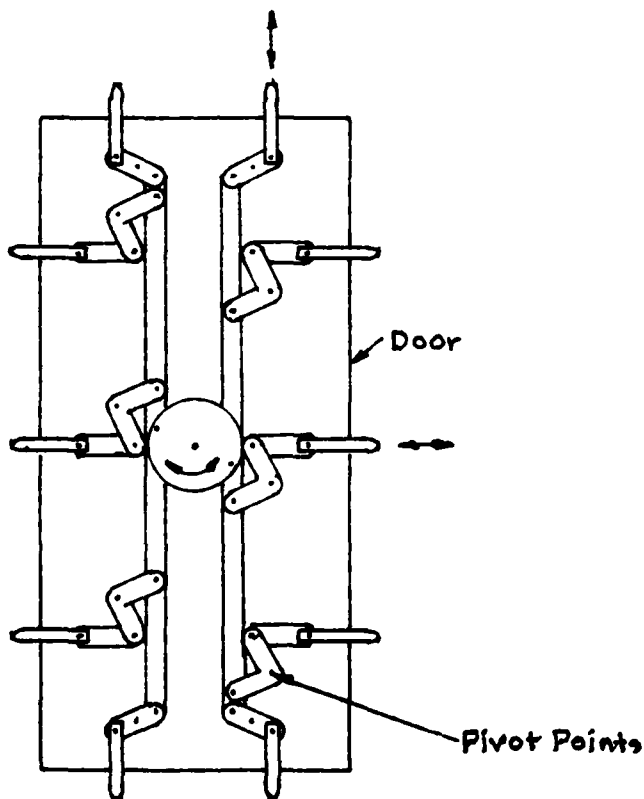
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MECHANICAL
BOLT LOCK
(Interior View)

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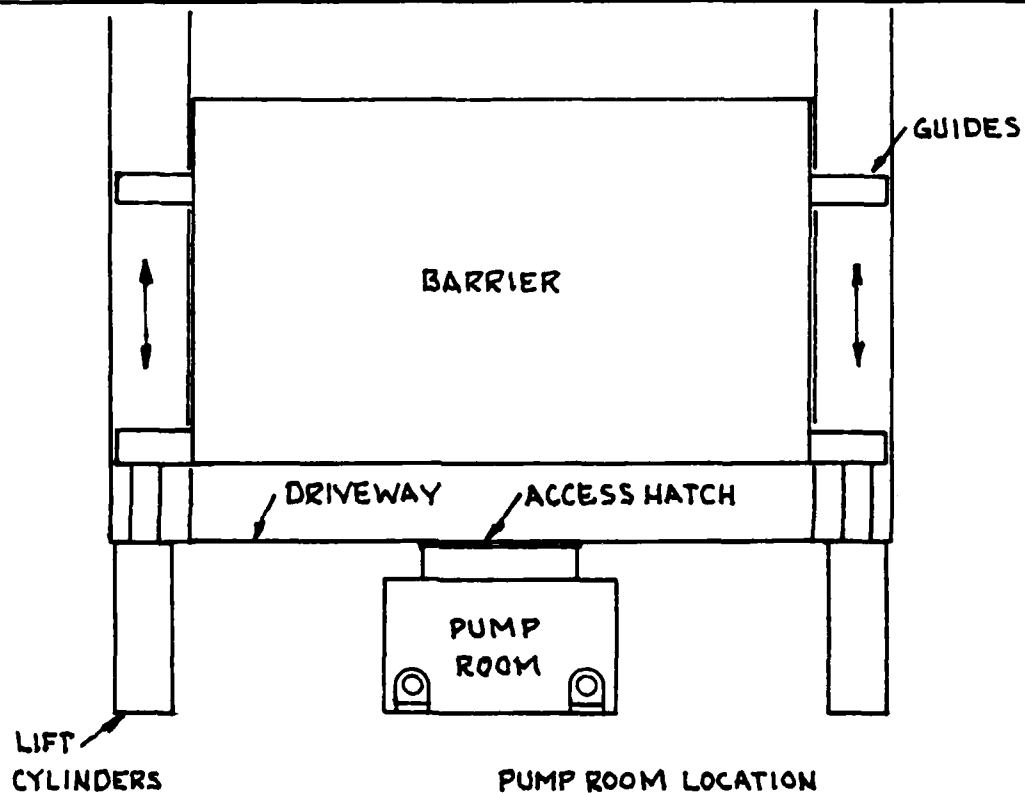
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 PROJECT No. 10304

DATE 3 June 1982
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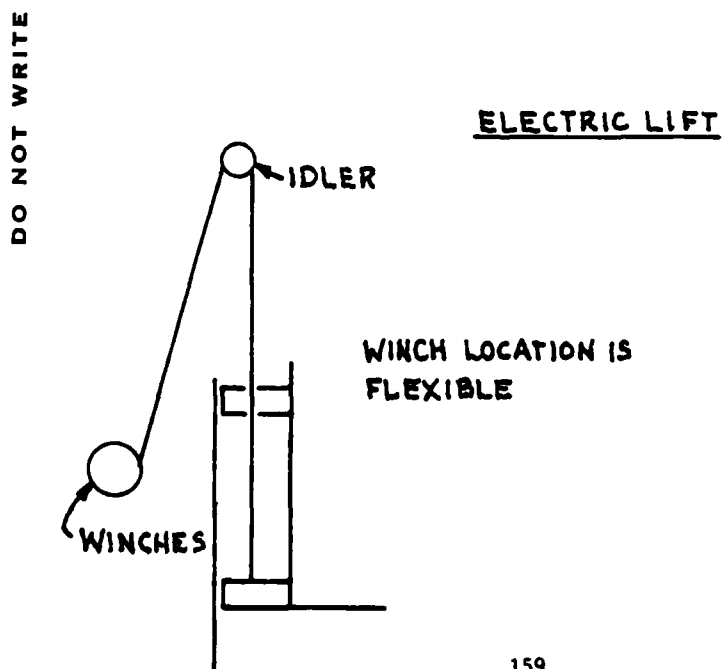
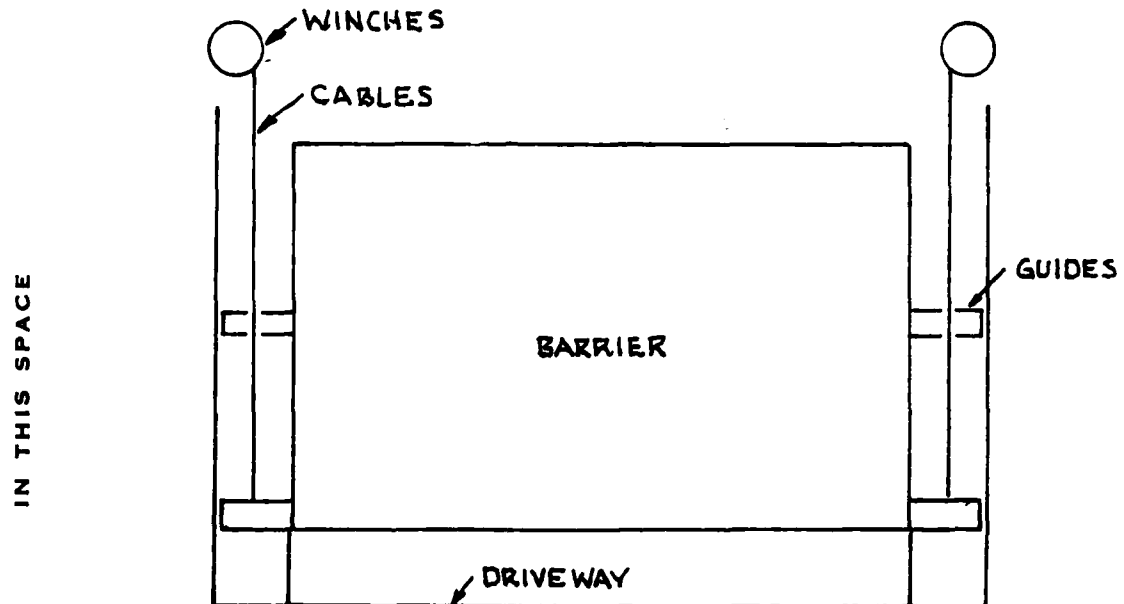


HYDRAULIC MECHANISM

P. (N-025-4

+

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	WORK		SET UP BY	RG
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			CHECKED BY	
			PAGE NO	OF
	PROJECT NO	10304	FILE NO	



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PROJECT NO. 10304

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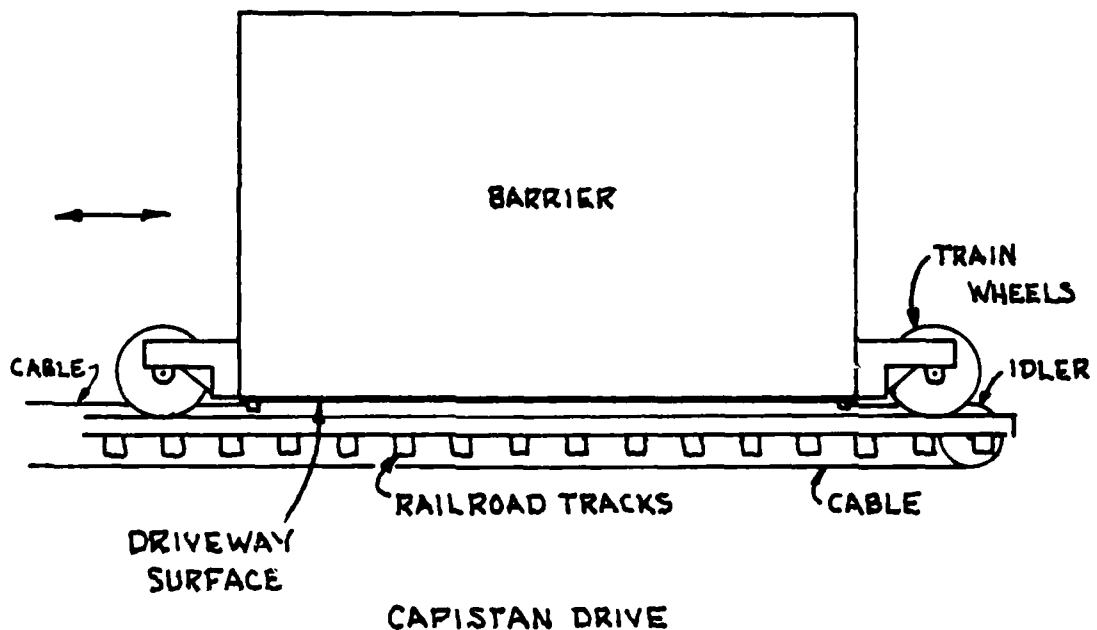
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P.O.N. 025-4

Cast Carbon Steel Wheels
AAR Spec. M208 RG54

38" 39375 lbs

36" 32871

33" 27500

28" 22400 6x11 Brq 40,000 lbs @ 500 RPM

+ *With Braking-Double
without braking

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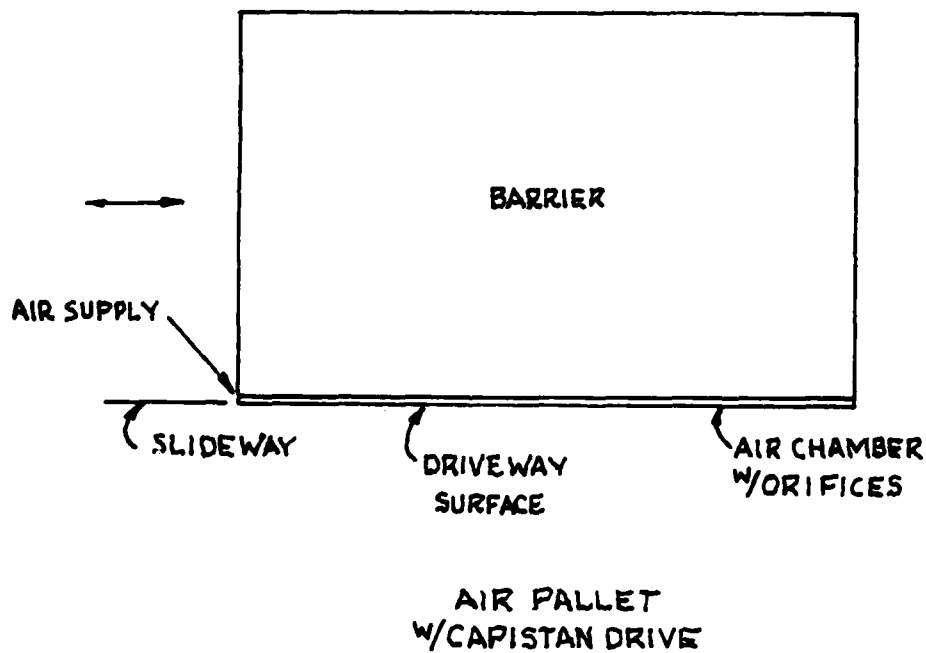
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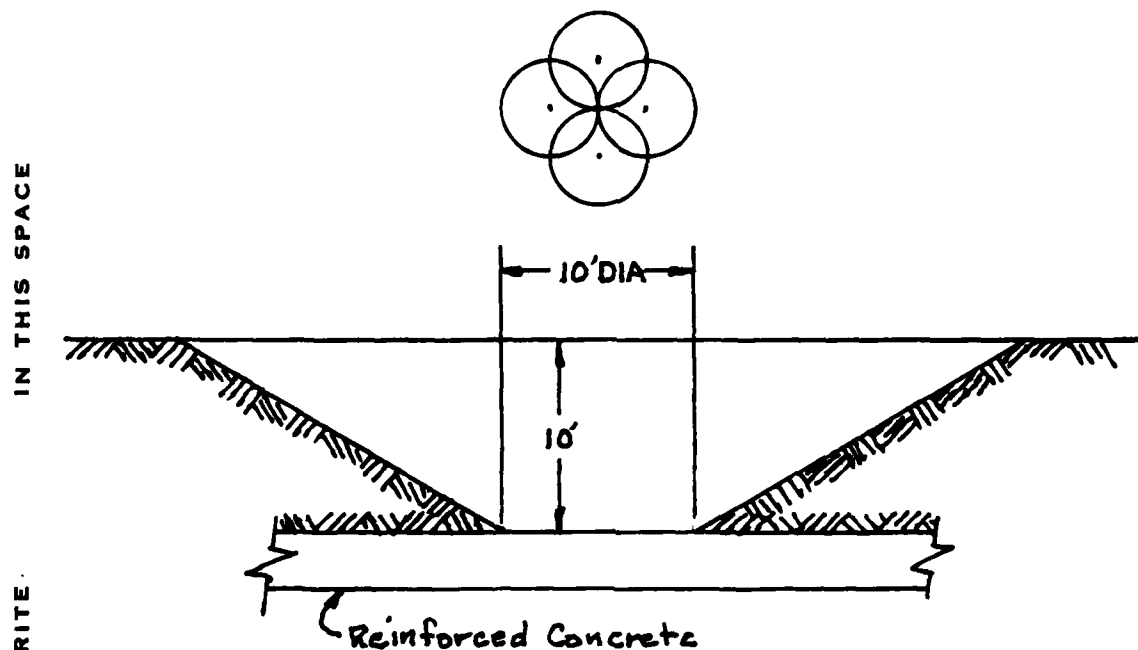
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EARTH COVER PENETRATION

+ BLACK & VEATCH CONSULTING ENGINEERS KANSAS CITY DALLAS DENVER ORLANDO	SUBJECT	CERL STUDY	DATE	14 July 1982
	WORK	Penetration of Earth Cover 10'	SET UP BY	RG
			COMPUTED BY	
			CHECKED BY	
	PROJECT NO.	10304	FILE NO.	
			PAGE NO.	OF



1ST CRATERING
4 CHARGES

GIVEN: A shaped charge can blast a borehole 7' deep.

Assumption: These boreholes can be loaded with a cratering charge large enough to clear a 10' diameter hole with 30° slope.

DEMOLITION: TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Place shaped charges for boreholes (4)	1.00
20	Attach detonating cord and detonate	.80
30	Place cratering charges with detonating cord attached.	1.20
40	Stem charges in boreholes and detonate	1.40
50	Place breaching charge and attach detonat. cord (breaching radius $R = 3\text{ ft}$)	2.00
60	Tamp breaching charge and detonate	3.00
Total 9.4 Minutes		

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SUBJECT CERL STUDY

WORK Penetration of Earth Cover 24'

PROJECT NO. 10304

FILE NO. _____

DATE 12 July 1982

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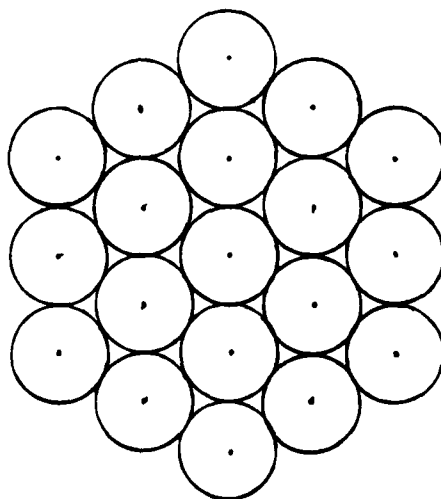
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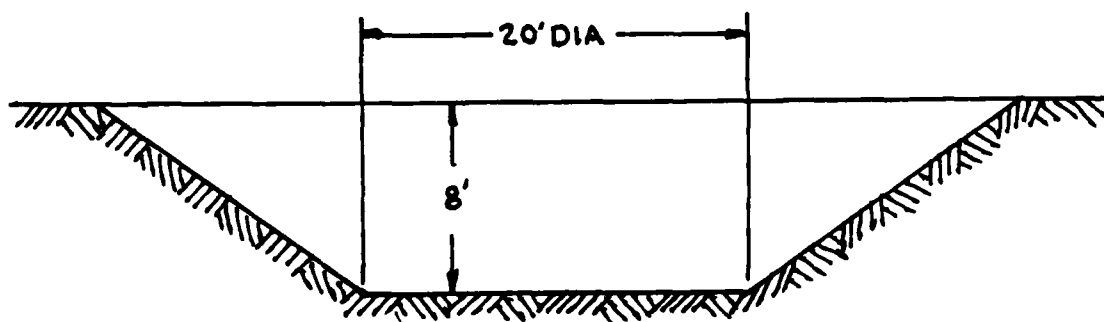
PAGE NO. 1 OF 3

GIVEN: A shaped charge can blast a borehole 7' deep to be loaded with a cratering charge to blow an 8' deep by 5' diameter hole with a 30° slope.

IN THIS SPACE



DO NOT WRITE



1ST CRATERING

19 CHARGES

Scale $\frac{1}{8}'' = 1'$

P. IN U.S.A.

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WORK Penetration of Earth Cover 24'

PROJECT No 10304

DATE 12 July 1982

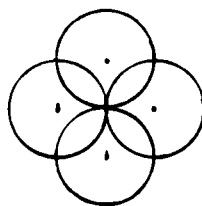
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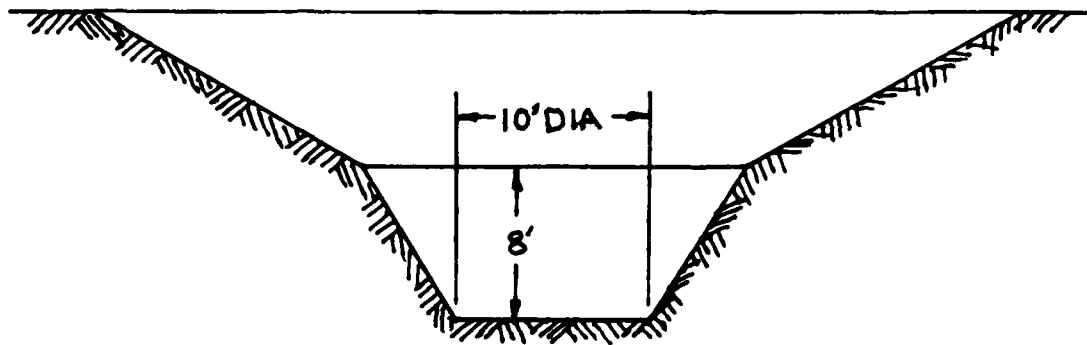
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2ND CRATERING
4 CHARGES

Scale $\frac{1}{8}'' = 1'$

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WORK Penetration of Earth Cover 24'

PROJECT NO. 10304

FILE NO. _____

DATE 12 July 1982

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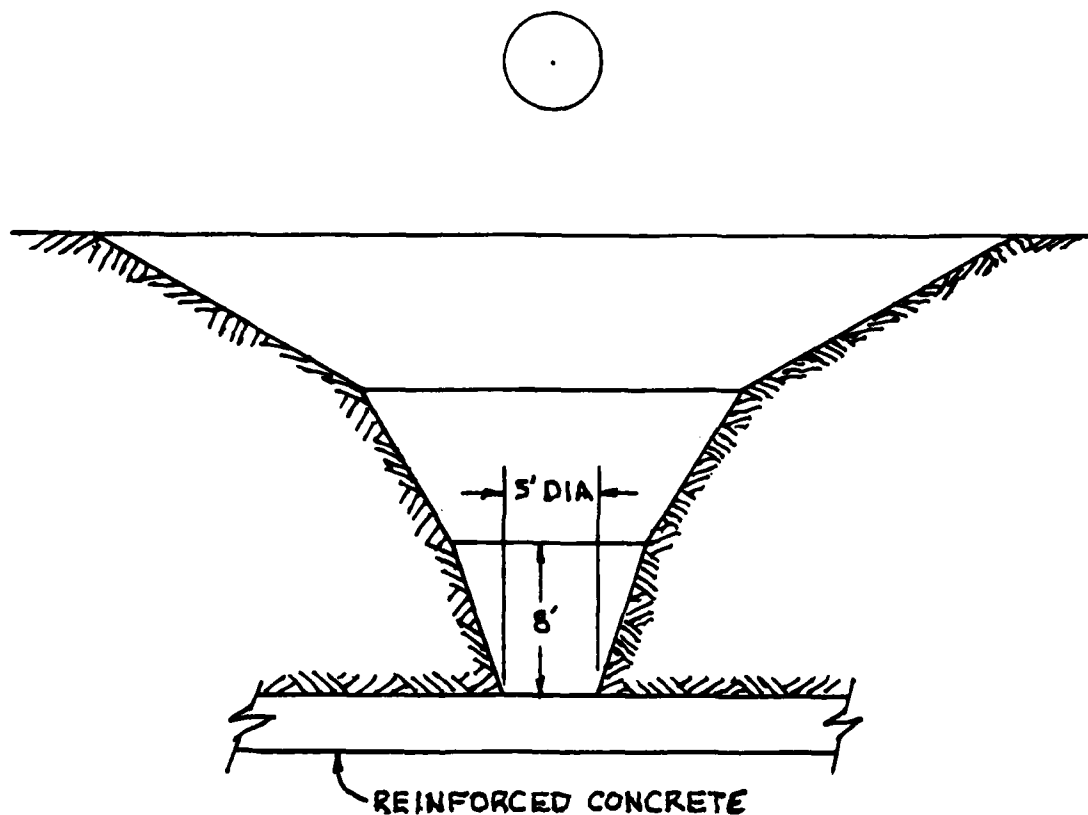
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3RD CRATERING
1 CHARGE

Scale $\frac{1}{8}'' = 1'$

DEMOLITION: TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Place shaped charges for boreholes (19)	4.75
20	Attach detonating cord and detonate	3.8
30	Place cratering charges (detonating cord attached)	5.7
40	Stem charges in boreholes and detonate	6.65
50	Place shaped charges for boreholes (4)	1.0
60	Attach detonating cord and detonate	.8
70	Place cratering charges	1.2
80	Stem charges in boreholes and detonate	1.4
90	Place shaped charge for borehole (1)	.25
100	Attach detonating cord and detonate	.2
110	Place cratering charge	.3
120	Stem charge in borehole and detonate	.35
130	Place breaching charge and attach detonat. cord (Breaching Radius R = 4 ft.)	3.0
140	Tamp charge and detonate	2.0
169	Total 31.4 minutes	

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WORK Penetration of Earth Cover & Burster Slab

PROJECT No. 10304

FILE No. _____

DATE 17 July 1982

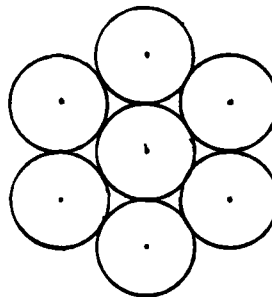
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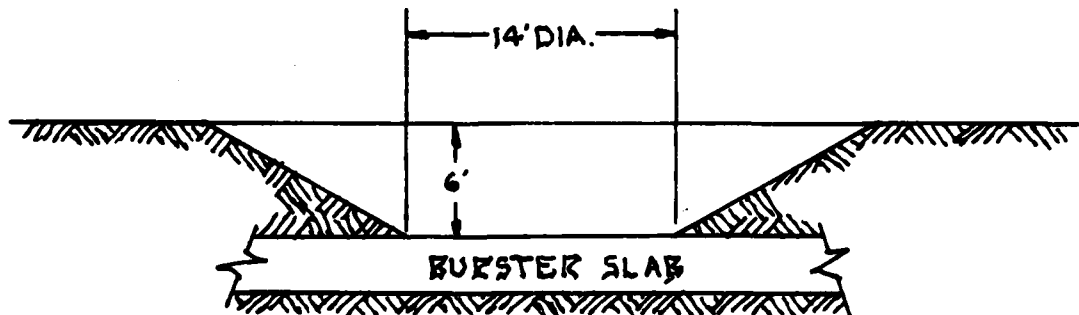
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1ST CRATERING
7 CHARGES

Scale 1/8" = 1'

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WORK Penetration of Earth Cover & Burster Slab

PROJECT NO 10304

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DATE 17 July 1982

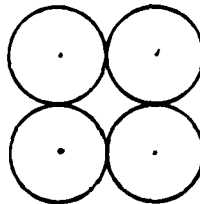
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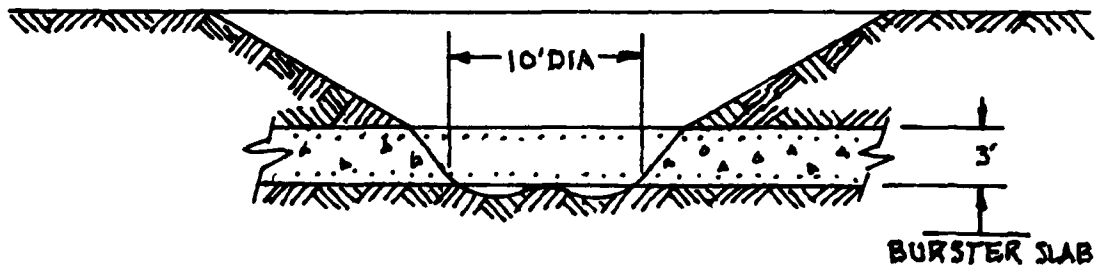
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2ND BREACHING

4 CHARGES

Note: Reinforcing rods must be cut after breaching. Use 1" ϕ rod on 18" centers both ways.
7 rods x 4 layers x 2 cuts = 56 charges

Scale $\frac{1}{8}" = 1'$

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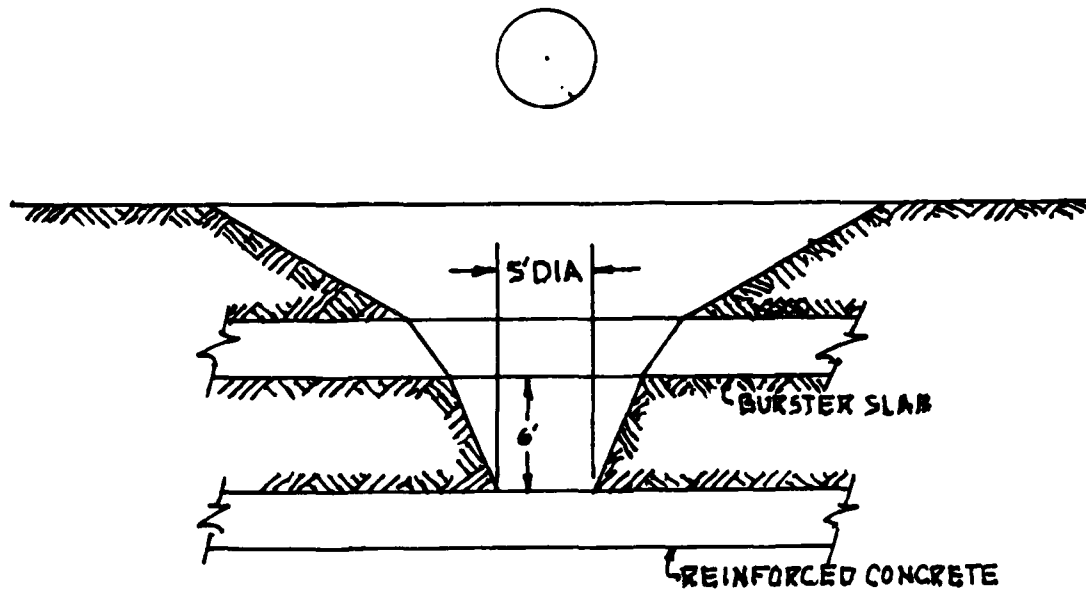
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3RD CRATERING

1 CHARGE

Note: Reinforcing rod would not
 have to be cut into the magazine
 since a man could go through the
 rebar into the magazine.

Scale $\frac{1}{8}'' = 1'$

DEMOLITION: TIME ESTIMATE		
OPER.	DESCRIPTION	TIME
10	Place 7 charges for boreholes	1.75
20	Attach detonating cord and detonate	1.40
30	Place cratering charges with detonating cord attached.	1.20
40	Stem charges in boreholes and detonate	2.45
50	Place breaching charges on burster slab and attach detonating cord. (4 Places)	12.0
60	Tamp breaching charges and detonate	8.0
70	Place 1 charge for borehole	.25
80	Attach detonating cord and detonate	.20
90	Place breaching charge on magazine and attach detonating cord	3.0
100	Tamp charge and detonate	2.0
Total 32.25 Minutes		.

DEMOLITION: TIME ESTIMATE

OPER.	DESCRIPTION	TIME
10	Place breaching charge	.20
20	Secure detonating cord to charge	.20
30	Move safe distance and detonate	.15
40	Move to barrier	.20
50	Place breaching charge	.20
60	Secure detonating cord	.20
70	Move safe distance and detonate	.20
80	Move to barrier	.25
90	Place breaching charge	.20
100	Secure detonating cord	.20
110	Move safe distance and detonate	.25
120	Move through barrier	.30
Total Min.		2.55
Note: Tamping could be required which would require an additional 3 minutes.		

APPENDIX D
SURVIVABILITY FEATURES

AIRCRAFT IMPACT

AIRCRAFT IMPACT ON CONCRETE BARRIERS

A complete analysis of the capability of a structure to withstand the impact of an aircraft requires the determination of the magnitude and duration of the reaction exerted by the aircraft on the structure, an estimate of the type of structural response, and an evaluation of the strength characteristics of the structure.

In order to develop methods for evaluation of overall structural response, the aircraft impact may be classified as "soft." This "softness" is characterized by significant local deformation of the aircraft in the region of impact. The deformation characteristics of the aircraft and the concrete barrier are used to develop an applied force time-history, and an analysis for overall response to the force is carried out.

The impact force time-history is developed based on the deformation of the aircraft, assuming that the target (concrete barrier) is rigid. In theory, the forcing function is also influenced by deformation of the target, but this effect is minimal and can be neglected. The load imposed on a rigid structure by an impacting deformable missile (such as an aircraft) is composed of two parts. The first part is the crushing strength, and the second part is the inertial force, or time rate of change of momentum of the missile.

Previous studies on this subject have demonstrated the relative insignificance of the crushing load distribution when compared with the mass distribution. This is interesting from the practical standpoint because it is always the mass distribution which is well-defined and

readily accessible. Structural drawings which are necessary for the computation of the crushing load are in some cases considered proprietary and are difficult to obtain. One may then use judgment to scale the crushing load distribution from drawings of similar aircraft which are available and have reasonable confidence that the final reaction curve will not be significantly in error.

Impact velocities are usually considered as those for take-off and landing and generally range from 150 to 200 mph. The peak loads in the reaction time curve occur when the wings impact the structure. Duration times for impact typically range from 0.2 to 0.3 seconds.

Since the largest structural response will usually result when the aircraft impacts normal to the surface of the structure, the outside walls as well as the roof of the structure should be checked.

For typical aircraft impact parameters, the reinforced concrete structures may experience extensive permanent damage. A finite-element analysis of the structure, using the force-time relationship, shows whether an elastic analysis is sufficient. In cases where an elastic analysis is not adequate, an elasto-plastic finite element analysis can be performed. Under such circumstances, an analysis based upon limit design and the estimated ductility ratios for the type of construction involved must be introduced. It is noted that assumed increases in ductility ratios and extent of damage would increase the load-carrying capacity of the structure.

Tests have shown that the effect of reinforcing steel in resisting penetration along the path of the missile is too small to warrant any

large increases in percentage of steel over that required to inhibit mass cracking, spalling, and scabbing. In fact, only about 0.3 percent longitudinal steel is required in each direction. At least 50 percent of this longitudinal reinforcement should be located close to the rear face of the slab, and at least 25 percent near the front face.

Previous work on nuclear power containment buildings has shown that a reinforced concrete roof 4 ft. thick is sufficient to resist the impact of a Boeing 707 aircraft. Work has also been done on other aircraft types including military jets. We are not aware of any work that considers the Boeing 747 impact; however, based on the available data, it is safe to conclude that a reinforced concrete roof about 6 ft. thick should be sufficient for a 747-type aircraft.

Although a 6-ft. thick reinforced concrete roof slab would meet the aircraft impact requirement, it would not meet other project requirements. Terrorists with shaped charge explosives could blast through an exposed roof slab and have direct access to the weapons. Also, exposing the structure of the storage facility would make its appearance more destabilizing to the local populace and apparent to an enemy. For these reasons, the storage facility should be covered with earth thick enough to deter terrorists and to support vegetation. Since earth cover would contribute to aircraft impact resistance, the thickness of the roof slab could be reduced. A 3-ft. thick reinforced concrete roof slab covered with 10 ft. of earth would be approximately equivalent to an exposed 6-ft. thick reinforced concrete roof slab.

References:

- 1) American Society of Civil Engineers, "Structural Analysis and Design of Nuclear Plant Facilities," Draft, New York, 1976.
- 2) American Society of Civil Engineers, "Structural Design of Nuclear Plant Facilities," 1975, Volume 1-A, p. 597.

BLAST PROTECTION

"Structures to Resist the Effect of Accidental Explosions"

(Reference: "Structures to Resist the Effect of Accidental Explosions,"
Technical Manual 5-1300 [Department of the Army, 15 June 1969].)

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DATE 7-20-82

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WORK Wall Thickness Designs
Container Cell

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PROJECT No. 10304

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Concrete : 4000 psi

Reinforcing Steel 60000 psi

P. GN-024-A

+ BLACK & VEATCH CONSULTING ENGINEERS — KANSAS CITY DALLAS DENVER ORLANDO	SUBJECT	<u>WEAPONS STORAGE CONCEPTS</u>		DATE	<u>19</u>
	WORK	<u>GAS PRESSURE LOADS</u>		SET UP BY	<u>WVN</u>
				COMPUTED BY	<u>WVH</u>
				CHECKED BY	<u>JLF</u>
				PAGE NO.	<u>OF</u>
	PROJECT NO.			FILE NO.	

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For a fully vented structure where the gas pressure pulse is not a factor in the design loading. $\frac{A}{V^{\frac{2}{3}}} \geq 0.60$ (See R 828, Blast

Environment From Fully And Partially Vented Explosions In Cebicles. Civil Engineering Laboratory Naval Construction Battalion Center, 1975. page 64 Figure 40)

Find required vent area of a storage cell for fully venting.

For Carrousel Concept K

Cell 16' Long
9' wide (Avg)
10' High

$$Vol. = 16 \times 9 \times 10 = 1440 \text{ cu ft.}$$

$$A = (1440)^{\frac{2}{3}} 0.6 = 76.5 \text{ sq. ft.}$$

$$\text{Use Vent } 16' \times 5' \text{ Area} = 80 > 76.5$$

For Mausoleum Concept I

Cell 16' Long
6' wide
12' High

$$Vol. = 16 \times 6 \times 12 = 1152 \text{ cu ft.}$$

$$A = (1152)^{\frac{2}{3}} 0.6 = 66 \text{ sq. ft.}$$

$$\text{Use Vent } 12' \times 6' = 72 \text{ sq. ft.} > 66$$

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WORK 3 Wall Cubicle With Roof
Container Cell

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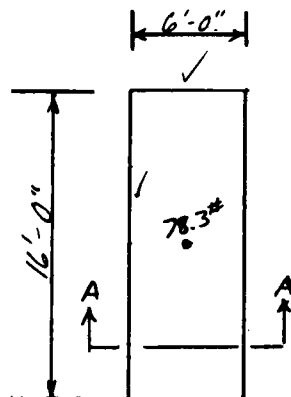
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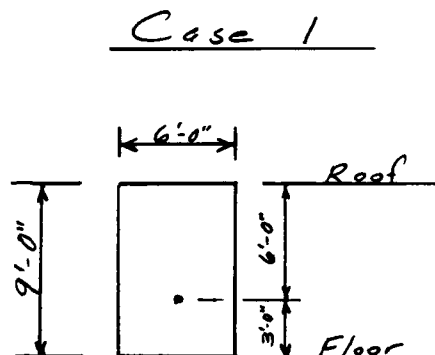
PAGE No. _____ OF _____

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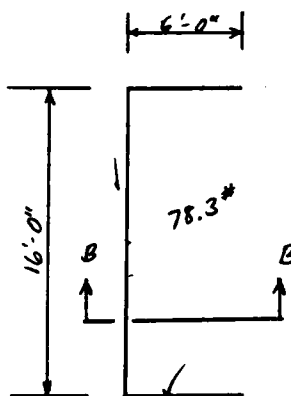
DO NOT WRITE



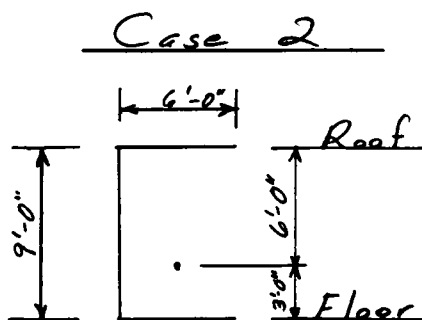
Plan



Section A-A



Plan



Section B-B

Allow Max 12° Rotation

P-CN-024-A

PROJECT 0304:

PROGRAM S78/01-1 CASE

CERL CASE 1 BACK WALL

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	8.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	9.00
BLAST WALL LENGTH	FT.	6.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	3.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	3.00
REFLECTION CODE		1 1 1 1 0

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	516.56
ROOF	384.26
LEFT SIDE WALL	609.16
RIGHT SIDE WALL	609.16
TOTAL	2119.14

PROJECT 0304:

PROGRAM S78/01-1 CASE

CER1 CASE 1 SIDE WALL

INPUT

DISTANCE OF CHARGE FROM BLAST WALL FT. 3.00

CHARGE WEIGHT LBS. 78.30

BLAST WALL HEIGHT FT. 9.00

BLAST WALL LENGHT FT. 16.00

HEIGHT OF CHARGE ABOVE GROUND FT. 3.00

MIN. DIST. BETWEEN CHARGE + ADJ WALL FT. 8.00

REFLECTION CODE 1 1 0 1 0

OUTPUT

REFLECTING SURFACE

IMPULSE PSI-MS

FLOOR 595.72

ROOF 429.82

RIGHT SIDE WALL 274.67

TOTAL 1300.21

PROJECT 0304:

PROGRAM S78/04-1 CASE

CERI CASE 1 ROOF SLAB

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	6.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	16.00
BLAST WALL LENGTH	FT.	6.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	8.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	3.00
REFLECTION CODE		1 0 1 1 0.

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	275.33
LEFT SIDE WALL	682.67
RIGHT SIDE WALL	682.67
TOTAL	1640.67

PROJECT 0304:

PROGRAM S78/01-1 CASE

CERIAL CASE 2 BACK WALL

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	3.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	9.00
BLAST WALL LENGTH	FT.	16.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	3.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	8.00
REFLECTION CODE		1 1 1 1 0

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	595.72
ROOF	429.82
LEFT SIDE WALL	274.67
RIGHT SIDE WALL	274.67
TOTAL	1574.88

PROJECT 0304:

PROGRAM 578/01-1 CASE

CERL CASE 2 SIDE WALL

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	8.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	9.00
BLAST WALL LENGTH	FT.	6.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	3.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	3.00
REFLECTION CODE		1 1 0 1 0

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	516.56
ROOF	384.26
RIGHT SIDE WALL	609.16
TOTAL	1509.98

PROJECT 0304:

PROGRAM S78/04-1 CASE

CERL CASE 2 ROOF SLAB

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	6.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	6.00
BLAST WALL LENGTH	FT.	16.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	3.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	8.00
REFLECTION CODE		1 0 1 1 0

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	682.67
LEFT SIDE WALL	275.33
RIGHT SIDE WALL	275.33
TOTAL	1233.33

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DATE 6-21-82

WORK Back Wall Case 1
Container Cell

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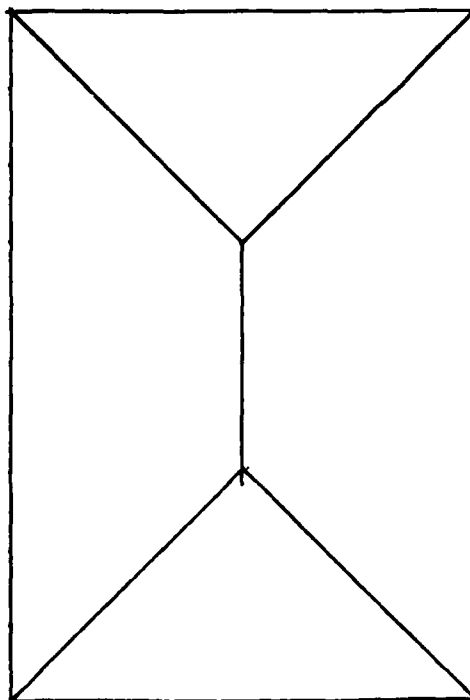
$$t_0 = 1.574 - .98 + 1.176 = \underline{1.77 \text{ ms}}$$

$$I_b = 2119.14 \text{ psi-ms}$$

$$L = 72 \text{ in.} \quad H = 108 \text{ in.}$$

Fixed on four edges.

$$y = 3'$$



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$$\frac{L}{H} = \frac{72}{108} = .667$$

Reference:

All formulas are from
TM 5-1300

$$\text{Optimum } P_u/P_H = 4.0 \quad (\text{Fig. 6-18, Page 6-21})$$

From Table 6-4 for Type III cross-section

$$\frac{i_b^2 H}{P_H d_c^3 f_{ds}} = C_1 + (C_u - C_1) \frac{X_m - X_1}{X_u - X_1} \quad (\text{Page 6-13})$$

But since $X_m = X_u$ (incipient failure)

$$\frac{i_b^2 H}{P_H d_c^3 f_{ds}} = C_u$$

$$144 C_u \times 10^{-4} = 34 \quad (\text{Fig. 6-15, Page 6-19})$$

$$C_u = \frac{34 \times 10^4}{144} \approx 2361$$

$$P_H d_c^3 = \frac{i_b^2 H}{C_u f_{ds}} \quad i_b = \text{total impulse from sheet D-7}$$

$$P_H d_c^3 = \frac{(2119.14)^2 (108)}{2361.1 \times 9 \times 10^4} = 2.282$$

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$$P_h d_c^3 = 2.282$$

$$P_h = .0025$$

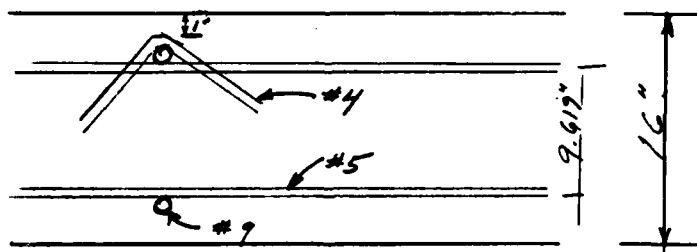
$$\therefore d_c = 9.7"$$

$$A_{sv} = .0025 \times 12 \times 9.7 = .29 \text{ in}^2/\text{ft}$$

$$A_{sh} = .01 \times 12 \times 9.7 = 1.16 \text{ in}^2/\text{ft}$$

$$\#9 @ 10" \rightarrow A_s = 1.20 \text{ in}^2/\text{ft} (A_{sh})$$

$$\#5 @ 12" \rightarrow A_s = .31 \text{ in}^2/\text{ft} (A_{sv})$$



$$T_c = 9.619 + .625 + 2(1.128) + 1.5 + 1.5 = 15.5" \quad \text{say } 16"$$

$$\text{Try } d_c = 9.619" \quad P_h = .00256 \text{ ok}$$

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WORK Side Wall Case 1
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$L = 108''$ $H = 192''$ → Assume one-way action.

$f_c = 1300.21$ psi-ms (from sheet D-8)

$C_u = 510$ (from Table 6-2, Page 6-11)

$$\frac{f_c^2 H}{P_H d_c^3 P_d s} = C_u \text{ (Equation 6-30)}$$

$$P_H d_c^3 = \frac{(1300.21)^2 \times 108}{510 \times 90000} = 3.98$$

$$d_c^3 = \frac{3.98}{.0025} = 1591 \quad d_c = 11.67''$$

$$A_s = .0025 \times 12 \times 11.67 = .35 \text{ in}^2/\text{ft}$$

$$\text{Try } \#6 @ 12'' \quad A_s = .44 \text{ in}^2/\text{ft}$$

$$P_H = \frac{.44}{12 \times 11.67} = .00314$$

$$\text{Use } d_c = 11''$$

$$T_c = 11 + .75 + .625 \times 2 + .75 \times 2 + 1 = 15.5''$$

say 16''

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WORK Roof Slab Case 1
Container Cell

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$$i_b = 1640.67 \text{ psi-ms (from sheet D-9)}$$

$$L = 192" \quad H = 72" \rightarrow \text{Assume one-way action}$$

$$C_u = 510 \quad (\text{from Table 6-2, Page 6-11})$$

$$\frac{i_b^2 H}{P_H d_c^3 f_{cs}} = C_u \quad (\text{Equation 6-30})$$

$$P_H d_c^3 = \frac{(1640.67)^2 \times 72}{510 \times 9000} = 4.22$$

$$P_H = .0025 \quad d_c^3 = \frac{4.22}{.0025} = 1689 \quad d_c = 11.91"$$

$$A_s = .0025 \times 12 \times 11.91 = 357 \text{ in}^2/f_t$$

$$A_s = .37 \text{ in}^2/f_t \quad \#5 @ 10"$$

$$P_H = \frac{.37}{12 \times 11.75} = .00262$$

$$T_c = 11.75 + .625 + 1.25 + 1.5 + 1 = 16.125$$

say 17"

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WORK Back Wall Case 2
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DO NOT WRITE

$$i_b = 1574.88 \text{ psi} \cdot \text{ms} \quad (\text{from sheet D-10})$$

$$L = 192" \quad H = 108" \quad \text{Assume one-way action}$$

$$C_u = 510 \quad (\text{from Table 6-2, Page 6-11})$$

$$\frac{i_b H}{P_H d_c^3 f_{dc}} = C_u \quad (\text{Equation 6-30})$$

$$P_H d_c^3 = \frac{(1574.88)^2 (108)}{(510) (90000)} = 5.84$$

$$P_V = .0025 \quad d_c^3 = 2334 \quad d_c = 13.26"$$

$$A_{sv} = .0025 \times 12 \times 13.26 = .40 \text{ in}^2/\text{ft}$$

$$\text{Try } A_{sv} = .44 \text{ in}^2/\text{ft} \quad (\#6 @ 12")$$

$$P_H = \frac{.44}{12 \times 13.26} = .0028$$

$$T_c = 13.25 + .75 + 1.5 + 1.5 + 1.0 = 18.0" \quad (\#4 \text{ spacing})$$

Say 18"

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WORK Side Wall Case 2
Container Cell

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$$i_b = 1509.98 \text{ psi} \cdot \text{ms} \quad (\text{from sheet D-11})$$

$$L = 108" \quad H = 72" \quad L/H = 1.5$$

Three edges fixed

$$P_V/P_H = .25 \quad (\text{Fig. 6-18, Page 6-21})$$

$$144 C_u \times 10^{-4} = 5.33 \quad (\text{Fig. 6-14, Page 6-18})$$

$$P_H d_c^3 = \frac{(1509.98)^2 (72)(144)}{(5.33 \times 10^4)(90000)} = 4.93$$

$$P_V = .0025 \quad \therefore \quad P_H = .01$$

$$d_c^3 = \frac{4.93}{.0025} = 1971 \quad d_c = 12.5"$$

$$A_{sV} = .0025 \times 12 \times 12.5 = .38 \text{ in}^2/\text{ft}$$

$$A_{sH} = .01 \times 12 \times 12.5 = 1.50 \text{ in}^2/\text{ft}$$

$$\text{Try } A_{sV} = .44 \text{ in}^2/\text{ft} \quad \#6 @ 12"$$

$$A_{sH} = 1.56 \text{ in}^2/\text{ft} \quad \#11 @ 12"$$

$$P_H = \frac{1.56}{12 \times 12} = .0108 \quad P_V = \frac{.44}{12 \times 12} = .003 \quad d_c = 11.7$$

$$T_c = 12 + 2.82 + .75 + 1.5 + 2 \times .75 = 18.57"$$

Say 19"

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WORK Root Slab Case 2
Container Cell

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$$i_b = 1233.33 \text{ psi-ms (from sheet D-12)}$$

$$L = 192 \quad H = 72 \quad L/H = 2.67$$

Fixed on three sides optimum $P_i/P_H = 1.3$
(Fig. 6-18, Page 6-21)

L/H	$144 C_u \times 10^{-4}$	
2.0	7.62	(Fig. 6-14, Page 6-18)
2.67	6.64 ✓	
3.0	6.15	

$$P_H d_c^3 = \frac{(1233.33)^2 \times (72) \times (144)}{(6.64 \times 10^4) \times (90000)} = 2.639$$

$$P_H = .0025 \quad A_{sH} = .0025 \times 12 \times 10.18 = .31 \text{ in}^2/\text{ft}$$

$$d_c = 10.18 \quad A_{sU} = .397 \text{ in}^2/\text{ft}$$

$$\text{Try } A_{sH} = .31 \text{ in}^2/\text{ft} \quad \#5 @ 12"$$

$$\text{Try } A_{sU} = .41 \text{ in}^2/\text{ft} \quad \#5 @ 9"$$

$$P_H = \frac{.31}{10 \times 12} = .00258 \quad d_c = \sqrt[3]{\frac{2.639}{.00258}} = 10.07 \text{ ok}$$

$$T_c = 10 + 1.5 + .625 + 1.25 + 1.25 = 14.625$$

say 15"

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Design Thicknesses

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Wall	Case 1	Case 2
Back Wall	16"	18"
Side Wall	16"	19"
Roof Slab	17"	15"

P. GN-024. A

AD-A133 540

ADVANCED STRUCTURAL CONCEPTS FOR WEAPONS STORAGE - FLAT
AND MOUNTAINOUS TERRAINS(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL JUN 83 CERL-TR-M-330

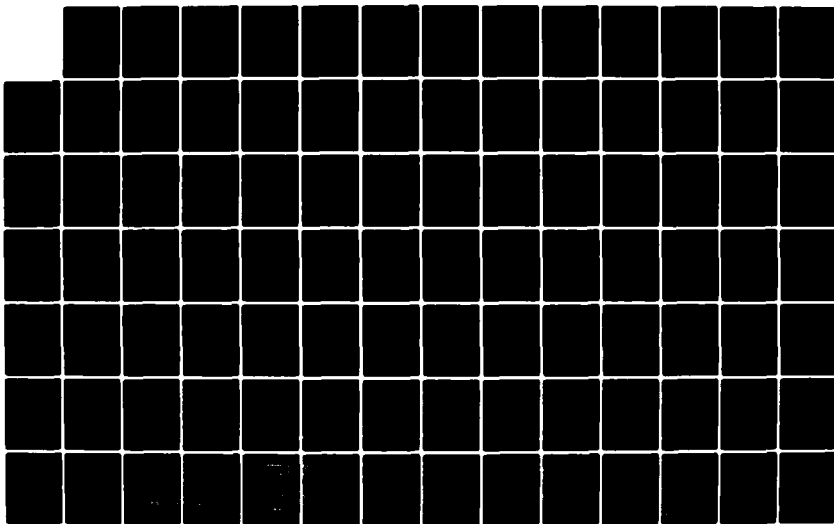
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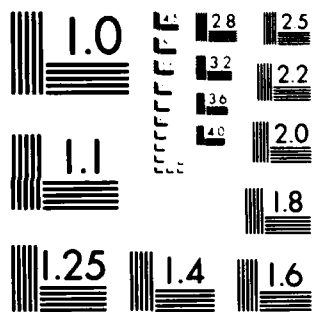
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MICROCOPY RESOLUTION TEST CHART
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WORK Large Wall - Magazine &
Maintenance

PROJECT NO. 10304

DATE 7-20 19 82

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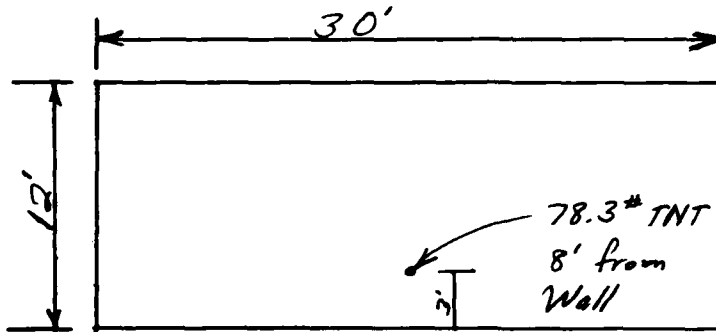
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Allow Max 12° Rotation
Fixed on four sides

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WORK Large Wall-Magazine &
Maintenance

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$$i_b = 850.36 \text{ psi-ms} \quad \underline{4 \text{ edges fixed}}$$

$$L/H = 30/12 = 2.5 \rightarrow \text{optimum } P_i/P_H = 4.0 \quad (\text{Fig. 6-18, Page 6-21})$$

$$30.5 = 1.44 C_u \times 10^{-4} \quad (\text{Fig. 6-15, Page 6-19})$$

$$P_H d_c^3 = \frac{(850.36)^2 (12 \times 12) 144}{(30.5 \times 10^4) \times 90,000} = 5.46$$

$$P_H = .0025 \quad d_c = 12.98 \text{ in.}$$

$$A_{sH} = .0025 \times 12 \times 12.98 = .39 \text{ in}^2/\text{ft}$$

$$A_{sV} = .01 \times 12 \times 12.98 = 1.56 \text{ in}^2/\text{ft}$$

$$A_{sH} = .44 \text{ in}^2/\text{ft} \quad (\#6 @ 12")$$

$$A_{sV} = 1.56 \text{ in}^2/\text{ft} \quad (\#11 @ 12")$$

$$P_H = \frac{.44}{12 \times 12.25} = .00299 \rightarrow d_c = 12.22 \text{ ok}$$

$$T_c = 12.25 + 1.41 + 1.5 + 1.5 + 1.5 = 18.16"$$

say 19"

PROJECT 0394:

PROGRAM S78/01-1 CASE

CERIAL WALL

INPUT

DISTANCE OF CHARGE FROM BLAST WALL	FT.	8.00
CHARGE WEIGHT	LBS.	78.30
BLAST WALL HEIGHT	FT.	12.00
BLAST WALL LENGTH	FT.	30.00
HEIGHT OF CHARGE ABOVE GROUND	FT.	3.00
MIN. DIST. BETWEEN CHARGE + ADJ WALL	FT.	15.00
REFLECTION CODE		1 1 1 1 0

OUTPUT

REFLECTING SURFACE	IMPULSE PSI-MS
FLOOR	334.58
ROOF	247.69
LEFT SIDE WALL	134.04
RIGHT SIDE WALL	134.04
TOTAL	850.36

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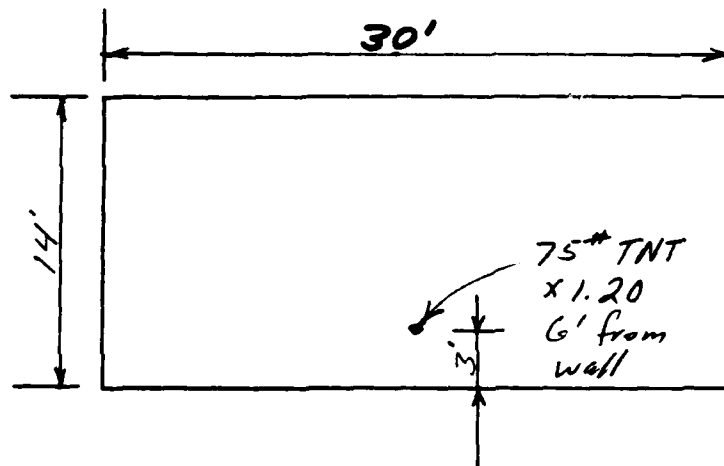
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Fixed on four sides.
Allow Max 5' Rotation

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Solve for t_o

$$t_o = (t_A)_F - (t_A)_A + (t_o)_F$$

$$W = 90'' \quad W^{1/3} = 4.48$$

For nearest point on wall in question, $R = 6'$

$$Z_A = \frac{R}{W^{1/3}} = \frac{6}{4.48} = 1.34$$

(From Fig. 4-5, TM 5-1300)

$$\frac{t_A}{W^{1/3}} = .125 \quad (t_A)_A = .125 \times 4.48 = .560 \text{ ms}$$

For furthest point on wall,

$$R = \sqrt{15^2 + 6^2 + 11^2} = 19.54'$$

$$Z_A = \frac{R}{W^{1/3}} = \frac{19.54}{4.48} = 4.36$$

$$\frac{t_A}{W^{1/3}} = 1.13 \quad (t_A)_F = 1.13(4.48) = 5.064 \text{ ms}$$

$$\frac{t_o}{W^{1/3}} = .89 \quad (t_o)_F = .89(4.48) = 3.988 \text{ ms}$$

$$t_o = 5.064 - .560 + 3.988 = \underline{8.492 \text{ ms}}$$

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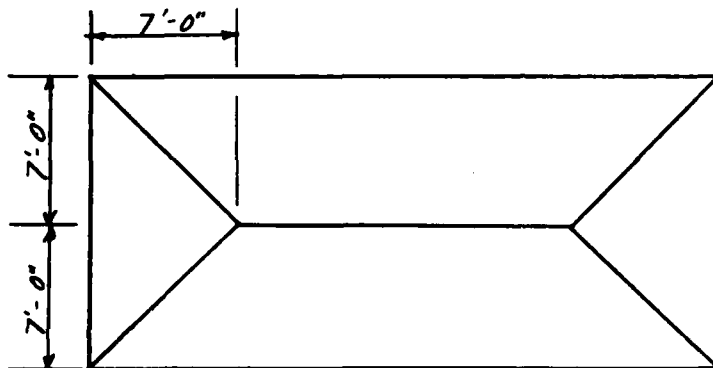
Fixed on four sides

5° yield angle

$$L/H = 30/14 = 2.14$$

$$H = 14' \quad L = 30'$$

$$\frac{H}{L} = \frac{14}{30} = .467 \quad H < L \quad y = H/2 = 7$$



$$i_b = 933.79 \text{ psi-ms}$$

Type II Cross-section

$$\text{Allowable } X_m = \frac{L \tan 5^\circ}{2} = \frac{14 \times 12 \times \tan 5^\circ}{2} = 7.349''$$

$$\left(\text{From Fig. 6-17} \right) \frac{P_v}{P_H} = 1.87$$

(Table 5-9,
Page 5-15)

$$\frac{X}{L} = \frac{7}{30} = .233$$

$$\left(\text{From Fig. 5-11,} \right) \frac{L}{H} \left(\frac{M_{MN} + M_{VP}}{M_{HN} + M_{HP}} \right)^{1/2} = 2.7$$

(Page 5-11)

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$$L/H = 2.14$$

$$\left(\frac{M_{VN} + M_{VP}}{M_{HN} + M_{HP}} \right)^{1/2} = \frac{2.9}{2.14} = 1.355$$

$$M_N = M_P \quad \frac{2M_{VN}}{2M_{HN}} = 1.355^2 = 1.8364$$

$$\frac{M_{VN}}{M_{HN}} = 1.8364 \quad \frac{P_V}{P_H} = 1.8364 \quad P_H = .5445 P_V \quad \text{For } 45^\circ$$

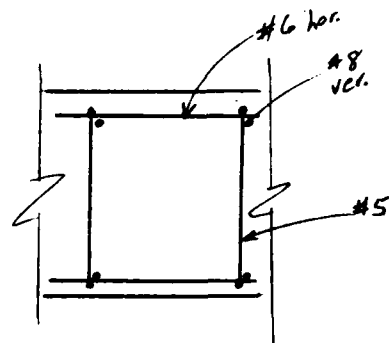
$$\text{Try } T_c = 18"$$

$$d'_V = 3/4 + .625 + .75 + .5 = 2.625"$$

$$d'_{HV} = 3/4 + .625 + .75/2 = 1.75"$$

$$d'_{HL} = 2.625 + .5 + .75/2 = 3.5"$$

$$d'_{AV} = \frac{1.75 + 3.5}{2} = 2.625"$$



$$d_c = d_{cH} = 18 - 2(2.625) = 12.75"$$

$$\text{Try } A_{SH} = .0018(12)(12.75) = .28 \text{ in}^2/\text{ft}$$

$$A_{SV} = \frac{.28}{.5445} = .51 \text{ in}^2/\text{ft}$$

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Try less reinforcement #6 ver.
#4 lacing
#4 hor.

$$T_c = 18''$$

$$d'v = .75 + .5 + .5 + .375 = 2.125''$$

$$d'H_v = .75 + .5 + .5/2 = 1.5''$$

$$d'H_h = 2.125 + .375 + .25 = 2.75''$$

$$d'H_{avg} = \frac{1.5 + 2.75}{2} = 2.125''$$

$$d_c = d_{cH} = 18 - 2(2.125) = 13.75''$$

$$\text{Try } A_{sh} = 0.018 \times 12 \times 13.75 = .297 \text{ in}^2/\text{ft.}$$

$$A_{sv} = \frac{.297}{.5445} = .55 \text{ in}^2/\text{ft.} \rightarrow 46 @ 9''$$

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try #7 ver.
#5 hor.
#4 laung

$$T_c = 18"$$

$$d'v = .75 + .5 + .625 + .875/2 = 2.3125"$$

$$d'_{H_u} = .75 + .5 + .625/2 = 1.5625"$$

$$d'_{H_L} = 2.3125 + .875/2 + .625/2 = 3.0625"$$

$$d'_{H_{avg}} = \frac{1.5625 + 3.0625}{2} = 2.3125"$$

$$d_c = d_{cH} = 18 - 2(2.3125) = 13.375"$$

$$A_{sH} = .0018 \times 12 \times 13.375 = .29 \text{ in}^2/\text{ft} \rightarrow \#5 @ 12"$$

$$A_{sv} = \frac{.29}{.5445} = .53 \text{ in}^2/\text{ft} \rightarrow \#7 @ 12"$$

$$P_H = \frac{.31}{12 \times 13.375} = .0019$$

$$\frac{P_H}{P_v} = \frac{.0019}{.00374} = .5167$$

$$P_v = \frac{.60}{12 \times 13.375} = .00374$$

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$$\frac{P_v}{P_h} = 1.9355$$

$$2.14 (1.9355)^{1/2} = 2.977$$

$$(Fig. 5-11) \quad x/L = .225$$

$$X = .225 \times 30 \times 12 = 81" \quad \alpha = \tan^{-1} \left(\frac{81}{84} \right) = 43.76^\circ \text{ at}$$

$$\text{Use } x = 81"$$

$$M_{VN} = M_{VP} = \frac{A_s f_{ds} d_c}{b} \quad f_{ds} = 1.2 [60,000 + \frac{1}{4} (90,000 - 60,000)]$$

$$= 81,000 \text{ psi} \quad (\text{Page 5-4})$$

$$= \frac{.60 \times 81,000 \times 13.375}{12} = 54,169 \text{ in}^2/\text{in}$$

$$M_{HN} = M_{HP} = \frac{.31 \times 81,000 \times 13.375}{12} = 27,987 \text{ in}^2/\text{in}$$

$$E_c = 3.83 \times 10^6 \text{ psi} \quad E_s = 29 \times 10^6 \text{ psi}$$

$$n = \frac{29}{3.83} = 7.57$$

$$I_g = \frac{b T_c^3}{12} = \frac{1(18)^3}{12} = 486 \text{ in}^4$$

$$d' = 2.3" \quad d = 15.7" \quad b = 1"$$

$$n = 7.57 \quad n-1 = 6.57 \quad A_s = A'_s = \frac{.60 \times .31}{2} = .455 \text{ in}^2/\text{ft}$$

$$= .038 \text{ in}^2/\text{in.}$$

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$$Kd = \frac{\frac{(kd)^2}{2} + 6.57(.038)(2.3) + 7.57(.038)(15.7)}{kd + 6.57(.038) + 7.57(.038)}$$

$$\frac{(kd)^2}{2} - \frac{(kd)^2}{2} + .53732 kd = 5.0869$$

$$kd^2 + 1.07464 kd = 10.174$$

$$[kd + .537]^2 - 10.174 + .537^2 = 10.462$$

$$[kd + .537] = \pm 10.462^{1/2} = \pm 3.235$$

$$kd = 3.235 - .537 = 2.697''$$

$$I_c = \frac{(2.697)^3}{3} + 6.57(.038)(2.697 - 2.3125)^2$$

$$+ 7.57(.038)(15.6875 - 2.697)^2$$

$$= 6.541 + .037 + 42.129 = 48.71 \text{ in}^4$$

$$I_a = \frac{I_g + I_c}{2} = \frac{486 + 487}{2} = 267.35 \text{ in}^4$$

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Properties at First Yield

$$H/L = 14/30 = .4667$$

$$B_{1H} = .0158 \quad B_2 = .0572 \quad B_3 = .0830$$

$$B_{1V} = .0415 \quad \gamma = .00256 \quad \nu = .3$$

$$M_{HP} = .0158 r H^2 = 27,987 \text{ in}^2/\text{in.}$$

$$r = \frac{1771329}{H^2}$$

$$M_{VP} = .0415 r H^2 = 54,169 \text{ in}^2/\text{in.}$$

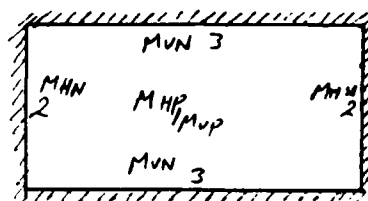
$$r = \frac{1305277}{H^2}$$

$$M_{HN} = .0572 r H^2 = 27,987 \text{ in}^2/\text{in.}$$

$$r = \frac{489283}{H^2} \leftarrow \text{Smallest}$$

$$M_{VN} = .083 r H^2 = 54,169 \text{ in}^2/\text{in.}$$

$$r = \frac{652639}{H^2}$$



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First Yield at Point 2

$$r_e = \frac{489283}{(14 \times 12)^2} = 17.34 \text{ psi}$$

$$M_{PH} @ r_e = .0158(17.34)(168)^2 = 7731 \text{ in}^2/\text{in}$$

$$M_{PV} @ r_e = .0415(17.34)(168)^2 = 20305 \text{ in}^2/\text{in}$$

$$M_{NV} @ r_e = .083(17.34)(168)^2 = 40610 \text{ in}^2/\text{in}$$

$$D = \frac{E_c I_g}{b(1-v^2)} = \frac{3.83(10^6)(267.35)}{1(1-.3^2)} = 1.125 \times 10^9 \text{ in}^4$$

$$\chi_e = \frac{\gamma r_e H^4}{D} = \frac{.00256 \times 17.34 \times 168^4}{1.125 \times 10^9} = .0314''$$

Properties @ 2nd Yield

$$M'_{NV} = M_{VN} - M_{NV} = 54169 - 40610 = 13559 \text{ in}^2/\text{in}$$

$$\frac{M'_{NV}}{M_{VN}} = \frac{13559}{54169} = 25(100) = \underline{25\%}$$

$$B_{1H} = .014 \quad B_3 = .0845 \quad v = .3$$

$$B_{1V} = .0419 \quad \gamma = .0026$$

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$$M'_{PH} = M_{HP} - M_{PH} = 27,987 - 7731 = 20,256 \text{ in}^2/\text{in}$$

$$M'_{PV} = M_{VP} - M_{PV} = 54169 - 20305 = 33864 \text{ in}^2/\text{in}$$

$$M_{HP}' = .014r H^2 = 20,256 \text{ in}^2/\text{in}$$

$$r = \frac{1446857}{H^2}$$

$$M_{VP}' = .0419r H^2 = 33864 \text{ in}^2/\text{in}$$

$$r = \frac{808210}{H^2}$$

$$M_{VN}' = .0845r H^2 = 13559 \text{ in}^2/\text{in}$$

$$r = \frac{160462}{H^2} \quad \text{smallest } r$$

2nd Yield at Point

$$\Delta r = \frac{160462}{(14 \times 12)^2} = 5.69 \text{ psi}$$

$$r_{ep1} = r_e + \Delta r = 17.34 + 5.69 = 23.03 \text{ psi}$$

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$$M_{PH}' @ \text{rep} = (.014)(5.69)(168)^2 = 2248 \text{ in}^{\#}/\text{in}$$

$$M_{PV}' @ \text{rep} = (.0419)(5.69)(168)^2 = 6729 \text{ in}^{\#}/\text{in}$$

$$D = \frac{3.83(10^6)(267.35)}{1(1-.3^2)} = 1.125 \times 10^9 \text{ in}^{\#}$$

$$\Delta X = \frac{.0026 \times 5.69 \times 168^4}{1.125 \times 10^9} = .0105 \text{ in.}$$

$$X_{cp1} = X_c + \Delta X = .0314 + .0105 = .0419 \text{ in.}$$

Properties @ Third Yield

$$M_{PH}^2 = M_{HP}' - M_{PH}' = 20256 - 2248 = 18008 \text{ in}^{\#}/\text{in}$$

$$M_{PV}^2 = M_{VP}' - M_{PV}' = 33864 - 6729 = 27135 \text{ in}^{\#}/\text{in}$$

$$B_{IV} = .1063 \quad B_{IH} = .045 \quad \gamma_1 = .0105$$

$$M_{HP}^2 = .045 r H^2 = 18008 \text{ in}^{\#}/\text{in}$$

$$r = \frac{400178}{H^2}$$

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$$M_{VP}^2 = .1063 r H^2 = 27135 \text{ in}^4/\text{in}$$

$$r = \frac{255268}{H^2} \leftarrow \text{smallest}$$

Third Yield at point 1

$$\Delta r_2 = \frac{255268}{(14 \times 12)^2} = 9.04 \text{ psi}$$

$$r_{cp2} = r_{cp} + \Delta r_2 = 23.03 + 9.04 = 32.07 \text{ psi}$$

$$M_H = .045 (9.04) (168)^2 = 11482 \text{ in}^4/\text{in}$$

$$D = 1.125 \times 10^9 \text{ in}^4$$

$$\Delta X_2 = \frac{.0105 \times 9.04 \times 168^4}{1.125 \times 10^9} = .0672 \text{ in.}$$

$$X_{cp2} = X_{cp} + \Delta X_2 = .0419 + .0672 = .1091 \text{ in.}$$

Properties at Final Yield

$$X = 81" \quad X < L/2$$

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$$r_u = \frac{5(M_{HN} + M_{HP})}{x^2} = \frac{5(27987 + 27987)}{81^2} = 42.66 \text{ psi}$$

or

$$r_u = \frac{8(M_{HN} + M_{HP})(3L - x)}{H^2(3L - 4x)} = \frac{16(54169)(3(360) - 81)}{168^2(3(360) - 4(81))} = 40.58 \text{ psi}$$

$$r_u = \frac{42.66 + 40.58}{2} = 41.62 \text{ psi}$$

$$\Delta r_3 = r_u - r_{ep2} = 41.62 - 32.07 = 9.55 \text{ psi}$$

$$D = 1.125 \times 10^9$$

$$\Delta x_3 = \frac{\delta_1 \Delta r_3 H^4}{D} = \frac{.0105(9.55)(168)^4}{1.125 \times 10^9} = .0710 \text{ in.}$$

$$x_p = x_{ep2} + \Delta x_3 = .1091 + .0710 = .1801 \text{ in.}$$

$$x_E = x_e \left(\frac{r_{ep1}}{r_u} \right) + x_{ep1} \left(\frac{r_{ep2} - r_e}{r_u} \right) + x_{ep2} \left(\frac{r_u - r_{ep1}}{r_u} \right) + x_p \left(1 - \frac{r_{ep2}}{r_u} \right)$$

$$= .0314 \left(\frac{23.03}{41.62} \right) + .0419 \left(\frac{32.07 - 17.34}{41.62} \right) + .1091 \left(\frac{41.62 - 23.03}{41.62} \right) + .1801 \left(1 - \frac{32.07}{41.62} \right)$$

$$= .01737 + .01483 + .04873 + .04133 = .1223 \text{ in.}$$

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$$m_{ss} = \frac{w T_c}{g} = \frac{1.5(150)(10^6)}{32.2(1728)} = 4044 \text{ lb-ms}^2/\text{in.}^3$$

$$K_{Lme} = .77 \quad (\text{From Table 6-1})$$

$$K_{Lmp} = .603 \quad x/L = 81/360 = .225 \quad (\text{Fig. 6-5})$$

$$\frac{1}{2}(K_{Lme} + K_{Lmp}) = \frac{1}{2}(.77 + .603) = .687$$

$$m_a = .687(4044) = 2778 \text{ lb-ms}^2/\text{in.}^3$$

$$m_u = .603(4044) = 2439 \text{ lb-ms}^2/\text{in.}^3$$

$$\frac{i_d^2}{2m_a} = \frac{r_u x_E}{2} + \frac{M_g \cdot r_u \cdot (X_m - x_E)}{m_u}$$

$$\frac{933.79^2}{2(2778)} = \frac{41.62 \cdot .1223}{2} + \frac{2778}{2439} (X_m - .1223)(41.62)$$

$$156.94 = 2.545 + 47.405 X_m - 5.7976$$

$$160.19 = 47.405 X_m \quad X_m = 3.379 \text{ in.}$$

$$\theta_m = \tan^{-1} \frac{3.379}{84} = \underline{2.3^\circ}$$

$$\underline{3.379" < 7.349" \quad \text{ok}}$$

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Assume $T_c = 15''$ (Using same steel)

$$P_H = \frac{.31}{12 \times 10.375} = .0025$$

$$\frac{P_V}{P_H} = \frac{.0048}{.0025} = 1.94$$

$$P_V = \frac{.60}{12 \times 10.375} = .0048$$

$$r_u = \frac{8}{L^2} (M_N + M_P) \quad M_N = M_P \therefore r_u = \frac{16 M_N}{L^2}$$

$$X_m = \frac{L \tan \theta}{2} = \frac{168 \tan 5^\circ}{2} = 7.347''$$

$$r_e = \frac{12 M_N}{L^2} \quad r_{ep} = r_u \quad n = 7.57$$

$$K_e = \frac{384 E_c I_c}{b L^4} \quad K_{ep} = \frac{384 E_c I_c}{5 b L^4}$$

$$I_g = \frac{(1)(15)^3}{12} = 281.25 \text{ in}^4$$

$$d' = 2.3'' \quad d = 12.7'' \quad b = 1''$$

$$n = 7.57'' \quad n-1 = 6.57'' \quad A_s = A_s' = \frac{.60 + .31}{2} = .455 \text{ in}^2/\text{ft}$$

$$= .038 \text{ in}^2/\text{in.}$$

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$$Kd = \frac{(Kd)^2}{2} + 6.57(.038)(2.3) + 7.57(.038)(12.7)$$

$$Kd + 6.57(.038) + 7.57(.038)$$

$$(Kd)^2 - \frac{(Kd)^2}{2} + .53732 Kd = 4.227$$

$$Kd^2 + 1.07464 Kd = 8.454$$

$$(Kd + .537)^2 = 8.454 + .537^2 = 8.74276$$

$$Kd + .537 = \pm \sqrt{8.74276} = \pm 2.9568$$

$$Kd = 2.9568 - .537 = 2.4195"$$

$$I_c = \frac{(2.4195)^3}{3} + 6.57(.038)(2.4195 - 2.3125)^2$$

$$+ 7.57(.038)(12.6875 - 2.4195)^2$$

$$= 4.72 + .003 + 30.33 = 35.05 \text{ in}^4/\text{in.}$$

$$I_a = \frac{I_g + I_c}{2} = \frac{281.25 + 35.05}{2} = \underline{\underline{158.15}}$$

$$M_u = \frac{A_s f_s d_c}{6} = \frac{.60 \times 81000 \times 10.375}{12} = 42019 \text{ in}^2/\text{in.}$$

$$M_N = M_p = 42019 \text{ in}^2/\text{in.}$$

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SUBJECT CERL

WORK Large Wall - Magazine &
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PROJECT NO. 10304

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$$r_u = \frac{16 M_N}{L^2} = \frac{16 (42019)}{(14 \times 12)^2} = 23.82 \text{ psi}$$

$$r_e = \frac{12 M_N}{L^2} = \frac{12 (42019)}{(14 \times 12)^2} = 17.87 \text{ psi}$$

$$K_e = \frac{384 \times 3.83 (10^6) \times 158.15}{(1) (168)^4} = 292.04$$

$$K_{ep} = \frac{292.04}{5} = 58.41$$

$$X_e = \frac{r_u}{K_e} = \frac{23.82}{292.04} = .08156 \text{ in.}$$

$$X_p - X_e = \frac{r_u - r_e}{K_{ep}} = \frac{23.82 - 17.87}{58.41} = .101866 \text{ in.}$$

$$X_p = .101866 + .08156 = .18343 \text{ in.}$$

$$X_E = .08156 + .18343 \left(1 - \frac{17.87}{23.82}\right) = .12738 \text{ in.}$$

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$$mass = \frac{w T_c}{g} = \frac{1.25 (150) (106)}{32.2 (1728)} = 3370 \#-ms^2/in^3$$

$$K_{Lme} = .77$$

$$K_{Lmp} = .79$$

$$K_{Lmp} = .66$$

} Table 6-1, Page 6-6

$$\frac{1}{2} (K_{Lme} + K_{Lmp}) = \frac{1}{2} (.77 + .66) = .715$$

$$m_a = .715 (3370) = 2409.55 \#-ms^2/in^3$$

$$m_u = .66 (3370) = 2224.2 \#-ms^2/in^3$$

$$\frac{933.79^2}{2 (2409.55)} = \frac{23.82 (1.2738)}{2} + \frac{2409.55 (23.82) (X_m - .12738)}{2224.2}$$

$$180.94 = 1.517 + 25.805 X_m - 3.287$$

$$\frac{182.71}{25.805} = X_m = 7.08 in. < 7.349"$$

$$\theta = \tan^{-1} \frac{7.08}{84} = \underline{4.82^\circ} < 5^\circ \text{ ok} \checkmark$$

P. GN-024-A

APPENDIX E
SUPPORTING SYSTEMS

APPENDIX E
SUPPORTING SYSTEMS

ESTIMATED REQUIREMENTS



1. VENTILATION

1.1 ASHRAE recommendations for the type of spaces provided are 30 cfm per person with a minimum of 15 cfm.

1.2 The motor/generator set for emergency standby power will require combustion air:

$$175 \text{ HP} \times \frac{2.5 \text{ cu. in./HP}}{1,728} \times 1800 \text{ rpm} = 456 \text{ cfm}$$

1.3 The fleet of trucks arriving to be loaded with weapons would not be accommodated within the facility. The following allowance will be accommodated within the facility:

Entering	-	1 truck
Leaving	-	1 truck
Loading	-	2 trucks
Waiting	-	2 trucks

Combustion air for the truck engines will be supplied from the truck tunnel. Motor speeds are estimated to be:

Entering	-	2,000 rpm
Leaving	-	2,000 rpm
Loading	-	1,000 rpm
Waiting	-	1,000 rpm

Allowing 500 cubic inches per truck engine, the combustion air requirement is 2,315 cubic feet per minute.

1.4 A schematic of the typical concept HVAC system follows the HVAC Scenario in this appendix.

2. ELECTRICAL

2.1 The electrical requirements to be estimated are:

Lighting

Heating

Motors for Material Handling

Fan Motors

Motors for Barrier Operation

Miscellaneous (such as Receptable Loads)

Surveillance and Intrusion Detection

2.2 Lighting levels for the facility will be in accordance with
IES recommendations as follows:

Tunnels & Hallways	20 ft.-candles
Storage Area	10 ft.-candles
Maintenance Area	50 ft.-candles
Equipment Area	10 ft.-candles
Security Area	30 ft.-candles

2.3 Watts per square foot for lighting are estimated as follows:

Tunnels & Hallways 12,000 ft. ² @ 2w	=	24,000 watts
Storage Area 12,000 ft. ² @ 1w	=	12,000
Maintenance Area 1,500 ft. @ 5w	=	7,500
Mechanical Area 1,500 ft. ² @ 1w	=	1,500
Security Area 400 ft. @ 3w	=	1,200
Total kW	=	46.2

2.4 Heating of ventilation air estimate:

$$\frac{200 \text{ cfm} \times 60 \text{m/h} \times .08 \times .24 \times 30 \text{ T}}{3,412} = 2 \text{ kW}$$

2.5 Motors for material handling estimate:

$$\frac{300 \text{ ft} \times 5,000 \text{ lb} \times .7457}{8 \text{ min} \times 33,000 \text{ ft-lb}} \times 2 = 8.5 \text{ kW}$$

2.6 Fan Motors for ventilation estimate:

$$.5 \text{ kw/1,000 cfm} \times 2,000 \text{ cfm} = 1.5 \text{ kW}$$

2.7 Motors for barrier operation (one only):

$$\frac{15 \text{ ft.} \times 300,000 \text{ lb} \times .7457}{5 \text{ min} \times 33,000 \text{ ft.-lb}} = 20.3 \text{ kW}$$

2.8 Miscellaneous:

Estimated 1.5 kW

2.9 Power required estimate:

$$\frac{80 \text{ kW}}{.9 \text{ P-F}} = 89 \text{ kW}$$

Surveillance and intrusion detection power requirements are not included because they are outside the scope of this study.

2.10 Motor/generator set:

$$\frac{89 \text{ kW}}{.9 \text{ eff.}} = 99 \text{ kW (Output of Engine)}$$

$$99 \text{ kW} \times 1.341 = 133 \text{ HP}$$

This horsepower output requires a 175 HP engine at 1,800 rpm.

3. FUEL CAPACITY. Standby generating capacity for 4 hours for the motor/generator set requires .8 lb/HP-hr. or:

$$\frac{175 \text{ HP} \times .8 \text{ lb/HP-hr} \times 4 \text{ hr}}{7 \text{ lb/gal}} = 80 \text{ gallon}$$

4. FIRE PROTECTION. An automatic extinguishing system charged with Halon is required in the Maintenance Area. It is assumed a fire would be Class B or C, but there is no basis for judging the severity. For estimating purposes, an 8 percent concentration is assumed. Estimates of the amount of Halon required for the 12 study concepts are in this appendix.

5. COMPRESSED AIR. It is anticipated that compressed air should be available to power tools which will be used in the Maintenance Area.

6. EMP/EMR PROTECTION. EMP/EMR protection will be required in the Maintenance Area.

7. WATER AND WASTE WATER. Water supply and wastewater collection systems are assumed to be available. It is assumed wastewater must be pumped up from the facility. Unless the facility must be buttoned-up with personnel inside, an emergency supply of water should not be required.

EQUIPMENT ROOM LAYOUT



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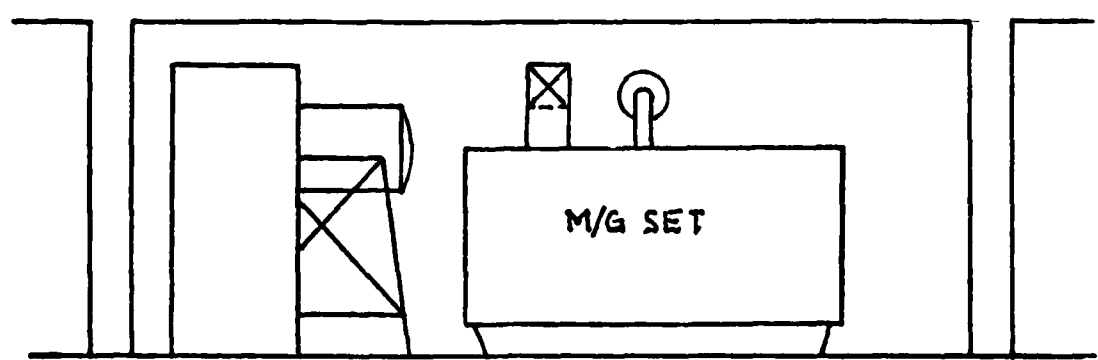
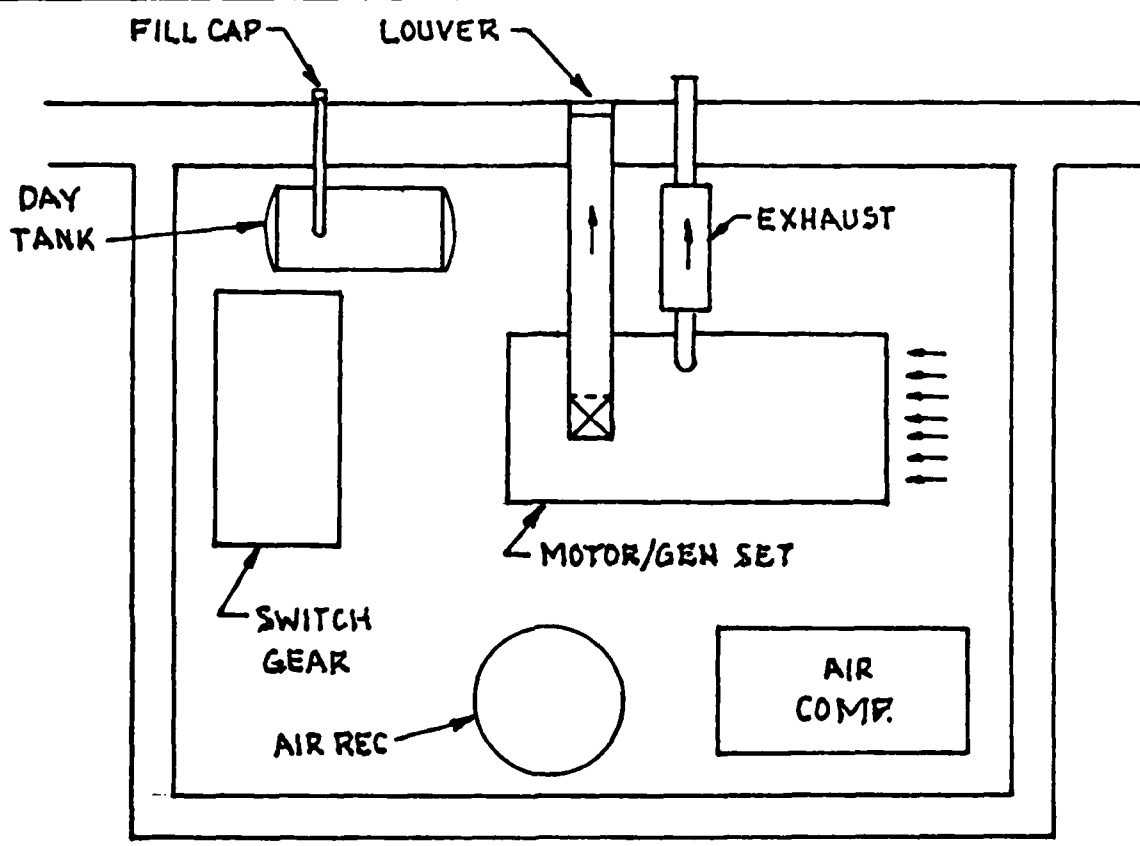
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MECHANICAL ROOM

P.GN.025-A

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HVAC SCENARIO

HVAC SCENARIO

1. MODES OF OPERATION

1.1 Load-out Mode. The additional load of truck engine exhaust on the ventilation system for this mode makes it the "worst" case. This load would consist of two engines idling while being loaded with containers, two engines idling while waiting to be loaded, and two engines at full rpm, one entering and one leaving the facility. The facility will be fully staffed and possibly the standby motor generator set would be operating. Truck tunnel entrances would be open.

1.2 Maintenance Mode. This mode consists of a full staff of personnel, the motor-generator set operating and truck tunnel closed. Conditions prevailing in this mode dictate the free passage of air from the facility to prevent a buildup of noxious fumes.

1.3 Standby Mode. In this mode, no personnel would be present; therefore no lights or heating would be required. In the case of site adaption requiring standby power, such as sump pumps, the motor-generator set must be vented. Such an event could also occur during the process of opening up the facility; if commercial power was not available, the motor-generator set would be needed to furnish power to open the facility. No circulation can be expected from a temperature differential due to cooler, heavier air within the facility.

2. SYSTEM OPERATION

2.1 Venting the Facility. The major portion of venting is the occurrence of engine exhaust within the truck tunnel. These fumes must be expelled from the facility. The expedient way to vent the truck

tunnel would be to bring in fresh air and pressurize the tunnel from a central point forcing any fumes back out of the tunnel. Thus any other venting of the facility can be taken into the tunnel and expelled by the same means.

2.2 Differential Pressures. Fumes from the tunnel must not be allowed to infiltrate the personnel spaces; therefore they must be pressurized at a higher pressure than the truck tunnel.

2.3 Air Supply. The personnel entrance tunnel provides a passage into the facility which can be used for an air intake which would also provide the very minimal ventilation needed in this passage. The air inlet to the personnel tunnel must be well separated from the exhaust from the truck tunnel to prevent short circuiting fumes back to the air intake.

2.4 Air Conditioning. Incoming air to the facility through the personnel tunnel would not require conditioning, other than initial filtering since arriving personnel would be dressed for outside conditions. The air passing down the tunnel would tend to approach the soil temperature which the facility would stabilize at, thus picking up or losing heat before reaching the occupied spaces within the facility. The occupied spaces, being well buried within the earth, will tend to stabilize at a temperature that is the average year round temperature of the location, in the central United States a nominal 55°F. This temperature space would require heating only to approximately 70°F. However, the incoming air must be below 75°F wet bulb temperature, or moisture

will condense on the walls. The provision of a refrigeration coil for dehumidification of incoming air will be considered a site adaptation. A DX coil at the entrance of the personnel tunnel for intake air would serve as dehumidification for the relatively low quantity of air required. Thus heating will be required under most conditions. A combination of electric space and duct heaters is recommended.

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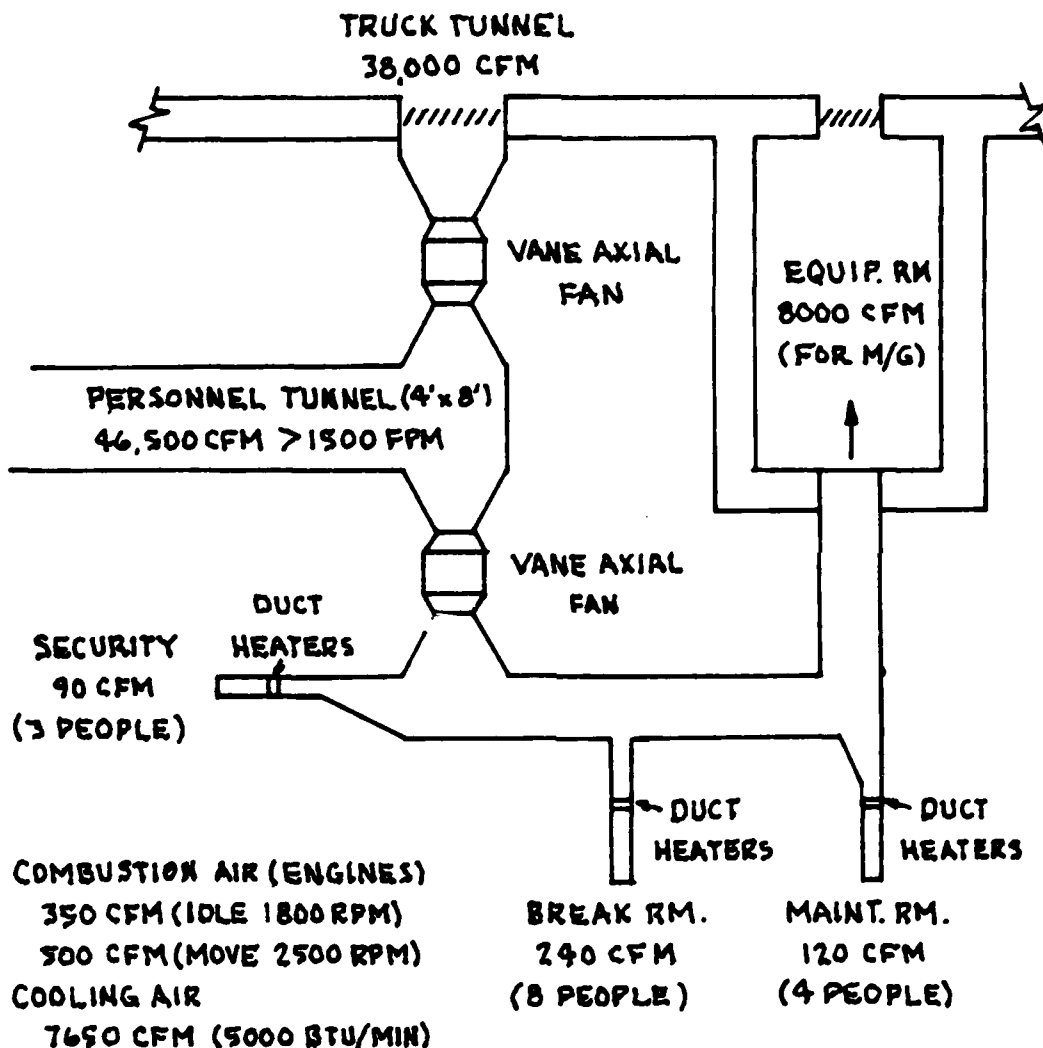
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$$7 \text{ Engines} \times 3000 \text{ BTU/Min} \times 60 \text{ min/hr} = 2,100,000 \text{ Btu/h}$$

$$\frac{2,100,000 \text{ Btu/h}}{1.08 \times 46,000 \text{ cfm}} = 42.3 \Delta T$$

HVAC SCHEMATIC

HALON FIRE PROTECTION ESTIMATES



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DATE 28 July 1982

WORK Halon - Total Flood @ 8% (Inerting) @ 55°F

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FIRE PROTECT - Halon for Maintenance Area Considered Class B & C

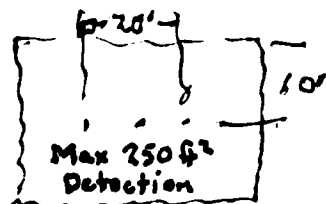
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SCHEME	SQUARE FOOTAGE	CUBIC FOOTAGE	HALON
A	30' x 70' = 2100 ft ²	29,400 ft ³	1029.7 lbs
B	30' x 46' = 1380 ft ²	19,320 ft ³	676.7 lbs
C	5' x 60' + 26' x 60 = 1860 ft ²	26,040 ft ³	912.0 lbs
D	30' x 58' = 1740 ft ²	24,360 ft ³	853.2 lbs
E	30' x 46' = 1380 ft ²	19,320 ft ³	676.7 lbs
F	30' x 60' = 1800 ft ²	25,200 ft ³	882.6 lbs
G	36' x 56' = 2016 ft ²	28,224 ft ³	988.5 lbs
H	30' x 50' = 1500 ft ²	21,000 ft ³	735.5 lbs
I	28' x 48' = 1344 ft ²	18,816 ft ³	659.0 lbs
J	28' x 50' x (2) = (1400 ft ² x 2 = 2800 ft ²)	39,200 ft ³	1373.0 lbs
K	40' x 44' = 1760 ft ²	24,640 ft ³	863.0 lbs
L	30' x 22' + 16' x 16' = 1216 ft ²	17,024 ft ³	596.7 lbs

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Fire Detectors
Halon Storage Units
Control Panel
Auxiliary Equip. (Bell, Pull Station, Door Guards)
Wiring (Shielded)

Scheme	Containers Req'd. Number
A	6 (196)
B	4 (196)
C	5 (196)
D	5 (196)
E	4 (196)
F	5 (196)
G	10 (101)
H	4 (196)
I	4 (196)
J	7 (101)



Note: No allowance for extended concentration period

K	5 (196)
L	6 (101)

P-IN-025.4

APPENDIX F
USER EVALUATION PROCEDURE

1. INTRODUCTION. The potential user of any of these weapons storage concepts needs a logical means to evaluate them before selecting one to construct. In addition, the user must also be able to evaluate any revisions to these concepts or any new concepts which may be developed. This evaluation process is made more difficult by the large number of factors which must be considered before a decision can be made. Therefore, a logical process is needed to properly evaluate all of the necessary factors and indicate which concept may be best for a particular situation. This process may be called a decision model. The discussion which follows is a description of one decision model. Provisions will be made to permit the individual user to modify this decision model to suit his particular needs or requirements.

2. GENERAL. This decision model is effective because it examines each aspect or factor separately, evaluates how well a particular concept complies with that factor, and adds the result to the succeeding results of a similar evaluation of all the other factors. This decision model is effective because it recognizes that all factors are not of equal importance. Finally this decision model is effective because it allows the user to identify other factors that are significant to his situation and to identify which factors are more significant than others.

This decision model is a process with four parts:

- a. Identifying all desirable attributes.
- b. Weighing of these attributes to reflect their relative importance.

- c. Evaluating the solutions based upon these attributes.
- d. Determining which solution best meets all of the desirable attributes.

3. DESIRABLE ATTRIBUTES. The first step is to identify all of the desirable attributes. The attributes listed in the decision model are a beginning. Each user may be expected to add additional attributes to meet his particular needs. Space has been left in the decision model for the user to add these attributes.

The attributes should be formulated as positive goals to be achieved. Caution should be exercised to avoid listing a single attribute in more than one way thus making that attribute unduly important. For example, one of the listed attributes could be the number of total personnel required to operate the facility. If a second attribute was to minimize the number of security guards, then the number of security personnel required is given undue importance because this factor was evaluated twice: once as security guards and once as part of the total number of personnel. It is important to list all of the attributes not just the ones considered prime attributes by the user. The relative importance of each attribute will be determined later. Those attributes which are insignificant will drop out at that time.

The attributes listed in the decision model have been organized into groups. This grouping facilitates the later steps of weighing and making the final determination. Thus it is recommended that any additional attributes be assigned to one of these pre-existing groups, or if necessary, new groups should be formed.

4. WEIGHING THE ATTRIBUTES. Once the list of attributes is complete, the user needs to weigh these various attributes. This process is an effort to recognize that some of the listed attributes are far more important to the user for his particular installation than others. Begin the weighing process by reviewing the attributes listed in the first group. Decide which attribute is the most important and give it a weight of 10. Next compare each succeeding attribute in relation to the one identified as the most important. If that attribute is almost as important as the first one, give the second attribute a weight of 8 or 9. If the second attribute is meaningless or has very little importance, give it a weight of 0, 1, or 2. If it is half as important, give it a weight of 4, 5, or 6. Continue comparing attributes in the first group giving each a weight of 0 to 10 until that group is completed. Then go on and weigh the remaining groups.

Once all of the groups are weighed, it is necessary to give each group its own weight. This weighing is done just as the individual attributes within a group were weighed. The user should identify the most important group and give it a weight of 10. The remaining groups are then compared to the most important group and given a weight of 0 to 10 accordingly

5. DEFAULT CONDITIONS. Frequently certain attributes may be considered as minimum or absolute requirements for any solution. These attributes are so important that unless they are met, a solution should not be considered. These attributes become default conditions. In this decision model they are listed with the other attributes. However, any

solution failing to comply with these attributes, requirements, or default conditions is rejected without further evaluation. Two such default conditions have been identified as the driving criteria for this study. They are as follows:

- a. It must be possible to load-out all of the weapons within 2 hours.
- b. A dedicated terrorist group must be kept out of the magazines for at least 30 minutes.

Any concept not meeting either of these two attributes does not comply with the required criteria. In this decision model, these two attributes and others are used as default conditions. If a concept fails to meet any one of these conditions, it is rejected without further evaluation.

6. EVALUATION PROCEDURE. Once the desirable attributes have been identified and weighed and the default conditions have been defined, it is possible to use this decision model to evaluate the various weapons storage concepts. Each concept is individually evaluated against the listed attributes, one attribute at a time. How well a concept meets a given attribute determines the score, a number from 0 to 10, given to that concept for meeting that attribute. If a concept completely satisfies a given attribute, it may be given a score of 10. If it does not satisfy that attribute at all, it should be given a very low score of 0 or 1. Some of the attributes in this decision model include a rating scale making it easy for the user to score the solutions. Other attributes may be more difficult to quantify, and the user may be required to evaluate his general impression with a score between 0 and 10.

As each attribute is scored, that score is multiplied by the weight given that attribute. The resulting product is added to products of the other attributes in that group. This sum is divided by the sum of the weights for all of the attributes within a group, and a composite score for that group of attributes is obtained. When all of the groups are completed, the composite scores for the various groups are multiplied by the weights of the respective groups. These products are totaled and then divided by the total of the weights given to the various groups. This number which should be between 0 and 10 will be the final score for that solution. The solution with the highest score is the solution which best meets all of the desirable attributes.

In evaluating the solutions, it is only necessary to change the score for each attribute or group of attributes. The weight of each attribute or group of attributes should not change. Remember also that a solution failing to pass a default condition should immediately be eliminated from consideration. However, if while evaluating a solution an improvement is discovered, that improvement should be made and the evaluation process for that solution started again.

WEAPONS STORAGE FACILITY DECISION MODEL

The following form (pp 253-273) could be completed by a potential weapons storage facility user.

WEAPONS STORAGE FACILITY

DECISION MODEL

USER INSTRUCTIONS

This decision model has nine groups of desirable attributes. These nine groups are as follows:

1. Load-Out Time
2. Security
3. Safety
4. Reliability
5. Efficiency
6. Material Handling Equipment
7. Personnel Requirements
8. Land Requirements
9. Cost

Space has been left for you, the user, to add another group necessary to respond to your particular requirements. Within each group there are one or more separate attributes listed. Space has been provided for you to add any additional desirable attributes necessary to evaluate your special conditions. First, you need to review all of these attributes. Then follow the instructions given below.

1. After you have reviewed the attributes listed, add any new attributes which you feel are necessary to adequately evaluate solutions to your particular situation. The attributes should be written as positive statements. List these new attributes within the appropriate groups. If necessary, start a new group(s). Try to avoid duplicating other attributes.

2. Beginning with the first group, Load-Out Time, identify the most important attribute and give it a weight of 10. Evaluate the remaining attributes in this group and assign each a numerical weight of 0 to 10 depending upon the importance of each attribute with respect to the most important attribute previously identified. When all attributes in this group are weighed, add the weights and enter the total in the indicated location.

3. Continue weighing the attributes, a group at a time, until all groups have been weighed.

4. On the summary sheet, repeat this process by weighing the groups. Total these weights also.

5. You have now completed the weighing process. You should not add attributes or change the various weights beyond this point unless you also start the entire process over with the first step.

6. Beginning with the first proposed scheme, evaluate that concept with respect to each attribute, one at a time. Give the concept a score, a number from 0 to 10, for each attribute depending upon how well it meets that attribute.

7. Multiply the score for each attribute by the weight of that attribute. Add these products together for each group of attributes. Divide these sums by the sums of the weights for each group of attributes.

8. You should now have a composite score for each group of attributes. This score should be a number between 0 and 10. Enter these composite scores on the summary sheet. Multiply each composite score by

its respective weight. Add the product together and divide by the sum of the weights previously figured. This number between 0 and 10 is the final score for the concept just evaluated.

9. Continue by repeating steps 6 through 8 with each succeeding concept.

10. The concept with the highest final score best meets all of the attributes.

***** DECISION MODEL *****

1. LOAD-OUT TIME

1.1 Estimate the normal load-out time in minutes (____ minutes).

Default criteria: If the time is more than 120 minutes, reject this concept.

If the time is less than 120 minutes, score as follows.

Load-Out Time in Minutes	Score
30 or less	10
31 to 40	9
41 to 50	8
51 to 60	7
61 to 70	6
71 to 80	5
81 to 90	4
91 to 100	3
101 to 110	2
111 to 120	1

Weight (____) x Score (____) = Product (____)

1.2 Estimate the manual load-out time in hours (____ hours). Score as follows.

Load-Out Time in Hours	Score
under 2	10
2 to 3	9
3 to 4	8
4 to 5	6
5 to 6	5
6 to 7	4
7 to 8	3
over 8	1

Weight (____) x Score (____) = Product (____)

1.3 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 1

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 1 on the Summary Sheet.

2. SECURITY

2.1 Estimate the time required for a well prepared terrorist group to reach a weapon in minutes (___ minutes).

Default Criteria: If the time is less than 30 minutes, reject this concept.

If the time is more than 30 minutes, score as follows:

Time in Minutes	Score
60 or more	10
50 to 59	8
40 to 49	6
30 to 39	4

Weight (___) x Score (___) = Product (___)

2.2 Do the truck drivers have to enter the magazines (storage areas) to obtain their weapons?

Score: Yes = 0 No = 10

Weight (___) x Score (___) = Product (___)

2.3 Is more than one weapon exposed when the magazine is opened for the load-out procedure?

Score: Yes = 0 No = 10

Weight (___) x Score (___) = Product (___)

2.4 When a weapon is moved from a magazine to the maintenance area, must it be moved through the truck tunnel?

Score: Yes = 0 No = 10

Weight (___) x Score (___) = Product (___)

2.5 Is there a buffer area between the magazines and the truck tunnel?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

2.6 Do maintenance personnel have to go through a magazine to reach the maintenance area or any other supporting area, such as the mechanical equipment room?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

2.7 Does the security area have a direct view of the truck tunnel entrances?

Score: Both tunnels = 10

One tunnel = 5

Neither tunnel = 0

Weight (___) x Score (___) = Product (___)

2.8 Does the security area have a direct view of the loading positions or entries to the magazines?

Score: All entries = 10

1/2 of the entries = 5

No. of entries = 0

Weight (___) x Score (___) = Product (___)

2.9 Does the security area have a direct view of persons coming in the personnel entry before they reach the sally port?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

2.10 Are the security measures predominantly passive, that is, not relying largely on manpower?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

2.11 (Attribute may be added by user.)

Score as follows:

Weight (___) x Score (___) = Product (___)

Composite Score for Group 2

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 2 on the Summary Sheet.

3. SAFETY

3.1 Will the weapons still be secure after the installation is struck by a falling 747 aircraft?

Default Criteria: If the answer to this question is no, reject this solution.

3.2 Are there any physical barriers located between the loading docks:

Score: Yes = 10

$N_0 = 0$

Weight () x Score () = Product ()

3.3 How far apart are the loading docks in feet? Score as follows:

Loading Dock Separation in Feet	Score
over 150	10
100 to 150	5
less than 100	0

Weight () x Score () = Product ()

3.4 Is there more than one wall or is there a large mass of earth or rock separating each weapon storage area?

Score: Yes = 10

$$N_0 = 0$$

Weight () x Score () = Product ()

3.5 Does a weapon need to be lifted more than 6 in. above the ground during its movement within the storage area?

Score: Yes = 0

No = 10

Weight () x Score () = Product ()

3.6 Does one weapon need to be moved over another weapon at any time?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

3.7 Are the weapons ever lifted more than 1-1/2 ft. above the loading dock or truck bed during the loading operation?

Score: Yes = 10

No = 0

3.8 What is the Kg/cu. ft. of HE stored in any storage area? Score as follows:

10^{-3} HE Kg/cu. ft.	Score
2.0 or less	10
2 to 3	8
3 to 4	6
4 to 5	4
5 to 6	2
6 to 7	1
over 7.0	0

Weight (___) x Score (___) = Product (___)

3.9 Does any weapon in storage have a line of sight with any other stored weapon?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

3.10 Does any weapon in storage have a line of sight with the entry to the magazine?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

3.11 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 3

a. Add up the weights of the attributes above ____.

b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 3 on the Summary Sheet.

4. RELIABILITY

4.1 Will this facility operate without external power? Can the doors be opened manually? Is emergency lighting available?

Default Criteria: If the answers to these questions is no, reject this solution.

4.2 Does the material handling equipment require external power such as electric power for an electric hoist?

Score: Yes = 0 No = 10

Weight (___) x Score (___) = Product (___)

4.3 May trucks easily use only one entry if one entrance is blocked?

Score: Yes = 10 No = 1

Weight (___) x Score (___) = Product (___)

4.4 Are the material handling systems reliable? Have they been used before? Are they simple machines?

Score: If all of the above are answered yes, then score = 10

 If any of the above are answered no, then score = 0

Weight (___) x Score (___) = Product (___)

4.5 Are the material handling systems simple to operate?

Score: Yes = 10 No = 0

Weight (___) x Score (___) = Product (___)

4.6 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 4

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 4 on the Summary Sheet.

5. EFFICIENCY

5.1 Is there only one maintenance area for the total facility?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

5.2 Is the maintenance area located equidistant from the storage areas?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

5.3 How many blast doors are there in the facility? Score as follows:

No. of Blast Doors	Score
6 or less	10
7 to 9	8
10 to 12	5
13 to 15	2
16 or more	0

Weight (___) x Score (___) = Product (___)

5.4 Can the weapons be removed in random order?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

5.5 Do the trucks have to be backed up during the normal load-out procedure?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

5.6 Can the maintenance area and utility rooms be easily served by a truck in the truck tunnel (as by a loading dock adjacent to the maintenance area)?

Score: Yes = 10

No = 0

Weight (____) x Score (____) = Product (____)

5.7 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 5

a. Add up the weights of the attributes above ____.

b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 5 on the Summary Sheet.

MATERIAL HANDLING EQUIPMENT

6.1 Can the weapons be loaded on trucks without power? Can they be loaded manually?

Default Criteria: If the answer to these questions is no, reject this solution.

6.2 How many types of equipment are needed to remove a weapon from the storage area and place it on a truck? Score as follows:

No. of Equipment Types	Score
1	10
2	7
3	3
4 or more	0

Weight (___) x Score (___) = Product (___)

6.3 Are common types of material handling equipment such as fork lifts, hand trucks, dollies, conveyors, bridge cranes, and monorail cranes used for all equipment?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

6.4 Are alternate means available to remove the weapons if the primary material handling equipment fails?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

6.5 Do the trucks require precise positioning for loading?

Score: Yes = 0

No = 10

Weight (___) x Score (___) = Product (___)

6.6 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 6

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 6 on the Summary Sheet.

7. PERSONNEL REQUIREMENTS

7.1 Determine the number of material handling personnel, exclusive of truck drivers, required during load-out (___ men). Score as follows:

No. of Men	Score
4 or less	10
5	9
6	8
7	7
8	6
9 or 10	5
11 or 12	4
13 or 14	3
15 or 16	2
17 to 19	1
20 or more	0

Weight (___) x Score (___) = Product (___)

7.2 Determine the number of security personnel, exclusive of the force accompanying the truck drivers, required during load-out (___ men).

Score as for item 7.1.

Weight (___) x Score (___) = Product (___)

7.3 Determine the number of security personnel required on site for day-to-day operations (___ men). Score as follows:

No. of Men	Score
0	10
1 or 2	8
3 or 4	6
5 or 6	4
7 or 8	2
9 or more	0

Weight (___) x Score (___) = Product (___)

7.4 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 7

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 7 on the Summary Sheet.

8. LAND REQUIREMENTS

8.1 Is the concept suitable for the site under consideration?

Score: Yes = 10

No = 0

Weight (___) x Score (___) = Product (___)

8.2 Determine the gross land area requirement in acres (___ acres).

Score as follows:

Gross Land Requirement in Acres	Score
3 or less	10
3 to 3-1/2	8
3-1/2 to 4	6
4 to 4-1/2	4
4-1/2 to 5	2
over 5	0

Weight (___) x Score (___) = Product (___)

8.3 (Attribute may be added by user.)

Score as follows:

Weight (___) x Score (___) = Product (___)

Composite Score for Group 8

a. Add up the weights of the attributes above ____.

b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 8 on the Summary Sheet.

9. COST

9.1 Determine the initial construction cost for this concept (\$_____). Score as follows:

Construction Cost in \$ millions	Score
under 5.0	10
5 to 7	9
7 to 9	8
9 to 11	7
11 to 13	6
13 to 15	5
15 to 17	4
17 to 19	3
19 to 22	2
22 to 25	1
over 25	0

Weight (____) x Score (____) = Product (____)

9.2 Determine the life cycle cost for this concept (\$_____). Score as follows.

Life Cycle Cost in \$ millions	Score
under 8	10
8 to 10	9
10 to 12	8
12 to 15	7
15 to 18	6
18 to 21	5
21 to 25	4
25 to 30	3
30 to 35	2
35 to 40	1
over 40	0

Weight (____) x Score (____) = Product (____)

9.3 (Attribute may be added by user.)

Score as follows:

•

Weight (____) x Score (____) = Product (____)

Composite Score for Group 9

- a. Add up the weights of the attributes above ____.
- b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 9 on the Summary Sheet.

10. _____ ATTRIBUTES

10.1 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

10.2 (Attribute may be added by user.)

Score as follows:

Weight (____) x Score (____) = Product (____)

Composite Score for Group 10

a. Add up the weights of the attributes above ____.

b. Add up the products of the attributes above ____.

Divide sum b by sum a.

Composite score = ____.

Enter this score on line 10 on the Summary Sheet.

SUMMARY SHEET

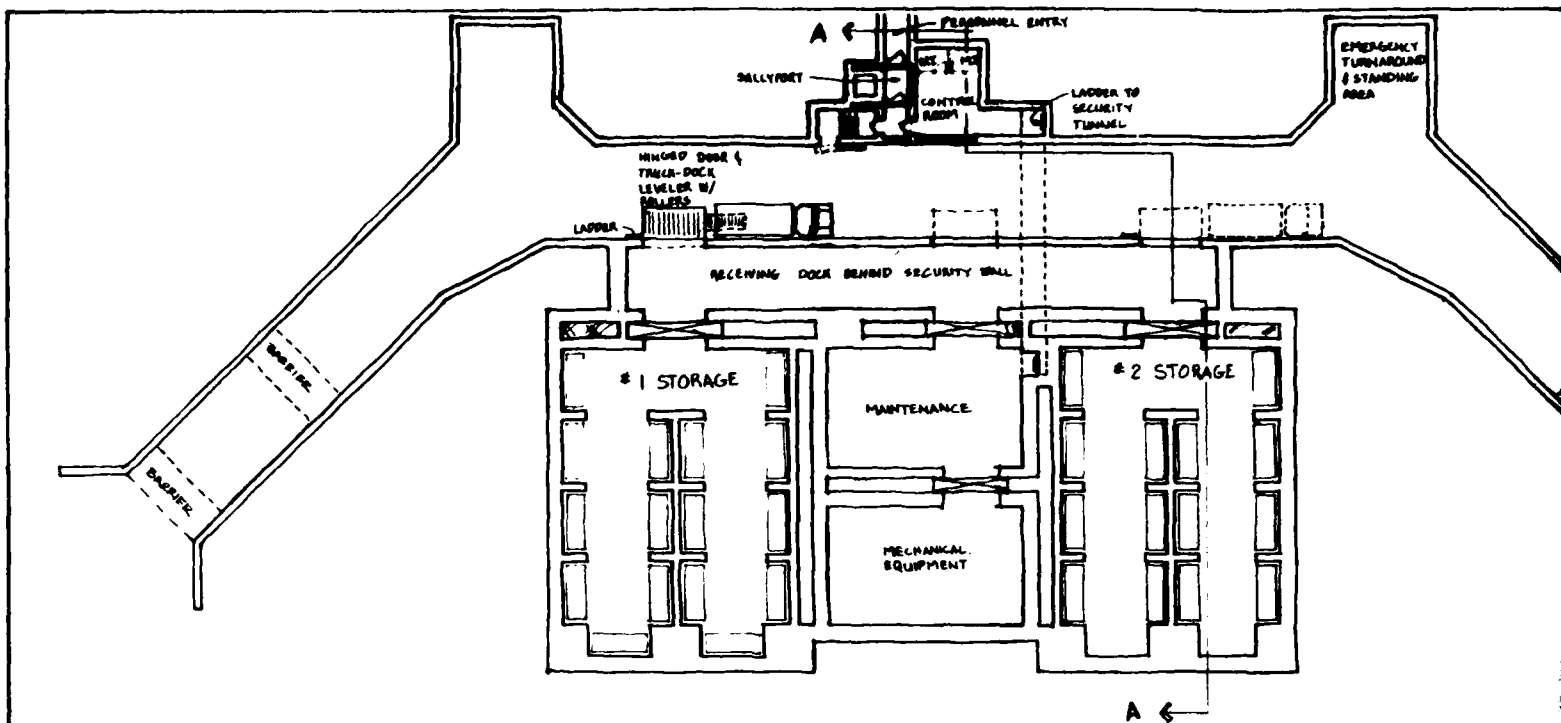
<u>Attribute Groups</u>	<u>Weight</u>		<u>Composite Score</u>	<u>Product</u>
1. LOAD-OUT TIME	_____	x	_____	= _____
2. SECURITY	_____	x	_____	= _____
3. SAFETY	_____	x	_____	= _____
4. RELIABILITY	_____	x	_____	= _____
5. EFFICIENCY	_____	x	_____	= _____
6. MATERIAL HANDLING EQUIPMENT	_____	x	_____	= _____
7. PERSONNEL REQUIREMENTS	_____	x	_____	= _____
8. LAND REQUIREMENTS	_____	x	_____	= _____
9. COST	_____	x	_____	= _____
10. _____ ATTRIBUTES	_____	x	_____	= _____

a. Add up the weights of the attributes above (_____).

b. Add up the products of the attributes above (_____).

c. Divide line b by line a. Final Score = _____.

APPENDIX G
EARLY CONCEPTS

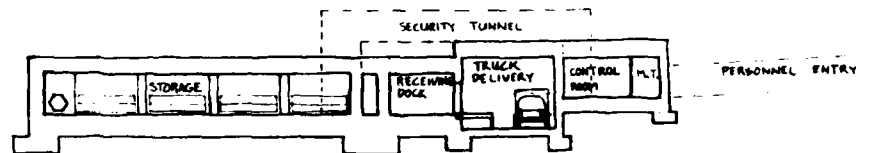


PLAN NO. 1

SCALE 1/16" = 1'-0"

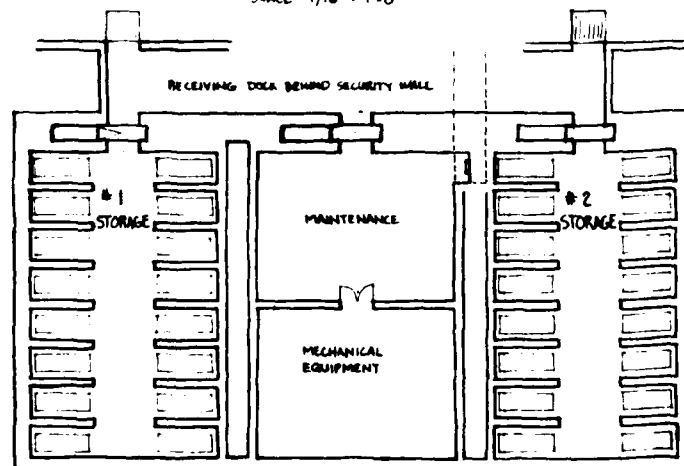
FORK TRUCK HANDLING OF CONTAINER

GROUND SURFACE



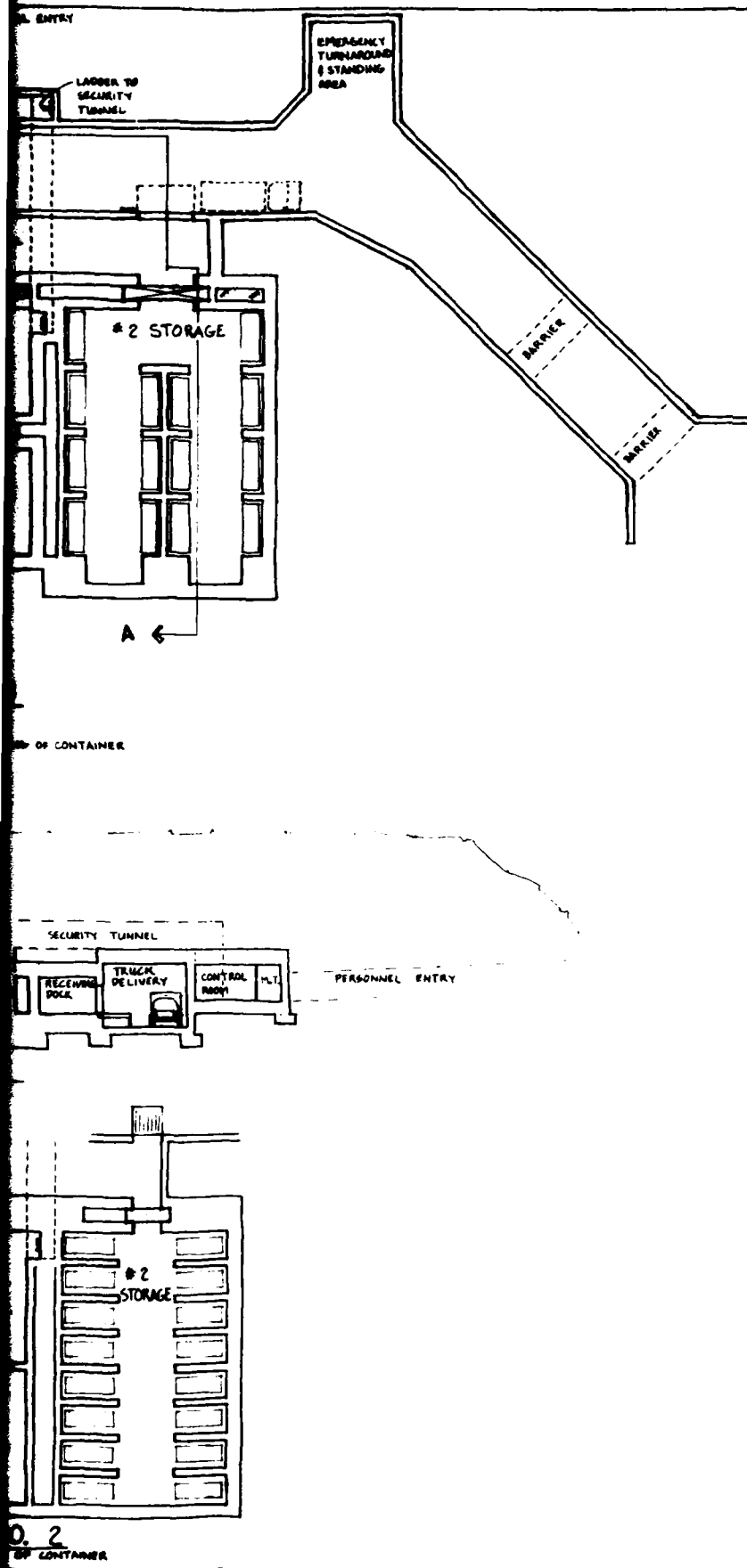
SECTION A-A

SCALE 1/16" = 1'-0"



ALTERNATE PLAN NO. 2

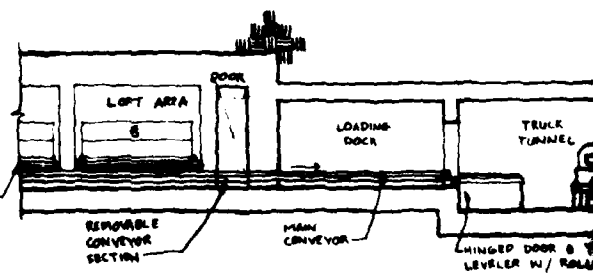
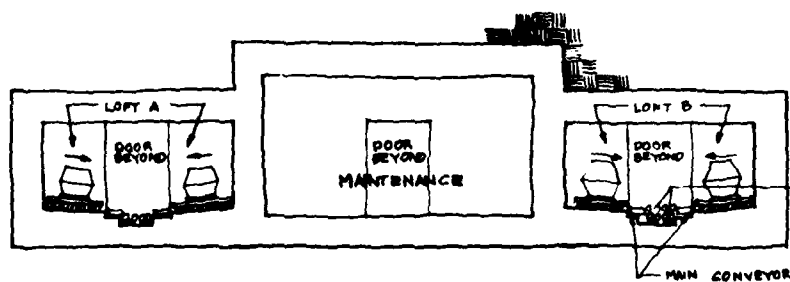
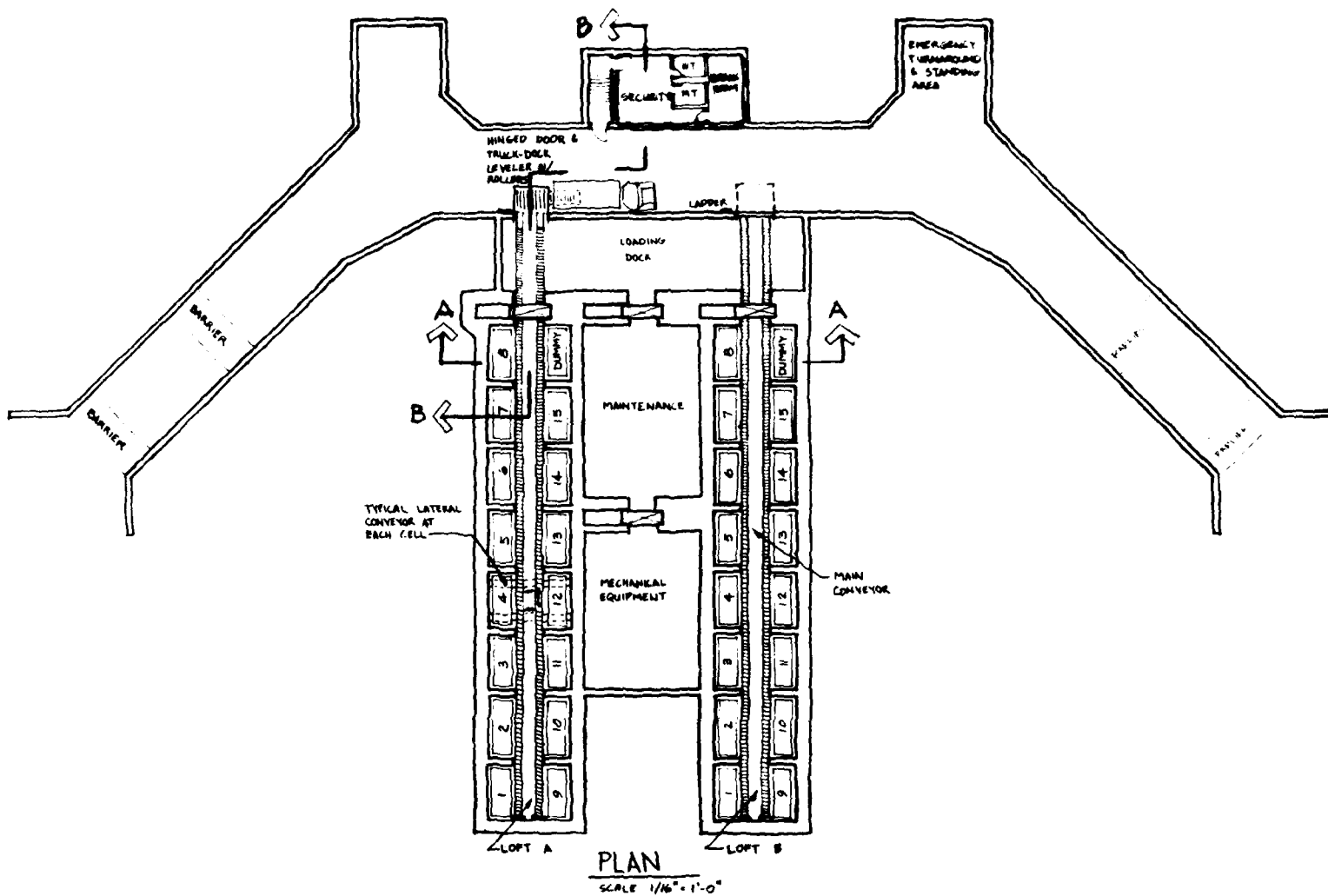
SCALE 1/16" = 1'-0" BALLY HANDLING OF CONTAINER



ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONS
- MAINTENANCE PERSONS AS REQ'D -
8 HR. SHIFT ONLY
3. TRUCK DRIVERS CAN ENTER, MAGAZINE &
REMOVE WEAPON W/ ASSISTANCE FROM
SECURITY PERSONS (REMOTE @ CONTROLS)
3. CONCEPT 1 USES MANUAL Pallet TRUCKS TO
MOVE WEAPONS FROM STORAGE POSITION TO
DOCK LEVELER & CONVEYOR TO TRUCK BED
SCHEME 2 USES REMOVABLE WHEELS TO
MOVE WEAPONS FROM STORAGE POSITION TO
TRUCK BED
4. WEAPONS COULD BE ENCLOSED IN CELLS
TO LIMIT ACCESS TO ONE AT A TIME
5. WEAPONS MAY BE ISSUED IN RANDOM
ORDER
6. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN

WEAPONS STORAGE CONCEPTS
MAGAZINE CONCEPTS
NO. 1 AND NO. 2
PLANS AND SECTION



EMERGENCY
TURNAROUND
& STANDING
AREA

END IV

PART IV

- ASSUMPTIONS
1. MAINTENANCE PERSONNEL AS REQUIRED
 2. MAINTENANCE PERSONNEL AS REQUIRED
 3. MAINTENANCE PERSONNEL AS REQUIRED
 4. MAINTENANCE PERSONNEL AS REQUIRED
 5. MAINTENANCE PERSONNEL AS REQUIRED
 6. MAINTENANCE PERSONNEL AS REQUIRED
 7. MAINTENANCE PERSONNEL AS REQUIRED
 8. MAINTENANCE PERSONNEL AS REQUIRED
 9. MAINTENANCE PERSONNEL AS REQUIRED
 10. MAINTENANCE PERSONNEL AS REQUIRED

LEFT AREA

DOOR

LOADING DOCK

TRUCK TUNNEL

WINDOW

SECURITY

REMOVABLE
CONVEYOR
SECTION

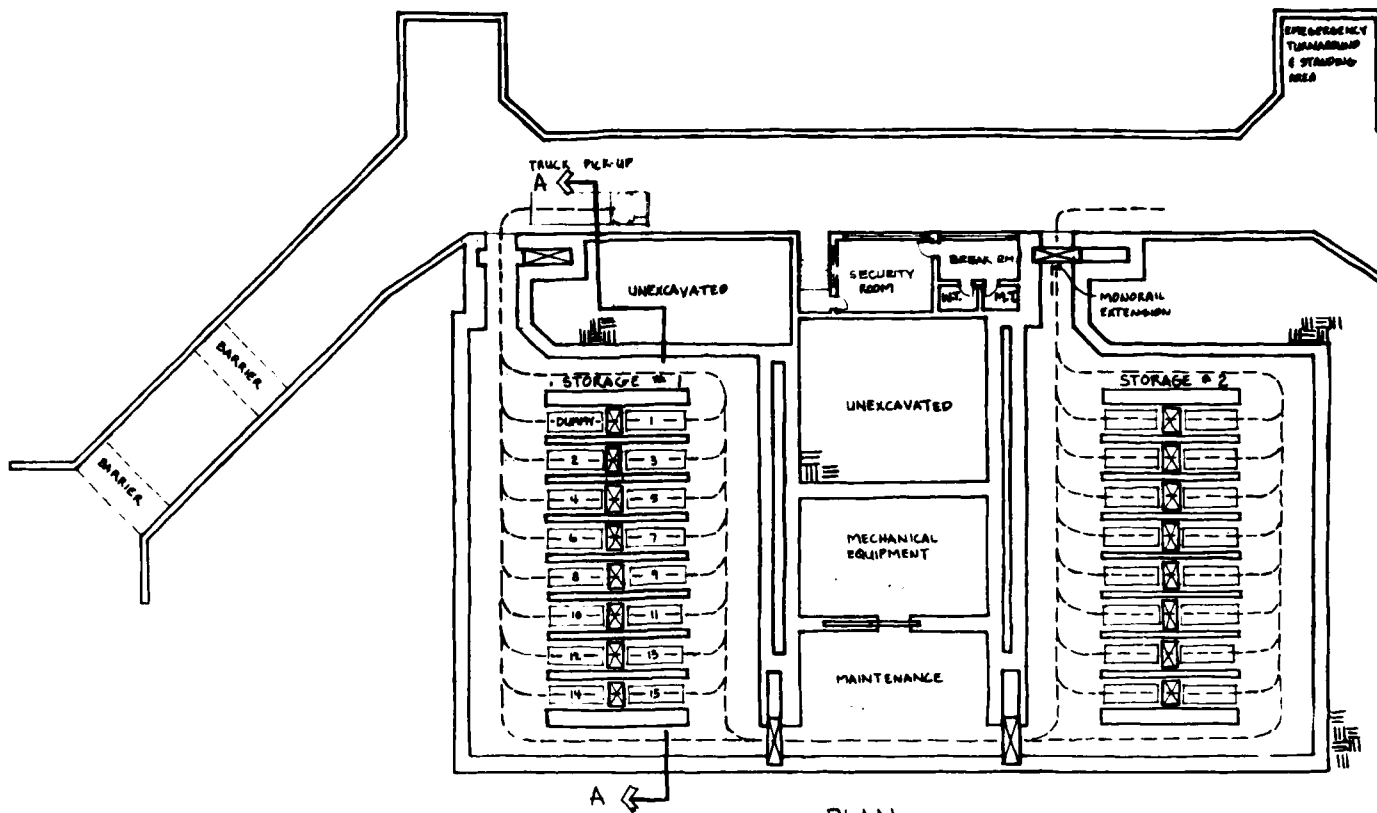
MAIN
CONVEYOR

HINGED DOOR & TRUCK-DOCK
LEVELER W/ ROLLERS

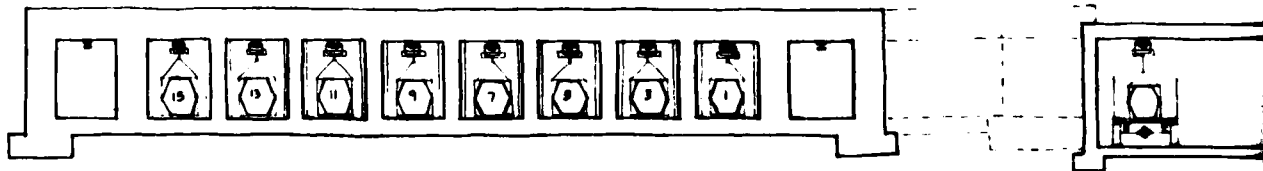
SECTION BB
SCALE 1/8" = 1'-0"

WEAPONS STORAGE CONCEPTS
CONCEPT NO 3.

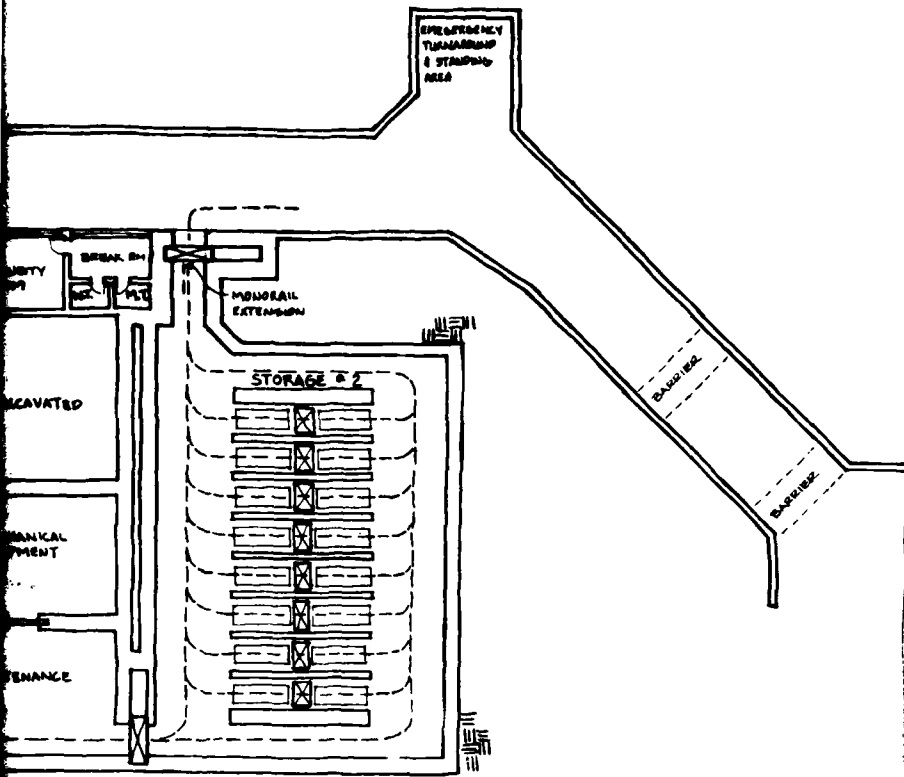
PLAN & SECTIONS



PLAN
SCALE 1/16" = 1'-0"

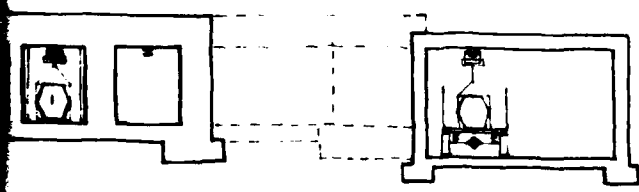


SECTION A-A
SCALE 1/8" = 1'-0"

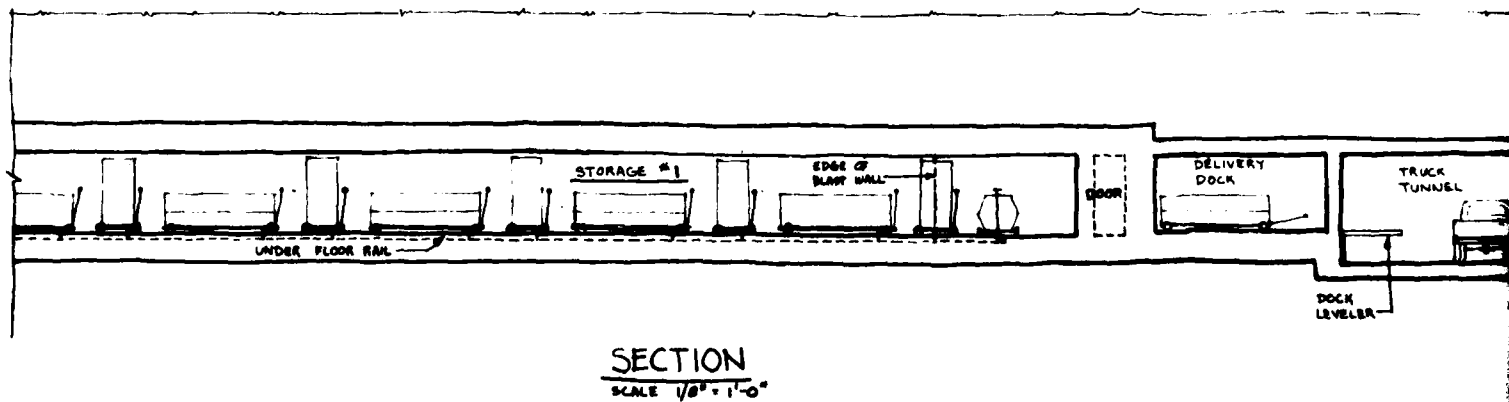
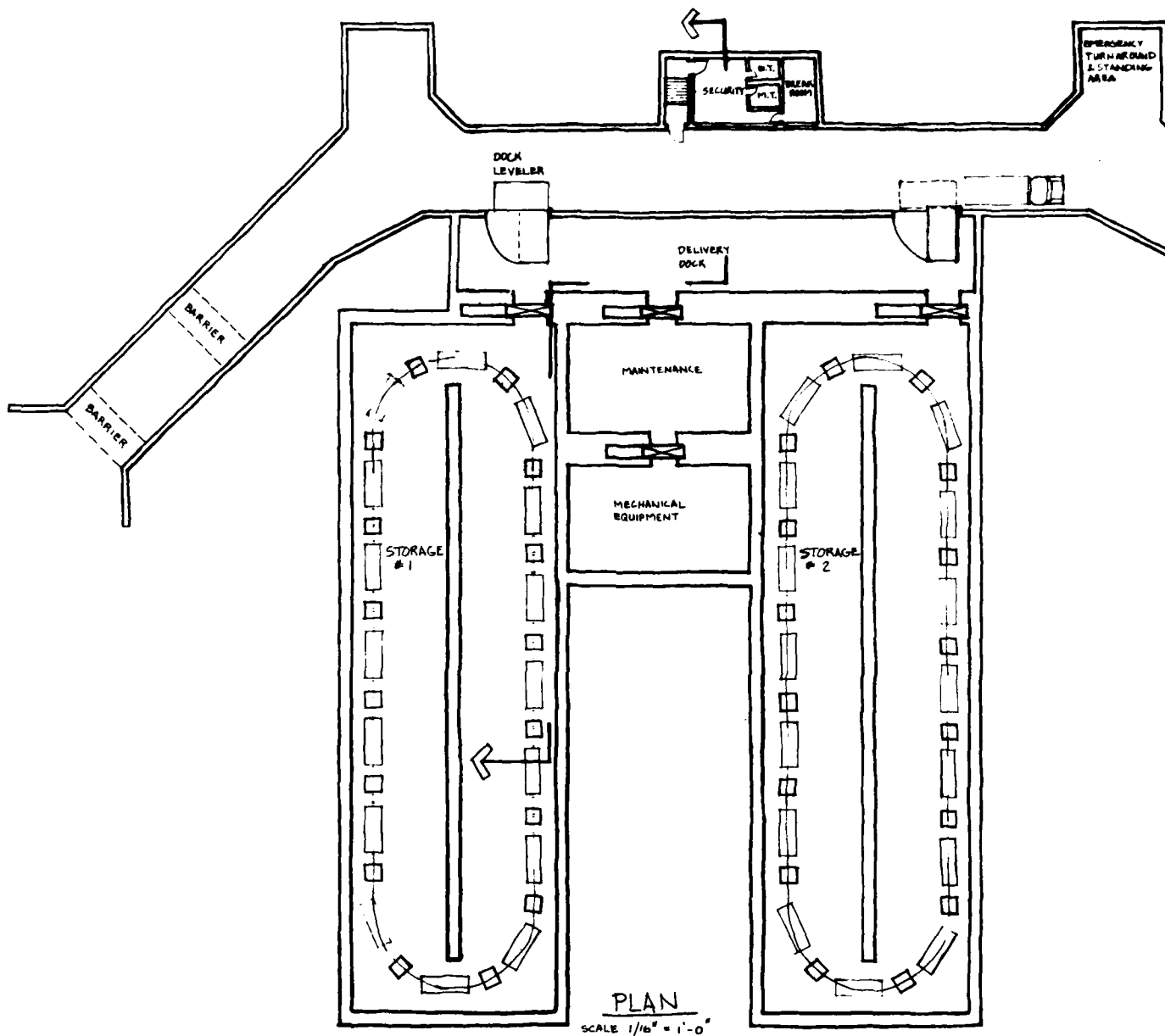


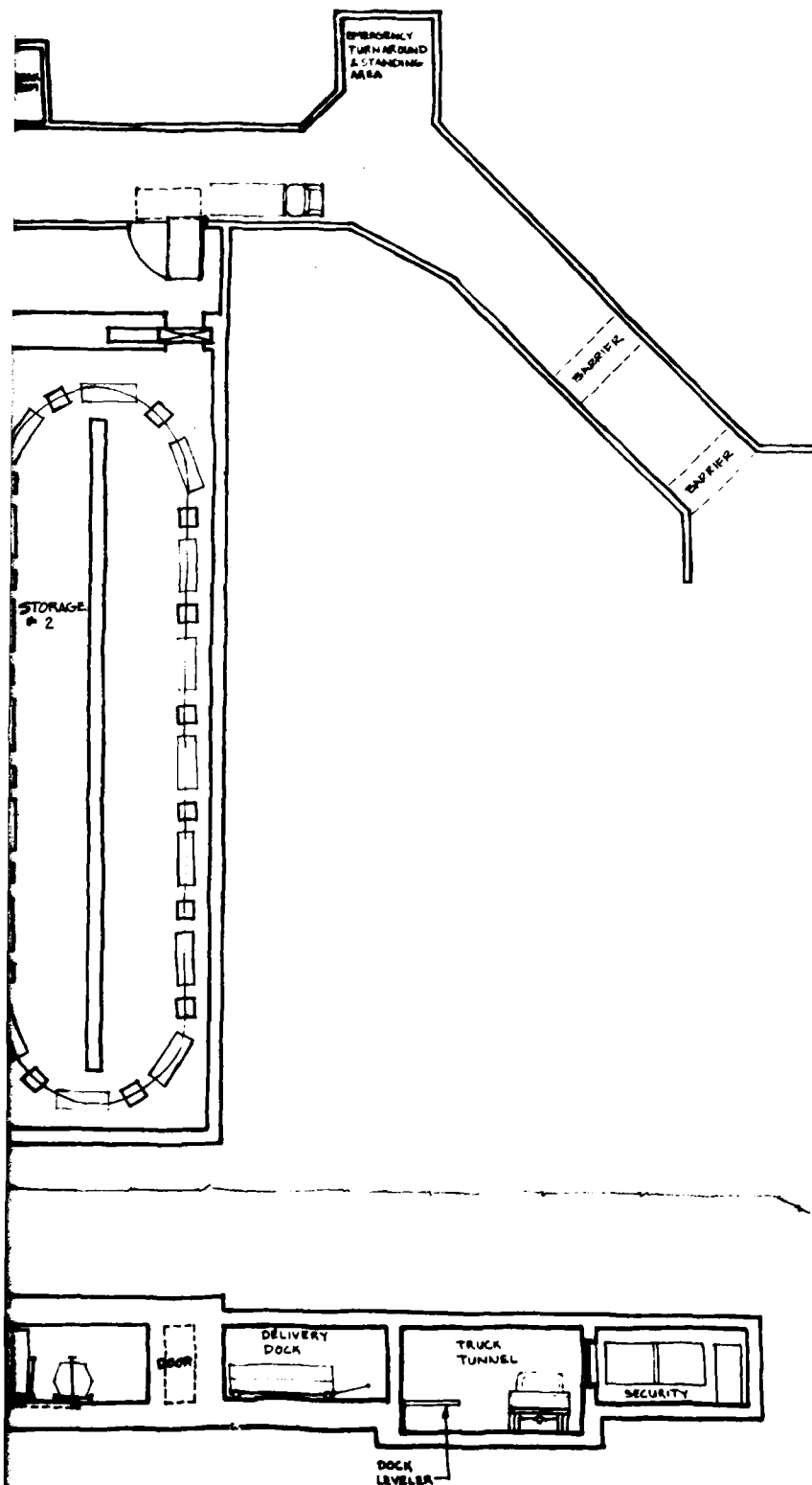
ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONS
- MAINTENANCE PERSONS AS REQ'D
8 HR. SHIFT ONLY
4 WEAPON HANDLERS
2. WEAPON HANDLERS MAY BE DELETED IF
TRUCK DRIVERS ARE PERMITTED TO ENTER
THE MAGAZINES
3. WEAPONS MAY BE ISSUED IN RANDOM ORDER -
BUT SOME DOCKEYING WEAPON, MAY BE
REQUIRED
4. SUITABLE FOR LEVEL & MOUNTAINOUS TERRAIN



MAGAZINE STORAGE CONCEPT
CONCEPT NO 4
PLAN AND SECTION



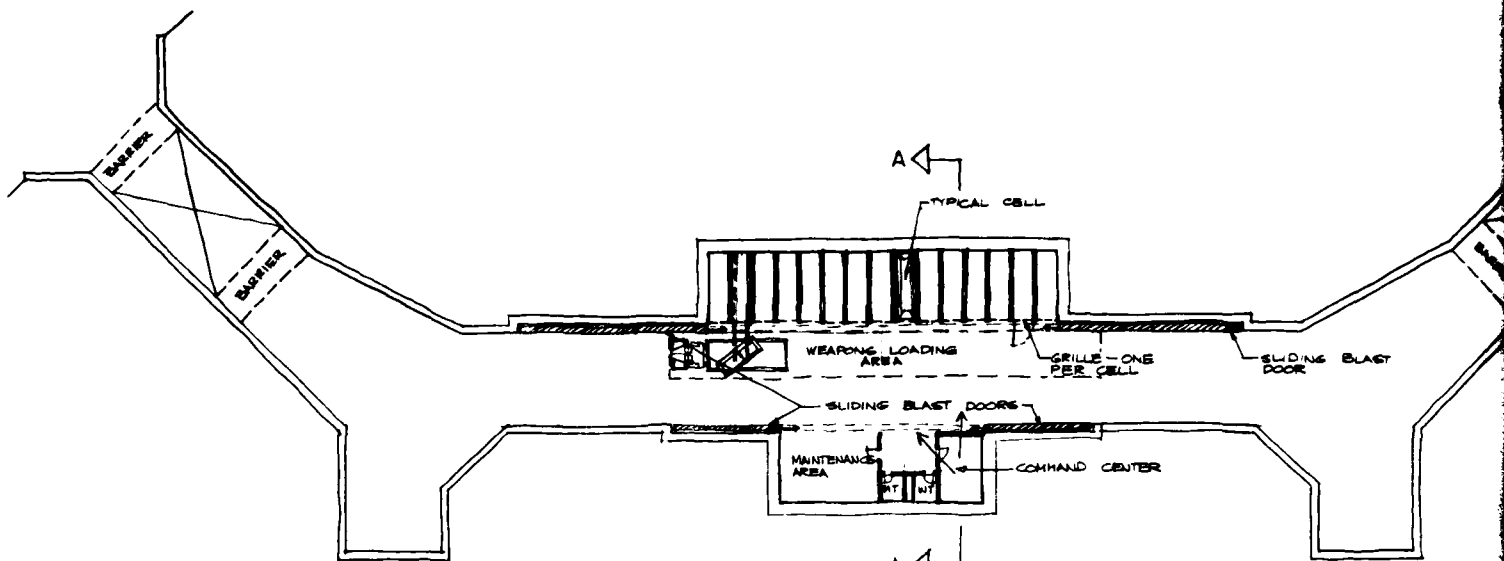


ASSUMPTIONS

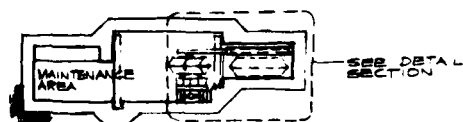
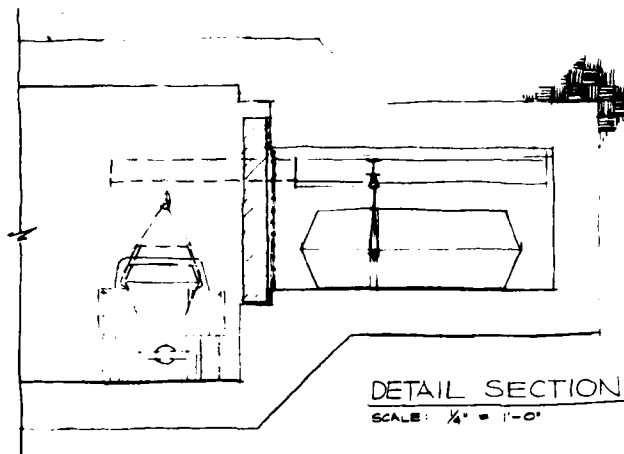
- 1 MANPOWER REQUIREMENTS
 - 2 SECURITY PERSONS
 - 1 MAINTENANCE PERSON AS REQD
 - 4 WEAPON HANDLERS
- 2 WEAPON HANDLERS COULD BE CM TED IF DONE BY TRUCK DRIVERS
- 3 WEAPONS MAY BE ISSUED IN RANDOM ORDER
- 4 SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN

WEAPONS STORAGE CONCEPTS
TOWLINE CONCEPT
NO. 5

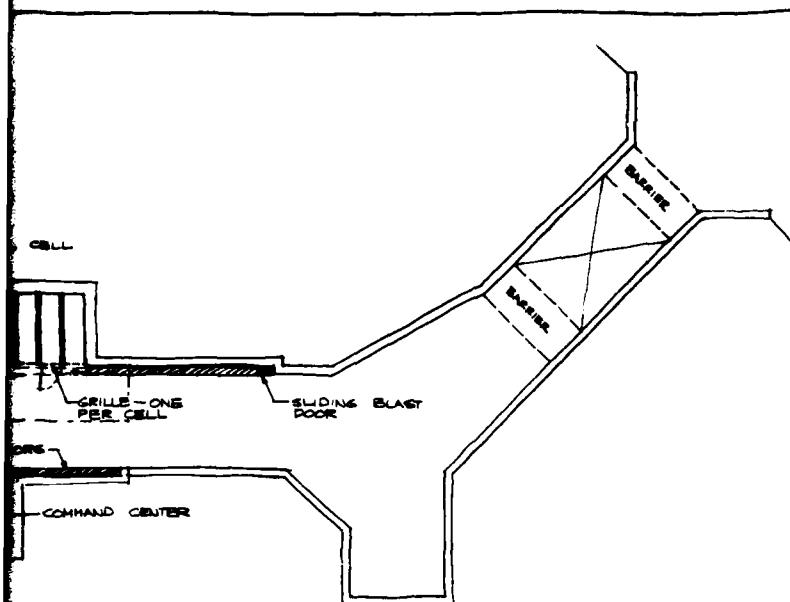
PLAN AND SECTION



FACILITY PLAN
SCALE: $\frac{1}{16}" = 1'-0"$



SECTION A-A
SCALE: $\frac{1}{16}" = 1'-0"$



ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONS
 - MAINTENANCE PERSONS AS REQUIRED
 - LIMIT TO SINGLE 8 HR. SHIFT
2. WEAPONS CAN BE ISSUED IN RANDOM SEQUENCE
3. TRUCK DRIVERS CANNOT ENTER MAGAZINE
4. SUITABLE FOR FLAT & MOUNTAINOUS TERRAIN

ALTERNATE -
 PROVIDE SINGLE UNIT MOVABLE SLIDING
 DOOR WITH AN OPENING FOR ONE WEAPON

DETAIL SECTION

SCALE: 1/4" = 1'-0"

SEE DETAIL SECTION

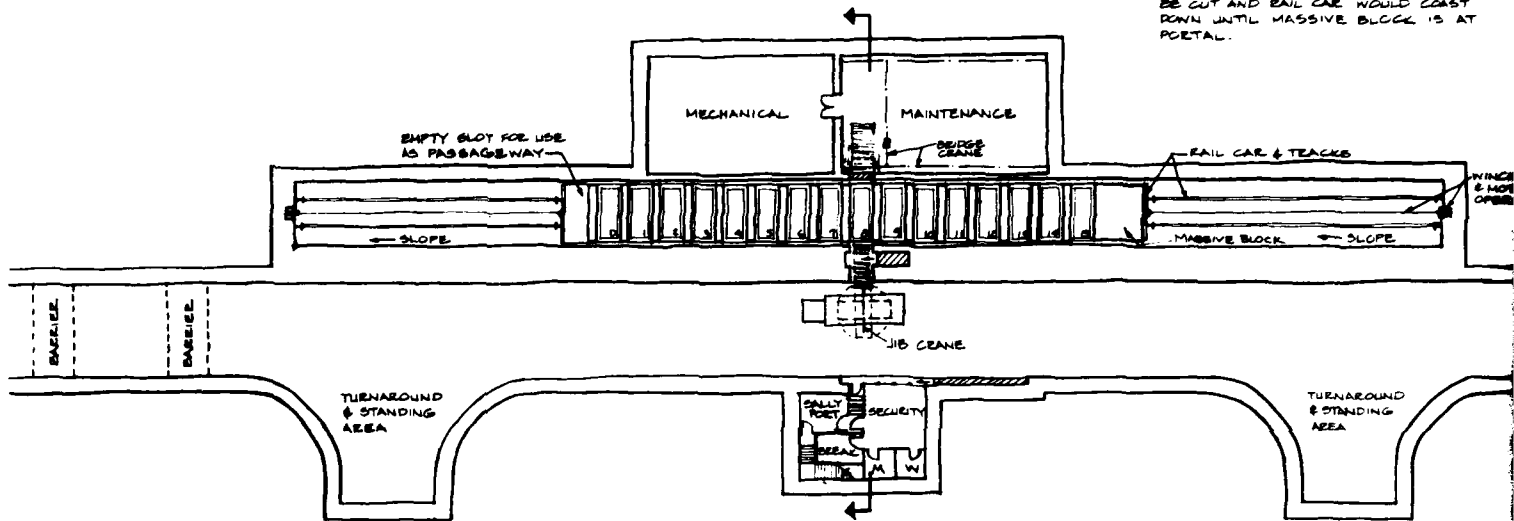
A-A
 1'-0"

WEAPONS STORAGE CONCEPTS
 FILE DRAWER CONCEPT
 NO. 6

PLAN & SECTIONS

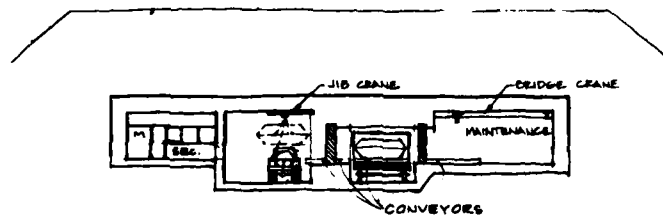
NOTE

RA - CAR SHOWN IN LOADING POSITION.
 NORMALLY, EMPTY SLOT AT PORTAL - FOR
 ACCESS TO MAINTENANCE.
 IN CASE OF ATTACK, WINCH POWER WOULD
 BE CUT AND RAIL CAR WOULD COAST
 DOWN UNTIL MASSIVE BLOCK IS AT
 PORTAL.



FACILITY PLAN

1/16" = 1'-0"

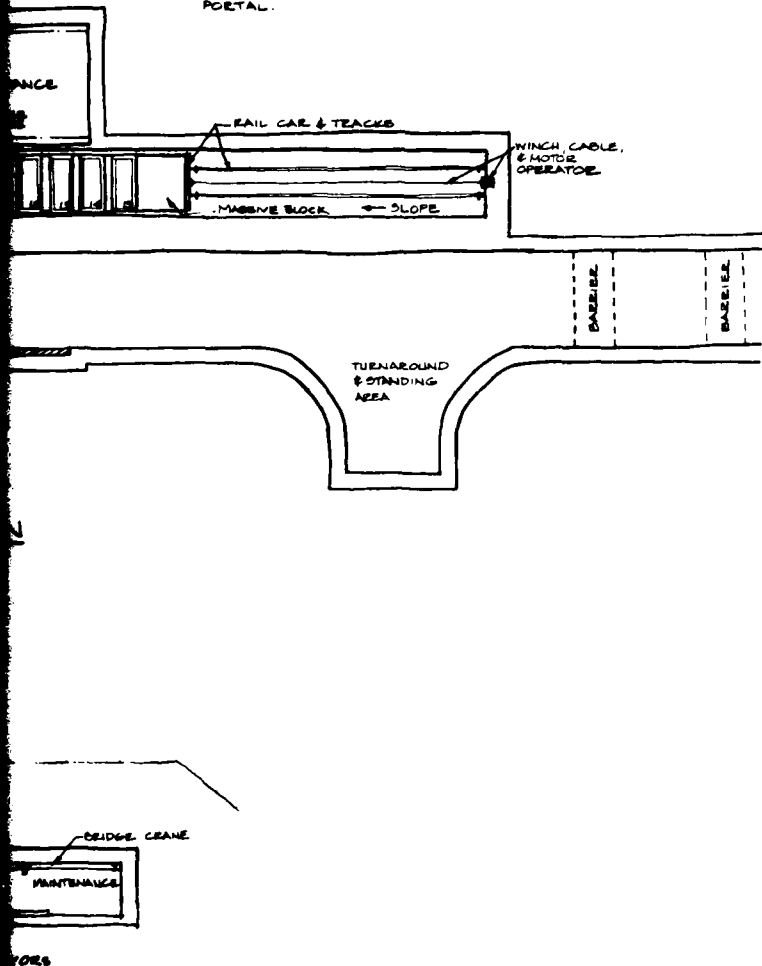


SECTION

1/16" = 1'-0"

NOTE

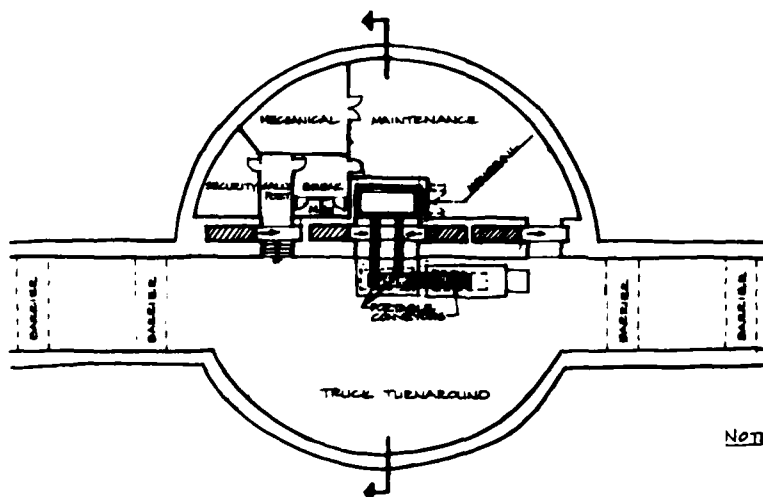
RAIL CAR SHOWN IN LOADING POSITION.
 NORMALLY, EMPTY SLOT AT PORTAL FOR
 ACCESS TO MAINTENANCE.
 IN CASE OF ATTACK, WINCH POWER WOULD
 BE CUT AND RAIL CAR WOULD COAST
 DOWN UNTIL MASSIVE BLOCK IS AT
 PORTAL.



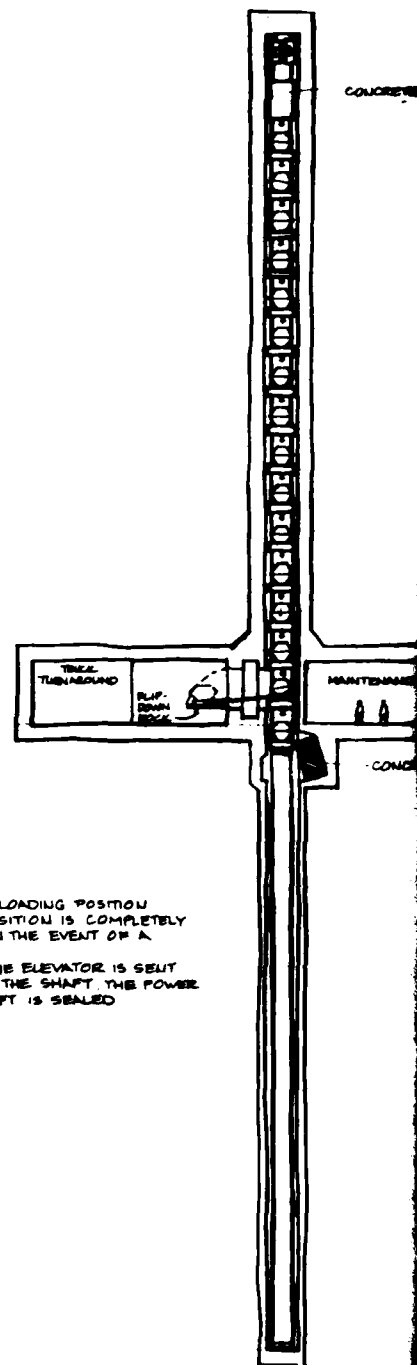
ASSUMPTIONS

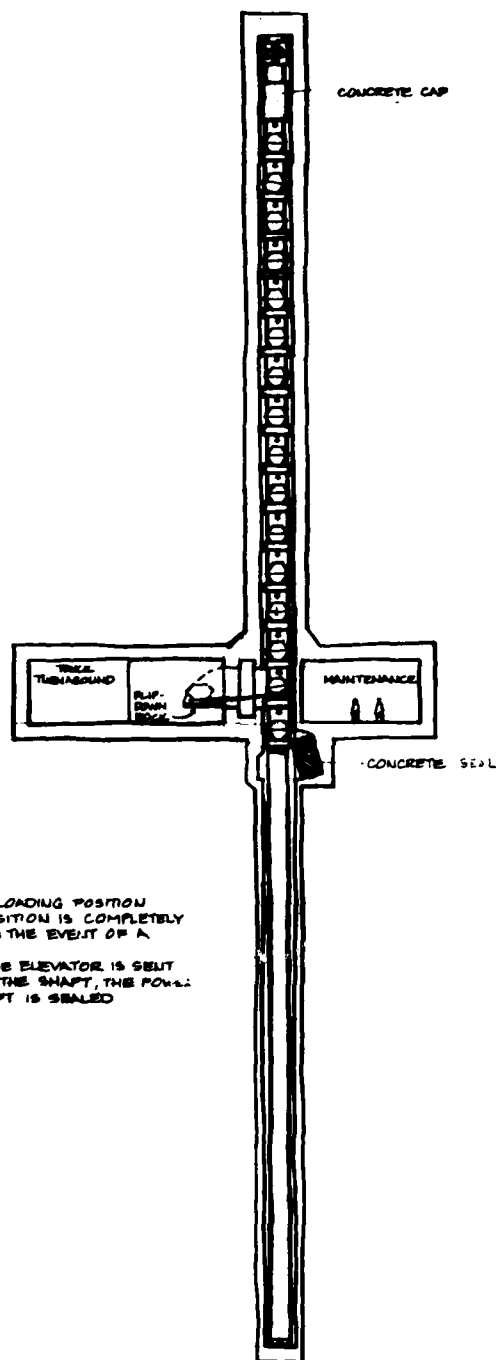
1. MANPOWER REQUIREMENTS
2. SECURITY PERSONS
3. MAINTENANCE PERSONS AS REQUIRED
4. 8 HR SHIFT ONLY
5. TRUCK DRIVERS WOULD ENTER MAGAZINE TO REMOVE A WEAPON WITH ASSISTANCE OF SECURITY PERSONNEL (REMOTE ASSIST)
6. STORAGE FOR ONLY 1 UNIT OF WEAPONS
7. WEAPONS MAY BE REMOVED IN RANDOM ORDER
8. TABLE FOR 1 UNIT OF WEAPONS
9. TABLE FOR 1 UNIT OF WEAPONS

WEAPONS STORAGE CONCEPTS
 SHUTTLE CAR CONCEPT
 NO. 7
 PLAN & SECTION



NOTE: ELEVATOR SHOWN IN LOADING POSITION
 NORMAL STORAGE POSITION IS COMPLETELY
 UP - FOR LOADING IN THE EVENT OF A
 POWER FAILURE
 IN CASE OF ATTACK, THE ELEVATOR IS SENT
 TO THE BOTTOM OF THE SHAFT THE POWER
 IS CUT & THE SHAFT IS SEALED



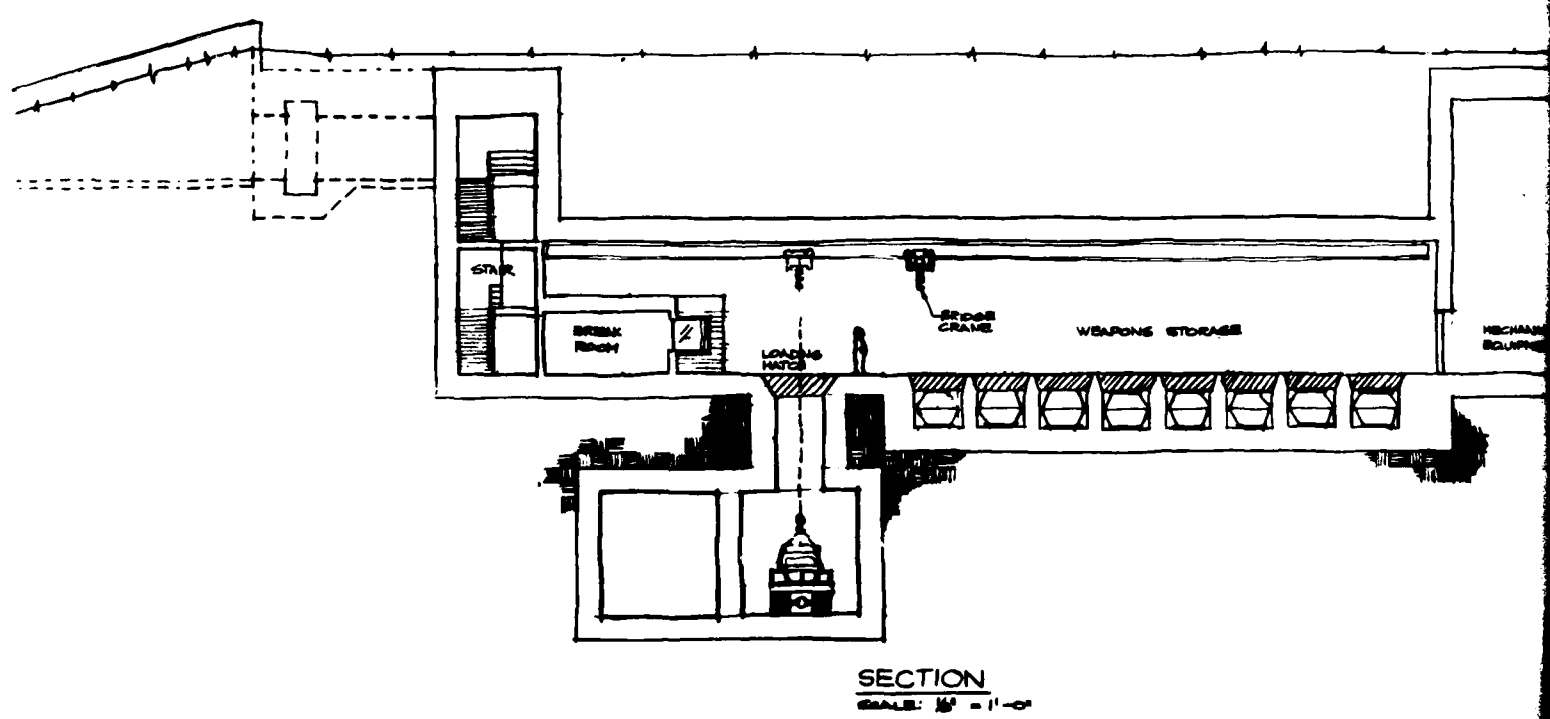
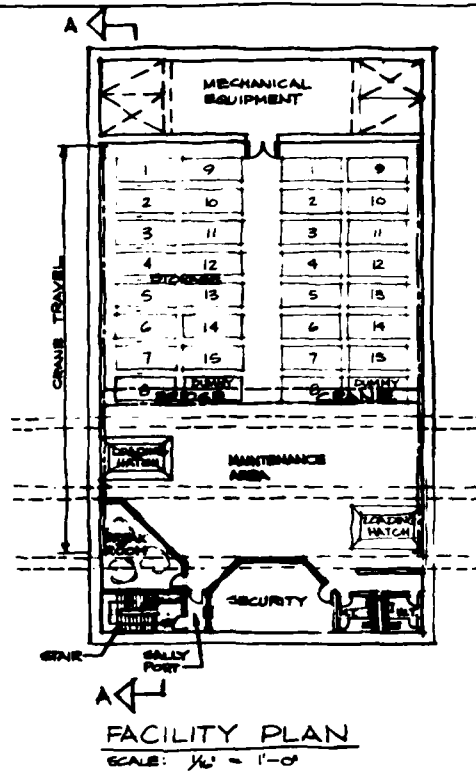


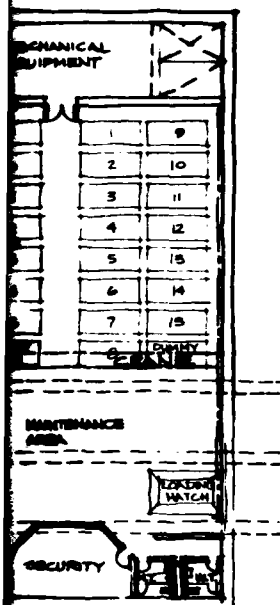
ASSUMPTIONS

1. MANPOWER REQUIREMENTS -
 - 2. SECURITY PERSONNEL
 - MAINTENANCE PERSONNEL AS REQUIRED LIMITED TO 6 HRS. SHIFT
2. TRUCK DRIVERS WOULD REMOVE WEAPON FROM ELEVATOR PROPERLY POSITIONED BY SECURITY PERSONNEL
3. A SECOND UNIT OF WEAPONS COULD BE EASILY ADDED
4. WEAPONS COULD BE ISSUED IN RANDOM ORDER
5. SUITABLE FOR MOUNTAINOUS TERRAIN ONLY

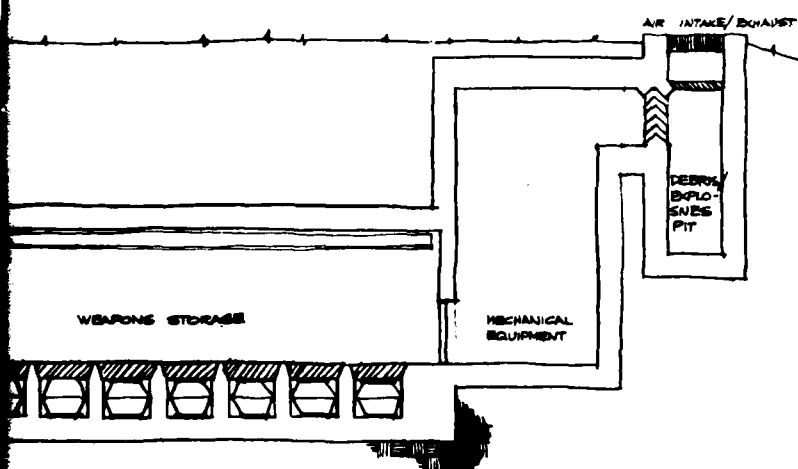
ELEVATOR SHOWN IN LOADING POSITION
NORMAL STORAGE POSITION IS COMPLETELY
UP - FOR LOADING IN THE EVENT OF A
POWER FAILURE
IN CASE OF ATTACK, THE ELEVATOR IS SENT
TO THE BOTTOM OF THE SHAFT, THE POWER
IS CUT & THE SHAFT IS SEALED

WEAPONS STORAGE CONCEPTS
ELEVATOR CONCEPT
NO. 6
PLAN & SECTION





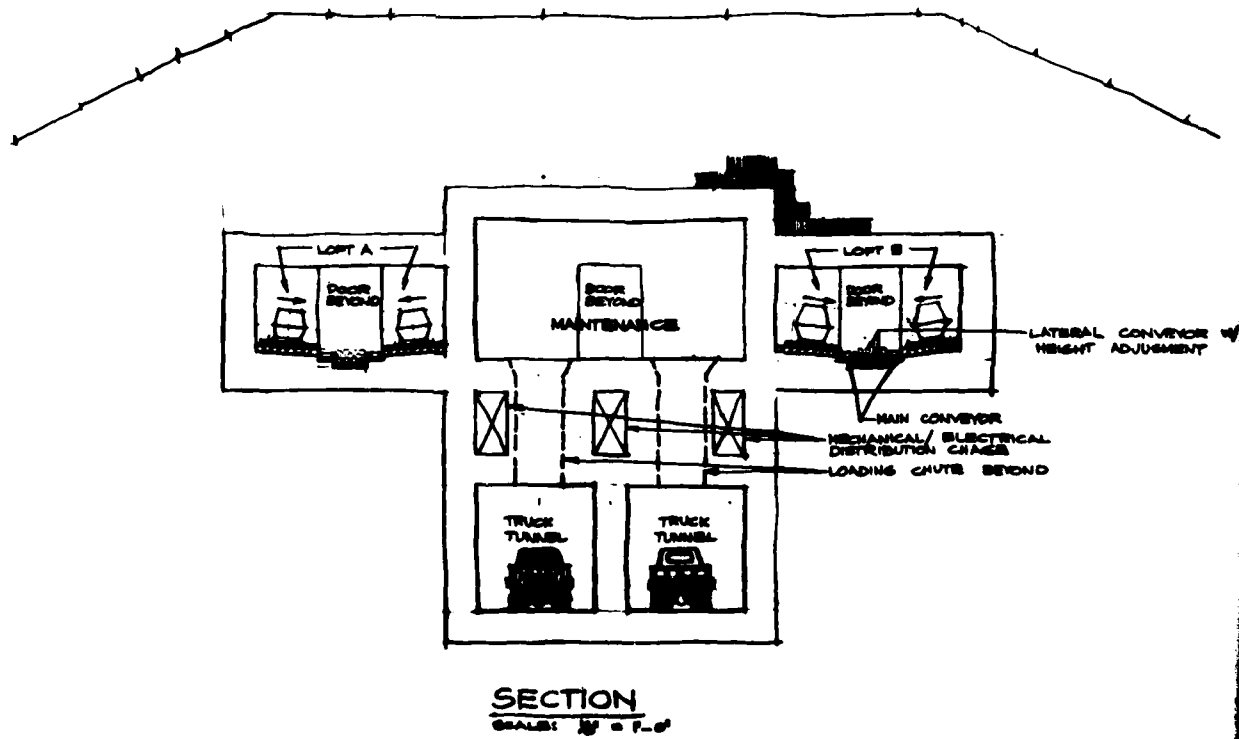
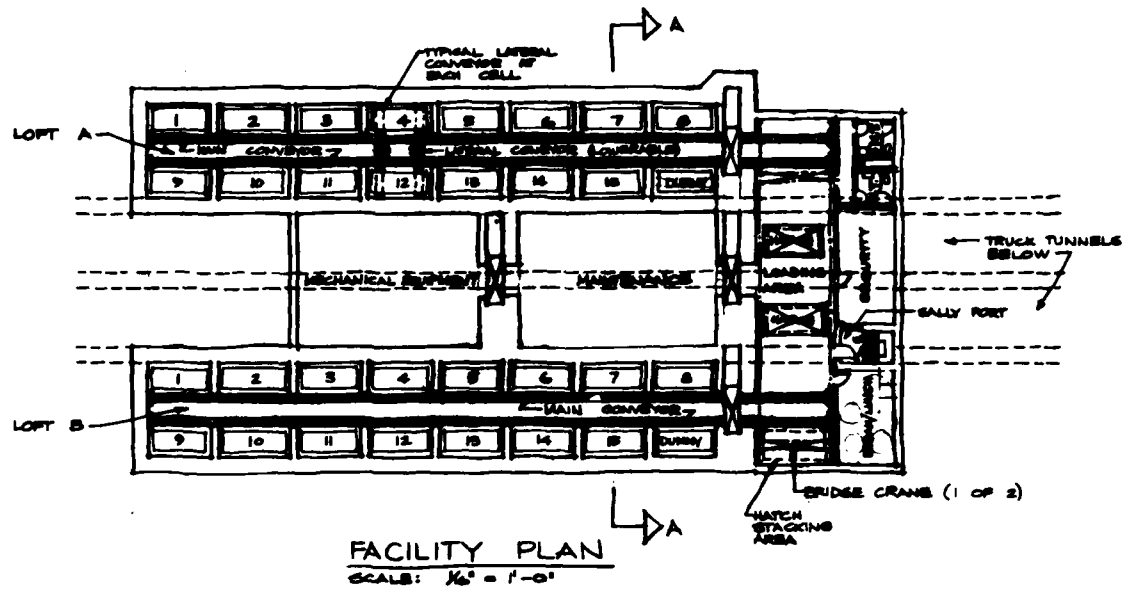
Y PLAN
= 1'-0"

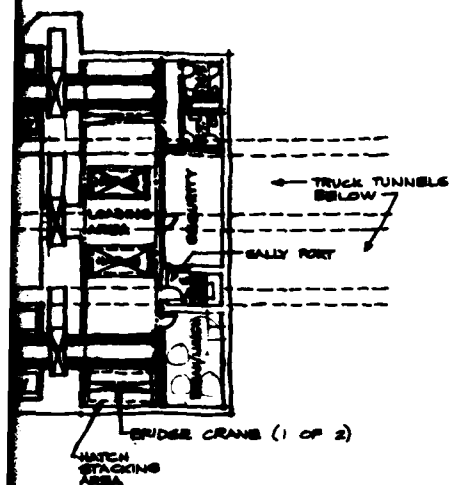


ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONNEL
 - MAINTENANCE PERSONNEL AS REQ'D
 - ONE SHIFT ONLY
2. WEAPONS HANDLERS
2. TRUCK DRIVERS WILL NOT ENTER MAGAZINE
3. A SECOND BRIDGE CRANE MAY BE NECESSARY
4. WEAPONS COULD BE PLACED ON THE FLOOR OF THE STORAGE AREA (SAND BAG DIVIDES WOULD BE REQUIRED)
5. WEAPONS COULD BE ISSUED IN RANDOM ORDER
6. SUITABLE FOR MOUNTAINOUS TERRAIN - FLAT TERRAIN WOULD REQUIRE A LONG RAMP DOWN TO TRUCK LEVEL

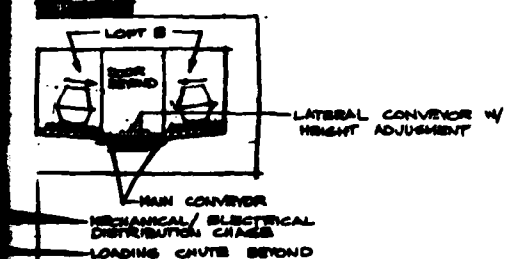
WEAPONS STORAGE CONCEPTS
HAYLOFT CONCEPT
NO. 9
PLAN & SECTION



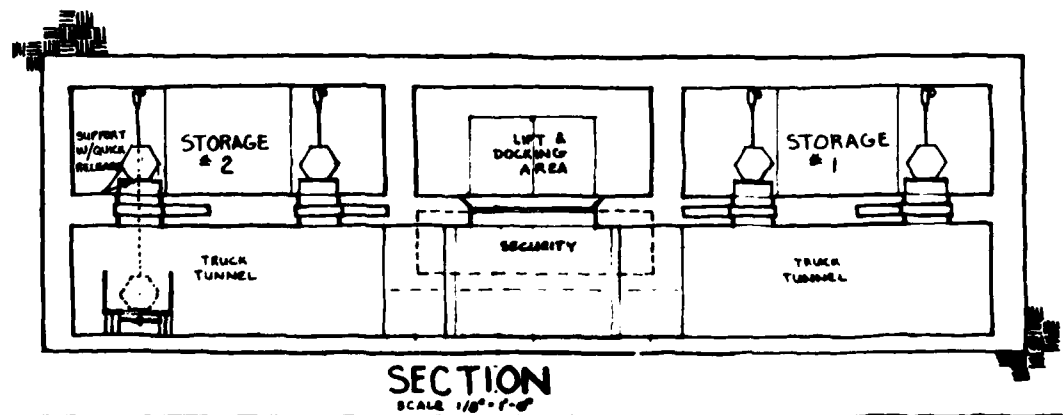
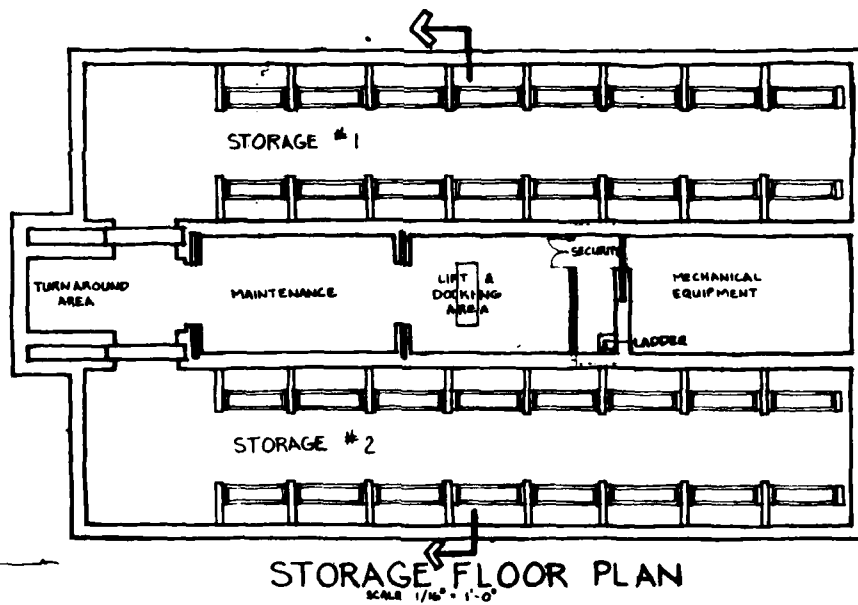
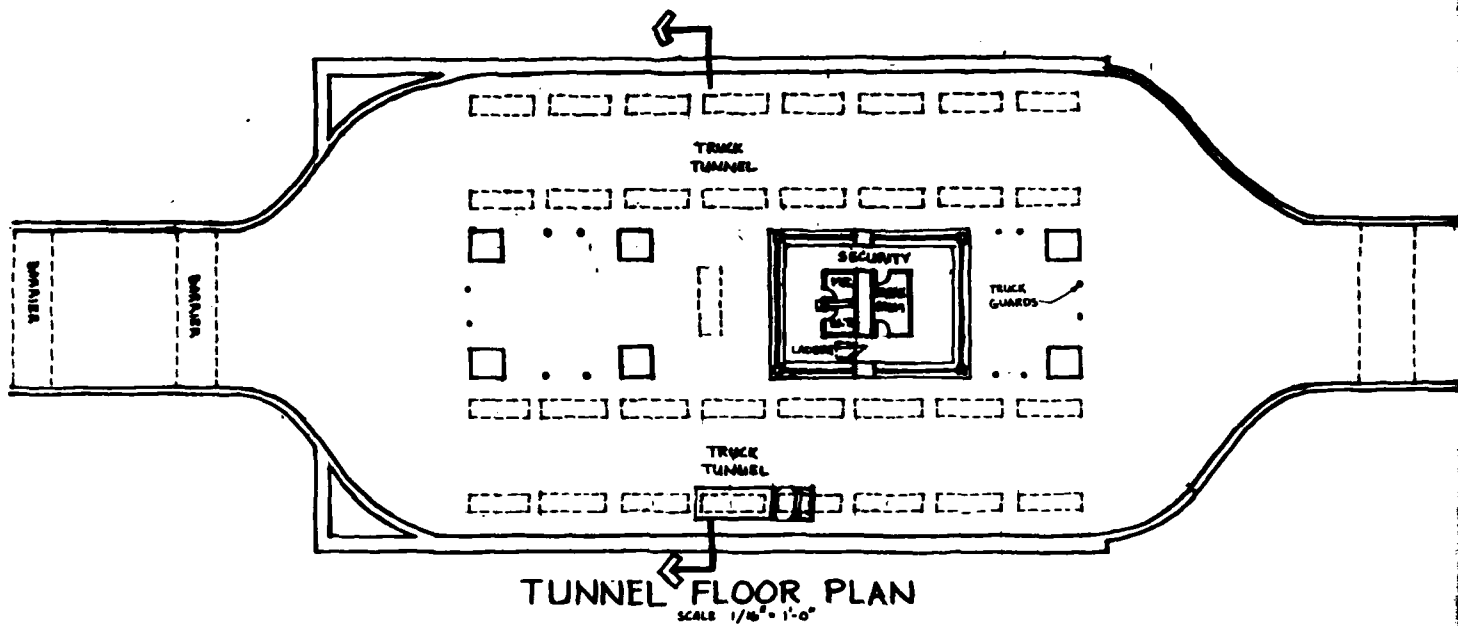


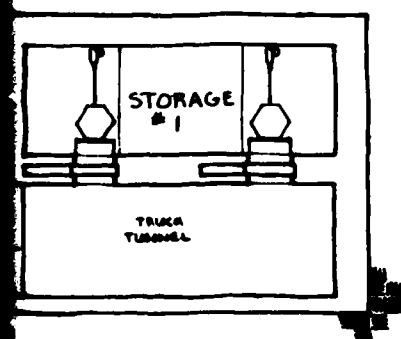
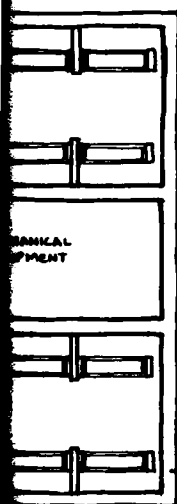
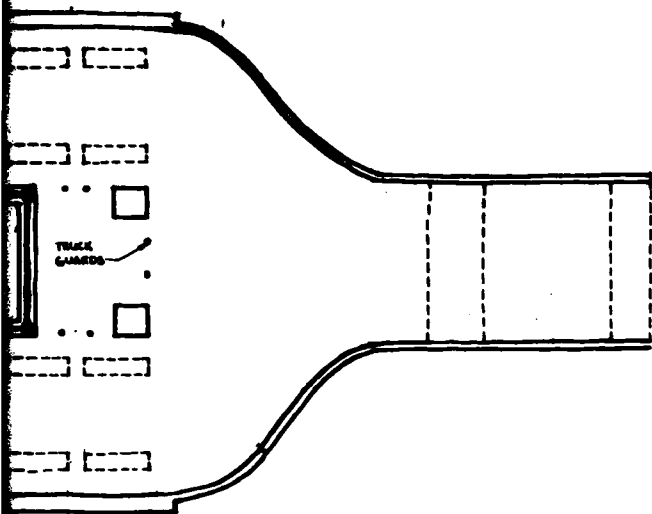
ASSUMPTIONS

1. MANPOWER REQUIREMENTS -
 - 2 SECURITY PERSONS
 - MAINTENANCE PERSONS AS REQUIRED
 - SINGLE 8 HR SHIFT 8 HOURS
 - 4 WEAPON HANDLERS
2. WEAPON HANDLERS COULD BE REDUCED TO 2 IF CONVEYORS ARE AUTOMATED
3. WEAPONS COULD BE ISSUED IN RANDOM ORDER
4. SUITABLE FOR MOUNTAINOUS TERRAIN - A LONG RAMP DOWN WOULD BE REQUIRED IN FLAT TERRAIN



WEAPONS STORAGE CONCEPTS
HAYLOFT 2 CONCEPT
NO. 10
PLAN & SECTION

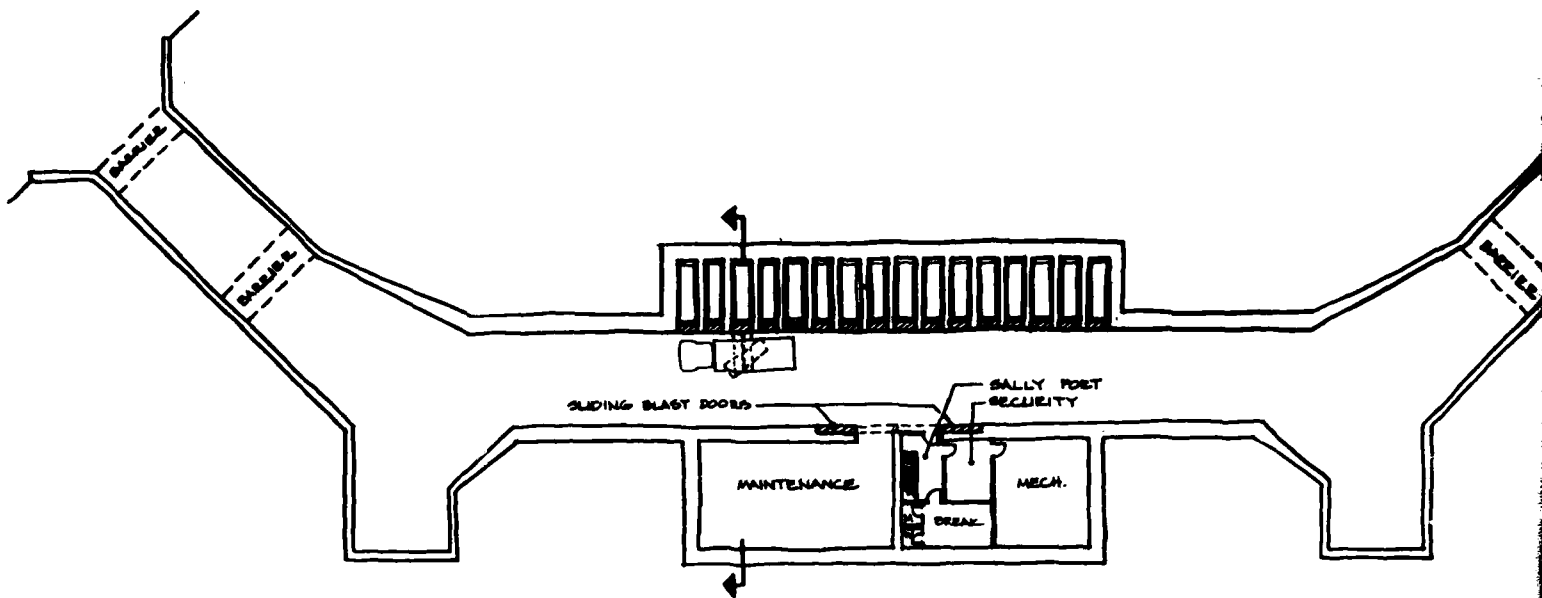




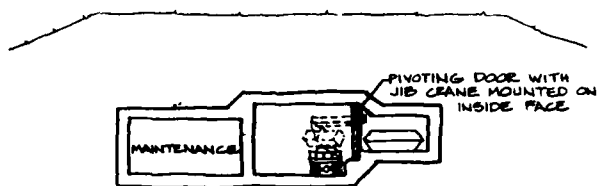
ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONNEL AS REQ'D
- MAINTENANCE PERSONNEL AS REQ'D
LIMIT TO 1 PER SHIFT/DAY
3. WEAPONS COULD BE ISSUED IN RANDOM ORDER
4. WEAPONS COULD BE LOADED & AT ONE TIME
5. SUITABLE FOR MOUNTAINOUS TERRAIN

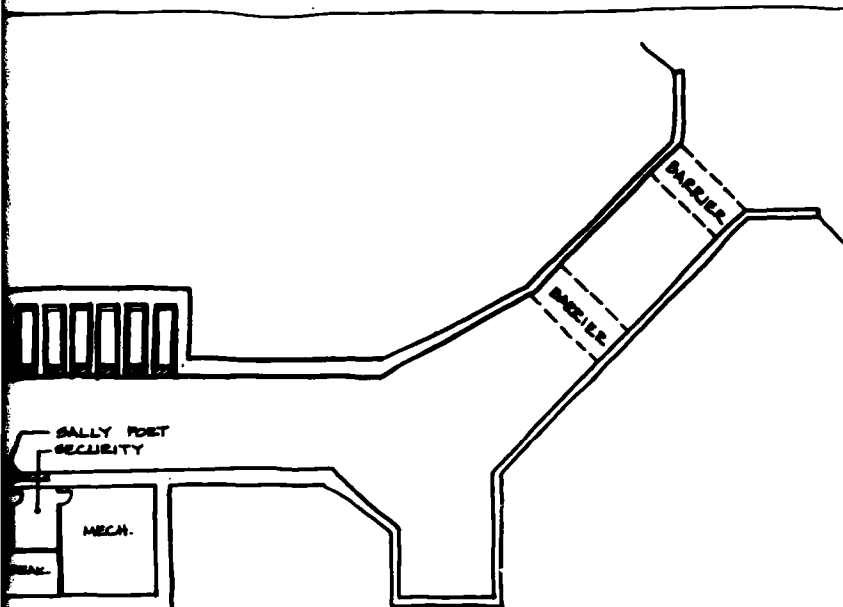
WEAPONS STORAGE CONCEPTS
HAYLOFT 3 CONCEPT
NO. 11
PLANS AND SECTION



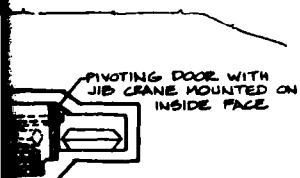
FACILITY PLAN
 $\frac{1}{16}'' = 1'-0''$



SECTION
 $\frac{1}{16}'' = 1'-0''$



PLAN



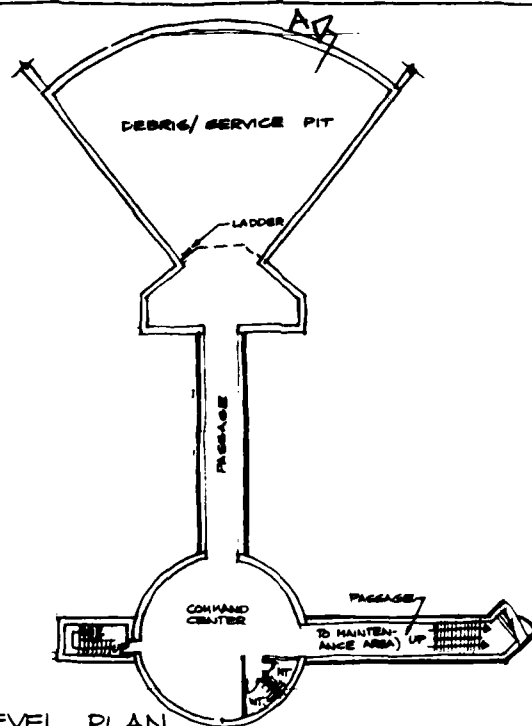
SECTION

ASSUMPTIONS

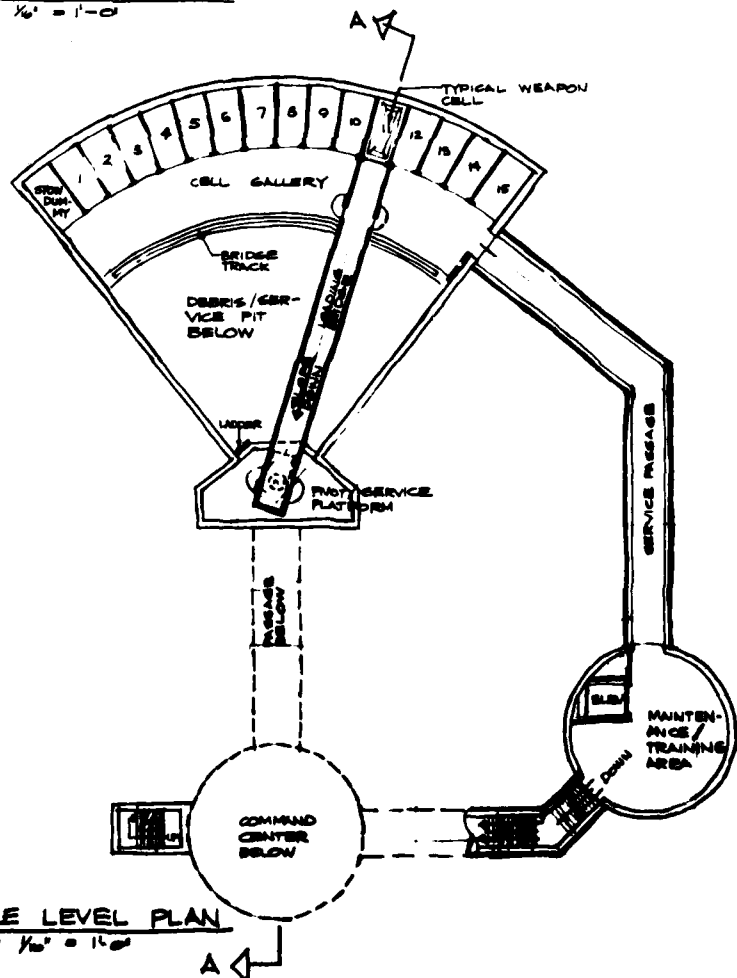
1. MANPOWER REQUIREMENTS:
2 SECURITY PERSONS
- MAINTENANCE PERSONS AS REQUIRED
8 HOUR SHIFT ONLY.
2. TRUCK DRIVERS WOULD ENTER A SINGLE CELL OF THE MAGAZINE TO REMOVE A WEAPON AFTER THE DOOR IS OPENED REMOTELY BY SECURITY PERSONNEL.
3. WEAPONS MAY BE REMOVED IN RANDOM ORDER.
4. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN.
5. ADAPTABLE FOR MORE THAN ONE UNIT OF WEAPONS.

WEAPONS STORAGE CONCEPTS
MAUSOLEUM CONCEPT
NO 12

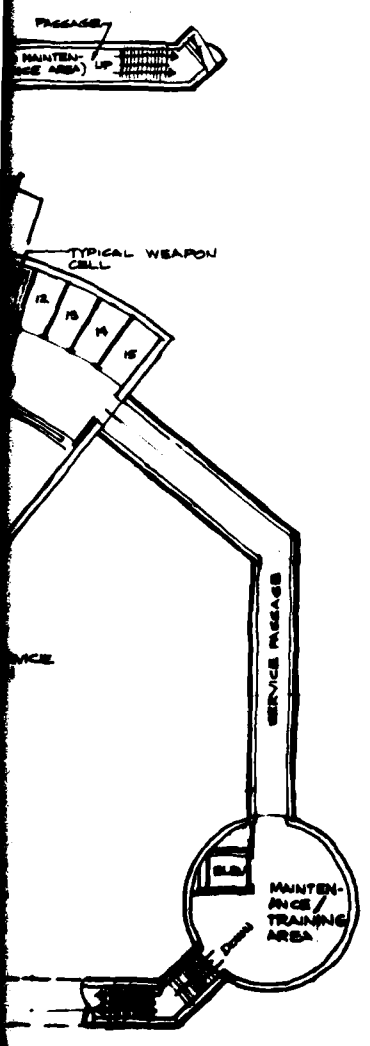
PLAN & SECTION



LOWER LEVEL PLAN
SCALE: $\frac{1}{16}" = 1'-0"$



MIDDLE LEVEL PLAN
SCALE: $\frac{1}{16}" = 1'-0"$



ASSUMPTIONS

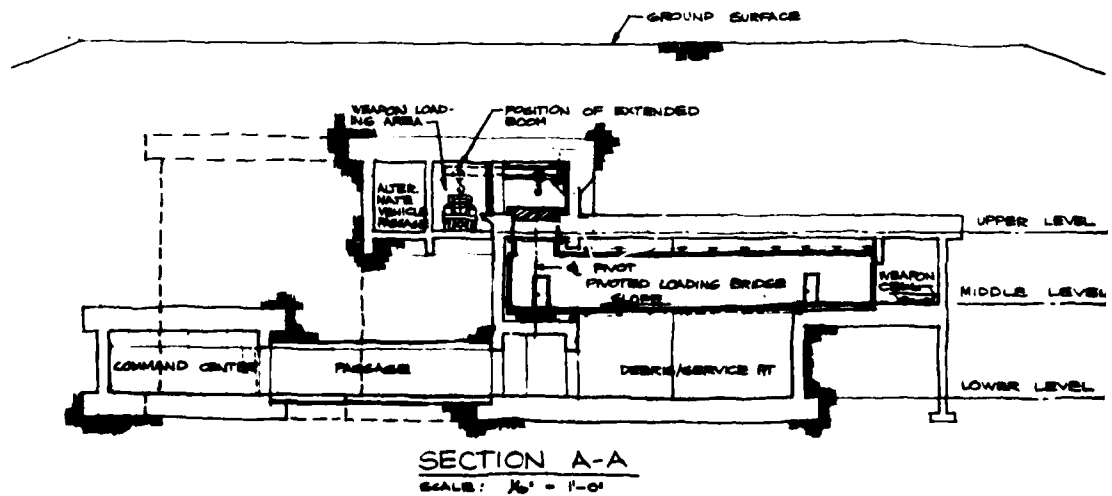
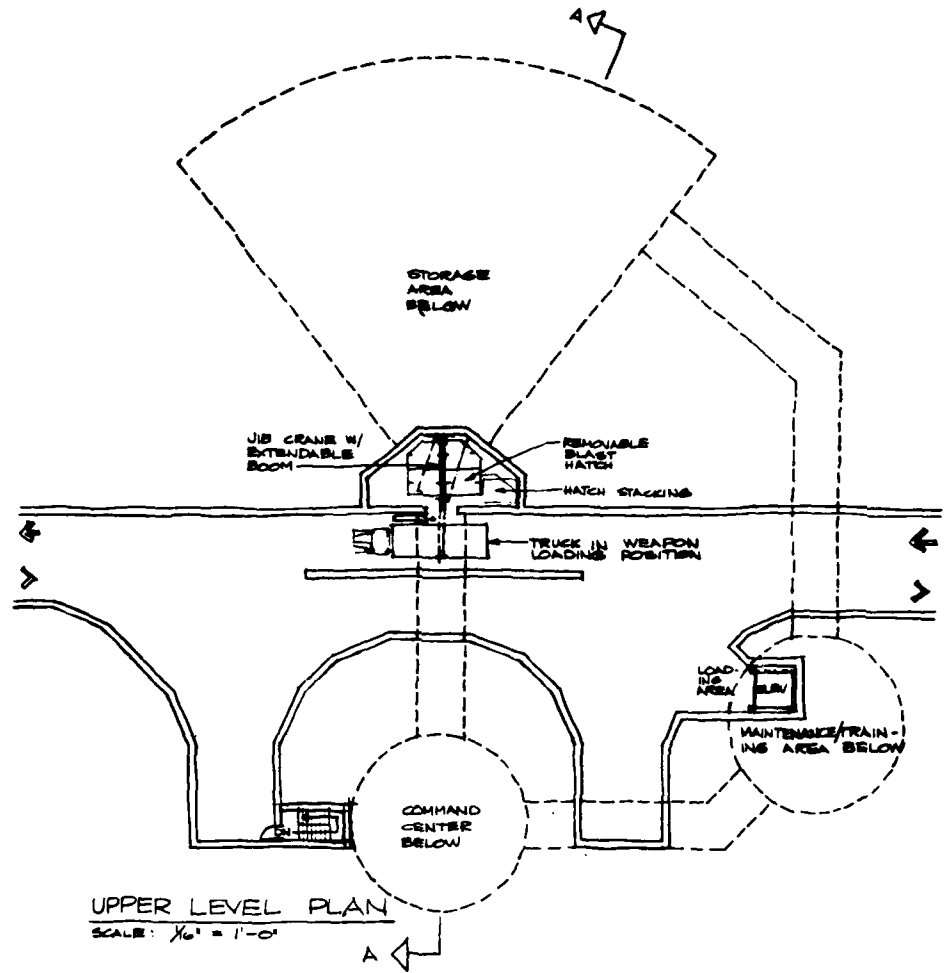
1. MANPOWER REQUIREMENTS -
 - 2. SECURITY PERSONS
 - MAINTENANCE PERSONS AS REQ'D
 - 5 ME 5 MEY ONLY
 - 3. WEAPON HANDLES
2. ONE WEAPON HANDLER COULD BE ELIMINATE IF TRUCK DRIVERS A ABLE TO OPERATE THE JIB CRANE
3. WEAPONS MAY BE ISSUED IN RANDOM ORDER
4. SUITABLE FOR FLAT & MOUNTAINOUS TERRAIN

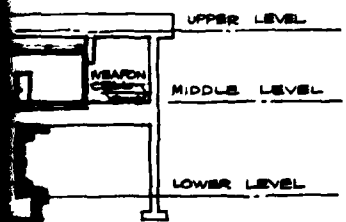
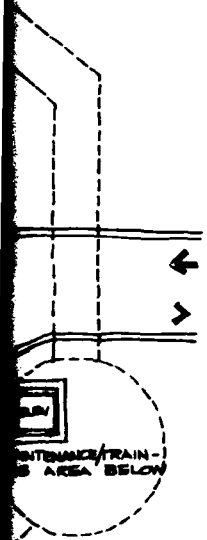
WEAPONS STORAGE CONCEPTS
WINDSHIELD WIPER CONCEPT

NO. 13
LOWER & MIDDLE LEVEL PLANS

DRAWING

OF 2





WEAPONS STORAGE CONCEPTS WINDSHIELD WIPER CONCEPT NO. 13 UPPER LEVEL PLAN & SECTION	
	DRAWING 2 OF 2

AD-A133 540

ADVANCED STRUCTURAL CONCEPTS FOR WEAPONS STORAGE - FLAT
AND MOUNTAINOUS TERRAINS(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL JUN 83 CERL-TR-M-330

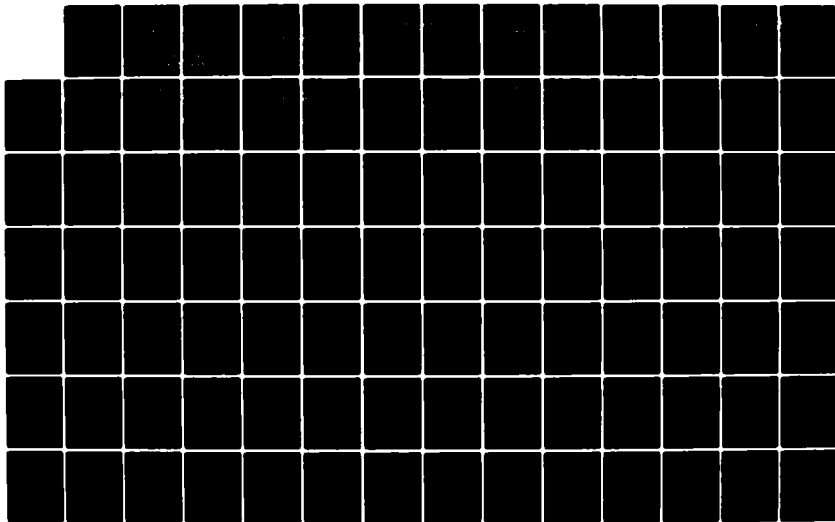
4/5

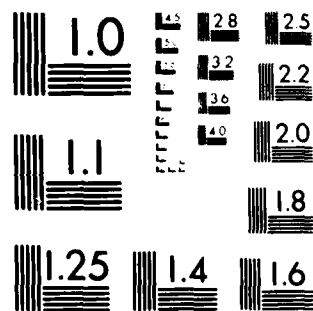
UNCLASSIFIED

MIPR-82-529

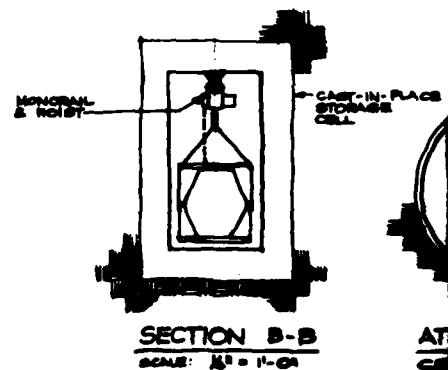
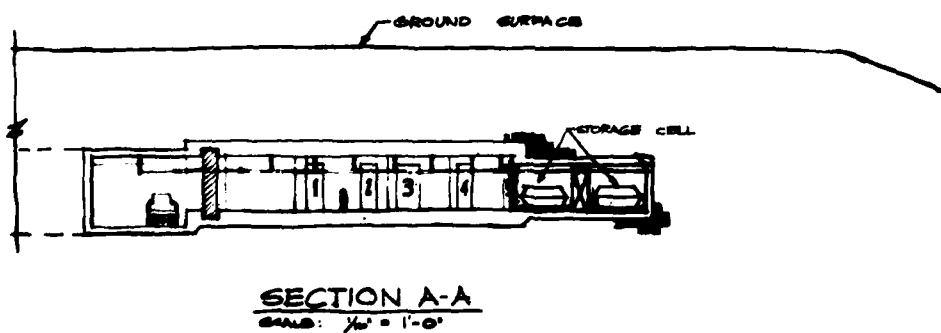
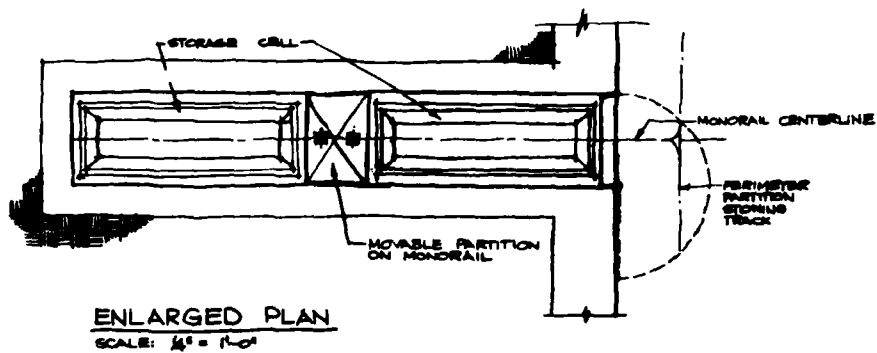
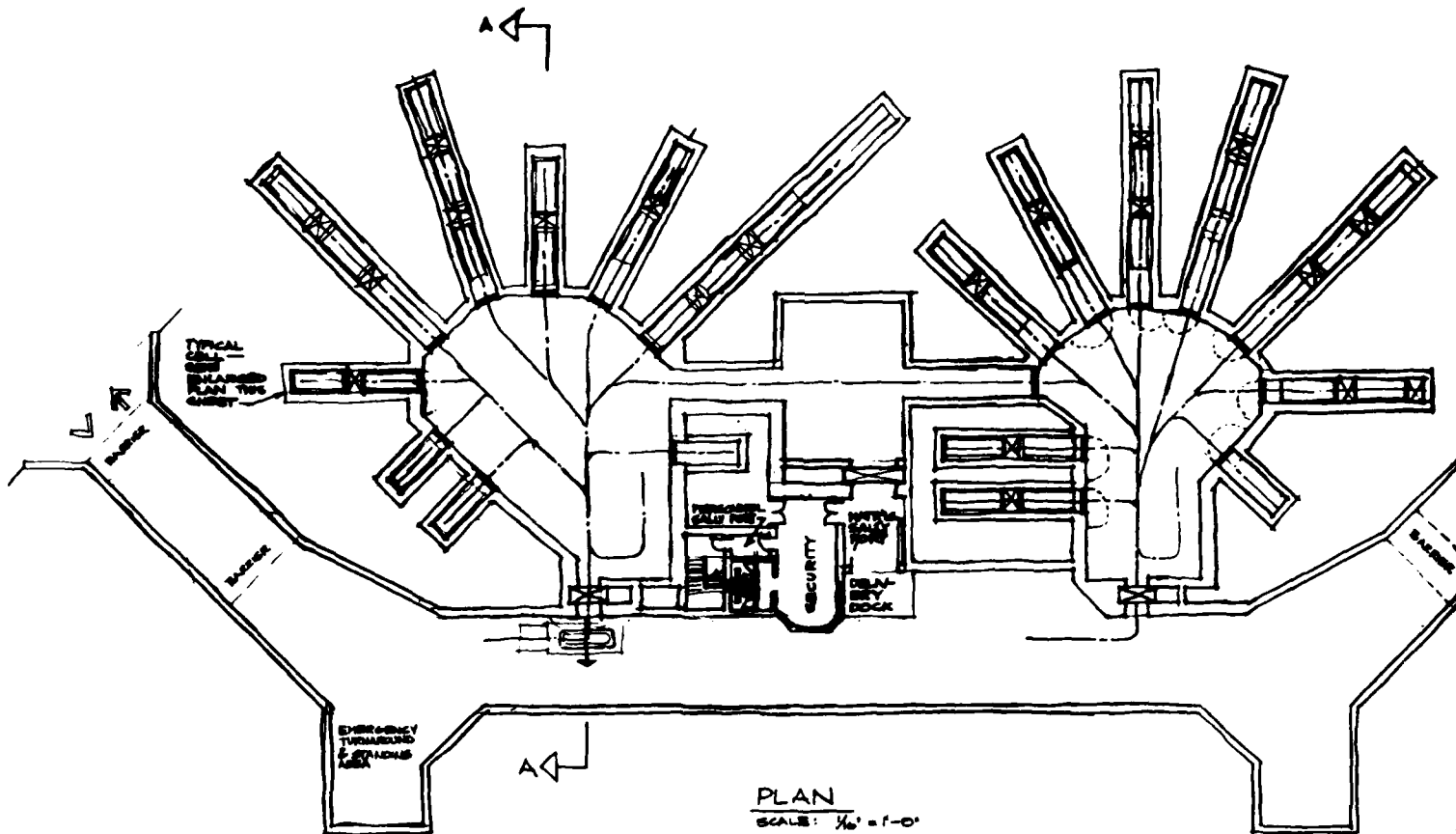
F/G 19/1

NL

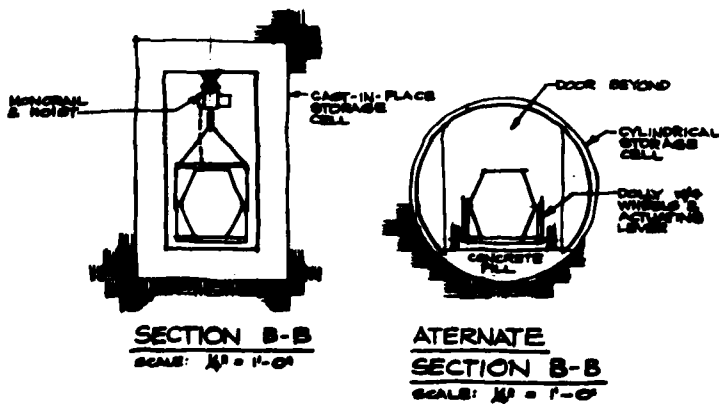
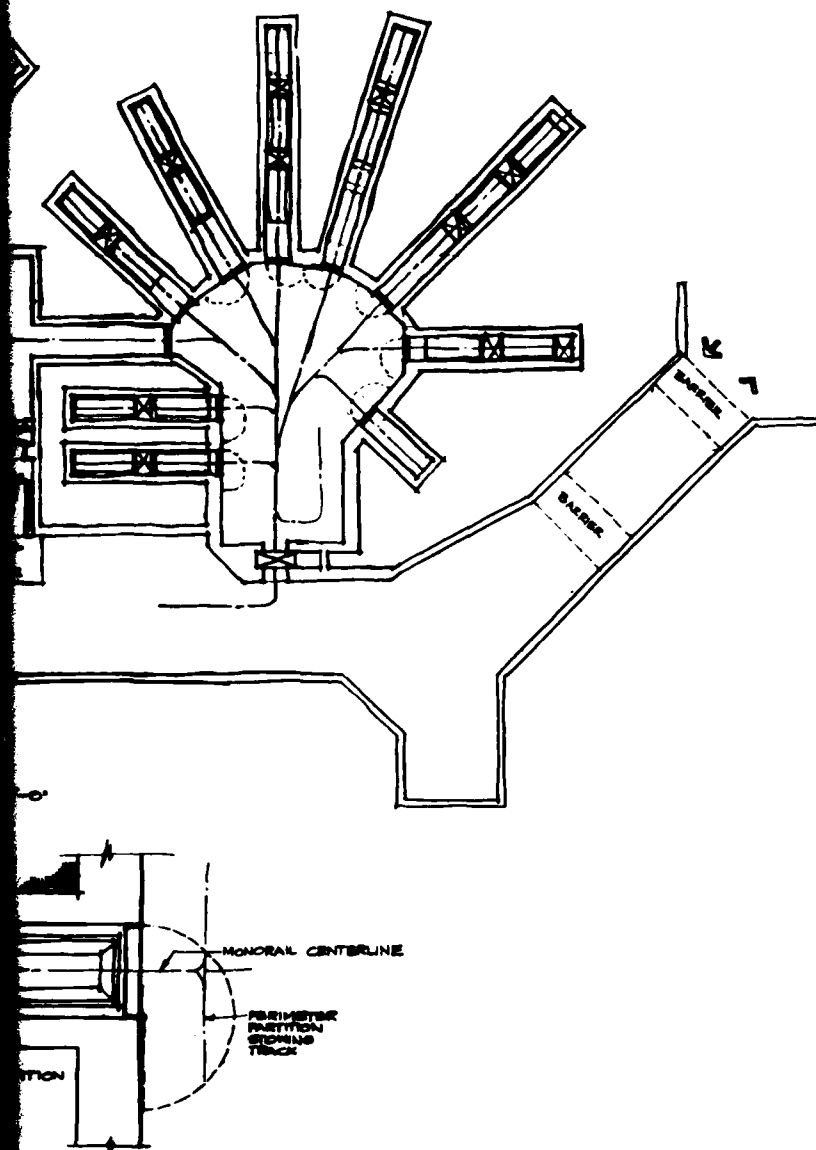




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



AT
SE
21

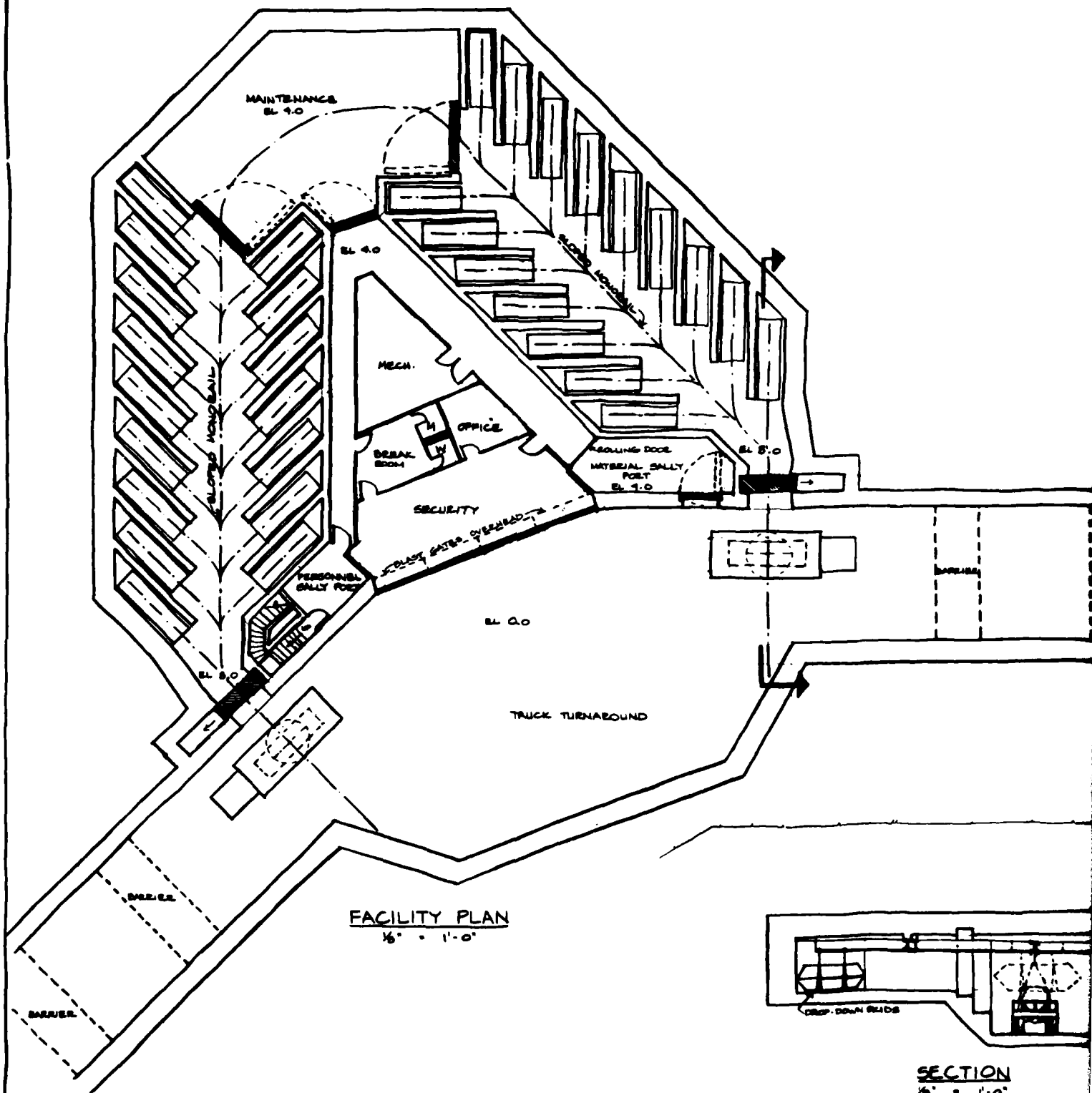


ASSUMPTIONS

1. MANPOWER REQUIREMENTS
2. SECURITY PERSONNEL
 - MAINTENANCE PERSONNEL AS REQUIRED
 - LIMITED TO SINGLE ONE SHIFT
4. WEAPON HANDLERS
2. IF TRUCK DRIVER COULD ENTER THE MAGAZINES THE WEAPON HANDLERS WOULD NOT BE REQUIRED
3. WEAPONS CANNOT BE EASILY ISSUED IN RANDOM ORDER
4. SUITABLE FOR FLAT & MOUNTAINOUS TERRAIN

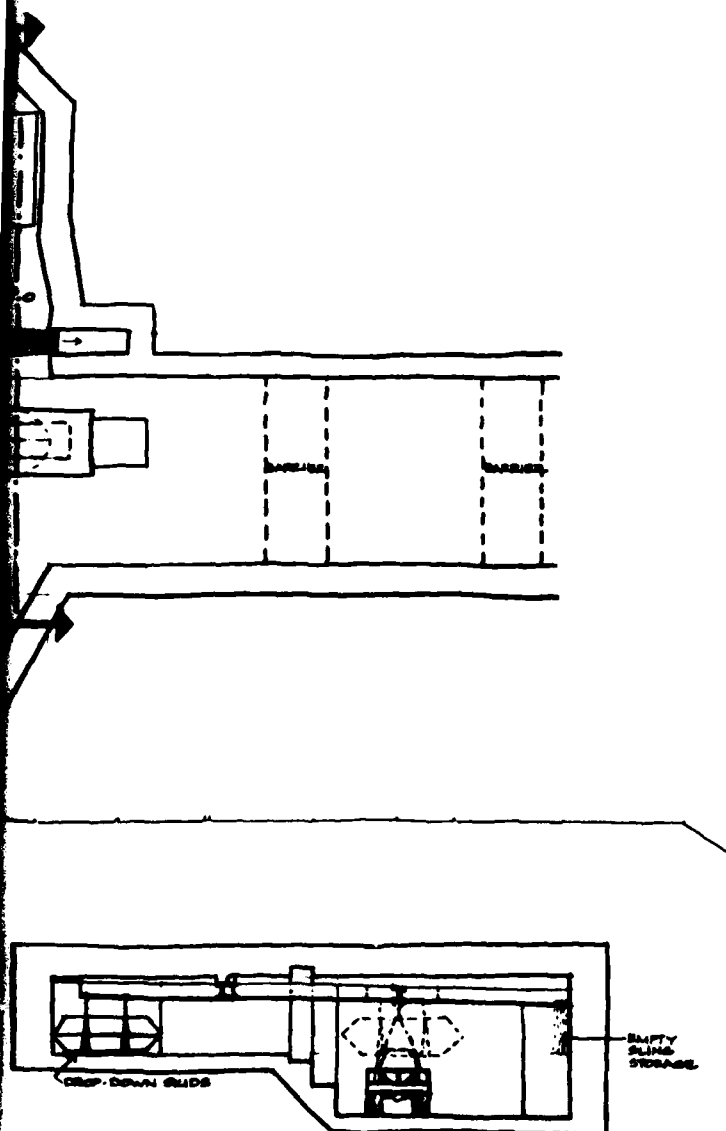
WEAPONS STORAGE CONCEPTS

CONCEPT NO. 14
PLAN & SECTIONS



ASSUMPTIONS

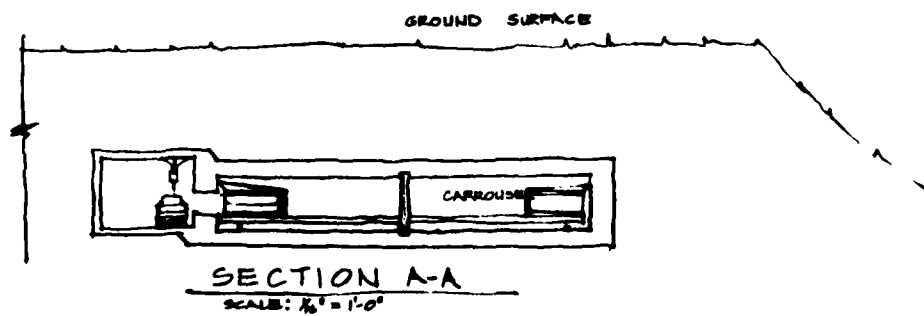
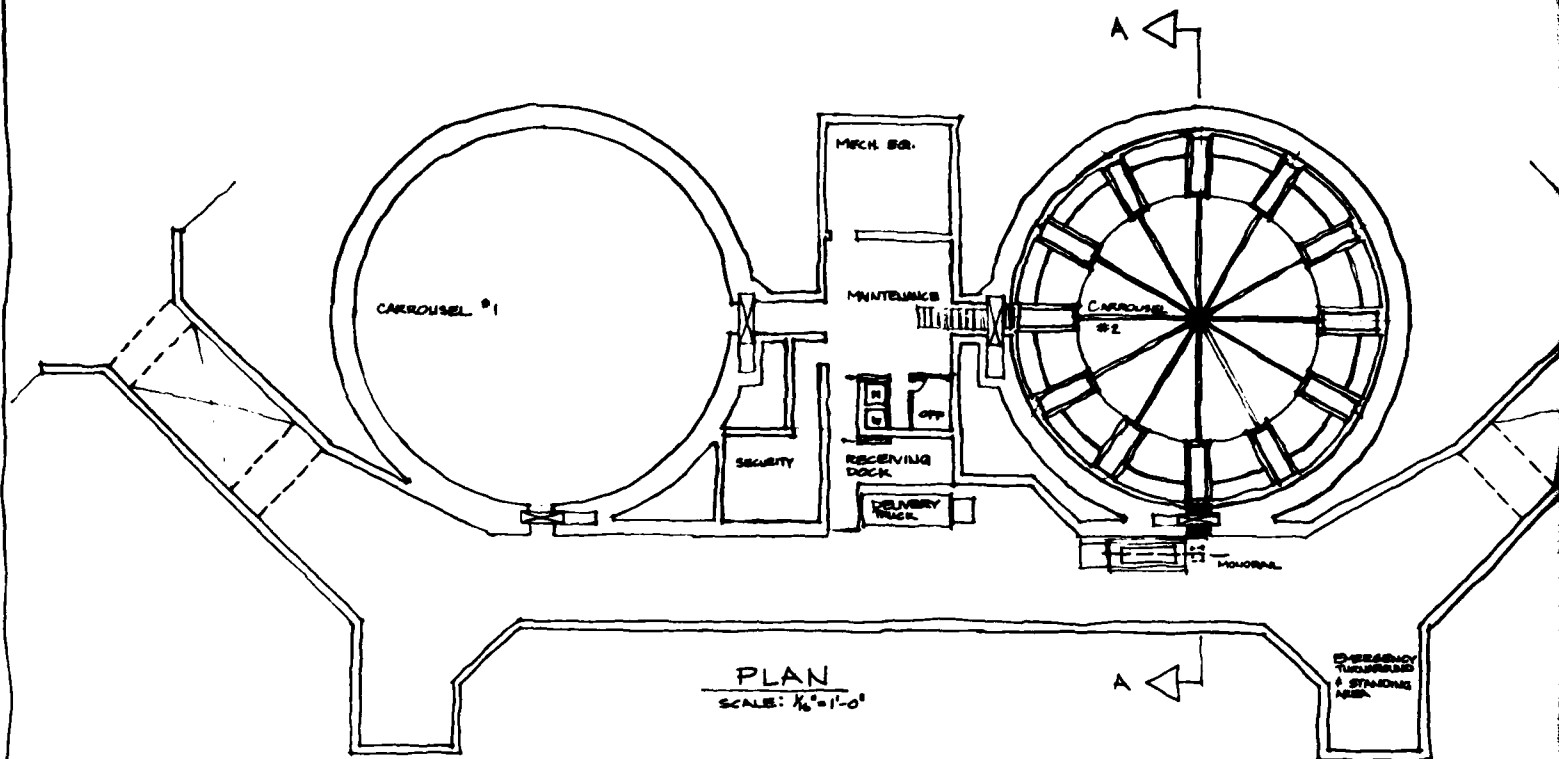
1. MANPOWER REQUIREMENTS
 - 2 SECURITY PERSONS
 - MAINTENANCE PERSONS AS REQ'D
 - 8 HR. SHIFT ONLY
 - 2 WEAPON HANDLERS
2. WEAPON HANDLERS COULD BE DELETED IF TRUCK DRIVERS WERE PERMITTED TO ENTER THE MAGAZINES
3. WEAPONS MAY BE ISSUED IN RANDOM ORDER
4. SUITABLE FOR LEVEL & MOUNTAINOUS TERRAIN

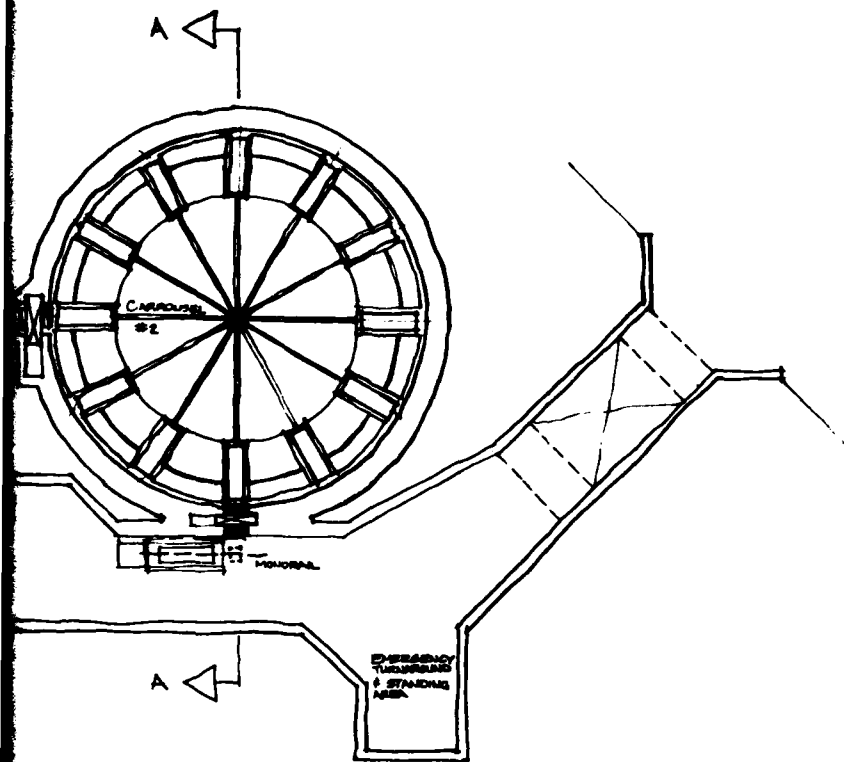


SECTION
1/8" = 1'-0"

WEAPONS STORAGE CONCEPT
FEATHER CONCEPT

NO. 15
PLAN & SECTION





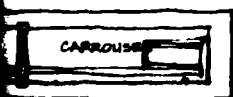
ASSUMPTIONS

1. MANPOWER REQUIREMENTS -
2. SECURITY PERSONNEL -
 - MAINTENANCE PERSONNEL AS REQUIRED LIMITED TO ONE SHIFT
2. TRUCK DRIVERS WOULD REMOVE WEAPON FROM CAROUSEL PROPERLY POSITIONED BY SECURITY PERSONNEL
3. WEAPONS COULD BE REMOVED IN RANDOM ORDER
4. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN

ALTERNATES

1. PLACE CAROUSEL ABOVE THE TRUCKS AS IN A HAY LOFT.
2. PLACE CAROUSEL BELOW THE TRUCKS AS IN A PIT.
3. PLACE A HUMP IN THE CAROUSEL @ THE DISCHARGE POINT.

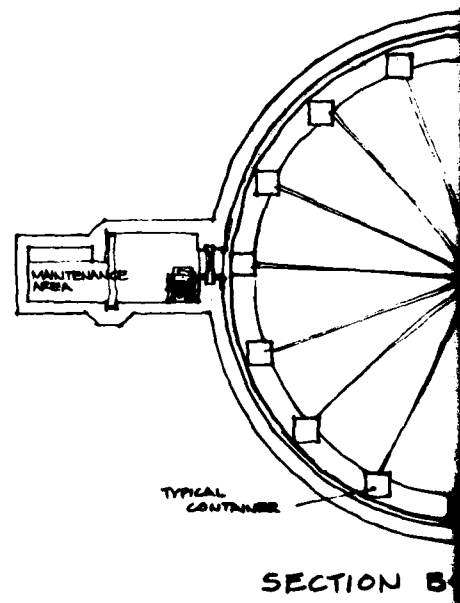
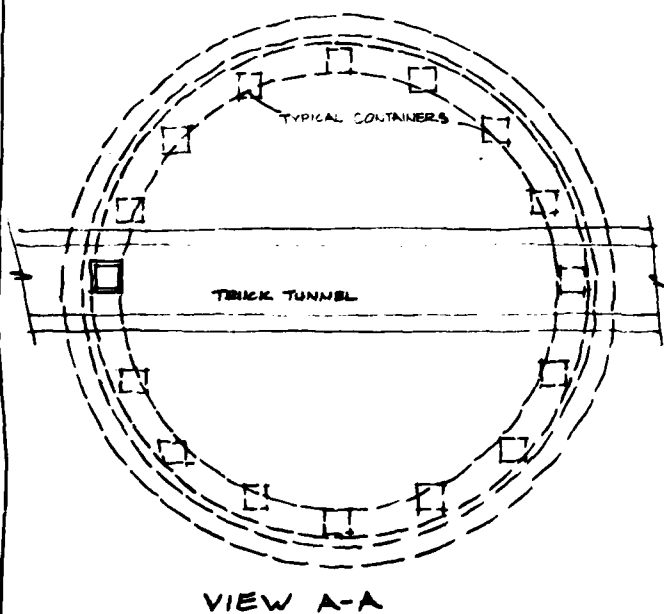
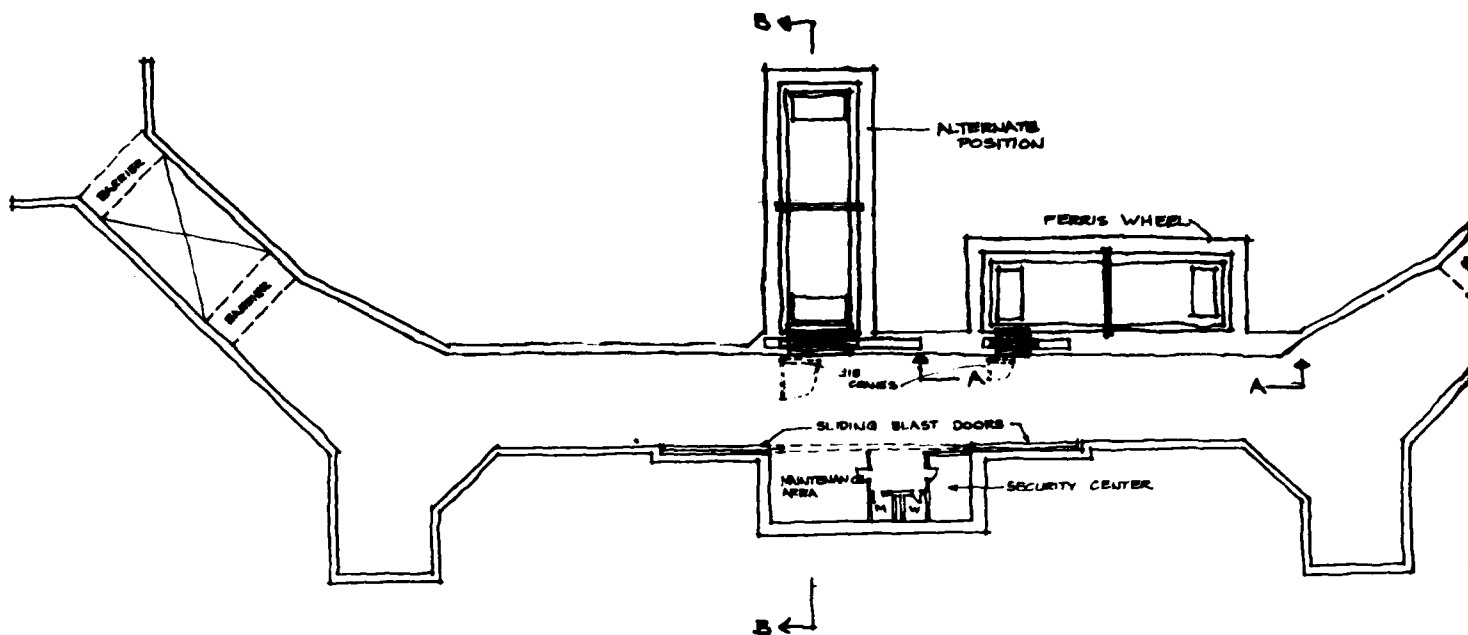
GROUND SURFACE



A-A

WEAPONS STORAGE CONCEPTS
CONCEPT 16
CAROUSEL
PLAN & SECTION

1 2

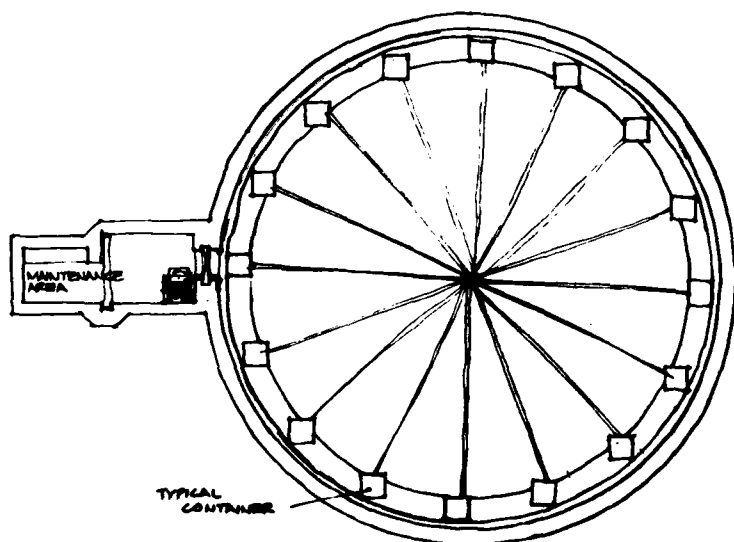


TERNATE
POSITION

FERRIS WHEEL

DOORS

SECURITY CENTER



TYPICAL
CONTAINER

SECTION B-B

ASSUMPTIONS

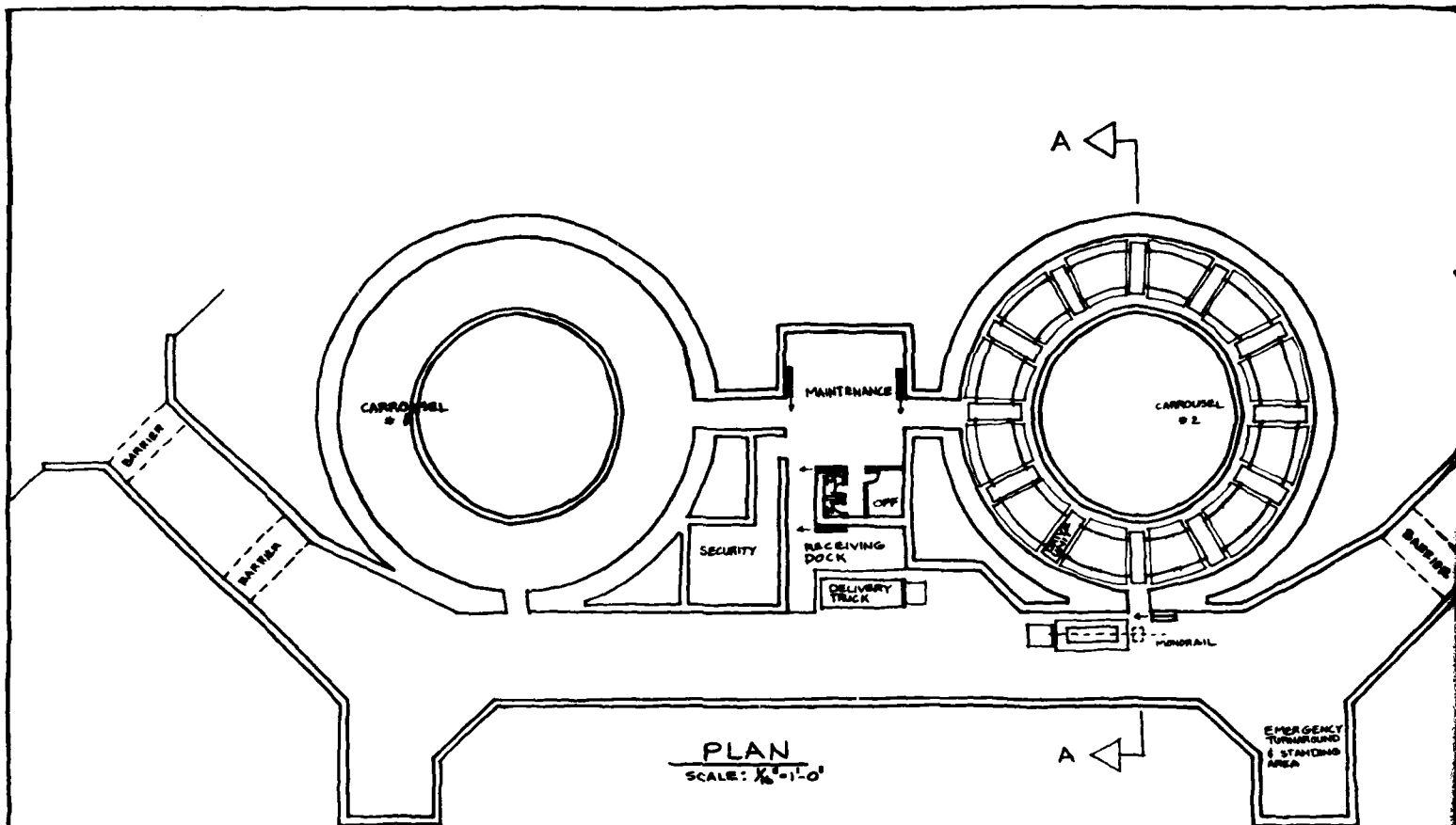
1. MANPOWER REQUIREMENTS -
2 SECURITY PERSONNEL
- MAINTENANCE PERSONNEL AS REQ'D
2. TRUCK DRIVERS WILL BE ONLY WEAPON
HANDLERS
3. WEAPON MAY BE REMOVED FROM MAGAZINE,
MOVED ACROSS THE TRUCK DRIVE &
MAINTAINED IN A LESS SECURE
MAINTENANCE AREA
4. TRUCK DRIVERS DO NOT ENTER MAGAZINE
5. WEAPONS MAY BE ISSUED IN RANDOM
ORDER
6. SUITABLE ONLY FOR MOUNTAINOUS TERRAIN

ALTERNATES

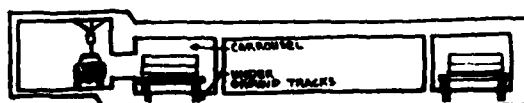
1. AXIS OF FERRIS WHEEL MAY BE
EITHER PARALLEL TO OR PERPENDICULAR
TO THE AXIS OF THE TRUCK DRIVE-
RS TO DRAWING.
2. WHEN THE AXIS IS PARALLEL, THE WEAPON
MAY BE REMOVED WITH
a) A HOIST FROM THE 12 O'CLOCK POSITION
b) A CONVEYOR FROM THE 3 & 9
O'CLOCK POSITIONS
THE OTHER POSITIONS PRESENT REMOVAL
PROBLEMS
3. WHEN THE AXIS IS PERPENDICULAR, THE
WEAPON MAY BE REMOVED FROM ANY
POSITION MAKING IT POSSIBLE TO VARY
THE LOCATION (VERTICALLY) OF THE
FERRIS WHEEL

WEAPONS STORAGE CONCEPTS
FERRIS WHEEL CONCEPT
NC. 17

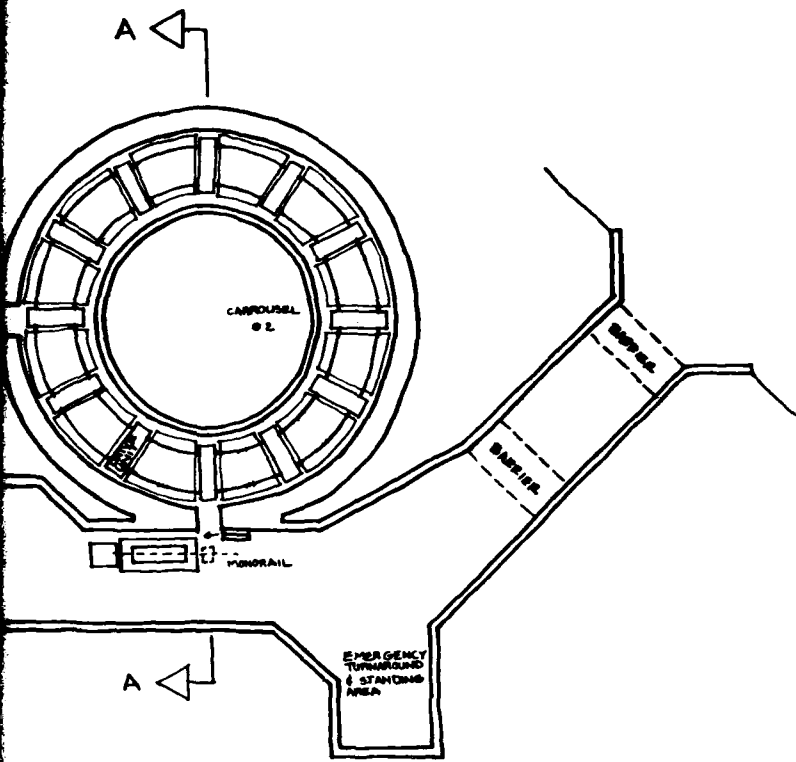
PLAN & SECTION



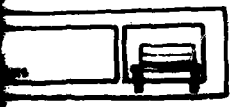
GROUND SURFACE



SECTION A-A
SCALE: 1/8" = 1'-0"



GROUND SURFACE

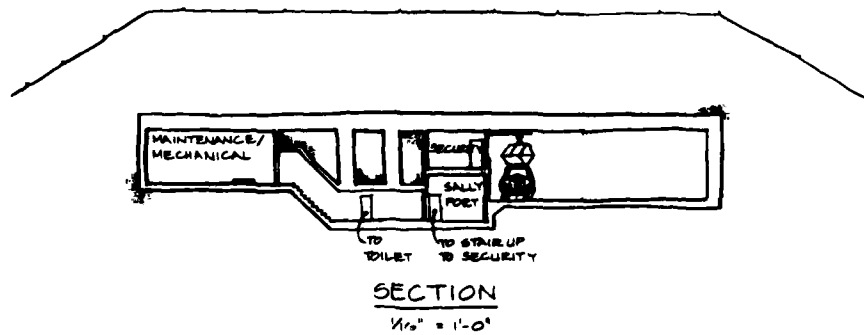
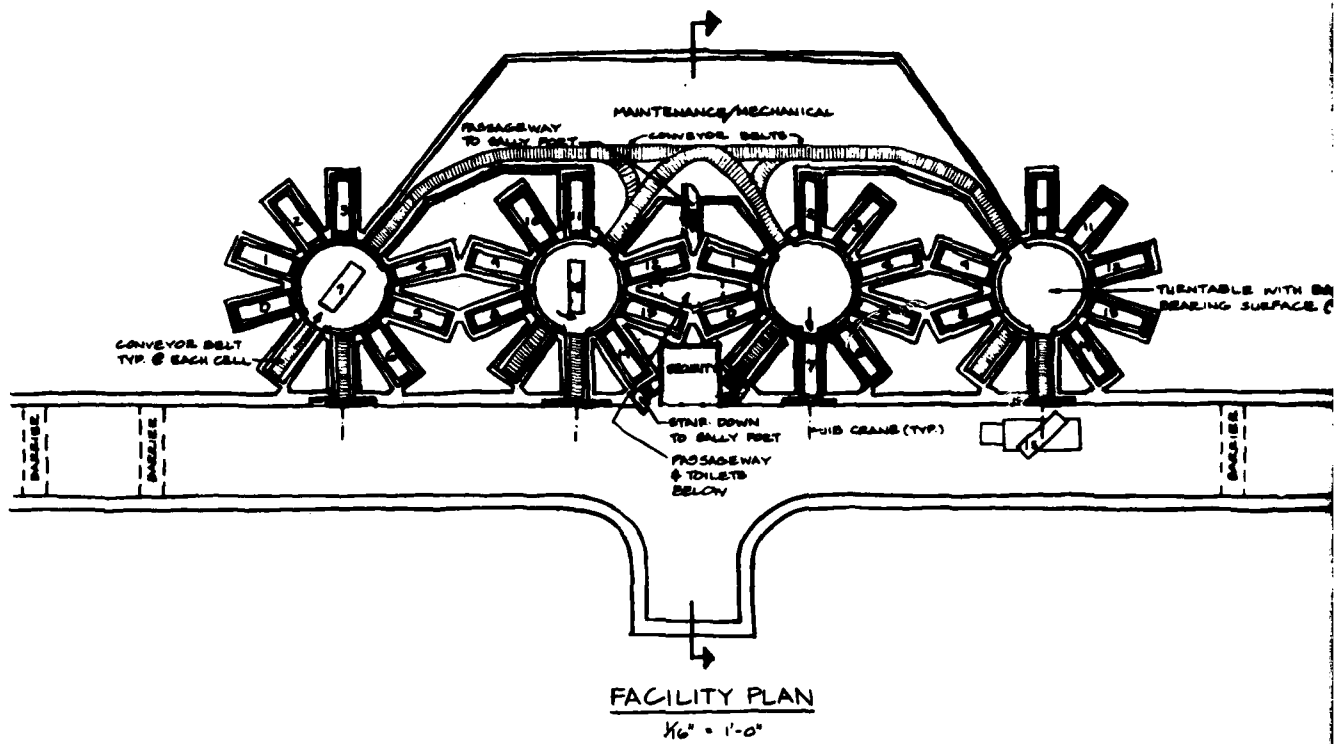


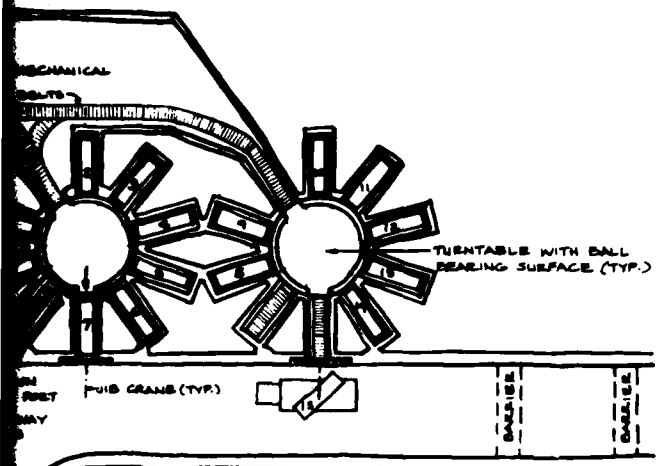
A-A

ASSUMPTIONS

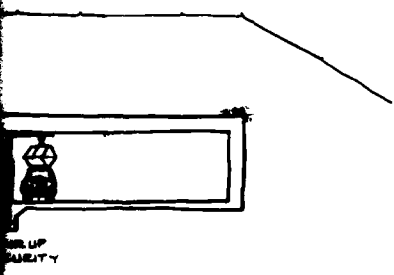
1. MANPOWER REQUIREMENTS
 - 2 SECURITY PERSONS
 - MAINTENANCE PERSON AS REQ'D
 - LIMITED TO 8 HR SHIFT
2. TRUCK DRIVERS WOULD REMOVE WEAPONS FROM CARROUSEL PROPERLY POSITIONED BY SECURITY PERSONS
3. WEAPONS COULD BE REMOVED IN RANDOM ORDER
4. SUITABLE FOR FLAT OR MOUNTANOUS TERRAIN

WEAPONS STORAGE CONCEPTS
 CARROUSEL CONCEPT
 NO. 18
 PLAN AND SECTION





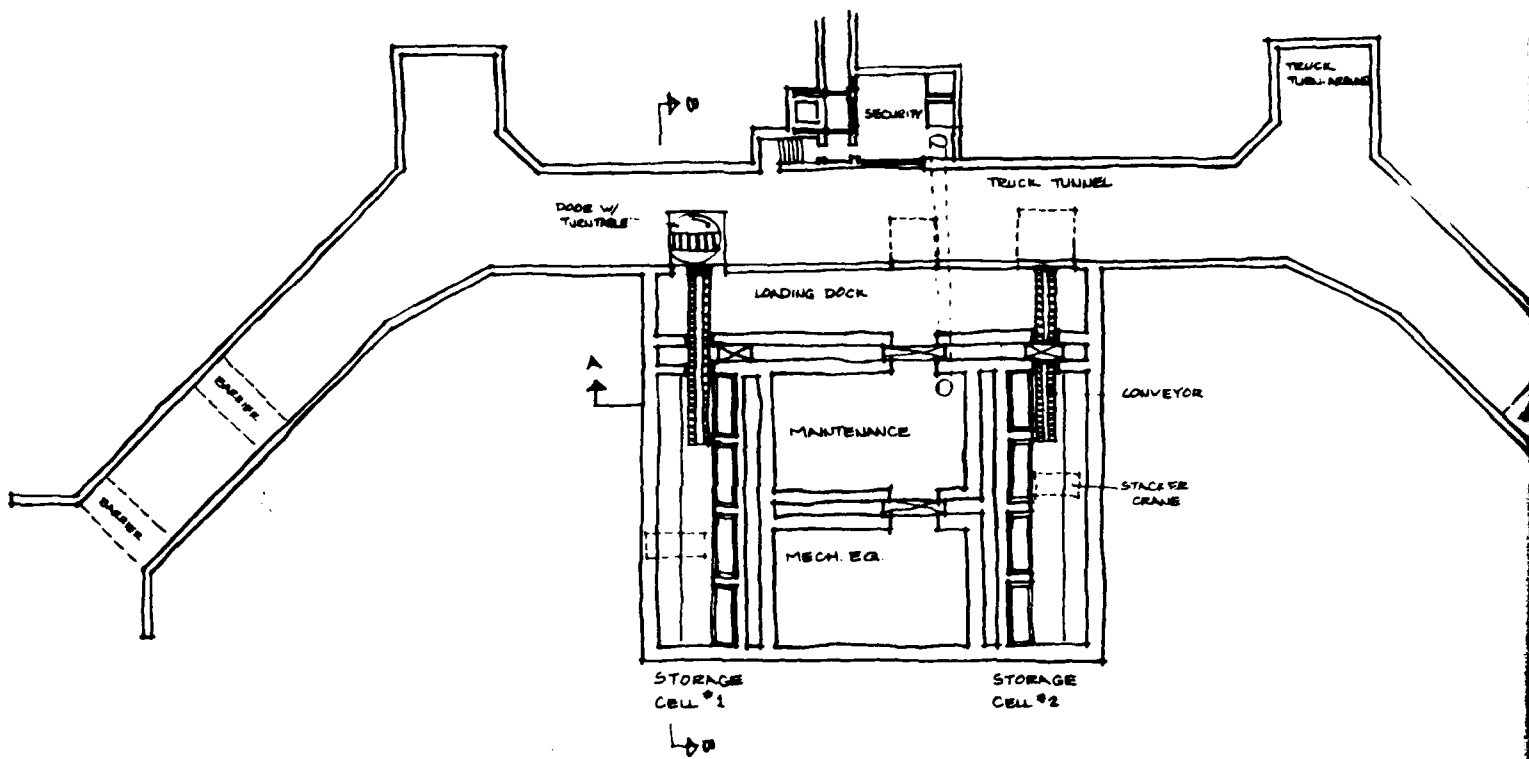
PLAN



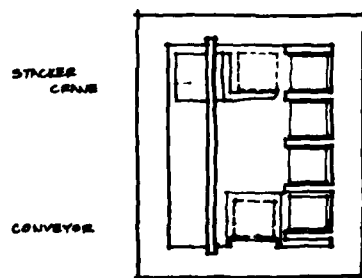
ASSUMPTIONS

1. MANPOWER REQUIREMENTS:
 2 SECURITY PERSONS
 4 WEAPONS HANDLERS
2. WEAPONS CAN BE ISSUED IN RANDOM ORDER.
3. TRUCK DRIVERS NEED NOT ENTER MAGAZINES.
4. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN.

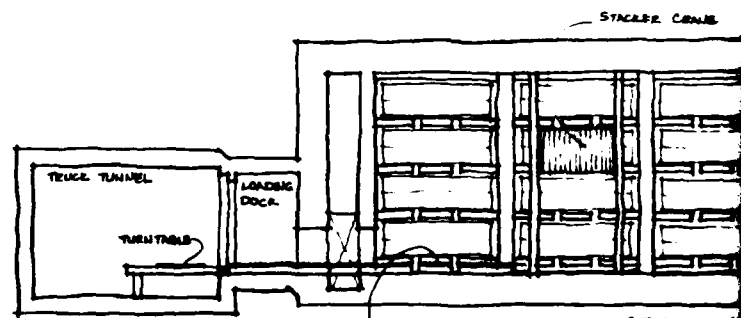
WEAPONS STORAGE CONCEPTS
 REVOLVER CONCEPT
 NO. 19
 PLAN & SECTION



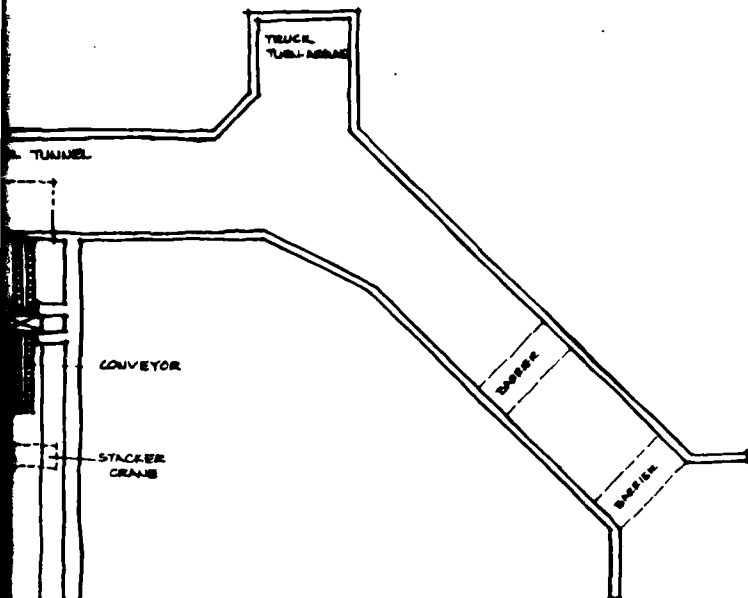
PLAN
1/4" = 1'-0"



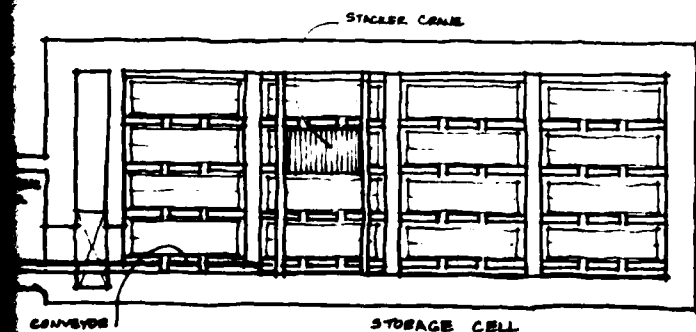
SECTION A
1/4" = 1'-0"



SECTION B-B
1/4" = 1'-0"



PAGE 2



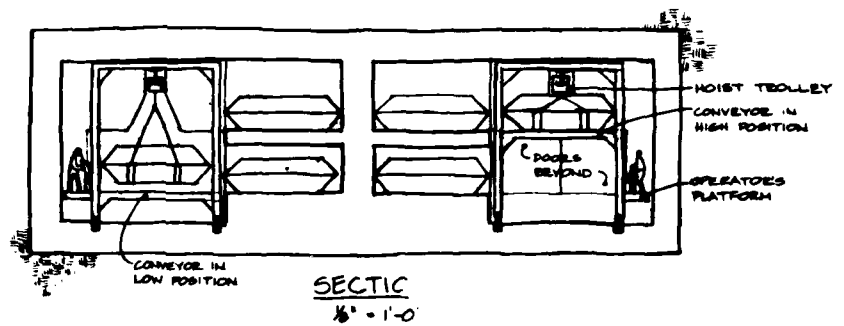
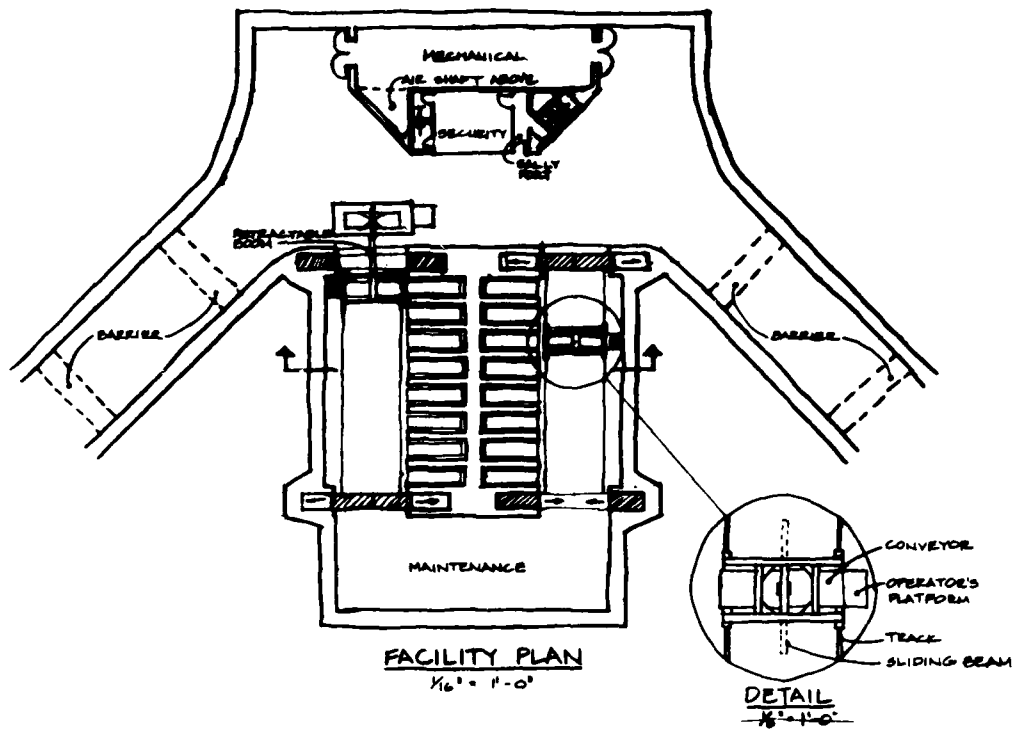
SECTION 6-B
8'-0"

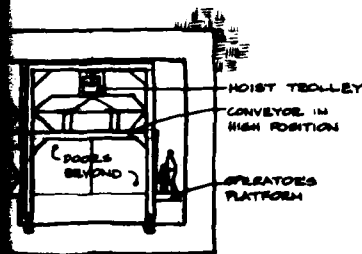
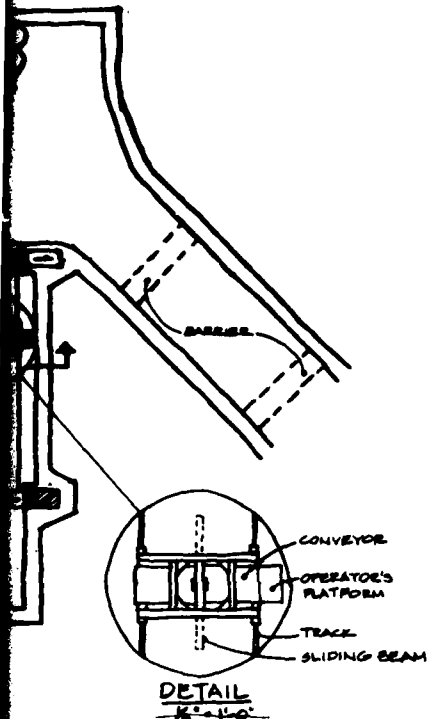
STORAGE CELL

ASSUMPTIONS

- 1. MAINTAIN REQUIREMENTS
- 2. 100% PERSONNEL
- 3. MAINTAIN PERSONNEL AS REQUIRED
- 2. WEAPON HANDLING
- 2. WEAPONS MAY BE ISSUED IN RANDOM ORDER
- 3. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN

WEAPONS STORAGE CONCEPT
STACKER CONCEPT
NO. 20
PLAN & SECTION





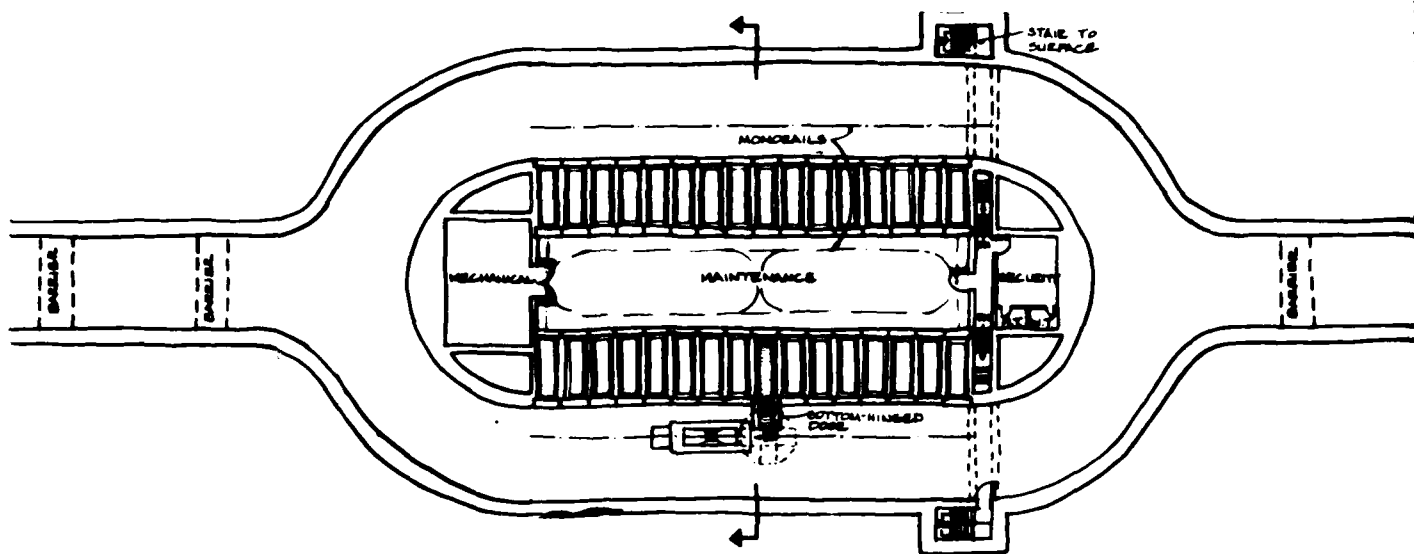
ASSUMPTIONS

1. MANPOWER REQUIREMENTS:
2 SECURITY PERSONS
2 WEAPON HANDLERS.
2. WEAPONS CAN BE ISSUED IN RANDOM ORDER.
3. TRUCK DRIVERS DO NOT ENTER MAGAZINE
4. SUITABLE FOR FLAT OR MOUNTAINOUS TERRAIN.

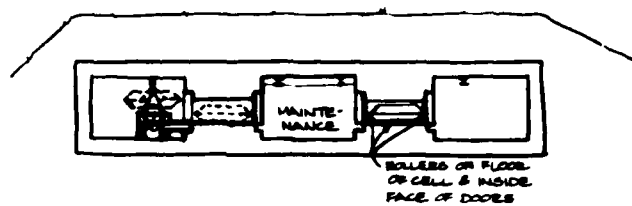
WEAPONS STORAGE CONCEPTS
TROLLEY-DOLLY CONCEPT

NO. 21

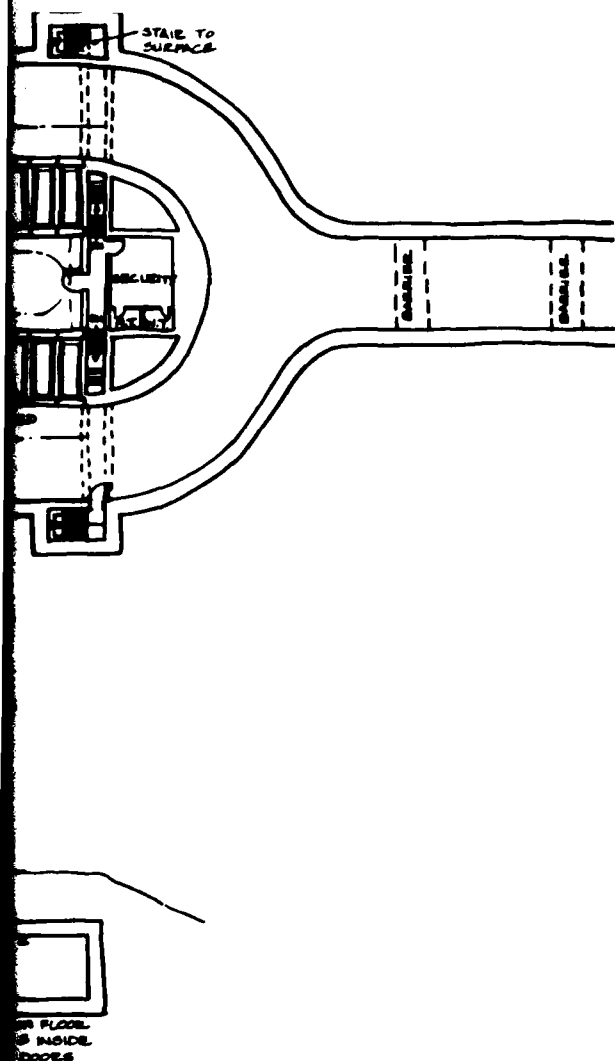
PLAN, SECTION, & DETAIL



FACILITY PLAN
 $\frac{1}{16}'' = 1'-0''$



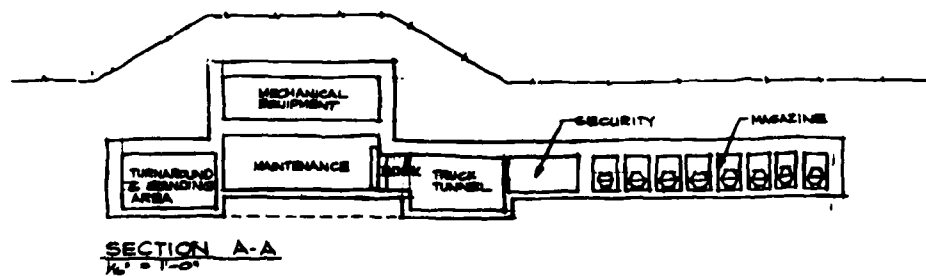
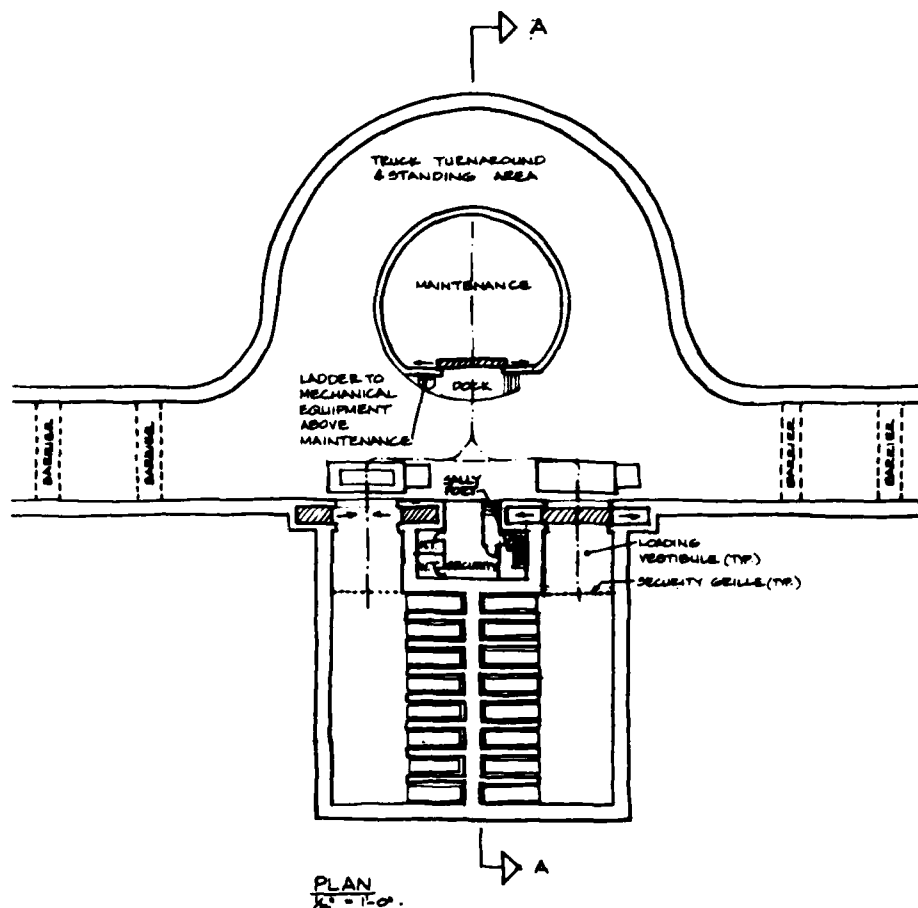
SECTION
 $\frac{1}{16}'' = 1'-0''$

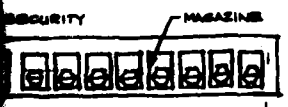
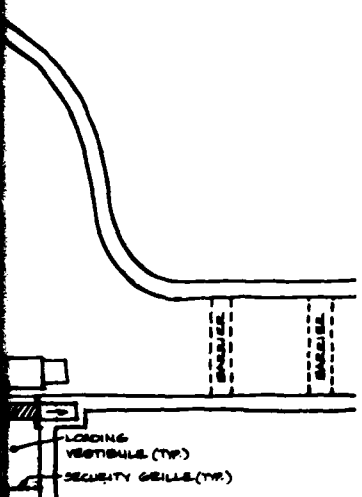


ASSUMPTIONS

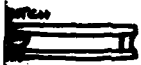
1. MANPOWER REQUIREMENTS:
2 SECURITY PERSONS
2. WEAPONS CAN BE ISSUED IN RANDOM ORDER
3. TRUCK DRIVERS ENTER ONE CELL OF MAGAZINE (DOOR RELEASED REMOTELY BY SECURITY PERSON)
4. SUITABLE FOR FLAT & MOUNTAINOUS TERRAIN.

WEAPONS STORAGE CONCEPTS
ELLIPTICAL CONCEPT
NO. 22
PLAN & SECTION



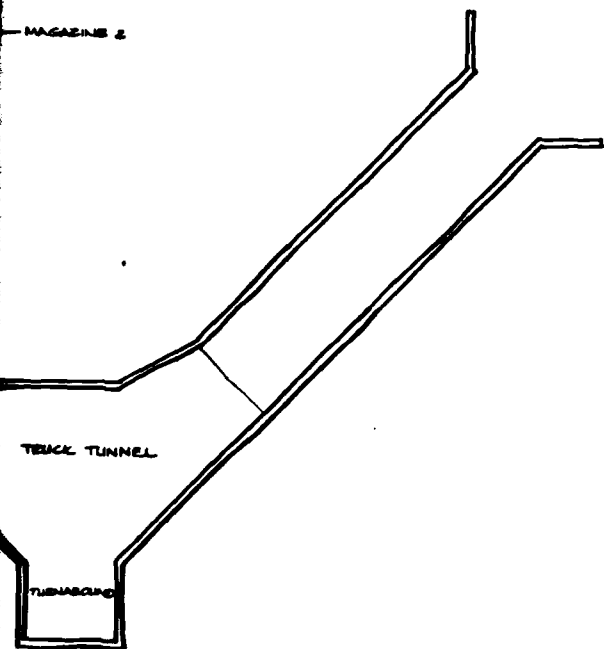


WEAPONS STORAGE CONCEPTS
 CONCEPT
 NO. 23
 PLAN & SECTION



BRIDGE CRANE

MAGAZINE 2



TRACK TUNNEL

TURNAROUND



WEAPONS STORAGE CONCEPTS
HAYLOFT CONCEPT
NO. 24
(NO. 9 REVISED 6/20/02)

APPENDIX H
CONSTRUCTION COST ESTIMATES

CONSTRUCTION COSTS

The following cost estimates are for cost comparison only and should not be used for construction purposes. The estimates are incomplete since some facility components, such as intrusion detection, are beyond the scope of this study. Also, the estimates do not apply to real construction schedules or locations since they are unknown at this time.

Construction costs have been estimated for 12 storage facility concepts in two different terrains. The costs used are U.S. averages for third quarter 1982. The estimates include the Contractor's overhead, profit, and bonds, as well as the design engineering fee. The estimates do not include construction contingencies, Government supervision and administration, and cost escalation.

The cost estimates are based on the following assumptions:

- The facilities will be built on existing Government property; therefore, property costs are unnecessary.
- The facilities will be constructed near populated areas; therefore, costs for mobilization and crew life support are unnecessary.
- There will be no unusual construction conditions.
- Utilities will be available at the sites.
- No state taxes are required on materials for Government projects.

On the next page is a tabulation of total costs, material quantities, and costs per square foot of the 12 study concepts for both flat and mountainous terrain. Notable differences in excavation and concrete quantities between flat and mountainous terrain are due to the construction methodologies outlined below.

	<u>Flat Terrain</u>	<u>Mountainous Terrain</u>
Overall Construction:	Partial excavation in soil, backfilling over completed structure for minimum 10 ft. earth cover.	Full excavation in rock, leaving domed configuration in which facility is constructed.
Floor Slab:	2 ft. thick concrete (mat foundation).	8 in. thick concrete (for level surface, primarily).
Walls:	2 ft. thick concrete (to withstand lateral load of earth).	8 in. thick concrete.
Roof:	3 ft. thick concrete (to withstand aircraft impact).	1.5 ft. thick concrete supported by 2 ft. columns at 20 ft. centers and 1.5 ft. x 3 ft. beams.

Quantity Comparisons

		Total Cost Thousands & % Confide	Excavation CY	Concrete CY	Uniquely SF	Backfill & Paving CY	Barrel CY	Haul Excess CY	Rock Balling LF	Gravels Linear SF	Encased Structure SF	Cost Per SF
(	Concept "A"											
	Mountain	100/10755	143500	1045	N/A	N/A	N/A	143500	13124	300000	30000	300
(	Flat Land	9479461	24435	13740	55710	30512	0	7000	N/A	N/A	30000	N/A
	Concept "B"											
	Mountain	20434010	221350	9150	N/A	N/A	N/A	221350	14035	340350	34035	350
	Flat Land	8700416	27455	10310	27405	28110	17405	0	N/A	N/A	28110	350
(	Concept "C"											
	Mountain	21571775	200000	4410	N/A	N/A	N/A	200000	10570	240000	24000	240
	Flat Land	1474632	43455	10440	24030	14750	0	7000	N/A	N/A	24030	350
	Concept "D"											
	Mountain	20770421	170455	4410	N/A	N/A	N/A	170455	13125	340350	34035	350
	Flat Land	70004154	210500	9010	24030	30046	17405	0	N/A	N/A	30046	350
(	Concept "E"											
	Mountain	44001000	100000	4555	N/A	N/A	N/A	100000	13125	170000	17000	170
	Flat Land	4425400	10000	8020	17000	31120	17405	0	N/A	N/A	31120	350
	Concept "F"											
(	Mountain	45004521	91475	4455	N/A	N/A	N/A	91475	13125	142000	14200	142
	Flat Land	8400617	15000	10550	97000	16055	0	15000	N/A	N/A	16055	160
	Concept "G"											
	Mountain	14055000	100000	4455	N/A	N/A	N/A	100000	13125	142000	14200	142
	Flat Land	11404101	30000	10310	27405	28110	17405	0	N/A	N/A	28110	350
(	Concept "H"											
	Mountain	12407154	55000	2405	N/A	N/A	N/A	55000	13125	170000	17000	170
	Flat Land	87504100	20000	10550	97000	16055	0	15000	N/A	N/A	16055	160
	Concept "I"											
	Mountain	15330000	50000	4455	N/A	N/A	N/A	50000	13125	142000	14200	142
	Flat Land	90011000	30000	10310	27405	28110	17405	0	N/A	N/A	28110	350
(	Concept "J"											
	Mountain	23437100	102000	9100	N/A	N/A	N/A	102000	13125	170000	17000	170
	Flat Land	10072011	41000	14000	105000	16510	15100	0	N/A	N/A	16510	165
	Concept "K"											
(	Mountain	27134000	100000	4455	N/A	N/A	N/A	100000	13125	142000	14200	142
	Flat Land	10004100	30000	10310	27405	28110	17405	0	N/A	N/A	28110	350
	Concept "L"											
	Mountain	45000100	81000	4455	N/A	N/A	N/A	81000	13125	142000	14200	142
	Flat Land	94015000	30000	10310	27405	28110	17405	0	N/A	N/A	28110	350

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 OF 4		
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "A"		ESTIMATOR Jaye		CHECKED BY				
<u>Recap</u>	SUMMARY	QUANTITY	LABOR	MATERIAL	TOTAL COST			
		NO. UNITS	UNIT MEAS.	PER UNIT				TOTAL
Fram Sht.	2				10,627,927		1,464,575	12,092,502
	3				10,000		92,000	102,000
	3				193,450		648,520	841,970
	4				2,791		9,492	12,283
	4				6,925		13,503	20,428
subtotal					10,841,093		2,228,090	13,069,183
PT&I					19% 2,059,808			2,059,808
Total Direct Cost					\$12,900,901			15,128,991
Overhead @ 15%								2,269,349
subtotal								17,398,340
Profit @ 8%								1,391,867
subtotal								18,790,207
Bond @ 1%								187,902
Total Construction Cost in 3rd Quarter 1982 Dollars								\$18,978,109
Design Engineering 6%								1,138,686
Total Cost (Comparative Cost Estimate)								\$20,116,795

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 OF 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "A"		ESTIMATOR Jaye		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	143,900	CY	65 ⁰⁰	9,353,500	—	—	9,353,500
Concrete	7,715	CY	121 ⁰⁰	939,565	138 ⁰⁰	1,071,570	2,011,135
Guniting Liner	209,480	SF	0 ⁸⁹	186,437	0 ⁸²	171,774	358,211
Rock Bolting	15,750	LF	1 ⁹¹	30,083	0 ⁵⁰	7,875	37,958
<u>Sub-Total</u>				10,509,585		1,251,219	11,760,804
Bullet Proof Glass	130	SF	18 ³⁸	2,390	33 ³⁵	4,336	6,726
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰⁰	240	200 ⁰⁰	800	1,040
2'-8" x 7'-0"	5	EA	60 ⁰⁰	300	180 ⁰⁰	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	50,805	SF	0 ⁵⁰	25,403	1 ⁰⁰	50,805	76,208
Electrical							
Power	50,805	SF	1 ²⁵	63,506	1 ¹⁵	88,909	152,415
Lighting	50,805	SF	0 ⁵⁰	25,403	1 ²⁵	63,506	88,909
<u>Totals - This Sheet</u>				10,623,927		1,414,575	12,092,502

CONSTRUCTION COST ESTIMATE.				DATE PREPARED 20 July 62		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT A		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	50	Lt	23.26	1163	10.43	522	1,685
20" x 20"	10	Lt	13.80	138	8.22	80	218
10" x 8"	50	Lt	4.87	244	2.83	142	386
		Lt					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	2	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	2	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,575	5,500	5,896
				<u>\$2,791.-</u>		<u>\$9,492.-</u>	<u>\$12,283.-</u>
FIRE PROTECTION							
Halon Units (1961b)	6	Ea	600.-	3600.-	1638	9,828.-	13,428.-
Detectors	9	Ea	275.-	2475.-	110.-	990.-	3,465.-
Control Panel	1	Ea	275.-	275.-	1,358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	200	Lt	1 ⁵⁰	300.-	2 ⁹⁰	580.-	220.-
				<u>6,925</u>		<u>13,503.</u>	
							<u>\$20,428.</u>

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (in Mountain)				BASES FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "B"		ESTIMATOR Jaye		CHECKED BY 			
<u>Recap</u>	SUMMARY	QUANTITY		LABOR		MATERIAL	
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL
							TOTAL COST
Frame Sht.	2				16,025,982		1,661,651
	3				136,880		284,000
	3				204,650		682,020
	4				2,613		9,450
	4				4,828		9,758
subtotal					16,374,953		2,646,879
PT&I					192		3,111,241
Total Direct Cost					19,486,194		22,133,073
Overhead @ 15%							3,319,961
subtotal							25,453,034
Profit @ 8%							2,036,243
subtotal							27,489,277
Bond @ 1%							274,893
Total Construction Cost in 3rd Quarter 1982 Dollars							27,764,170
Design Engineering 6%							1,665,849
Total Cost (Comparative Cost Estimate)							29,430,019

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				 BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "B"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	223,850	CY	65 ⁰⁰	14,550,250	—	—	14,550,250
Concrete	9,385	CY	121 ⁰⁰	1,135,585	138 ⁰⁰	1,295,130	2,430,715
Guniting Liner	246,320	SF	0 ⁸²	219,225	0 ⁸²	201,982	421,207
Rock Bolting	18,525	LF	1 ⁹¹	35,383	0 ⁵⁰	9,263	44,646
<i>Sub-Totals</i>				15,940,443		1,506,375	17,446,818
Bullet Proof Glass	172	SF	10 ³⁸	3,151	33 ³⁵	5,736	8,887
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	6	EA	60 ⁰⁰	360	200 ⁰⁰	1,200	1,560
2'-8" x 7'-0"	5	EA	60 ⁰⁰	300	180 ⁰⁰	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	35,235	SF	0 ⁵⁰	17,917	1 ⁰⁰	35,835	53,752
Electrical							
Power	35,235	SF	1 ²⁵	44,794	1 ⁷⁵	62,711	107,505
Lighting	35,235	SF	0 ⁵⁰	17,917	1 ²⁵	44,794	62,711
<i>Sub-Totals</i>				90,539		170,276	260,815
Totals - This Sheet				16,025,982		1,661,651	17,687,633

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT B		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Conveyor	100	ft	180-	72,000-	180-	176,000-	196,000-
Container Transfer	32	Ea	1500-	48,000-	2500-	80,000-	128,000-
Monorail	80	ft	5-	400-	45-	3,600-	4,000-
Trolley Hoist	2	Ea	200-	400-	5700-	11,400-	11,800-
Bridge Crane	3	Ea	4000-	12,000-	12,000-	36,000-	48,000-
Container Sling	2	Ea	—	—	1500-	3,000-	3,000-
Conveyor Drive	12	Ea	500	6,000-	2000-	24,000-	30,000-
				136,800		234,000	420,800-
Equipment							
Motor/Gen Set (100 KW)	1	Ea	4000-	4000-	21,000-	21,000-	25,000-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000-	2,000-	10,000-	10,000-	12,000-
Piping - 1 1/2"	200	ft	3-	600-	1.35	270-	870-
Personnel Barrier 6500#	5	Ea	350-	1750-	9750-	48,750-	50,500-
Operating Mechanism	5	Ea	1400-	7000-	1250-	6250-	13,250-
Locking System	5	Ea	2100-	10,500-	1250-	6250-	16,750-
Truck Entrance Barrier	8	Ea	5000-	40,000-	24,000-	160,000-	200,000-
Operating Mechanism	8	Ea	2300-	18,400-	4000-	32,000-	50,400-
Locking System	8	Ea	3200-	25,600-	2600-	20,800-	46,400-
Draw Bridge	4	Ea	4100-	16,400-	42300-	169,200-	185,600-
Operating Mechanism	4	Ea	2400-	9,600-	6,000-	24,000-	33,600-
Locking System	4	Ea	3200-	12,800-	4,000-	16,000-	28,800-
Blast Door	10	Ea	1200-	12,000-	10,000-	100,000-	112,000-
Operating Mechanism	10	Ea	2300-	23,000-	5500-	55,000-	78,000-
Locking System	10	Ea	2100-	21,000-	1250-	12,500-	33,500-
				204,650		1,332,020	886,570-

CONSTRUCTION COST ESTIMATE.				DATE PREPARED 20 July 62		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT B		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	329
Entrance Filter (5000 cfm)	1	Ea	21	21	26	26	127
Ductwork							
40" x 20"	30	Lt	23.26	698	10.43	313	1,011
10" x 8"	24	Lt	4.87	117	2.82	68	185
20" x 20"	40	Lt	13.60	552	6.03	321	873
		Lt					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
HVAC SUB-TOTALS				<u>\$ 2,613</u>		<u>\$ 9,450</u>	<u>\$ 12,063</u>
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600	2400	1638	6,552	8,952
Detectors	6	Ea	275	1650	110	660	2,310
Control Panel	1	Ea	275	275	1358	1,358	1,633
Auxiliary Equip.	1	Lot	275	275	747	747	1,022
Wiring (Shielded 2 Wire)	152	Lt	1.50	228	2.30	441	669
Fire Protection Totals				<u>4,828</u>		<u>9,758</u>	<u>14,526</u>

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 OF 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "C"		ESTIMATOR Jaye		CHECKED BY			
Recap SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Fram Sht. 2				15,460,890		1,140,568	16,601,458
3				19,150		314,275	333,425
3				182,250		615,020	797,270
4				2,383		9,378	11,761
4				6,203		12,051	18,254
subtotal				15,670,876		2,091,292	17,762,168
PT&I			19%	2,977,466			2,977,466
Total Direct Cost				18,648,342			20,739,634
Overhead @ 15%							3,110,945
subtotal							23,850,579
Profit @ 8%							1,908,046
subtotal							25,758,625
Bond @ 1%							257,586
Total Construction Cost in 3rd Quarter 1982 Dollars							26,016,211
Design Engineering 6%							1,560,974
Total Cost (Comparative Cost Estimate)							27,577,185

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BASES FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "C"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	222,200	CY	65 ⁰⁰	14,443,000	—	—	14,443,000
Concrete	5,612	CY	121 ⁰⁰	679,052	138 ⁰⁰	774,456	1,453,508
Guniting Liner	244,040	SF	0 ⁸²	217,196	0 ⁸²	200,113	417,309
Rock Bolting	18,375	LF	1 ⁹¹	35,096	0 ⁵⁰	9,188	44,284
<u>Sub-Totals</u>				15,374,341		983,757	16,358,098
Bullet Proof Glass	200	SF	18 ³⁸	3,676	33 ³⁵	6,670	10,346
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰⁰	240	200 ⁰⁰	800	1,040
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	36,130	SF	0 ⁵⁰	18,065	1 ⁰⁰	36,130	54,195
Electrical							
Power	36,130	SF	1 ²⁵	45,163	1 ⁷⁵	63,228	108,391
Lighting	36,130	SF	0 ⁵⁰	18,065	1 ²⁵	45,163	63,228
<u>Sub-Totals</u>				91,549		171,811	263,360
<u>Totals - This Sheet</u>				15,460,890		1,140,568	16,601,458

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT C		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Monrail	1500	ft	5-	7500-	45-	67,500-	75,000.-
Trolley Hoist	32	Ea	200-	6400-	5700-	182,400-	188,800.-
Sling	32	Ea	-	-	1500-	48,000-	48,000.-
Monorail Switch	35	Ea	150-	5250-	450-	15,750-	21,000.-
Maint. Dolly	1	Ea	-	-	625-	625-	625.-
Bridge Crane (Maint.)	1	Ea	4000-	4000-	10,000-	10,000-	14,000.-
				23,150.-		324,275.-	347,425.-
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000-	4000-	21,000-	21,000-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000-	2,000-	10,000-	10,000-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350-	1750-	9750-	48,750-	50,500.-
Operating Mechanism	5	Ea	1400-	7000-	1250-	6250-	13,250.-
Locking System	5	Ea	2100-	10,500-	1250-	6250-	16,750.-
Truck Entrance Barrier	8	Ea	5000-	40,000-	24,000-	160,000-	200,000.-
Operating Mechanism	8	Ea	2300-	18,400-	4000-	32,000-	50,400.-
Locking System	8	Ea	3200-	25,600-	2600-	20,800-	46,400.-
Draw Bridge	4	Ea	4100-	16,400-	42,300-	169,200-	185,600.-
Operating Mechanism	4	Ea	2400-	9,600-	6,000-	24,000-	33,600.-
Locking System	4	Ea	3200-	12,800-	4,000-	16,000-	28,800.-
Blast Door	6	Ea	1200-	7200-	10,000-	60,000-	67,200.-
Operating Mechanism	6	Ea	2300-	13,800-	5500-	33,000-	46,800.-
Locking System	6	Ea	2100-	12,600-	1250-	7,500-	20,100.-
				182,250	Subtotal	615,220	797,270.-
				338			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 7	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT C		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	PER UNIT	LABOR TOTAL	PER UNIT	MATERIAL TOTAL	TOTAL COST
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21		16	16	107
Ductwork							
40" x 20"	32	ft	23.26	744	10.43	334	1,078
20" x 20"	10	ft	13.80	138	8.02	80	218
10" x 8"	40	ft	4.47	195	2.83	113	308
10" x 20"	10	ft	6.21	62	10.35	103	163
Registers							
8" x 10"	3	Ea	6	18	12	30	48
10" x 20"	1	Ea	8	8	12	18	26
20" x 20"	1	Ea	6	6	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				2,382		9,378	11,761
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8,190.-	11,190.-
Detectors	8	Ea	275.-	2200.-	110.-	880.-	3,080.-
Control Panel	1	Ea	275.-	275.-	1358.-	1358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	302	ft	1.50	453.	2.90	876.	1,329
				6203.		12,051	18,254

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4					
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____							
LOCATION											
ARCHITECT ENGINEER BLACK & VEATCH											
DRAWING NO. CONCEPT "D"		ESTIMATOR Jaye		CHECKED BY							
Recap		SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST	
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL				
Fram Sht.	2				11,019,454		954,242			11,973,696	
	3				21,984		172,020			194,004	
	3				193,450		648,520			841,970	
	4				2,623		9,406			12,029	
	4				5,739		11,575			17,314	
subtotal					11,243,250		1,795,763			13,039,013	
PT&I					192		2,136,218			2,136,218	
Total Direct Cost					13,379,468					15,175,231	
Overhead @ 15%										2,276,285	
subtotal										17,451,516	
Profit @ 8%										1,396,121	
subtotal										18,847,637	
Bond @ 1%										188,476	
Total Construction Cost in 3rd Quarter 1982 Dollars										19,036,113	
Design Engineering 6%										1,142,168	
Total Cost (Comparative Cost Estimate)										20,178,281	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BAIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "D"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	156,455	CY	65 ⁰⁰	10,169,575	—	—	10,169,575
Concrete	4,685	CY	121 ⁰⁰	566,885	138 ⁰⁰	646,530	1,213,415
Gunita Liner	20,985	SF	0 ⁸²	179,767	0 ⁸²	165,628	345,395
Rock Bolting	15,225	LF	1 ⁹¹	29,280	0 ⁸⁰	7,613	36,693
<u>Sub-Totals</u>				<u>10,945,307</u>		<u>819,771</u>	<u>11,765,078</u>
Bullet Proof Glass	260	SF	18 ³⁸	4,779	33 ³⁵	8,671	13,450
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	2	EA	60 ⁰⁰	120	200 ⁰⁰	400	520
2'-8" x 7'-0"	2	EA	60 ⁰⁰	120	180 ⁰⁰	360	480
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	30,235	SF	0 ⁵⁸	15,117	1 ⁰⁰	30,235	45,352
Electrical							
Power	30,235	SF	1 ²⁵	37,794	1 ¹⁵	52,911	90,705
Lighting	30,235	SF	0 ⁸⁰	15,117	1 ²⁵	37,794	52,911
<u>Sub-Totals</u>				<u>79,147</u>		<u>149,471</u>	<u>228,618</u>
<u>Totals - This Sheet</u>				<u>11,019,454</u>		<u>954,242</u>	<u>11,973,696</u>

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4		
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
DRAWING NO. CONCEPT D		ESTIMATOR Griffin		CHECKED BY				
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Material Handling Eq.								
Loading Dolly	2	Ea	8000.-	16,000.-	25000.-	50,000.-	66,000.-	
Track	576	ft	1.50	864.-	90.-	51,840.-	52,704.-	
Power Cable	300	ft	2.-	600.-	12.-	3600.-	4200.-	
Container Sling	32	Ea	-	-	1500.-	48,000.-	48,000.-	
Bridge Crane	1	Ea	4000.-	4000.-	10000.-	10,000.-	14,000.-	
Monorail	64	ft	5.-	320.-	45.-	2880.-	3,200.-	
Trolley Hoist	1	Ea	200.-	200.-	5700.-	5,700.-	5,900.-	
				22034	Subtotal	172,020	194,054.-	
Equipment								
Motor/Gen Set (100 KW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-	
Complete w/Sw Gear								
Compressed Air System	1	Ea	2000.-	2000.-	10,000.-	10,000.-	12,000.-	
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-	
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	40,750.-	50,500.-	
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-	
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20000.-	160,000.-	200,000.-	
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-	
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-	
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	167,200.-	185,600.-	
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-	
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-	
Blast Door	8	Ea	1200.-	9,600.-	10,000.-	80,000.-	89,600.-	
Operating Mechanism	8	Ea	2300.-	18,400.-	5500.-	44,000.-	62,400.-	
Locking System	8	Ea	2100.-	16,800.-	1250.-	10,000.-	26,800.-	
				193,450	Subtotal	648,520	841,970.-	
				342				

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 82		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT D		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000cfm)	1	Ea	21	21	86	86	107
Ductwork							
40"x20"	30	ft	23.26	698	11.43	313	1,011
10"x8"	24	ft	4.87	117	2.83	68	185
20"x8"	40	ft	8.91	356	4.22	160	516
20"x20"	15	ft	13.80	207	8.02	120	327
Registers							
8" x 10"	3	Ea	6	18	10	30	48
8" x 20"	1	Ea	7	7	15	15	22
20" x 20"	1	Ea	8	8	31	31	39
Damper, Blast 8" x 10"	1	Ea	3	3	17	17	25
Vaneaxial Fan 2500cfm @ .3	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 Kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 2,623</u>		<u>\$ 9,406</u>	<u>\$ 12,029</u>
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8,190.-	11,190.-
Detectors	7	Ea	275.-	1925.-	110.-	770.-	2,695.-
Control Panel	1	Ea	275.-	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	176	ft	1.50	264.0	2.90	510.0	774.-
Fire Protection Totals				<u>5,739</u>		<u>11,575</u>	<u>17,314</u>
				343			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "E"		ESTIMATOR Jaye		CHECKED BY				
Recap SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2					7,831,213		867,438	8,698,651
3					67,500		111,775	179,275
3					171,050		581,520	752,570
4					2,613		9,447	12,060
4					4,828		9,758	14,586
subtotal					8,077,204		1,579,938	9,657,142
PT&I				192	1,534,669			1,534,669
Total Direct Cost					9,611,873			11,191,811
Overhead @ 15%								1,678,772
subtotal								12,870,583
Profit @ 8%								1,029,647
subtotal								13,900,230
Bond @ 1%								139,002
Total Construction Cost in 3rd Quarter 1982 Dollars								14,039,232
Design Engineering 6%								842,353
Total Cost (Comparative Cost Estimate)								14,881,585

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BASE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "E"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	108,630	CY	65 ⁰⁰	7,060,950	—	—	7,060,950
Concrete	4,355	CY	121 ⁰⁰	526,955	138 ⁰⁰	600,990	1,127,945
Gunita Liner	174,050	SF	0 ⁸²	154,905	0 ⁸²	142,721	297,626
Rock Bolting	13,125	LF	1 ⁹¹	25,069	0 ⁵⁰	6,563	31,632
<u>Sub-Totals</u>				7,767,879		750,273	8,518,152
Bullet Proof Glass	300	SF	18 ³⁸	5,514	33 ³⁵	10,005	15,519
Bullet Proof Dr. 3'x7'	9	EA	200 ⁰⁰	1,800	750 ⁰⁰	6,750	8,550
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	5	EA	60 ⁰⁰	300	180 ⁰⁰	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	24,640	SF	0 ⁵⁰	12,320	1 ⁰⁰	24,640	36,960
Electrical							
Power	24,640	SF	1 ²⁵	30,800	1 ⁷⁵	43,120	73,920
Lighting	24,640	SF	0 ⁵⁰	12,320	1 ²⁵	30,800	43,120
<u>Sub-Totals</u>				68,334		132,165	200,499
<u>Totals - This Sheet</u>				7,831,213		867,438	8,698,651

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT E		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Stacker Crane	2	Ea	9000-	18,000-	22,000-	44,000-	62,000.-
Rails	275	ft	100-	27,500.-	45-	12,375-	39,875.-
Conveyor	80	ft	100-	8000.-	180-	14,400.-	22,400.-
Conveyor Drive	4	Ea	500-	2,000.-	2600-	8,900.-	10,900.-
Bridge Crane	3	Ea	4000-	12,000-	10,000-	30,000-	42,000.-
Sling	2	Ea	-	-	1500-	3000.-	3,000.-
				67,500	Subtotal		179,275.-
						111,775	
Equipment							
Motor/Gen Set (100 KW)	1	Ea	4000-	4000.-	21,000-	21,000.-	25,000.-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000-	2000.-	10,000-	10,000.-	12,000.-
Piping - 1 1/2"	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350-	1750.-	9750-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400-	7000.-	1250-	6250.-	13,250.-
Locking System	5	Ea	2100-	10,500.-	1250-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	9000-	40,000.-	20,000-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300-	18,400.-	4000-	32,000.-	50,400.-
Locking System	8	Ea	3200-	25,600.-	2600-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100-	16,400.-	42,300-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400-	9,600.-	6,000-	24,000.-	33,600.-
Locking System	4	Ea	3200-	12,800.-	4,000-	14,000.-	26,800.-
Blast Door	4	Ea	1200-	4,800.-	10,000-	40,000.-	44,800.-
Operating Mechanism	4	Ea	2300-	9,200.-	5500-	22,000.-	31,200.-
Locking System	4	Ea	2100-	8,400.-	1250-	5,000.-	13,400.-
				171,050	Subtotal		752,570.-
						521,520	

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT E		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	36	36	107
Ductwork							
40" x 20"	30	ft	23.26	698	15.43	310	1,008
10" x 8"	24	ft	4.87	117	2.83	68	185
20" x 20"	40	ft	13.80	552	8.02	321	873
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 2,613		\$ 9,447	\$ 12,260
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600	2400	1638	6,552	8,952
Detectors	6	Ea	275	1650	110	660	2,310
Control Panel	1	Ea	275	275	1358	1,358	1,633
Auxiliary Equip	1	Lot	275	275	747	747	1,022
Wiring (Shielded 2 Wire)	152	ft	1.50	228	2.30	441	669
				4,828		9,758	14,586

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "F"		ESTIMATOR Jaye		CHECKED BY			
Recap		SUMMARY		LABOR		MATERIAL	
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL
Fram Sht.	2				7,356,451		1,158,689
	3				181,200		523,600
	3				210,250		698,770
	4				2,431		9,377
	4				5,745		11,587
	subtotal				7,756,077		2,402,023
PT&I				19%	1,473,655		1,473,655
	Total Direct Cost				9,229,732		11,631,755
	Overhead @ 15%						1,744,763
	subtotal						13,376,518
	Profit @ 8%						1,070,121
	subtotal						14,446,639
	Bond @ 1%						144,466
	Total Construction Cost in 3rd Quarter 1982 Dollars						14,591,105
	Design Engineering 6%						875,468
	Total Cost (Comparative Cost Estimate)						15,466,573

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-1-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE			
LOCATION				☒ CODE A (Final design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Partial design) ☐ OTHER (Specify)			
ARCHITECT ENGINEER BLACK & VEATCH				CHECKED BY			
DRAWING NO. CONCEPT "F"		ESTIMATOR Jaye					
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	97,475	CY	65 ⁰⁰	6,335,875	—	—	6,335,875
Concrete	6,035	CY	121 ⁰⁰	730,235	138 ⁰⁰	832,830	1,563,065
Guniting Liner	197,020	SF	0 ⁸²	175,348	0 ⁸²	161,556	336,904
Rock Bolting	14,850	LF	1 ⁹¹	28,364	0 ⁵⁰	7,425	35,789
<u>Sub-Totals</u>				7,269,822		1,001,811	8,271,633
Bullet Proof Glass	220	SF	18 ³⁸	4,044	33 ³⁵	7,337	11,381
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	36,030	SF	0 ⁵²	18,015	1 ⁰⁰	36,030	54,045
Electrical							
Power	36,030	SF	1 ²⁵	45,038	1 ⁷⁵	63,053	108,088
Lighting	36,030	SF	0 ⁵⁰	18,015	1 ²⁵	45,038	63,053
<u>Sub-Totals</u>				91,629		171,878	263,507
<u>Totals - This Sheet</u>				7,356,451		1,158,689	8,515,140

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BAIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT F		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	43	43	261	261	261
Entrance Filter (3000 cfm)	1	Ea	21	21	26	26	27
Ductwork							
20" x 20"	50	ft	13.80	690	3.02	401	1091
20" x 8"	50	ft	8.91	446	4.00	200	646
10" x 8"	10	ft	4.27	43	2.82	28	77
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	3	8	18	18	26
20" x 20"	1	Ea	3	8	31	31	39
Blast Damper (8" x 10")	1	Ea	3	3	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	70	396	1,375	5,500	5,896
				\$ 2,431		\$ 9,377	\$ 11,808
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8,190.-	11,190.-
Detectors	7	Ea	275.-	1925.-	110.-	770.-	2695.-
Control Panel	1	Ea	275.-	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	180	ft	1.50	270.-	2.90	522.-	792.-
				5,745		11,587	17,332

CONSTRUCTION COST ESTIMATE

DATE PREPARED

8-9-82

SHEET 1 of 4

PROJECT

CERL STUDY (in Mountain)

BASIS FOR ESTIMATE

☒ CODE A (No design completed)☐ CODE B (Preliminary design)☐ CODE C (Final design)☐ OTHER (Specify)

LOCATION

ARCHITECT ENGINEER

BLACK & VEATCH

DRAWING NO.

CONCEPT "G"

ESTIMATOR

Jaye

CHECKED BY

Recap	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
	Fram Sht. 2				7,654,758		1,183,351	8,838,109
	3				12,000		84,000	96,000
	3				159,850		548,020	707,870
	4				1,861		9,073	10,934
	4				9,026		17,189	26,215
	subtotal				7,837,495		1,841,633	9,679,128
	PT&I			19%	1,489,124			1,489,124
	Total Direct Cost				9,326,619			11,168,252
	Overhead @ 15%							1,675,238
	subtotal							12,843,490
	Profit @ 8%							1,027,479
	subtotal							13,870,969
	Bond @ 1%							138,710
	Total Construction Cost in 3rd Quarter 1982 Dollars							14,009,679
	Design Engineering 6%							840,581
	Total Cost (Comparative Cost Estimate)							14,850,260

CONSTRUCTION COST ESTIMATE				DATE PREPARED R- 2-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "G"		ESTIMATOR Jaye		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	101,815	CY	65 ⁰⁰	6,617,975	—	—	6,617,975
Concrete	6,205	CY	121 ⁰⁰	750,805	138 ⁰⁰	856,290	1,607,095
Guniting Liner	188,095	SF	0 ⁸²	167,405	0 ⁸²	154,238	321,643
Rock Bolting	14,175	LF	1 ⁹¹	27,074	0 ⁵⁰	7,088	34,162
<u>Sub-Totals</u>				\$7,563,259		\$1,017,616	\$8,580,875
Bullet Proof Glass	300	SF	18 ³⁸	5,514	33 ³⁵	10,005	15,519
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	2	EA	60 ⁰⁰	120	200 ⁰⁰	400	520
2'-8" x 7'-0"	5	EA	60 ⁰⁰	300	180 ⁰⁰	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	37,495	SF	0 ⁵⁰	18,748	1 ⁰⁰	37,495	56,243
Electrical							
Power	37,495	SF	1 ²⁵	46,869	1 ⁷⁵	65,616	112,485
Lighting	37,495	SF	0 ⁰⁰	18,748	1 ²⁵	46,869	65,617
<u>Sub-Totals</u>				\$96,499		\$180,735	\$277,234
<u>Totals - This Sheet</u>				\$7,654,758		\$1,183,351	\$8,838,109

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT G		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Bridge Crane 45'	2	Ea	4000.-	8,000.-	13,000.-	26,000.-	34,000.-
Bridge Crane 32'	1	Ea	4000.-	4,000.-	10,000.-	10,000.-	14,000.-
Sling	32	Ea	-	-	1500.-	48,000.-	48,000.-
				12,200	Subtotal		96,000.-
						84,200	
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000.-	4,000.-	21,000.-	21,000.-	25,000.-
Complete w/ Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1,750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7,000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	9000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	2	Ea	1200.-	2,400.-	10,000.-	20,000.-	22,400.-
Operating Mechanism	2	Ea	2300.-	4,600.-	5500.-	11,000.-	15,600.-
Locking System	2	Ea	2100.-	4,200.-	1250.-	2,500.-	6,700.-
				159,850	Subtotal		707,870
						548,020	

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 82		SHEET 4 OF 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				 BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT G		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	10	ft	23.26	233	10.43	104	237
20" x 20"	22	ft	13.60	304	8.02	176	480
10" x 8"	16	ft	4.87	78	2.83	45	123
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	12	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Dust Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 1,861</u>		<u>\$ 9,073</u>	<u>\$ 10,934</u>
FIRE PROTECTION							
Halon Units (101 lb)	10	Ea	600.-	6000.-	1367.-	13,670.-	19,670.-
Detectors	8	Ea	275.-	2200.-	110.-	880.-	3,080.-
Control Panel	1	Ea	275.-	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	184	ft	1.50	276.-	2.90	534	810.-
				<u>9,026</u>		<u>17,189</u>	<u>26,215</u>

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 OF 4		
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "H"		ESTIMATOR Jaye		CHECKED BY				
Recap SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Fram Sht. 2					5,680,328		1,339,989	7,020,317
3					32,320		259,680	292,000
3					237,450		668,770	906,220
4					2,113		9,209	11,322
4					4,840		9,781	14,621
subtotal					5,957,051		2,287,429	8,244,480
PT&I				192	1,131,840			1,131,840
Total Direct Cost					7,088,891			9,376,320
Overhead @ 15%								1,406,448
subtotal								10,782,768
Profit @ 8%								862,621
subtotal								11,645,389
Bond @ 1%								116,454
Total Construction Cost in 3rd Quarter '82 Dollars								11,761,843
Design Engineering 6%								705,711
Total Cost (Comparative Cost Estimate)								12,467,554

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 OF 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "H"		ESTIMATOR Jaye		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	69,590	CY	65 ⁰⁰	4,523,350	—	—	4,523,350
Concrete	7,145	CY	121 ⁰⁰	864,545	138 ⁰⁰	986,010	1,850,555
Guniting Liner	172,250	SF	0 ⁸²	153,303	0 ⁸²	141,245	294,548
Rock Bolting	12,975	LF	1 ⁹¹	24,782	0 ⁵⁰	6,488	31,270
<u>Sub-Totals</u>				\$5,565,980		\$1,133,743	\$6,699,723
Bullet Proof Glass	219	SF	18 ³⁵	4,025	33 ³⁵	7,304	11,329
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰⁰	240	200 ⁰⁰	800	1,040
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	48,330	SF	0 ⁵⁰	24,165	1 ⁰⁰	48,330	72,495
Electrical							
Power	48,330	SF	1 ²⁵	60,413	1 ⁷⁵	84,578	144,991
Lighting	48,330	SF	0 ⁵⁰	24,165	1 ²⁵	60,413	84,578
<u>Sub-Totals</u>				\$119,348		\$221,245	\$340,593
<u>Totals - This Sheet</u>				\$5,680,328		\$1,339,989	\$7,020,316

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT H		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Monorail	32	Ea	60.-	1920.-	540.-	17,280.-	19,200.-
Trolley Hoist	32	Ea	200.-	6400.-	5700.-	182,400.-	188,800.-
Bridge Crane (Maint)	1	Ea	4000.-	4000.-	10,000.-	10,000.-	14,000.-
Controller	2	Ea	10,000.-	20,000.-	25,000.-	50,000.-	70,000.-
				32,320	Subtotal		292,000.-
						259,680	
Equipment							
Trap Doors	32	Ea	350.-	11,200.-	1200.-	38,400.-	49,600.-
Operating Mechanism	32	Ea	900.-	28,800.-	1250.-	40,000.-	68,800.-
Locking System	32	Ea	1000.-	32,000.-	800.-	25,600.-	57,600.-
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000.-	2000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	3	Ea	1200.-	3,600.-	10,000.-	30,000.-	33,600.-
Operating Mechanism	3	Ea	2300.-	6,900.-	5500.-	16,500.-	23,400.-
Locking System	3	Ea	2100.-	6,300.-	1250.-	3,750.-	10,050.-
				237,450.-		668,770.-	906,220.-

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CONSTRUCTION COST ESTIMATE.				DATE PREPARED 20 July 62		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT H		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3060 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	36	ft	13.80	497	8.02	289	786
20" x 8"	36	ft	8.91	321	4.00	144	465
10" x 8"	10	ft	4.87	49	2.83	28	77
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vane axial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 2,113		\$ 9,209	\$ 11,322
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600.-	2400.-	1638.-	6552.-	8952.-
Detectors	6	Ea	275.-	1650.-	110.-	660.-	2,310.-
Control Panel	1	Ea	275.-	275.-	1358.-	1358	1,633.-
Auxiliary Equip.	1	Lot	275.-	275	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	160	ft	1.52	240.-	2.92	467.-	704.-
				4840		9,781	14,621
				359			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "I"		ESTIMATOR Jaye		CHECKED BY			

	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
<u>Recap</u>								
Fram Sht.	2				7,015,828		1,165,838	8,181,666
	3				154,850		274,135	428,985
	3				350,250		1,117,520	1,467,770
	4				2,825		9,483	12,308
	4				4,828		9,758	14,586
subtotal					7,528,581		2,576,734	10,105,315
PT&I				192	1,430,430			1,430,430
Total Direct Cost					8,959,011			11,535,745
Overhead @ 15%								1,730,362
subtotal								13,266,107
Profit @ 8%								1,061,289
subtotal								14,327,396
Bond @ 1%								143,274
Total Construction Cost in 3rd Quarter 1982 Dollars								14,470,670
Design Engineering 6%								868,239
Total Cost (Comparative Cost Estimate)								15,338,909

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 OF 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "I"		ESTIMATOR <i>Jaye</i>		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	92,250	CY	65 ⁰⁰	5,996,250	—	—	5,996,250
Concrete	6,030	CY	121 ⁰⁰	729,630	138 ⁰⁰	832,140	1,561,770
Guniting Liner	188,600	SF	0 ⁸²	167,854	0 ⁸²	154,652	322,506
Rock Bolting	14,175	LF	1 ⁹¹	27,074	0 ⁵⁰	7,088	34,162
<u>Sub-Totals</u>				\$6,920,808		\$993,880	\$7,914,688
Bullet Proof Glass	190	SF	18 ³¹	3,492	33 ³⁵	6,337	9,829
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	5	EA	60 ⁰⁰	300	200 ⁰⁰	1,000	1,300
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	39,950	SF	0 ⁵⁰	19,975	1 ⁰⁰	39,913	59,925
Electrical							
Power	39,950	SF	1 ²⁵	49,938	1 ⁷⁵	69,913	119,851
Lighting	39,950	SF	0 ⁵⁰	19,975	1 ²⁵	49,938	69,913
<u>Sub-Totals</u>				\$100,020		\$186,958	\$286,968
<u>Totals - This Sheet</u>				\$7,015,828		\$1,165,838	\$8,181,666

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT I		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY	LABOR		MATERIAL		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Conveyor	720	ft	100.-	72,000.-	180.-	129,600.-	201,600.-
Conveyor Drive	32	Ea	500.-	16,000.-	2000.-	64,000.-	80,000.-
Bridge Crane (Maint)	1	Ea	4000.-	4,000.-	10,000.-	10,000.-	14,000.-
Bridge Crane	2	Ea	4000.-	8,000.-	8500.-	17,000.-	25,000.-
Bridge Crane Rails	264	ft	50.-	12,200.-	90.-	23,760.-	36,960.-
Monorail	275	ft	150.-	41,250.-	45.-	12,375.-	53,625.-
Trolley Hoist	2	Ea	200.-	400	5700.-	11,400.-	11,800.-
Sling	4	Ea	-	-	1500.-	6,000.-	6,000.-
				154,850	Subtotal	274,135	428,985.-
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000	10,000.-	12,000.-
Piping - 1" x	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	36	Ea	1200.-	43,200.-	10,000.-	360,000.-	403,200.-
Operating Mechanism	36	Ea	2300.-	82,800.-	5500.-	198,000.-	280,800.-
Locking System	36	Ea	2100.-	75,600.-	1250.-	45,000.-	120,600.-
					Subtotal		1,467,770.-
				350,250		1,117,520	
				362			

CONSTRUCTION COST ESTIMATE.				DATE PREPARED 20 July '82		SHEET 1 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT I		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	30	ft	23.26	698	10.23	313	1,011
20" x 20"	15	ft	12.30	207	3.12	120	327
10" x 8"	150	ft	4.49	674	2.01	302	976
		ft					
Registers							
8" x 10"	3	Ea	16	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	6	6	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 2,625</u>		<u>\$ 7,483</u>	<u>\$ 12,308</u>
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600.-	2400.-	1638.-	6552.-	8,952.-
Detectors	6	Ea	275.-	1650.-	110.-	660.-	2,310.-
Control Panel	1	Ea	275.-	275.-	1358.-	1358.-	1,633.-
Auxiliary Equip	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	152	ft	1.50	228.-	2.90	441.-	669
Fire Protection Totals				<u>4828</u>		<u>9,758</u>	<u>14,586</u>
				363			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 OF 4		
PROJECT CERL STUDY (in Mountain)				BASE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION 								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "J"		ESTIMATOR Jaye		CHECKED BY 				
Recap SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Fram Sht.	2				13,248,649		1,566,070	14,814,719
	3				250,000		318,760	568,760
	3				182,250		615,020	797,270
	4				4,231		9,889	14,120
	4				9,068		16,004	25,072
subtotal					13,694,198		2,525,743	16,219,941
PT&I					192			2,601,898
Total Direct Cost					16,296,096			18,821,839
Overhead @ 15%								2,823,276
subtotal								21,645,115
Profit @ 8%								1,731,609
subtotal								23,376,724
Bond @ 1%								233,767
Total Construction Cost in 3rd Quarter 1982 Dollars								23,610,491
Design Engineering 6%								1,416,629
Total Cost (Comparative Cost Estimate)								25,027,120

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BAIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "J"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	182,405	CY	65 ⁰⁰	11,856,325	—	—	11,856,325
Concrete	8,290	CY	121 ⁰⁰	1,003,090	138 ⁰⁰	1,144,020	2,147,110
Guniting Liner	278,755	SF	0 ⁸²	248,092	0 ⁸²	228,579	476,671
Rock Bolting	21,000	LF	1 ⁹¹	40,110	0 ⁵⁰	10,500	50,610
<u>Sub-Totals</u>				\$13,147,617		\$1,383,099	\$14,530,716
Bullet Proof Glass	260	SF	18 ³⁸	4,779	33 ³⁵	8,671	13,450
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	8	EA	60 ⁰⁰	480	200 ⁰⁰	1,600	2,080
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	41,970	SF	0 ⁵⁰	20,985	1 ⁰⁰	41,970	62,955
Electrical							
Power	41,970	SF	1 ²⁵	52,463	1 ⁷⁵	73,447	125,910
Lighting	41,970	SF	0 ⁵⁰	20,985	1 ²⁵	52,463	73,447
<u>Sub-Totals</u>				\$106,032		\$197,971	\$304,003
<u>Totals - This Sheet</u>				\$13,248,649		\$1,566,070	\$14,814,719

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "J"		ESTIMATOR Griffin		CHECKED BY			
SUMMARY		QUANTITY		LABOR		MATERIAL	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	TOTAL COST
Material Handling Eq.							
Rail (40 lb.)	1152	ft	100.-	115,200.-	45.-	51,840.-	167,040.-
Rail Car w/Conc. Block	36	Ea	1500.-	54,000.-	2200.-	79,200.-	133,200.-
Drive Unit w/Chain	2	Ea	1500.-	3,000.-	8500.-	17,000.-	20,000.-
Jib Crane	2	Ea	2000.-	4,000.-	7500.-	15,000.-	19,000.-
Trolley Hoist w/Sling	2	Ea	200.-	400.-	7200.-	14,400.-	14,800.-
Bridge Crane 28'	2	Ea	4000.-	8,000.-	8500.-	17,000.-	25,000.-
Conveyor	624	ft	100.-	62,400.-	180.-	112,320.-	174,720.-
Conveyor Drive	6	Ea	500.-	3,000.-	2000.-	12,000.-	15,000.-
				250,000	Subtotal		568,760.-
Equipment							
						318,760	
Motor/Gen Set (100 KW)	1	Ea	4000.-	4,000.-	21,000.-	21,800.-	23,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	24,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	6	Ea	1200.-	7,200.-	10,000.-	60,000.-	67,200.-
Operating Mechanism	6	Ea	2300.-	13,800.-	5500.-	33,000.-	46,800.-
Locking System	6	Ea	2100.-	12,600.-	1250.-	7,500.-	20,100.-
				182,250	Subtotal		197,270.-
						615,020	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 62		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "J"		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	15	ft	23.26	349	10.43	157	506
20" x 20"	160	ft	12.26	1,962	4.24	678	2,640
10" x 8"	150	ft	4.49	674	2.01	306	980
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	33	48
10" x 20"	1	Ea	6	6	18	18	24
20" x 20"	1	Ea	6	6	31	31	39
Blast Damper (8" x 10")	1	Ea	3	3	17	17	25
Vane axial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 4,231</u>	<u>\$ 9,829</u>	<u>\$ 14,100</u>	
FIRE PROTECTION							
Halon Units (101 lb)	7	Ea	600-	4200.-	1367-	9569.-	13,769.-
Detectors	12	Ea	275-	3300.-	110.-	1320.-	4,620.-
Control Panel (2 Zone)	2	Ea	275-	550.-	1358-	2716.-	3,266.-
Auxiliary Equip.	2	Lot	275-	550.-	747-	1494.-	2,044.-
Wiring (Shielded 2 Wire)	312	ft	1 ⁵⁰	468-	2 ⁹⁰	905-	1,373.-
				<u>9,068</u>	<u>16,004</u>	<u>25,072</u>	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "K"		ESTIMATOR Jaye		CHECKED BY			
Recap SUMMARY		QUANTITY		LABOR		MATERIAL	
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL
Frame Sht. 2					6,501,080	980,227	7,481,307
3					137,780	157,670	295,450
3					176,650	598,270	774,920
4					1,708	9,005	10,713
4					5,727	11,552	17,279
subtotal					6,822,945	1,756,724	8,579,669
PT & I				19%	1,296,360		1,296,360
Total Direct Cost					8,119,305		9,876,029
Overhead @ 15%							1,481,404
subtotal							11,357,433
Profit @ 8%							908,595
subtotal							12,266,028
Bond @ 1%							122,660
Total Construction Cost in 3rd Quarter 1982 Dollars							12,388,688
Design Engineering 6%							743,321
Total Cost (Comparative Cost Estimate)							13,132,009

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (in Mountain)				BAIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "K"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	86,695	CY	65 ⁰⁰	5,635,175	—	—	5,635,175
Concrete	5,085	CY	121 ⁰⁰	615,285	138 ⁰⁰	701,730	1,317,015
Guniting Liner	173,445	SF	0 ⁸²	154,366	0 ⁸²	142,225	296,591
Rock Bolting	13,050	LF	1 ⁹¹	24,926	0 ⁵⁰	6,525	31,451
<u>Sub-Totals</u>				6,429,752		850,480	7,280,232
Bullet Proof Glass	330	SF	18 ³⁸	6,065	33 ²⁵	11,006	17,071
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	28,330	SF	0 ⁵⁰	14,165	1 ⁰⁰	28,330	42,495
Electrical							
Power	28,330	SF	1 ²⁵	35,413	1 ⁷⁵	49,578	84,991
Lighting	28,330	SF	0 ⁸⁰	14,165	1 ²⁵	35,413	49,578
<u>Sub-Totals</u>				76,328		144,747	221,075
<u>Totals - This Sheet</u>				6,501,080		980,227	7,481,307

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY					BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____		
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT K			ESTIMATOR Griffin		CHECKED BY		

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Rail (40 lb)	770	ft	100.-	77,000.-	45.-	34,650.-	111,650.-
Rail Cars w/Conc. Block	36	Ea	1500.-	54,000.-	2200.-	79,200.-	133,200.-
Drive Unit w/Chain	2	Ea	1000.-	2,000.-	6400.-	13,000.-	15,000.-
Monorail	2	Ea	190.-	380.-	1710.-	3420.-	3,800.-
Trolley Hoist	2	Ea	200.-	400.-	5700.-	11,400.-	11,800.-
Sling	2	Ea	1.-	-	1500.-	3,000.-	3,000.-
Bridge Crane 45'	1	Ea	4000.-	4000.-	13,000.-	17,000.-	17,000.-
				137,780	Subtotal		295,450.-
					157,670		
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	5	Ea	1200.-	6,000.-	10,000.-	50,000.-	56,000.-
Operating Mechanism	5	Ea	2300.-	11,500.-	5500.-	27,500.-	39,000.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6,250.-	16,750.-
				176,650	Subtotal		774,920.-
					598,270		
				370			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 62		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT K		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	20	ft	13.80	276	2.22	160	436
10" x 8"	20	ft	4.87	97	2.23	57	154
20" x 8"	10	ft	8.91	89	4.00	40	129
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vane axial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	37	37	305	305	342
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 1,708</u>		<u>\$ 9,005</u>	<u>\$ 10,713</u>
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8190.-	11,190.-
Detectors	7	Ea	275.-	1925.-	110.-	770.-	2695.-
Control Panel (1 zone)	1	Ea	275.-	275.-	1358.-	1358.-	1633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1022.-
Wiring (Shielded 2 wire)	168	ft	1.50	252.-	2.90	487.-	739.-
				<u>5,727</u>		<u>11,552</u>	<u>17,279</u>
				371			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 OF 4	
PROJECT CERL STUDY (in Mountain)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "L"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation & Haul	81,165	CY	65 ⁰⁰	5,275,725	—	—	5,275,725
Concrete	6,475	CY	121 ⁰⁰	783,475	138 ⁰⁰	893,550	1,677,025
Guniting Liner	176,175	SF	0 ⁸²	156,796	0 ⁸²	144,464	301,260
Rock Bolting	13,225	LF	1 ⁹¹	25,355	0 ⁵⁰	6,638	31,993
<u>Sub-Totals</u>				6,241,351		1,044,652	7,286,003
Bullet Proof Glass	340	SF	18 ³⁸	6,249	33 ³⁵	11,339	17,588
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	7	EA	60 ⁰⁰	420	200 ⁰⁰	1,400	1,820
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	3	EA	100 ⁰⁰	300	350 ⁰⁰	1,050	1,350
Plumbing	40,955	SF	0 ⁵⁰	20,478	1 ⁰⁰	40,955	61,433
Electrical							
Power	40,955	SF	1 ²⁵	51,194	1 ⁷⁵	71,671	122,865
Lighting	40,955	SF	0 ⁵⁰	20,478	1 ²⁵	51,194	71,672
<u>Totals - This Sheet</u>				6,341,710		1,226,731	7,568,441

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT L		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Conveyor w/Drives	32	Ea	1000.-	32,000.-	4700.-	150,400.-	182,400.-
Loading Bridge	2	Ea	3000.-	6000.-	25000.-	50,000.-	56,000.-
Rail	96	Ft	100.-	9600.-	45.-	4320.-	13,920.-
Monorail	2	Ea	150.-	300.-	1500.-	3000.-	3300.-
Trolley Hoist	2	Ea	200.-	400.-	5700.-	11,400.-	11,800.-
Bridge Crane	3	Ea	4000.-	12,000.-	8500.-	25,500.-	37,500.-
				60,300.-		244,620.-	304,920.-
Equipment							
Motor/Gen Set (100 KW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000.-	2000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	Ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	5	Ea	1200.-	6,000.-	10,000.-	50,000.-	56,000.-
Operating Mechanism	5	Ea	2300.-	11,500.-	5500.-	27,500.-	39,000.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6,250.-	16,750.-
				176,650.-		598,270.-	774,920.-

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 82		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT L		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	42	42	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	48	ft	13.20	662	3.02	385	1,047
10" x 8"	20	ft	4.87	97	2.83	57	154
		ft					
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 2,005</u>		<u>\$ 9,190</u>	<u>\$ 11,195</u>
FIRE PROTECTION							
Halon Units (101 lb)	6	Ea	600	3600	1367	8202	11,802
Detectors	5	Ea	275	1375	110	550	1925
Control Panel (1 Zone)	1	Ea	275	275	1358	1358	1633
Auxiliary Equip.	1	Lot	275	275	747	747	1022
Wiring (Shielded 2 wire)	100	ft	1.50	150	2.90	290	440
				<u>5,675</u>		<u>11,147</u>	<u>16,822</u>
				375			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "A"		ESTIMATOR Jaye		CHECKED BY				
Recap SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2					2,771,730		2,812,814	5,584,544
3					10,000		92,000	102,000
3					193,450		648,520	841,970
4					2,791		9,492	12,283
4					6,925		13,503	20,428
subtotal					2,984,896		3,576,329	6,561,225
PT&I				19%	567,130			567,130
Total Direct Cost					3,552,026			7,128,355
Overhead @ 15%								1,069,253
subtotal								8,197,608
Profit @ 8%								655,809
subtotal								8,853,417
Bond @ 1%								88,534
Total Construction Cost in 3rd Quarter 1982 Dollars								8,941,951
Design Engineering 6%								536,517
Total Cost (Comparative Cost Estimate)								9,478,468

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "A"		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	42,435	CY	2 ⁹⁴	103,541	—	—	103,541
Concrete	13,790	CY	167 ⁰²	2,302,930	180 ⁰²	2,482,200	4,785,130
Waterproofing	97,715	SF	0 ⁴⁵	43,972	1 ³⁰	117,258	161,230
Backfilling & Mounding	34,515	CY	3 ⁶³	125,290	—	—	125,290
Borrow	N/A	CY	4 ⁹⁹	—	4 ⁹²	—	—
Haul Excess	7,920	CY	0 ⁷⁵	5,940	—	—	5,940
Sub-Totals				2,653,388		2,599,456	5,252,844
Bullet Proof Glass	130	SF	10 ³⁸	2,390	33 ²⁵	4,336	6,726
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰²	240	200 ⁰²	800	1,040
2'-8" x 7'-0"	5	EA	60 ⁰²	300	180 ⁰²	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Plumbing	50,805	SF	0 ⁵²	25,403	1 ⁰⁰	50,805	76,208
Electrical							
Power	50,805	SF	1 ³⁵	63,506	1 ³⁵	88,909	152,415
Lighting	50,805	SF	0 ⁵²	25,403	1 ³⁵	63,506	88,909

Sub-Totals				123,342		228,356	351,698
Totals - This Sheet				2,771,730		2,812,814	5,584,544

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT A		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	50	ft	23.26	1163	10.43	522	1,685
20" x 20"	10	ft	13.80	138	8.02	80	218
10" x 8"	50	ft	4.87	244	2.83	142	386
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$2,791.-</u>		<u>\$9,492.-</u>	<u>\$12,283.-</u>
FIRE PROTECTION							
Halon Units (196 lb)	6	Ea	600.-	3600.-	1638	9,828.-	13,428.-
Detectors	9	Ea	275.-	2475.-	110.-	990.-	3,465.-
Control Panel	1	Ea	275.-	275.-	1,358	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	200	ft	1.50	300.-	2.90	580.-	880.-
				6,925		13,503.	
							\$20,428.
				379			

CONSTRUCTION COST ESTIMATE

DATE PREPARED

8-9-82

SHEET 1 of 4

PROJECT

CERL STUDY (Flat Land)

LOCATION

ARCHITECT ENGINEER

BLACK & VEATCH

BASIS FOR ESTIMATE

- ☒ CODE A (No design completed)
☐ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify) _____

DRAWING NO.

CONCEPT "B"

ESTIMATOR

Jaye

CHECKED BY

Recap	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht.	2				2,100,724		2,193,175	4,293,899
	3				136,880		284,000	420,880
	3				204,650		682,020	886,670
	4				2,613		9,450	12,063
	4				4,828		9,758	14,586
	subtotal				2,449,695		3,178,403	5,628,098
PT&I				192	465,442			465,442
Total Direct Cost					2,915,137			6,093,540
Overhead @ 15%								914,031
subtotal								7,007,571
Profit @ 8%								560,606
subtotal								7,568,177
Bond @ 1%								75,682
Total Construction Cost in 3rd Quarter 1982 Dollars								7,643,859
Design Engineering 6%								458,631
Total Cost (Comparative Cost Estimate)								8,102,490

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (Flat Land)				BASE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT 'B'				ESTIMATOR 		CHECKED BY 	
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	27,435	CY	2 ²⁴	66,941	—	—	66,941
Concrete	10,310	CY	167 ⁰²	1,721,770	180 ⁰²	1,855,800	3,577,570
Waterproofing	79,045	SF	0 ⁴⁵	35,570	1 ³⁰	94,854	130,424
Backfilling & Mounding	28,115	CY	3 ⁶²	102,057	—	—	102,057
Borrow	17,825	CY	4 ⁹⁹	88,847	4 ⁷²	87,245	176,092
Haul Excess	N/A	CY	0 ⁷⁵	—	—	—	—
Sub-Totals				2,015,185		2,037,899	4,053,084
Bullet Proof Glass	172	SF	18 ³¹	3,151	33 ²⁵	5,736	8,887
Bullet Proof Dr. 3' x 7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	6	EA	60 ⁰²	360	200 ⁰²	1,200	1,560
2'-8" x 7'-0"	5	EA	60 ⁰²	300	180 ⁰²	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Plumbing	35,835	SF	0 ⁵²	17,917	1 ⁰⁹	35,835	53,752
Electrical							
Power	35,835	SF	1 ²⁵	44,794	1 ⁷⁵	62,711	107,505
Lighting	35,835	SF	0 ⁵²	17,917	1 ²⁵	44,794	62,711

Sub-Totals			\$ 90,539		\$ 170,276	\$ 260,815
Totals - This Sheet			2,100,724		2,193,175	4,293,899

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT B		ESTIMATOR Griffin		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Conveyor	100	ft	180-	72,000-	180-	126,000-	198,000-
Container Transfer	32	Ea	1500-	48,000-	2500-	80,000-	128,000-
Monorail	80	ft	5-	400-	45-	3,600-	4,000-
Trolley Hoist	2	Ea	200-	400-	5700-	11,400-	11,800-
Bridge Crane	3	Ea	4000-	12,000-	12,000-	36,000-	48,000-
Container Sling	2	Ea	—	—	1500-	3,000-	3,000-
Conveyor Drive	12	Ea	500	6,000-	2000-	24,000-	30,000-
				136,800		284,000	420,800-
Equipment							
Motor/Gen Set (100 KW)	1	Ea	4000-	4000-	21,000-	21,000-	25,000-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000-	2,000-	10,000-	10,000-	12,000-
Piping - 1 1/2"	200	ft	3-	600-	1.35	270-	870-
Personnel Barrier 6500#	5	Ea	350-	1750-	9750-	48,750-	50,500-
Operating Mechanism	5	Ea	1400-	7000-	1250-	6250-	13,250-
Locking System	5	Ea	2100-	10,500-	1250-	6250-	16,750-
Truck Entrance Barrier	8	Ea	5000-	40,000-	24,000-	160,000-	200,000-
Operating Mechanism	8	Ea	2300-	18,400-	4000-	32,000-	50,400-
Locking System	8	Ea	3200-	25,600-	2600-	20,800-	46,400-
Draw Bridge	4	Ea	4100-	16,400-	42300-	169,200-	185,600-
Operating Mechanism	4	Ea	2400-	9,600-	6,000-	24,000-	33,600-
Locking System	4	Ea	3200-	12,800-	4,000-	16,000-	28,800-
Blast Door	10	Ea	1200-	12,000-	10,000-	100,000-	112,000-
Operating Mechanism	10	Ea	2300-	23,000-	5500-	55,000-	78,000-
Locking System	10	Ea	2100-	21,000-	1250-	12,500-	33,500-
				204,650		682,020	886,670-
				382			

CONSTRUCTION COST ESTIMATE.				DATE PREPARED 20 July '82		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT B		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	30	ft	23.26	698	10.43	313	1,011
10" x 8"	24	ft	4.87	117	2.83	68	185
20" x 20"	40	ft	13.80	552	8.02	321	873
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ 2")	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
HVAC SUB-TOTALS				<u>\$2,613</u>	<u>\$9,450</u>	<u>\$12,063</u>	
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600	2400	1638	6,552	8,952
Detectors	6	Ea	275	1650	110	660	2,310
Control Panel	1	Ea	275	275	1,358	1,358	1,633
Auxiliary Equip.	1	Lot	275	275	747	747	1,022
Wiring (Shielded 2 Wire)	152	ft	1.50	228	2.90	441	669
Fire Protection Totals				<u>4,828</u>	<u>9,758</u>	<u>14,586</u>	

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "C"		ESTIMATOR Jaye		CHECKED BY				
<u>Recap</u>	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2					1,988,461		2,055,751	4,044,212
3					19,150		314,275	333,425
3					182,250		615,020	797,270
4					2,383		9,378	11,761
4					6,203		12,051	18,254
subtotal					2,198,447		3,006,475	5,204,922
PT & I					192 417,705			417,705
Total Direct Cost					2,616,152			5,622,627
Overhead @ 15%								834,394
subtotal								6,466,021
Profit @ 8%								517,282
subtotal								6,983,303
Bond @ 1%								69,833
Total Construction Cost in 3rd Quarter 1982 Dollars								7,053,136
Design Engineering 6%								423,188
Total Cost (Comparative Cost Estimate)								7,476,324

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 OF 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "C"				ESTIMATOR		CHECKED BY	
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	43,435	CY	2 ²⁴	105,981	—	—	105,981
Concrete	10,140	CY	167 ⁰⁰	1,676,680	180 ⁰⁰	1,807,200	3,483,880
Waterproofing	76,450	SF	0 ⁴⁵	34,403	1 ²⁰	91,740	126,143
Backfilling & Mounding	18,150	CY	3 ⁶³	65,884	—	—	65,884
Borrow	N/A	CY	4 ⁹²	—	4 ⁹²	—	—
Haul Excess	25,285	CY	0 ⁷⁵	18,964	—	—	18,964
Sub-Totals				1,901,912		1,898,940	3,800,852
Bullet Proof Glass	200	SF	18 ³⁵	3,676	33 ²⁵	6,670	10,346
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰⁰	240	200 ⁰⁰	800	1,040
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	36,130	SF	0 ⁵²	18,065	1 ⁰⁰	36,130	54,195
Electrical							
Power	36,130	SF	1 ²⁵	45,163	1 ⁷⁵	63,228	108,391
Lighting	36,130	SF	0 ⁵²	18,065	1 ²⁵	45,163	63,228
Sub-Totals				91,549		171,811	263,360
Totals - This Sheet				1,988,461		2,055,751	4,044,212

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT C		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Monrail	1500	ft	5-	7500-	45-	67,500-	75,000.-
Trolley Hoist	32	Ea	200-	6400-	5700-	182,400-	188,800.-
Sling	32	Ea	-	-	1500-	48,000-	48,000.-
Monorail Switch	35	Ea	150-	5250-	450-	15,750-	21,000.-
Maint. Dolly	1	Ea	-	-	625-	625-	625.-
Bridge Crane (Maint.)	1	Ea	4000-	4000-	10,000-	10,000-	14,000.-
				23,150.-		324,275.-	347,425.-
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000-	4000-	21,000-	21,000-	25,000.-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000-	2000-	10,000-	10,000-	12,000.-
Piping - 1 1/2"	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350-	1750-	9750-	48,750-	50,500.-
Operating Mechanism	5	Ea	1400-	7000-	1250-	6250-	13,250.-
Locking System	5	Ea	2100-	10,500-	1250-	6250-	16,750.-
Truck Entrance Barrier	8	Ea	5000-	40,000-	20,000-	160,000-	200,000.-
Operating Mechanism	8	Ea	2300-	18,400-	4000-	32,000-	50,400.-
Locking System	8	Ea	3200-	25,600-	2600-	20,800-	46,400.-
Draw Bridge	4	Ea	4100-	16,400-	42,300-	169,200-	185,600.-
Operating Mechanism	4	Ea	2400-	9,600-	6,000-	24,000-	33,600.-
Locking System	4	Ea	3200-	12,800-	4,000-	16,000-	28,800.-
Blast Door	6	Ea	1200-	7200-	10,000-	60,000-	67,200.-
Operating Mechanism	6	Ea	2300-	13,800-	5500-	33,000-	46,800.-
Locking System	6	Ea	2100-	12,600-	1250-	7,500-	20,100.-
				182,250	Subtotal	615,020	797,270.-

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT C		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	32	ft	23.26	744	10.43	334	1,078
20" x 20"	10	ft	13.80	138	8.02	80	218
10" x 8"	40	ft	4.87	195	2.83	113	308
10" x 20"	10	ft	6.01	60	10.35	103	163
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vane axial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 2,383</u>	<u>\$ 9,378</u>	<u>\$ 11,761</u>	
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600	3000	1638	8,190	11,190
Detectors	8	Ea	275	2200	110	880	3,080
Control Panel	1	Ea	275	275	1358	1358	1,633
Auxiliary Equip.	1	Lot	275	275	747	747	1,022
Wiring (Shielded 2 Wire)	302	ft	1.50	453	2.90	876	1,329
				<u>6203</u>	<u>12051</u>	<u>18254</u>	

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "D"		ESTIMATOR Jaye		CHECKED BY			
Recap SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2				1,871,381		1,934,461	3,805,842
3				21,984		172,020	194,004
3				193,450		648,520	841,970
4				2,623		9,406	12,029
4				5,739		11,575	17,314
subtotal				2,095,171		2,775,982	4,871,159
PT & I				192 398,084			398,084
Total Direct Cost				2,493,261			5,269,243
Overhead @ 15%							790,386
subtotal							6,059,629
Profit @ 8%							484,770
subtotal							6,544,399
Bond @ 1%							65,444
Total Construction Cost in 3rd Quarter 1982 Dollars							6,609,843
Design Engineering 6%							396,591
Total Cost (Comparative Cost Estimate)							7,006,434

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (Flat Land)				DATE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "D"		ESTIMATOR 		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	21,999	CY	2 ²⁴	53,678	—	—	53,678
Concrete	9,210	CY	167 ⁰²	1,538,070	180 ⁰²	1,657,800	3,195,870
Waterproofing	74,960	SF	0 ⁴⁵	33,732	1 ¹⁰	89,952	123,684
Backfilling & Mounding	32,460	CY	3 ⁶³	118,556	—	—	118,556
Borrow	10,661	CY	4 ¹⁹	53,198	4 ⁷²	52,238	105,436
Haul Excess	N/A	CY	0 ⁷⁸	—	—	—	—
<u>Sub-Totals</u>				1,797,234		1,799,990	3,597,224
Bullet Proof Glass	260	SF	10 ³¹	4,779	33 ³⁵	8,671	13,450
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	2	EA	60 ⁰²	120	200 ⁰²	400	520
2'-8" x 7'-0"	2	EA	60 ⁰²	120	180 ⁰²	360	480
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Plumbing	30,235	SF	0 ⁵⁸	15,117	1 ⁰²	30,235	45,352
Electrical							
Power	30,235	SF	1 ³⁵	37,794	1 ⁷⁵	52,911	90,705
Lighting	30,235	SF	0 ⁶²	15,117	1 ³⁵	37,794	52,911
<u>Sub-Totals</u>				79,147		149,471	228,618
Totals - This Sheet				1,871,381		1,934,461	3,805,842

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT D		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Loading Dolly	2	Ea	8000.-	16,000.-	25000.-	50,000.-	66,000.-
Track	576	ft	1.50	864.-	90.-	51,840.-	52,704.-
Power Cable	300	ft	2.-	600.-	12.-	3600.-	4200.-
Container Sling	32	Ea	-	-	1500.-	48,000.-	48,000.-
Bridge Crane	1	Ea	4000.-	4000.-	10000.-	10,000.-	14,000.-
Monorail	64	ft	5.-	320.-	45.-	2880.-	3,200.-
Trolley Hoist	1	Ea	200.-	200.-	5700.-	5,700.-	5,900.-
				22034	Subtotal	172,020	194,054.-
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete w/ Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500 ^{lb}	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	24,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	8	Ea	1200.-	9,600.-	10,000.-	80,000.-	89,600.-
Operating Mechanism	8	Ea	2300.-	18,400.-	5500.-	44,000.-	62,400.-
Locking System	8	Ea	2100.-	16,800.-	1250.-	10,000.-	26,800.-
				193,450	Subtotal		841,970.-
						648,520	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 1982		SHEET 4 OF 4		
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH DRAWING NO. CONCEPT D				ESTIMATOR CHECKED BY 				
BAIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____								
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC								
Entrance Louver		1	Ea	48	48	261	261	309
Entrance Filter (5000cfm)		1	Ea	21	21	86	86	107
Ductwork								
40"x20"		30	ft	23.26	698	11.43	313	1,011
10"x8"		24	ft	4.87	117	2.83	68	185
20"x8"		40	ft	8.91	356	4.00	160	516
20"x20"		15	ft	13.80	207	8.02	120	327
Registers								
8"x10"		3	Ea	6	18	10	30	48
8"x20"		1	Ea	7	7	15	15	22
20"x20"		1	Ea	8	8	31	31	39
Dampar, Blast 8"x10"		1	Ea	8	8	17	17	25
Vaneaxial Fan 3500cfm @ .2		2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 Kw)		1	Ea	39	39	305	305	344
Space Heater		4	Ea	99	396	1,375	5,500	5,896
					<u>\$ 2,623</u>		<u>\$ 9,406</u>	<u>\$ 12,029</u>
FIRE PROTECTION								
Halon Units (196 lb)		5	Ea	600.-	3000.-	1638-	8,190.-	11,190.-
Detectors		7	Ea	275.-	1925.-	110-	770.-	2,695.-
Control Panel		1	Ea	275.-	275.-	1358-	1,358.-	1,633.-
Auxiliary Equip.		1	Lot	275-	275.-	747-	747.-	1,022.-
Wiring (Shielded 2 Wire)		176	ft	1.50	264.0	2.90	510.0	774.-
Fire Protection Totals					<u>5,739</u>		<u>11,575</u>	<u>17,314</u>
391								

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "E"		ESTIMATOR Jaye		CHECKED BY				
RECAP SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2					1,721,619		1,778,326	3,499,945
3					67,500		111,775	179,275
3					171,050		581,520	752,570
4					2,613		9,440	12,053
4					4,828		9,758	14,586
subtotal					1,967,610		2,490,819	4,458,429
PT&I				192	373,846			373,846
Total Direct Cost					2,341,456			4,832,275
Overhead @ 15%								724,841
subtotal								5,557,116
Profit @ 8%								444,569
subtotal								6,001,685
Bond @ 1%								60,017
Total Construction Cost in 3rd Quarter 1982 Dollars								6,061,702
Design Engineering 6%								363,703
Total Cost (Comparative Cost Estimate)								6,425,405

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (Flat Land)				DATE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "E"		ESTIMATOR 		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	19,185	CY	2 ²⁴	46,811	—	—	46,811
Concrete	8,425	CY	167 ⁰⁰	1,406,975	180 ⁰⁰	1,516,500	2,923,475
Waterproofing	72,020	SF	0 ⁴⁵	32,409	1 ³⁰	86,424	118,833
Backfilling & Mounding	31,070	CY	3 ⁶³	112,784	—	—	112,784
Borrow	11,885	CY	4 ⁹⁹	59,306	4 ⁹²	58,237	117,543
Haul Excess	N/A	CY	0 ⁷⁵	—	—	—	—
Sub-Totals				1,658,285		1,661,161	3,319,446
Bullet Proof Glass	300	SF	18 ³¹	5,514	33 ³⁵	10,005	15,519
Bullet Proof Dr. 3'x7'	9	EA	200 ⁰⁰	1,800	750 ⁰⁰	6,750	8,550
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	5	EA	60 ⁰⁰	300	180 ⁰⁰	900	1,200
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	24,640	SF	0 ⁵⁸	12,320	1 ⁰⁰	24,640	36,960
Electrical							
Power	24,640	SF	1 ³⁵	30,800	1 ³⁵	43,120	73,920
Lighting	24,640	SF	0 ⁶⁰	12,320	1 ³⁵	30,800	43,120
Sub-Totals				1,834		132,165	200,499
Totals - This Sheet				1,721,619		1,778,326	3,499,945

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT E		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Stacker Crane	2	Ea	9000-	18,000-	22,000-	44,000-	62,000.-
Rails	275	ft	100-	27,500.-	45-	12,375-	39,875.-
Conveyor	80	ft	100-	8000.-	180-	14,400.-	22,400.-
Conveyor Drive	4	Ea	500-	2,000.-	2000-	8,000.-	10,000.-
Bridge Crane	3	Ea	4000-	12,000-	10,000-	30,000-	42,000.-
Sling	2	Ea	-	-	1500-	3000.-	3,000.-
				67,500	Subtotal		179,275.-
						111,775	
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000-	4000.-	21,000-	21,000.-	25,000.-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000-	2,000.-	10,000-	10,000.-	12,000.-
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350-	1750.-	9750-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400-	7000.-	1250-	6250.-	13,250.-
Locking System	5	Ea	2100-	10,500.-	1250-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000-	40,000.-	24000-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300-	18,400.-	4000-	32,000.-	50,400.-
Locking System	8	Ea	3200-	25,600.-	2600-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100-	16,400.-	42,300-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400-	9,600.-	6000-	24,000.-	33,600.-
Locking System	4	Ea	3200-	12,800.-	4,000-	14,000.-	26,800.-
Blast Door	4	Ea	1200-	4,800.-	10,000-	40,000.-	44,800.-
Operating Mechanism	4	Ea	2300-	9,200.-	5500-	22,000.-	31,200.-
Locking System	4	Ea	2100-	8,400.-	1250-	5000.-	13,400.-
				171,250	Subtotal		752,370.-
						581,520	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT E		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3060 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	30	ft	23.26	698	10.43	310	1,008
10" x 8"	24	ft	4.87	117	2.83	68	185
20" x 20"	40	ft	13.80	552	8.02	321	873
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vane axial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 2,613		\$ 9,447	\$ 12,060
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600.-	2400.-	1638.-	6,552.-	8,952.-
Detectors	6	Ea	275.-	1650.-	110.-	660.-	2,310.-
Control Panel	1	Ea	275	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	152	ft	1.50	228-	2.90	441.-	669-
				4,828		9,758	14,586

CONSTRUCTION COST ESTIMATE

DATE PREPARED

8-9-82

SHEET 1 of 4

PROJECT

CERL STUDY (Flat Land)

LOCATION

ARCHITECT ENGINEER

BLACK & VEATCH

BASE FOR ESTIMATE

☒ CODE A (No design completed)☐ CODE B (Preliminary design)☐ CODE C (Final design)☐ OTHER (Specify) _____

DRAWING NO.

CONCEPT "F"

ESTIMATOR

Jaye

CHECKED BY

Recap	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
	Frame Sht.	2			2,109,352		2,239,142	4,348,494
		3			181,200		523,600	704,800
		3			210,250		698,770	909,020
		4			2,431		9,377	11,808
		4			5,745		11,587	17,332
	subtotal				2,508,978		3,482,476	5,991,454
	PT&I			19%	476,706			476,706
	Total Direct Cost				2,985,684			6,468,160
	Overhead @ 15%							970,224
	subtotal							7,438,384
	Profit @ 8%							595,071
	subtotal							8,033,455
	Bond @ 1%							80,335
	Total Construction Cost in 3rd Quarter 1982 Dollars							8,113,790
	Design Engineering 6%							486,827
	Total Cost (Comparative Cost Estimate)							8,600,617

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CEEL STUDY (FLAT LAND)				BASES FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "F"		ESTIMATOR 		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	32,450	CY	2 ²⁴	79,178	—	—	79,178
Concrete	10,950	CY	167 ⁰⁰	1,828,650	180 ⁰⁰	1,971,000	3,799,650
Waterproofing	92,720	SF	0 ⁴⁵	41,724	1 ³⁰	111,264	152,988
Backfilling & Mounding	16,955	CY	3 ⁶³	61,547	—	—	61,547
Borrow	N/A	CY	4 ²⁵	—	4 ²⁵	—	—
Haul Excess	15,495	CY	0 ⁷⁵	11,621	—	—	11,621
<u>Sub-Totals</u>				2,022,720		2,082,264	4,104,984
Bullet Proof Glass	220	SF	18 ³³	4,044	33 ³⁵	7,387	11,381
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	36,030	SF	0 ⁵⁰	18,015	1 ⁰⁰	36,030	54,045
Electrical							
Power	36,030	SF	1 ²⁵	45,038	1 ⁷⁵	63,053	108,091
Lighting	36,030	SF	0 ⁵⁰	18,015	1 ²⁵	45,038	63,053
<u>Sub-Totals</u>				91,632		171,878	263,510
<u>Totals - This Sheet</u>				2,109,352		2,239,142	4,348,494

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT F		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Turntable w/Wall	4	Ea	2000-	8000.-	8000-	32,000-	40,000.-
Conveyor w/Drive	32	Ea	350-	11,200.-	4400-	156,800.-	168,000.-
Crane w/Retract. Boom	4	Ea	1500-	6000.-	10,000-	40,000.-	46,000.-
Conveyor	1360	Ft	100.-	136,000.-	180.-	244,800.-	380,800.-
Bridge Crane	5	Ea	4000-	20,000.-	10,000-	50,000.-	70,000.-
				181,200.-		523,600.-	704,800.-
Equipment							
Motor/Gen Set (100 kW)	1	Ea	4000-	4000.-	21,000-	21,000.-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000-	2,000.-	10,000-	10,000.-	12,000.-
Piping - 1" x	200	Ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350-	1750.-	9750-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400-	7000.-	1250-	6250.-	13,250.-
Locking System	5	Ea	2100-	10,500.-	1250-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000-	40,000.-	24,000-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300-	18,400.-	4000-	32,000.-	50,400.-
Locking System	8	Ea	3200-	25,600.-	2600-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100-	16,400.-	42,300-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400-	9,600.-	6,000-	24,000.-	33,600.-
Locking System	4	Ea	3200-	12,800.-	4,000-	14,000.-	26,800.-
Blast Door	11	Ea	1200-	13,200.-	10,000-	110,000.-	123,200.-
Operating Mechanism	11	Ea	2300-	25,300.-	5500-	60,500.-	85,800.-
Locking System	11	Ea	2100-	23,100.-	12,500-	13,750.-	36,850.-
				210,250	Subtotal		909,020.-
						698,770	

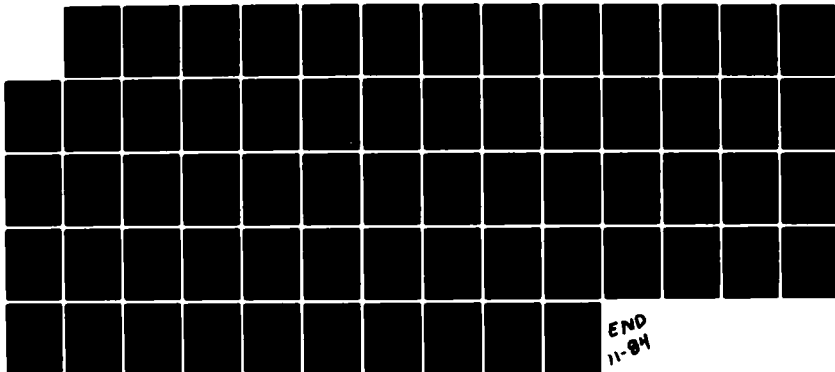
AD-A133 540

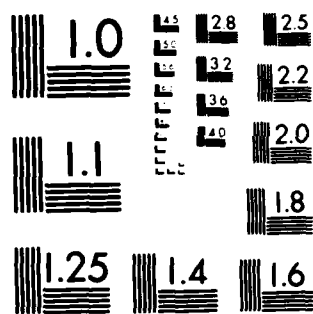
ADVANCED STRUCTURAL CONCEPTS FOR WEAPONS STORAGE - FLAT
AND MOUNTAINOUS TERRAINS(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL JUN 83 CERL-TR-M-330
MIPR-82-529 F/G 19/1

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 62		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT F		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3600 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	50	ft	13.80	690	8.02	401	1091
20" x 8"	50	ft	8.91	446	4.00	200	646
10" x 8"	10	ft	4.87	49	2.82	28	77
		ft					
Registers							
8" x 16"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vane axial Fan (3500 cfm @ .2)	2	Ea	350	700	1,850	3,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 2,431		\$ 9,377	\$ 11,808
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8,190.-	11,190.-
Detectors	7	Ea	275.-	1925.-	110.-	770.-	2695.-
Control Panel	1	Ea	275.-	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	180	ft	1.50	270.-	2.90	522.-	792.-
				5,745		11,587	17,332

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "G"		ESTIMATOR Jaye		CHECKED BY			
<i>Recap</i> SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht. 2				4,415,220		2,454,732	6,869,952
3				12,000		84,000	96,000
3				159,850		548,020	707,870
4				1,861		9,073	10,934
4				9,026		17,189	26,215
subtotal				4,597,957		3,113,014	7,710,971
PT&I				192			873,612
Total Direct Cost				5,471,569			8,584,583
Overhead @ 15%							1,287,687
subtotal							9,872,270
Profit @ 8%							789,782
subtotal							10,662,052
Bond @ 1%							106,621
Total Construction Cost in 3rd Quarter 1982 Dollars							10,768,673
Design Engineering 6%							646,120
Total Cost (Comparative Cost Estimate)							11,414,793

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (FLAT LAND)				BASE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "G"		ESTIMATOR 		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	37,035	CY	2 ²⁴	78,165	—	—	78,165
Concrete	11,330	CY	167 ⁰²	1,892,110	180 ⁰²	2,039,400	3,931,510
Waterproofing	94,460	SF	0 ⁴⁸	42,507	1 ¹²	113,352	155,859
Backfilling & Mounding	59,840	CY	3 ⁶²	2,172,192	—	—	2,172,192
Borrow	27,805	CY	4 ⁹⁹	138,747	4 ⁹⁸	136,245	274,992
Haul Excess	N/A	CY	0 ⁷⁵	—	—	—	—
<u>Sub-Totals</u>				4,323,721		2,288,997	6,612,718
Bullet Proof Glass	300	SF	18 ³¹	5,514	33 ³⁵	10,005	15,519
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	2	EA	60 ⁰²	120	200 ⁰²	400	5,20
2'-8" x 7'-0"	5	EA	60 ⁰²	300	180 ⁰²	900	1,200
6'-0" x 7'-0"	2	EA	100 ⁰²	200	350 ⁰²	700	900
Plumbing	37,495	SF	0 ⁵²	18,748	1 ⁰²	37,495	56,243
Electrical							
Power	37,495	SF	1 ²⁵	46,869	1 ¹²	65,616	112,485
Lighting	37,495	SF	0 ⁰²	18,748	1 ²⁵	46,869	65,617
<u>Sub-Totals</u>				96,499		180,735	277,234
<u>Totals - This Sheet</u>				4,415,220		2,454,732	6,869,952

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT 8		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	10	ft	23.26	233	10.43	104	337
20" x 20"	22	ft	13.80	304	8.02	176	480
10" x 8"	16	ft	4.87	78	2.83	45	123
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 1,861	\$ 9,073	\$ 10,934	
FIRE PROTECTION							
Halon Units (101 lb)	10	Ea	600.-	6000.-	1367.-	13,670.-	19,670.-
Detectors	8	Ea	275.-	2200.-	110.-	880.-	3,080.-
Control Panel	1	Ea	275.-	275.-	1358.-	1,358.-	1,633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	184	ft	1.50	276.-	2.90	534	810.-
				9,026	17,189	26,215	
				403			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "A"		ESTIMATOR Jaye		CHECKED BY			
SUMMARY		QUANTITY		LABOR		MATERIAL	
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL
Recap							
From Sht.	2				2,390,249		2,612,863
	3				32,320		259,680
	3				237,450		668,770
	4				2,113		9,209
	4				4,840		9,781
subtotal					2,666,972		3,560,303
PT & I				192	506,725		506,725
Total Direct Cost					3,173,697		6,734,000
Overhead @ 15%							1,010,100
subtotal							7,744,100
Profit @ 8%							619,528
subtotal							8,363,628
Bond @ 1%							83,636
Total Construction Cost in 3rd Quarter 1982 Dollars							8,447,264
Design Engineering 6%							506,836
Total Cost (Comparative Cost Estimate)							8,954,100

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (FLAT LAND)				BASE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "H"		ESTIMATOR 		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	20,080	CY	2 ²⁴	48,995	—	—	48,995
Concrete	12,815	CY	167 ⁰²	2,140,105	180 ⁰²	2,306,700	4,446,805
Waterproofing	83,265	SF	0 ⁴⁵	37,469	1 ³⁵	99,918	137,387
Backfilling & Mounding	11,900	CY	3 ⁶³	43,197	—	—	43,197
Borrow	N/A	CY	4 ⁹⁹	—	4 ⁹²	—	—
Haul Excess	8,180	CY	0 ⁷⁵	6,135	—	—	6,135
Sub-Totals				2,275,901		2,406,618	4,682,519
Bullet Proof Glass	219	SF	18 ³¹	4,025	33 ³⁵	7,304	11,329
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	4	EA	60 ⁰²	240	200 ⁰²	800	1,040
2'-8" x 7'-0"	4	EA	60 ⁰²	240	180 ⁰²	720	960
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Plumbing	48,330	SF	0 ⁵²	24,165	1 ⁰²	48,330	72,495
Electrical							
Power	48,330	SF	1 ³⁵	60,413	1 ⁷⁵	84,578	144,991
Lighting	48,330	SF	0 ⁵²	24,165	1 ³⁵	60,413	84,578
Sub-Totals				119,348		221,245	340,593
Totals - This Sheet				2,390,249		2,612,863	5,003,112

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT H		ESTIMATOR Griffin		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Monorail	32	Ea	60.-	1920.-	540.-	17,280.-	19,200.-
Trolley Hoist	32	Ea	200.-	6400.-	5700.-	182,400.-	188,800.-
Bridge Crane (Maint)	1	Ea	4000.-	4000.-	10,000.-	10,000.-	14,000.-
Controller	2	Ea	10,000.-	20,000.-	25,000.-	50,000.-	70,000.-
				32,320	Subtotal		292,000.-
						259,680	
Equipment							
Trap Doors	32	Ea	350.-	11,200.-	1200.-	38,400.-	49,600.-
Operating Mechanism	32	Ea	900.-	28,800.-	1250.-	40,000.-	68,800.-
Locking System	32	Ea	1000.-	32,000.-	800.-	25,600.-	57,600.-
Motor/Gen Set (100 KW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete 1/2 Sw Gear							
Compressed Air System	1	Ea	2000.-	2000.-	10,000.-	10,000.-	12,000.-
Piping - 1 1/2"	200	ft	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	24,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	14,000.-	26,800.-
Blast Door	3	Ea	1200.-	3,600.-	10,000.-	30,000.-	33,600.-
Operating Mechanism	3	Ea	2300.-	6,900.-	5500.-	16,500.-	23,400.-
Locking System	3	Ea	2100.-	6,300.-	1250.-	3,750.-	10,050.-
				237,450.-		668,770.-	906,220.-

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT H		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3060 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	36	ft	13.80	497	8.02	289	786
20" x 8"	36	ft	8.91	321	4.00	144	465
10" x 8"	10	ft	4.87	49	2.83	28	77
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				\$ 3,113		\$ 9,209	\$ 11,322
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600.-	2400.-	1628.-	6552.-	8952.-
Detectors	6	Ea	275.-	1650.-	110.-	660.-	2,210.-
Control Panel	1	Ea	275.-	275.-	1358.-	1358	1,633.-
Auxiliary Equip.	1	Lot	275.-	275	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	160	ft	1.50	240.-	2.90	464.-	704.-
				4840		9,781	14,621

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "I"		ESTIMATOR Jaye		CHECKED BY				
<u>Recap</u> SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Frame Sht. 2					2,197,689		2,290,978	4,488,667
3					154,850		274,135	428,985
3					350,250		1,117,520	1,467,770
4					2,825		9,483	12,308
4					4,828		9,758	14,586
subtotal					2,710,442		3,701,874	6,412,316
PT&I				192	514,984			514,984
Total Direct Cost					3,225,426			6,927,300
Overhead @ 15%								1,039,095
subtotal								7,966,395
Profit @ 8%								637,312
subtotal								8,603,707
Bond @ 1%								86,037
Total Construction Cost in 3rd Quarter 1982 Dollars								8,689,744
Design Engineering 6%								521,384
Total Cost (Comparative Cost Estimate)								9,211,128

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 of 4	
PROJECT CERL STUDY (FLAT LAND)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT/ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "I"		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	34,120	CY	2 ²⁴	83,253	—	—	83,253
Concrete	11,240	CY	167 ⁰²	1,877,080	180 ⁰²	2,023,200	3,900,280
Waterproofing	79,850	SF	0 ⁴⁵	35,933	1 ²⁰	95,820	131,753
Backfilling & Mounding	28,060	CY	3 ⁶³	101,858	—	—	101,858
Borrow	N/A	CY	4 ⁹⁹	—	4 ⁹²	—	—
Haul Excess	6,060	CY	0 ⁷⁵	4,545	—	—	4,545
Sub-Totals				2,102,669		2,119,020	4,221,689
Bullet Proof Glass	190	SF	18 ³¹	3,492	33 ²⁵	6,337	9,829
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	5	EA	60 ⁰²	300	200 ⁰²	1,000	1,300
2'-8" x 7'-0"	4	EA	60 ⁰²	240	180 ⁰²	720	960
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Trimming	39,950	SF	0 ⁵²	19,975	1 ⁰²	39,950	59,925
Electrical							
Power	39,950	SF	1 ²⁵	49,938	1 ⁷⁵	69,913	119,851
Lighting	39,950	SF	0 ⁶⁰	19,975	1 ²⁵	49,938	69,913
Sub-Totals				100,020		186,958	286,978
Totals - This Sheet				2,197,689		2,290,978	4,488,667

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4		
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
DRAWING NO. CONCEPT I		ESTIMATOR Griffin		CHECKED BY 				
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Material Handling Eq.								
Conveyor	720	ft	100.-	72,000.-	180.-	129,600.-	201,600.-	
Conveyor Drive	32	Ea	500.-	16,000.-	2000.-	64,000.-	80,000.-	
Bridge Crane (Maint)	1	Ea	4000.-	4,000.-	10,000.-	10,000.-	14,000.-	
Bridge Crane	2	Ea	4000.-	8,000.-	8,500.-	17,000.-	25,000.-	
Bridge Crane Rails	264	ft	50.-	13,200.-	90.-	23,760.-	36,960.-	
Monorail	275	ft	150.-	41,250.-	45.-	12,375.-	53,625.-	
Trolley Hoist	2	Ea	200.-	400.-	5700.-	11,400.-	11,800.-	
Sling	4	Ea	-	-	1500.-	6,000.-	6,000.-	
				154,850	Subtotal	274,135	428,985.-	
Equipment								
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-	
Complete 4/Sw Gear								
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-	
Piping - 1 1/2"	200	ft	3.-	600.-	1.35	270.-	870.-	
Personnel Barrier 6500#	5	Ea	350.-	1,750.-	9750.-	48,750.-	50,500.-	
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-	
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	24,000.-	160,000.-	200,000.-	
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-	
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-	
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-	
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-	
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-	
Blast Door	36	Ea	1200.-	43,200.-	10,000.-	360,000.-	403,200.-	
Operating Mechanism	36	Ea	2300.-	82,800.-	5500.-	198,000.-	280,800.-	
Locking System	36	Ea	2100.-	75,600.-	1250.-	45,000.-	120,600.-	
					Subtotal		1,467,770.-	
				350,250		1,117,520		
				410				

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 62		SHEET 4 of 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT I		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	20	SF	23.26	698	10.43	313	1,011
20" x 20"	15	SF	13.80	207	8.02	120	327
10" x 8"	150	SF	4.49	674	2.01	302	976
		SF					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vanaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				2,825	9,483	12,308	
FIRE PROTECTION							
Halon Units (196 lb)	4	Ea	600.-	2400.-	1638.-	6552.-	8,952.-
Detectors	6	Ea	275.-	1650.-	110.-	660.-	2,310.-
Control Panel	1	Ea	275.-	275.-	1358.-	1358.-	1,633.-
Auxiliary Equip	1	Lot	275.-	275.-	747.-	747.-	1,022.-
Wiring (Shielded 2 Wire)	152	SF	1.50	228.-	2.90	441.-	669
Fire Protection Totals				4828	9,758	14,586	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				DATE FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION 								
ARCHITECT/ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "J"		ESTIMATOR Jaye		CHECKED BY 				
Recap		QUANTITY		LABOR		MATERIAL		TOTAL COST
SUMMARY		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Frame Sht. 2					3,012,727		3,027,662	6,040,389
3					250,000		318,760	568,760
3					182,250		615,020	797,270
4					4,231		9,889	14,120
4					9,068		16,004	25,072
subtotal					3,458,276		3,987,335	7,445,611
PT&I				19%	657,072			657,072
Total Direct Cost					4,115,348			8,102,683
Overhead @ 15%								1,215,402
subtotal								9,318,085
Profit @ 8%								745,447
subtotal								10,063,532
Bond @ 1%								100,635
Total Construction Cost in 3rd Quarter 1982 Dollars								10,164,167
Design Engineering 6%								609,851
Total Cost (Comparative Cost Estimate)								10,774,018

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-2-82		SHEET 2 OF 4	
PROJECT CERL STUDY (FLAT LAND) LOCATION ARCHITECT/ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
DRAWING NO. CONCEPT "J"		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	47,385	CY	2 ⁹⁴	115,619	—	—	115,619
Concrete	14,620	CY	167 ⁰²	2,441,540	180 ⁰²	2,631,600	5,073,140
Waterproofing	115,795	SF	0 ⁴⁵	52,108	1 ⁷⁵	138,954	191,062
Backfilling & Mounding	62,565	CY	3 ⁶²	226,929	—	—	226,929
Borrow	15,130	CY	4 ⁹⁹	75,499	4 ⁷²	74,137	149,636
Haul Excess		CY	0 ⁷⁵		—	—	
Sub-Totals				2,911,695		2,844,691	5,756,386
Bullet Proof Glass	260	SF	10 ³¹	4,779	33 ²⁵	8,671	13,450
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰²	1,000	750 ⁰²	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	8	EA	60 ⁰²	480	200 ⁰²	1,600	2,080
2'-8" x 7'-0"	4	EA	60 ⁰²	240	180 ⁰²	720	960
6'-0" x 7'-0"	1	EA	100 ⁰²	100	350 ⁰²	350	450
Plumbing	41,970	SF	0 ⁵²	20,985	1 ⁰²	41,970	62,955
Electrical							
Power	41,970	SF	1 ²⁵	52,463	1 ⁷⁵	23,447	125,910
Lighting	41,970	SF	0 ⁵²	20,985	1 ²⁵	52,463	73,448
Sub-Totals				106,032		197,971	304,003
Totals - This Sheet				3,012,727		3,027,662	6,044,389

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "J"		ESTIMATOR Griffin		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Material Handling Eq.							
Rail (40 lb.)	1152	Lt	100.-	115,200.-	45.-	51,840.-	167,040.-
Rail Car w/Conc. Block	36	Ea	1500.-	54,000.-	2200.-	79,200.-	133,200.-
Drive Unit w/Chain	2	Ea	1500.-	3,000.-	8500.-	17,000.-	20,000.-
Jib Crane	2	Ea	2000.-	4,000.-	7500.-	15,000.-	19,000.-
Trolley Hoist w/Sling	2	Ea	200.-	400.-	7200.-	14,400.-	14,800.-
Bridge Crane 28'	2	Ea	4000.-	8,000.-	8500.-	17,000.-	25,000.-
Conveyor	624	Lt	100.-	62,400.-	180.-	112,320.-	174,720.-
Conveyor Drive	6	Ea	500.-	3,000.-	2000.-	12,000.-	15,000.-
				250,000	Subtotal		568,760.-
Equipment						318,760	
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	25,000.-
Complete w/Sw Gear							
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-
Piping - 1" x	200	Lt	3.-	600.-	1.35	270.-	870.-
Personnel Barrier 6500#	5	Ea	350.-	1,750.-	9750.-	48,750.-	50,500.-
Operating Mechanism	5	Ea	1400.-	7,000.-	1250.-	6,250.-	13,250.-
Locking System	5	Ea	2100.-	10,500.-	1250.-	6,250.-	16,750.-
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20,000.-	160,000.-	200,000.-
Operating Mechanism	8	Ea	2200.-	18,400.-	4000.-	32,000.-	50,400.-
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-
Draw Bridge	4	Ea	4100.-	16,400.-	42,300.-	169,200.-	185,600.-
Operating Mechanism	4	Ea	2400.-	9,600.-	6,000.-	24,000.-	33,600.-
Locking System	4	Ea	3200.-	12,800.-	4,000.-	16,000.-	28,800.-
Blast Door	6	Ea	1200.-	7,200.-	10,000.-	60,000.-	67,200.-
Operating Mechanism	6	Ea	2300.-	13,800.-	5500.-	33,000.-	46,800.-
Locking System	6	Ea	2100.-	12,600.-	1250.-	7,500.-	20,100.-
				182,250	Subtotal		797,270.-
						615,020	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "J"		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
40" x 20"	15	ft	23.26	349	10.43	157	506
20" x 20"	160	ft	12.26	1,962	4.24	678	2,640
10" x 8"	150	ft	4.49	674	2.01	306	980
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ 2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 4,231</u>		<u>\$ 9,889</u>	<u>\$ 14,120</u>
FIRE PROTECTION							
Halon Units (101 lb)	7	Ea	600	4200	1367	9569	13,769
Detectors	12	Ea	275	3300	110	1320	4,620
Control Panel (2 Zone)	2	Ea	275	550	1358	2716	3,266
Auxiliary Equip.	2	Lot	275	550	747	1494	2,044
Wiring (Shielded 2 Wire)	312	ft	1.50	468	2.90	905	1,373
				<u>9,068</u>		<u>16,004</u>	<u>25,072</u>
				415			

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "K"		ESTIMATOR Jaye		CHECKED BY				
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Recap								
From Sht. 2					2,508,959		1,921,013	4,429,972
3					137,780		157,670	295,450
3					176,650		598,270	774,920
4					1,708		9,005	10,713
4					5,727		11,552	17,279
subtotal					2,830,884		2,697,510	5,528,334
PT&I				192	537,857			537,857
Total Direct Cost					3,368,681			6,066,191
Overhead @ 15%								909,929
subtotal								6,976,120
Profit @ 8%								558,090
subtotal								7,534,210
Bond @ 1%								75,342
Total Construction Cost in 3rd Quarter 1982 Dollars								7,609,552
Design Engineering 6%								456,572
Total Cost (Comparative Cost Estimate)								8,066,124

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 of 4	
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "K"		ESTIMATOR Jaye		CHECKED BY			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	27,910	CY	2 ⁴⁴	681,004	—	—	681,004
Concrete	9,295	CY	167 ⁰⁰	1,552,265	180 ⁰⁰	1,673,100	3,225,365
Waterproofing	63,110	SF	0 ⁴⁵	28,400	1 ³⁰	75,732	104,132
Backfilling & Mounding	36,570	CY	3 ⁶³	132,749	—	—	132,749
Borrow	8,160	CY	4 ⁹⁹	43,213	4 ⁹⁰	42,434	85,647
Haul Excess	—	CY	0 ⁷⁵	—	—	—	—
<u>Subtotal</u>				2,437,631		1,791,266	4,228,897
Bullet Proof Glass	330	SF	18 ³⁸	6,065	33 ³⁵	11,006	17,071
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	3	EA	60 ⁰⁰	180	200 ⁰⁰	600	780
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	1	EA	100 ⁰⁰	100	350 ⁰⁰	350	450
Plumbing	28,330	SF	0 ⁵⁰	14,165	1 ⁰⁰	28,330	42,495
Electrical							
Power	28,330	SF	1 ²⁵	35,413	1 ⁷⁵	49,578	84,991
Lighting	28,330	SF	0 ⁵⁰	14,165	1 ²⁵	35,413	49,578
<u>Subtotal</u>				76,828		144,747	221,575
Totals - This Sheet				2,508,959		1,921,013	4,429,972

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4		
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
DRAWING NO. CONCEPT K		ESTIMATOR Griffin		CHECKED BY 				
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Material Handling Eq.								
Rail (40 lb)	770	ft	100.-	77,000.-	45-	34,650.-	111,650.-	
Rail Cars w/Conc. Block	36	Ea	1500.-	54,000.-	2200.-	79,200.-	133,200.-	
Drive Unit w/Chain	2	Ea	1000.-	2,000.-	6400.-	13,000.-	15,000.-	
Monorail	2	Ea	190.-	380.-	1710.-	3420.-	3,800.-	
Trolley Hoist	2	Ea	200.-	400.-	5700.-	11,400.-	11,800.-	
Sling	2	Ea	1-	-	1500.-	3,000.-	3,000.-	
Bridge Crane 45'	1	Ea	4000.-	4000.-	13000.-	17,000.-	17,000.-	
				137,780	Subtotal		295,450.-	
						157,670		
Equipment								
Motor/Gen Set (100 KW)	1	Ea	4000.-	4000.-	21000.-	21,000.-	25,000.-	
Complete w/Sw Gear								
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-	
Piping - 1 1/2"	200	ft	3.-	600.-	1.35	270.-	870.-	
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9750.-	48,750.-	50,500.-	
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-	
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	20000.-	160,000.-	200,000.-	
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-	
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-	
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-	
Operating Mechanism	4	Ea	2400.-	9,600.-	6000.-	24,000.-	33,600.-	
Locking System	4	Ea	3200.-	12,800.-	4000.-	16,000.-	28,800.-	
Blast Door	5	Ea	1200.-	6,000.-	10000.-	50,000.-	56,000.-	
Operating Mechanism	5	Ea	2300.-	11,500.-	5500.-	27,500.-	39,000.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6,250.-	16,750.-	
				176,650	Subtotal		774,920.-	
						598,270		

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July 62		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT K		ESTIMATOR		CHECKED BY			

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (3000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	20	ft	13.80	276	8.02	160	436
10" x 8"	20	ft	4.87	97	2.83	57	154
20" x 8"	10	ft	8.91	89	4.00	40	129
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (3500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 1,708</u>		<u>\$ 9,005</u>	<u>\$ 10,713</u>
FIRE PROTECTION							
Halon Units (196 lb)	5	Ea	600.-	3000.-	1638.-	8190.-	11,190.-
Detectors	7	Ea	275.-	1925.-	110.-	770.-	2695.-
Control Panel (1 Zone)	1	Ea	275.-	275.-	1358.-	1358.-	1633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1022.-
Wiring (Shielded 2 Wire)	168	ft	1.50	252.-	2.90	487.-	739.-
				<u>5,727</u>		<u>11,552</u>	<u>17,279</u>

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8-9-82		SHEET 1 of 4		
PROJECT CERL STUDY (Flat Land)				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
LOCATION								
ARCHITECT ENGINEER BLACK & VEATCH								
DRAWING NO. CONCEPT "L"		ESTIMATOR Jaye		CHECKED BY				
<i>Recap</i>	SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
From Sht.	2				2,621,453		2,677,850	5,299,303
	3				60,300		244,620	304,920
	3				176,650		598,270	774,920
	4				2,005		9,190	11,195
	4				5,675		11,147	16,822
subtotal					2,866,083		3,541,077	6,407,160
PT&I				19%	544,556			544,556
Total Direct Cost					3,410,639			6,951,716
Overhead @ 15%								1,042,757
subtotal								7,994,473
Profit @ 8%								639,558
subtotal								8,634,031
Bond @ 1%								86,340
Total Construction Cost in 3rd Quarter 1982 Dollars								8,720,371
Design Engineering 6%								523,223
Total Cost (Comparative Cost Estimate)								9,243,594

CONSTRUCTION COST ESTIMATE				DATE PREPARED 7-31-82		SHEET 2 OF 4	
PROJECT CERL STUDY (Flat Land)				 BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION 							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT "L"		ESTIMATOR Jaye		CHECKED BY 			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Excavation	24,315	CY	2 ¹⁴	59,499	—	—	59,499
Concrete	12,465	CY	167 ⁰⁰	2,081,655	180 ⁰⁰	2,243,700	4,325,355
Waterproofing	91,520	SF	0 ⁴⁵	41,184	1 ²⁰	109,824	151,008
Backfilling & Mounding	53,415	CY	3 ⁶³	193,896	—	—	193,896
Borrow	29,030	CY	4 ⁹⁹	144,860	4 ⁹⁰	142,247	287,107
Haul Excess	N/A	CY	0 ⁷⁵	—	—	—	—
Sub-Totals				2,521,094		2495,771	5,016,865
Bullet Proof Glass	340	SF	18 ³⁸	6,249	33 ²⁵	11,339	17,588
Bullet Proof Dr. 3'x7'	5	EA	200 ⁰⁰	1,000	750 ⁰⁰	3,750	4,750
Hollow Metal Doors w/ Frame & Hardware							
3'-0" x 7'-0"	7	EA	60 ⁰⁰	420	200 ⁰⁰	1,400	1,820
2'-8" x 7'-0"	4	EA	60 ⁰⁰	240	180 ⁰⁰	720	960
6'-0" x 7'-0"	3	EA	100 ⁰⁰	300	350 ⁰⁰	1,050	1,350
Plumbing	40,955	SF	0 ⁵⁰	20,478	1 ⁰⁰	40,955	61,433
Electrical							
Power	40,955	SF	1 ²⁵	51,194	1 ⁷⁵	71,671	122,865
Lighting	40,955	SF	0 ⁵⁰	20,478	1 ²⁵	51,194	71,672
Sub-Totals				105,359		197,079	302,438
Totals - This Sheet				2,621,453		2,677,850	5,299,303

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 3 of 4		
PROJECT CERL STUDY LOCATION ARCHITECT ENGINEER BLACK & VEATCH DRAWING NO. CONCEPT L				ESTIMATOR Griffin CHECKED BY BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____				
SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Material Handling Eq.								
Conveyor w/Drives	32	Ea	1000.-	32,000.-	4700.-	150,400.-	182,400.-	
Loading Bridge	2	Ea	3000.-	6000.-	25000.-	50,000.-	56,000.-	
Rail	96	ft	100.-	9600.-	45.-	4320.-	13,920.-	
Monorail	2	Ea	150.-	300.-	1500.-	3000.-	3300.-	
Trolley Hoist	2	Ea	200.-	400.-	5700.-	11,400.-	11,800.-	
Bridge Crane	3	Ea	4000.-	12,000.-	8500.-	25,500.-	37,500.-	
				60,300.-		244,620.-	304,920.-	
Equipment								
Motor/Gen Set (100 kW)	1	Ea	4000.-	4000.-	21,000.-	21,000.-	23,000.-	
Complete w/Sw Gear								
Compressed Air System	1	Ea	2000.-	2,000.-	10,000.-	10,000.-	12,000.-	
Piping - 1"φ	200	ft	3.-	600.-	1.35	270.-	870.-	
Personnel Barrier 6500#	5	Ea	350.-	1750.-	9150.-	48,750.-	50,500.-	
Operating Mechanism	5	Ea	1400.-	7000.-	1250.-	6250.-	13,250.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6250.-	16,750.-	
Truck Entrance Barrier	8	Ea	5000.-	40,000.-	24,000.-	160,000.-	200,000.-	
Operating Mechanism	8	Ea	2300.-	18,400.-	4000.-	32,000.-	50,400.-	
Locking System	8	Ea	3200.-	25,600.-	2600.-	20,800.-	46,400.-	
Draw Bridge	4	Ea	4100.-	16,400.-	42300.-	169,200.-	185,600.-	
Operating Mechanism	4	Ea	2400.-	9,600.-	6000.-	24,000.-	33,600.-	
Locking System	4	Ea	3200.-	12,800.-	4000.-	16,000.-	28,800.-	
Blast Door	5	Ea	1200.-	6,000.-	10,000.-	50,000.-	56,000.-	
Operating Mechanism	5	Ea	2300.-	11,500.-	5500.-	27,500.-	39,000.-	
Locking System	5	Ea	2100.-	10,500.-	1250.-	6,250.-	16,750.-	
				176,630.-		598,270.-	774,920.-	

CONSTRUCTION COST ESTIMATE				DATE PREPARED 20 July '82		SHEET 4 OF 4	
PROJECT CERL STUDY				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION							
ARCHITECT ENGINEER BLACK & VEATCH							
DRAWING NO. CONCEPT L		ESTIMATOR		CHECKED BY			
SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	PER UNIT	LABOR TOTAL	PER UNIT	MATERIAL TOTAL	TOTAL COST
HVAC							
Entrance Louver	1	Ea	48	48	261	261	309
Entrance Filter (5000 cfm)	1	Ea	21	21	86	86	107
Ductwork							
20" x 20"	48	ft	13.80	662	8.02	385	1,047
10" x 8"	20	ft	4.87	97	2.83	57	154
		ft					
		ft					
Registers							
8" x 10"	3	Ea	6	18	10	30	48
10" x 20"	1	Ea	8	8	18	18	26
20" x 20"	1	Ea	8	8	31	31	39
Blast Damper (8" x 10")	1	Ea	8	8	17	17	25
Vaneaxial Fan (2500 cfm @ .2)	2	Ea	350	700	1,250	2,500	3,200
Duct Heater (6 kw)	1	Ea	39	39	305	305	344
Space Heater	4	Ea	99	396	1,375	5,500	5,896
				<u>\$ 2,005</u>		<u>\$ 9,190</u>	<u>\$ 11,195</u>
FIRE PROTECTION							
Halon Units (101 lb)	6	Ea	600-	3600-	1367-	8202.-	11,802.-
Detectors	5	Ea	275.-	1375.-	110.-	550.-	1925.-
Control Panel (1 Zone)	1	Ea	275.-	275.-	1358.-	1758.-	1633.-
Auxiliary Equip.	1	Lot	275.-	275.-	747.-	747.-	1022.-
Wiring (Shielded 2 wire)	100	ft	1.50	150-	2.90	290-	440-
				<u>5,675</u>		<u>11,147</u>	<u>16,822</u>

APPENDIX I
LIFE CYCLE COST ESTIMATES

LIFE CYCLE COSTS

The following life cycle cost estimates are for cost comparisons only and are not for budgeting purposes.

FACILITY LIFE

Design Life = 25 years.

First Year of Operation = 1982.

FACILITY COSTS

Total Investment in BOD (Beneficial Occupancy Date) Year = Construction Cost (see Appendix H).

O&M Cost = labor and material costs for operating and maintaining facility (see pages 427 through 432). Note: Alert operations cannot be anticipated and are not included.

Energy Cost = cost of electricity required when facility is occupied for operations and maintenance (see pages 433 through 435).

Life Cycle Cost = present value of all the above costs over the 25-year life.

TYPICAL STORAGE FACILITY OPERATIONS

<u>Operation</u>	<u>Duration & Frequency</u>	<u>Personnel Type</u>	<u>No.</u>
Weapons Inventory	8 hrs. weekly	Security	2
		Ordnance Clerk	2
Load-out Training	8 hrs. monthly	Security Trainer	1
		Security	*
		Material Handler Trainer	1
		Material Handler	*
Facility Maintenance	8 hrs. quarterly	Security	2
		Facility Maintainer	2
Weapons Maintenance	240 hrs. yearly	Security	2
		Ordnance Maintainer	2

*same as for load-out

<u>Personnel Type</u>	<u>Annual Assumed Cost</u>	<u>Category</u>
Security	\$100,000	1
Ordnance Clerk	\$100,000	1
Security Trainer	\$120,000	2
Material Handler Trainer	\$130,000	3
Material Handler	\$120,000	2
Facility Maintainer	\$120,000	2
Ordnance Maintainer	\$150,000	4

BLACK &
VEATCH
CONSULTING
ENGINEERS
KANSAS CITY
DALLAS
DENVER
ORLANDO

SUBJECT CERL STUDY

DATE 14 July 1982

WORK Operating Costs

SET UP BY RG

COMPUTED BY _____

CHECKED BY _____

PAGE NO. 1 OF 3

PROJECT NO. 10304

FILE NO. _____

STAFF COSTS

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
A	2592	1	49.60	128,563.30
	928	2	59.52	55,234.56
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 225,699.84

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
B	2592	1	49.60	128,563.30
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
C	2592	1	49.60	128,563.30
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
D	2592	1	49.60	128,563.30
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

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SUBJECT CERL STUDY

DATE 14 July 1982

WORK _____

SET UP BY RG

COMPUTED BY _____

CHECKED BY _____

PAGE NO 2 OF 3

PROJECT NO. 10304

FILE NO. _____

STAFF COSTS

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
E	2592	1	49.60	128,563.20
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
F	2592	1	49.60	128,563.20
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
G	2592	1	49.60	128,563.20
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
H	2592	1	49.60	128,563.20
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$ 202,844.16

Category 1 = \$100,000/yr

2 = 120,000/yr

3 = 130,000/yr

4 = 150,000/yr

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SUBJECT CERL STUDY

DATE 14 July 1982

SET UP BY RG

COMPUTED BY _____

CHECKED BY _____

PAGE NO. 3 OF 3

PROJECT NO. 10304

FILE NO. _____

STAFF COSTS

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
I	2592	1	49.60	128,563.20
	352	2	59.52	21,303.04
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$191,768.32

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
J	2032	1	49.60	100,787.20
	352	2	59.52	21,303.04
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$163,992.32

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
K	2592	1	49.60	128,563.20
	352	2	59.52	21,303.04
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$191,768.32

CONCEPT	HRS/YR	PERSONNEL/CATEGORY	COST/HOUR	COST/YR
L	2592	1	49.60	128,563.20
	544	2	59.52	32,378.88
	96	3	64.48	6,190.08
	480	4	74.40	35,712.-

TOTAL OPER. COST \$202,844.16

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SUBJECT CERL STUDY

WORK Operating Costs

PROJECT NO 10304

FILE NO _____

DATE 6 Aug 1982

SET UP BY RG

COMPUTED BY _____

CHECKED BY _____

PAGE NO 1 OF 1

MAINTENANCE COSTS

CONCEPT	EQUIPMENT COST	MAINT. %	YEARLY COST
A	\$1,162,250.-	↑ 5 ↓	58,112.-
B	1,587,697.-		79,385.-
C	1,397,905.-		69,895.-
D	1,267,787.-		63,389.-
E	1,140,604.-		57,030.-
F	1,955,122.-		97,756.-
G	1,000,813.-		50,041.-
H	1,456,754.-		72,838.-
I	2,289,142.-		114,457.-
J	1,672,214.-		83,611.-
K	1,307,051.-		65,353.-
L	1,318,350.-		65,918.-

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SUBJECT CERL STUDY

WORK Life Cycle Data

PROJECT NO. 10304

DATE 6 Aug 19 82

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CHECKED BY _____

PAGE NO. _____ OF _____

FILE NO. _____

O&M COSTS

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CONCEPT	STAFF COSTS	MAINT. COSTS	TOTAL COSTS
A	225,700.-	58,112.-	283,812.-
B	202,844.-	79,385.-	282,229.-
C	202,844.-	69,895.-	272,739.-
D	202,844.-	63,389.-	266,233.-
E	202,844.-	57,030.-	259,874.-
F	202,844.-	97,156.-	300,600.-
G	202,844.-	50,041.-	252,885.-
H	202,844.-	72,838.-	275,682.-
I	191,768.-	114,457.-	306,225.-
J	163,992.-	83,611.-	247,603.-
K	191,768.-	65,353.-	257,121.-
L	202,844.-	65,918.-	268,762.-

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DATE 6 Aug 1982

WORK Operating Costs

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PROJECT No. 10304

FILE No. _____

ENERGY COSTS

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CONCEPT	AREA (FT ²)	KWH@ 3W/FT ²	HRS/YR	PRICE	COST/YR
A	50,805	152.4	↑	↑	3604.80
B	35,835	107.5	↑	↑	2542.62
C	36,130	108.4	↑	↑	2563.55
D	30,235	90.7	↑	↑	2145.28
E	24,640	73.9	↑	↑	1748.30
F	36,030	108.1	608	.0389	2556.46
G	37,495	112.5	↑	↑	2660.41
H	48,330	145.0	↑	↑	3429.19
I	39,950	119.8	↑	↑	2834.60
J	41,970	125.9	↑	↑	2977.92
K	28,330	85.0	↑	↑	2010.12
L	40,955	122.9	↑	↑	2905.90

Table I-1. DoE - Projected Energy Prices and Escalation Rates

DoE Region 11

Current and projected energy prices (in mid-1981 dollars)						Projected energy price escalation rates (percentage change compounded annually)		
Fuel type	Mid-1981 base-year		Mid-1985	Mid-1990	Mid-1995	Mid-1981-mid-1985	Mid-1985-mid-1990	Mid-1990-mid-1995 and beyond
	(Dollar per sales unit) ¹	(Dollars per 10 ⁶ Btu)	(Dollars per 10 ⁶ Btu)	(Dollars per 10 ⁶ Btu)	(Dollars per 10 ⁶ Btu)			
RESIDENTIAL SECTOR								
Electricity	.057 (kWh)...	16.74	20.36	20.81	20.62	5.28	.24	-.19
Distillate	1.334 (gal)...	9.62	10.62	12.05	16.25	2.31	2.55	6.16
LPG	.900 (gal)...	9.42	10.41	11.69	13.65	2.52	2.35	6.00
Natural Gas	.004 (ft ³)...	4.42	6.21	6.62	7.45	8.88	1.28	2.38
COMMERCIAL SECTOR								
Electricity	.058 (kWh)...	17.10	21.01	21.10	20.86	5.28	.09	-.23
Distillate	1.262 (gal)...	9.10	10.05	11.47	15.66	2.51	2.69	6.42
Residual	.949 (gal)...	6.34	8.94	10.19	12.29	8.99	2.64	3.82
Natural Gas	.004 (ft ³)...	3.98	5.59	6.01	6.82	8.85	1.46	2.58
Steam Coal	39.375 (ton)...	1.75	2.22	2.42	2.49	6.11	1.77	.59
INDUSTRIAL SECTOR								
Electricity	.042 (kWh)...	12.32	15.13	15.58	15.48	5.27	.58	-.12
Distillate	1.266 (gal)...	9.13	10.08	11.50	15.69	2.51	2.66	6.42
Residual	.949 (gal)...	6.34	8.96	10.13	10.92	9.02	2.50	1.52
Natural Gas	.004 (ft ³)...	3.52	4.94	5.12	5.89	8.84	.72	2.83
Natural Gas MFPI	.005 (ft ³)...	4.52	6.35	5.10	5.83	8.89	-4.32	2.72
Steam Coal	37.800 (ton)...	1.68	2.82	3.19	3.35	13.80	2.51	.96
TRANSPORTATION								
Gasoline	1.622 (gal)...	12.97	15.92	17.09	21.92	5.26	1.42	5.11

¹ Note that these prices are equivalent to those in the adjacent col. (both for mid-1981), but they are stated in different units of energy. Price per sales unit of energy is derived from price per million Btu by dividing the price by a million and multiplying by the Btu content of a sales unit of energy, assuming the following Btu content per sales unit of energy: 3,412 Btu/kWh of electricity; 138,690 Btu/gal of distillate; 95,300 Btu/gal of LPG; 1,016 Btu/ft³ of natural gas; 149,690 Btu/gal of residual; 22,500 Btu/ton of steam coal; and 125,071 Btu/gal of gasoline. For example, in DoE Region 1, for electricity, $\frac{9.085/\text{kWh} \times 1,000,000 \text{ Btu}}{3,412 \text{ Btu/kWh}}$

Note: Region 11 is U.S. average

From: LIFE-CYCLE COSTING MANUAL
(NBS Handbook 135) for the
Federal Energy Management
Programs - updated 6/15/82,
Table C-11.



Owner CERL STUDY Computed By TW/L
Plant _____ Date 10/25 19 82
Project No. _____ File No. _____ Checked By _____
Title _____ Date _____ 19 _____
Page _____ of _____

Electricity Cost - Escalation Factor

1982 - 1985 5.28 % / year
1986 - 1990 0.09 % / year
1991 + - 0.23 % / year

Program can only use one escalation rate; therefore an average rate will be used which gives the same total escalation over the 25 year period

Equivalent Avg. Escal. Rate.

$$\begin{aligned} \text{Rate} &= [(1.0528)^3 (1.0009)^5 (0.9977)^{17}]^{\frac{1}{25}} \\ &= [(1.1669)(1.0045)(0.9616)]^{\frac{1}{25}} \\ &= 1.1272^{\frac{1}{25}} \\ &= 1.0048 \\ &= .0048 \\ &\text{or } 0.48 \% / \text{year} \end{aligned}$$

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17 MAY 1983

CERL STUDY

YEAR ZERO IS DEFINED AS BENEFICIAL OCCUPANCY DATA (BOD)	1982
YEAR ZERO COST OF ELECTRICAL ENERGY	\$.0389/kWH
ESCALATION RATE FOR ELECTRICAL ENERGY	0.48%
ECONOMIC LIFE	25 YEARS
DISCOUNT RATE	10%

PLAN M-A
MOUNTAIN CONCEPT A

INVESTMENT(1982\$) 20116795
O+M 283812
ELEC USE, KWH 92668

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	20116795	0	0	0	20116795	1	20116795
1		283812		3622	287434	.9090909092	261304
2		283812		3639	287451	.8264462809	237563
3		283812		3657	287469	.7513148008	215980
4		283812		3674	287486	.6830134552	196357
5		283812		3692	287504	.6209213228	178517
6		283812		3710	287522	.5644739298	162299
7		283812		3728	287540	.5131581179	147553
8		283812		3746	287558	.4665073799	134148
9		283812		3764	287576	.4240976181	121960
10		283812		3782	287594	.3855432891	110880
11		283812		3800	287612	.3504938992	100806
12		283812		3818	287630	.3186308174	91648
13		283812		3836	287648	.2896643794	83321
14		283812		3855	287667	.2633312540	75752
15		283812		3873	287685	.2393920490	68870
16		283812		3892	287704	.2176291355	62613
17		283812		3911	287723	.1978446686	56924
18		283812		3929	287741	.1798587896	51753
19		283812		3948	287760	.1635079906	47051
20		283812		3967	287779	.1486436278	42777
21		283812		3986	287798	.1351305709	38890
22		283812		4005	287817	.1228459737	35357
23		283812		4024	287836	.1116781581	32145
24		283812		4044	287856	.1015255987	29225
25		283812		4063	287875	.0922959980	26570

TOTAL PRESENT VALUE 22727057

PLAN M-B
MOUNTAIN CONCEPT B

INVESTMENT(1982\$) 29430019
O+M 282229
ELEC USE, KWH 65363

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	29430019	0	0	0	29430019	1	29430019
1		282229		2555	284784	9090909092	258894
2		282229		2567	284796	8264462809	235369
3		282229		2579	284808	7513148008	213981
4		282229		2592	284821	6830134552	194536
5		282229		2604	284833	6209213228	176859
6		282229		2617	284846	5644739298	160788
7		282229		2629	284858	5131581179	146177
8		282229		2642	284871	4665073799	132894
9		282229		2655	284884	4240976181	120818
10		282229		2667	284896	3855432891	109840
11		282229		2680	284909	3504938992	99859
12		282229		2693	284922	3186308174	90785
13		282229		2706	284935	2896643794	82535
14		282229		2719	284948	2633312540	75036
15		282229		2732	284961	2393920490	68217
16		282229		2745	284974	2176291355	62019
17		282229		2758	284987	1978446686	56383
18		282229		2771	285000	1798587896	51260
19		282229		2785	285014	1635079906	46602
20		282229		2798	285027	1486436278	42367
21		282229		2812	285041	1351305709	38518
22		282229		2825	285054	1228459737	35018
23		282229		2839	285068	1116781581	31836
24		282229		2852	285081	1015255987	28943
25		282229		2866	285095	0922959980	26313

TOTAL PRESENT VALUE 32015867

PLAN M-C
MOUNTAIN CONCEPT C

INVESTMENT(1982\$) 27577185
O+M 272739
ELEC USE, KWH 65901

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	27577185	0	0	0	27577185	1	27577185
1		272739		2576	275315	.9090909092	250286
2		272739		2588	275327	.8264462809	227543
3		272739		2601	275340	.7513148008	206867
4		272739		2613	275352	.6830134552	188069
5		272739		2626	275365	.6209213228	170980
6		272739		2638	275377	.5644739298	155443
7		272739		2651	275390	.5131581179	141319
8		272739		2664	275403	.4665073799	128477
9		272739		2676	275415	.4240976181	116803
10		272739		2689	275428	.3855432891	106190
11		272739		2702	275441	.3504938992	96540
12		272739		2715	275454	.3186308174	87768
13		272739		2728	275467	.2894643794	79793
14		272739		2741	275480	.2633312540	72543
15		272739		2754	275493	.2393920490	65951
16		272739		2768	275507	.2176291355	59958
17		272739		2781	275520	.1978446686	54510
18		272739		2794	275533	.1798587896	49557
19		272739		2808	275547	.1635079906	45054
20		272739		2821	275560	.1486436278	40960
21		272739		2835	275574	.1351305709	37238
22		272739		2848	275587	.1228459737	33855
23		272739		2862	275601	.1116781581	30779
24		272739		2876	275615	.1015255987	27982
25		272739		2890	275629	.0922959980	25439

TOTAL PRESENT VALUE 30077090

PLAN M-D
MOUNTAIN CONCEPT D

INVESTMENT(1982\$) 20178281
O+M 266233
ELEC USE, KWH 55149

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	20178281	0	0	0	20178281	1	20178281
1		266233		2156	268389	9090909092	243990
2		266233		2166	268399	8264462809	221817
3		266233		2176	268409	7513148008	201660
4		266233		2187	268420	6830134552	183334
5		266233		2197	268430	6209213228	166674
6		266233		2208	268441	5644739298	151528
7		266233		2218	268451	5131581179	137758
8		266233		2229	268462	4665073799	125240
9		266233		2240	268473	4240976181	113859
10		266233		2251	268484	3855432891	103512
11		266233		2261	268494	3504938992	94106
12		266233		2272	268505	3186308174	85554
13		266233		2283	268516	2896643794	77780
14		266233		2294	268527	2633312540	70712
15		266233		2305	268538	2393920490	64286
16		266233		2316	268549	2176291355	58444
17		266233		2327	268560	1978446686	53133
18		266233		2338	268571	1798587896	48305
19		266233		2350	268583	1635079906	43915
20		266233		2361	268594	1486436278	39925
21		266233		2372	268605	1351305709	36297
22		266233		2384	268617	1228459737	32998
23		266233		2395	268628	1116781581	30000
24		266233		2407	268640	1015255987	27274
25		266233		2418	268651	0922959980	24795
TOTAL PRESENT VALUE							22615176

PLAN M-E
MOUNTAIN CONCEPT E

INVESTMENT(1982\$) 14881585
O+M 259874
ELEC USE, KWH 44943

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	14881585	0	0	14881585	1	14881585
1		259874	1757	261631	.9090909092	237846
2		259874	1765	261639	.8264462809	216231
3		259874	1774	261648	.7513148008	196580
4		259874	1782	261656	.6830134552	178715
5		259874	1791	261665	.6209213228	162473
6		259874	1799	261673	.5644739298	147708
7		259874	1808	261682	.5131581179	134284
8		259874	1817	261691	.4665073799	122081
9		259874	1825	261699	.4240976181	110986
10		259874	1834	261708	.3855432891	100900
11		259874	1843	261717	.3504938992	91730
12		259874	1852	261726	.3186308174	83394
13		259874	1861	261735	.2896643794	75815
14		259874	1870	261744	.2633312540	68925
15		259874	1878	261752	.2393920490	62661
16		259874	1887	261761	.2176291355	56967
17		259874	1897	261771	.1978446686	51790
18		259874	1906	261780	.1798587896	47083
19		259874	1915	261789	.1635079906	42805
20		259874	1924	261798	.1486436278	38915
21		259874	1933	261807	.1351305709	35378
22		259874	1943	261817	.1228459737	32163
23		259874	1952	261826	.1116781581	29240
24		259874	1961	261835	.1015255987	26583
25		259874	1971	261845	.0922959980	24167

TOTAL PRESENT VALUE 17257004

PLAN M-F
MOUNTAIN CONCEPT F

INVESTMENT(1982\$) 15466573
O+M 300600
ELEC USE, KWH 65719

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	15466573	0	0	15466573	1	15466573
1		300600	2569	303169	.9090909092	275608
2		300600	2581	303181	.8264462809	250563
3		300600	2593	303193	.7513148008	227794
4		300600	2606	303206	.6830134552	207094
5		300600	2618	303218	.6209213228	188275
6		300600	2631	303231	.5644739298	171166
7		300600	2644	303244	.5131581179	155612
8		300600	2656	303256	.4665073799	141471
9		300600	2669	303269	.4240976181	128616
10		300600	2682	303282	.3855432891	116928
11		300600	2695	303295	.3504938992	106303
12		300600	2708	303308	.3186308174	96643
13		300600	2721	303321	.2896643794	87861
14		300600	2734	303334	.2633312540	79877
15		300600	2747	303347	.2393920490	72619
16		300600	2760	303360	.2176291355	66020
17		300600	2773	303373	.1978446686	60021
18		300600	2787	303387	.1798587896	54567
19		300600	2800	303400	.1635079906	49608
20		300600	2813	303413	.1486436278	45100
21		300600	2827	303427	.1351305709	41002
22		300600	2840	303440	.1228459737	37276
23		300600	2854	303454	.1116781581	33889
24		300600	2868	303468	.1015255987	30810
25		300600	2882	303482	.0922959980	28010
TOTAL PRESENT VALUE						18219307

PLAN M-G
MOUNTAIN CONCEPT G

INVESTMENT(1982\$) 14850260
O+M 252885
ELEC USE, KWH 68391

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	14850260	0	0	14850260	1	14850260
1		252885	2673	255558	9090909092	232326
2		252885	2686	255571	8264462809	211216
3		252885	2699	255584	7513148008	192024
4		252885	2712	255597	6830134552	174576
5		252885	2725	255610	6209213228	158714
6		252885	2738	255623	5644739298	144292
7		252885	2751	255636	5131581179	131182
8		252885	2764	255649	4665073799	119262
9		252885	2778	255663	4240976181	108426
10		252885	2791	255676	3855432891	98574
11		252885	2804	255689	3504938992	89618
12		252885	2818	255703	3186308174	81475
13		252885	2831	255716	2896643794	74072
14		252885	2845	255730	2633312540	67342
15		252885	2859	255744	2393920490	61223
16		252885	2872	255757	2176291355	55660
17		252885	2886	255771	1978446686	50603
18		252885	2900	255785	1798587896	46005
19		252885	2914	255799	1635079906	41825
20		252885	2928	255813	1486436278	38025
21		252885	2942	255827	1351305709	34570
22		252885	2956	255841	1228459737	31429
23		252885	2970	255855	1116781581	28573
24		252885	2984	255869	1015255987	25977
25		252885	2999	255884	0922959980	23617

TOTAL PRESENT VALUE 17170866

PLAN M-H
MOUNTAIN CONCEPT H

INVESTMENT(19826) 12467554
O+M 275682
ELEC USE, KWH 88154

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	12467554	0	0	0	12467554	1	12467554
1		275682		3446	279128	.9090909092	253752
2		275682		3462	279144	.8264462809	230698
3		275682		3479	279161	.7513148008	209738
4		275682		3496	279178	.6830134552	190682
5		275682		3512	279194	.6209213228	173358
6		275682		3529	279211	.5644739298	157607
7		275682		3546	279228	.5131581179	143288
8		275682		3563	279245	.4665073799	130270
9		275682		3580	279262	.4240976181	118434
10		275682		3597	279279	.3855432891	107674
11		275682		3615	279297	.3504938992	97892
12		275682		3632	279314	.3186308174	88998
13		275682		3649	279331	.2896643794	80912
14		275682		3667	279349	.2633312540	73561
15		275682		3685	279367	.2393920490	66878
16		275682		3702	279384	.2176291355	60802
17		275682		3720	279402	.1978446686	55278
18		275682		3738	279420	.1798587896	50256
19		275682		3756	279438	.1635079906	45690
20		275682		3774	279456	.1486436278	41539
21		275682		3792	279474	.1351305709	37765
22		275682		3810	279492	.1228459737	34334
23		275682		3828	279510	.1116781581	31215
24		275682		3847	279529	.1015255987	28379
25		275682		3865	279547	.0922959980	25801
TOTAL PRESENT VALUE							15002359

PLAN M-I
MOUNTAIN CONCEPT I

INVESTMENT(1982\$) 15338909
O+M 306225
ELEC USE, .KWH 72869

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	15338909	0	0	0	15338909	1	15338909
1		306225		2848	309073	.9090909092	280976
2		306225		2862	309087	.8264462809	255444
3		306225		2876	309101	.7513148008	232232
4		306225		2889	309114	.6830134552	211129
5		306225		2903	309128	.6209213228	191944
6		306225		2917	309142	.5644739298	174503
7		306225		2931	309156	.5131581179	158646
8		306225		2945	309170	.4665073799	144230
9		306225		2959	309184	.4240976181	131124
10		306225		2974	309199	.3855432891	119209
11		306225		2988	309213	.3504938992	108377
12		306225		3002	309227	.3186308174	98529
13		306225		3017	309242	.2896643794	89576
14		306225		3031	309256	.2633312540	81437
15		306225		3046	309271	.2393920490	74037
16		306225		3060	309285	.2176291355	67309
17		306225		3075	309300	.1978446686	61193
18		306225		3090	309315	.1798587896	55633
19		306225		3105	309330	.1635079906	50578
20		306225		3119	309344	.1486436278	45982
21		306225		3134	309359	.1351305709	41804
22		306225		3150	309375	.1228459737	38005
23		306225		3165	309390	.1116781581	34552
24		306225		3180	309405	.1015255987	31413
25		306225		3195	309420	.0922959980	28558

TOTAL PRESENT VALUE 18145331

PLAN M-J
MOUNTAIN CONCEPT J

INVESTMENT(1982\$) 25027120
O+M 247603
ELEC USE, KWH 76553

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	25027120	0	0	0	25027120	1	25027120
1		247603		2992	250595	.9090909092	227814
2		247603		3007	250610	.8264462809	207115
3		247603		3021	250624	.7513148008	188298
4		247603		3036	250639	.6830134552	171189
5		247603		3050	250653	.6209213228	155636
6		247603		3065	250668	.5644739298	141495
7		247603		3079	250682	.5131581179	128640
8		247603		3094	250697	.4665073799	116952
9		247603		3109	250712	.4240976181	106326
10		247603		3124	250727	.3855432891	96666
11		247603		3139	250742	.3504938992	87884
12		247603		3154	250757	.3186308174	79899
13		247603		3169	250772	.2896643794	72640
14		247603		3184	250787	.2633312540	66040
15		247603		3200	250803	.2393920490	60040
16		247603		3215	250818	.2176291355	54585
17		247603		3230	250833	.1978446686	49624
18		247603		3246	250849	.1798587896	45117
19		247603		3262	250865	.1635079906	41018
20		247603		3277	250880	.1486436278	37292
21		247603		3293	250896	.1351305709	33904
22		247603		3309	250912	.1228459737	30823
23		247603		3325	250928	.1116781581	28023
24		247603		3341	250944	.1015255987	25477
25		247603		3357	250960	.0922959980	23163

TOTAL PRESENT VALUE 27302783

PLAN M-K
MOUNTAIN CONCEPT K

INVESTMENT(1982\$) 13132009
O+M 257121
ELEC USE, KWH 51674

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	13132009	0	0	0	13132009	1	13132009
1		257121		2020	259141	.9090909092	235583
2		257121		2029	259150	.8264462809	214174
3		257121		2039	259160	.7513148008	194711
4		257121		2049	259170	.6830134552	177017
5		257121		2059	259180	.6209213228	160930
6		257121		2069	259190	.5644739298	146306
7		257121		2079	259200	.5131581179	133010
8		257121		2089	259210	.4665073799	120923
9		257121		2099	259220	.4240976181	109934
10		257121		2109	259230	.3855432891	99944
11		257121		2119	259240	.3504938992	90862
12		257121		2129	259250	.3186308174	82605
13		257121		2139	259260	.2896643794	75098
14		257121		2149	259270	.2633312540	68274
15		257121		2160	259281	.2393920490	62070
16		257121		2170	259291	.2176291355	56429
17		257121		2181	259302	.1978446686	51301
18		257121		2191	259312	.1798587896	46640
19		257121		2202	259323	.1635079906	42401
20		257121		2212	259333	.1486436278	38548
21		257121		2223	259344	.1351305709	35045
22		257121		2233	259354	.1228459737	31861
23		257121		2244	259365	.1116781581	28965
24		257121		2255	259376	.1015255987	26333
25		257121		2266	259387	.0922959980	23940

TOTAL PRESENT VALUE 15484915

PLAN M-L
MOUNTAIN CONCEPT L

INVESTMENT(1982\$) 13200719
O+M 268762
ELEC USE, KWH 74702

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	13200719	0	0	0	13200719	1	13200719
1		268762		2920	271682	.9090909092	246984
2		268762		2934	271696	.8264462809	224542
3		268762		2948	271710	.7513148008	204140
4		268762		2962	271724	.6830134552	185591
5		268762		2976	271738	.6209213228	168728
6		268762		2991	271753	.5644739298	153397
7		268762		3005	271767	.5131581179	139459
8		268762		3019	271781	.4665073799	126788
9		268762		3034	271796	.4240976181	115268
10		268762		3048	271810	.3855432891	104795
11		268762		3063	271825	.3504938992	95273
12		268762		3078	271840	.3186308174	86617
13		268762		3093	271855	.2896643794	78747
14		268762		3107	271869	.2633312540	71592
15		268762		3122	271884	.2393920490	65087
16		268762		3137	271899	.2176291355	59173
17		268762		3152	271914	.1978446686	53797
18		268762		3167	271929	.1798587896	48909
19		268762		3183	271945	.1635079906	44465
20		268762		3198	271960	.1486436278	40425
21		268762		3213	271975	.1351305709	36752
22		268762		3229	271991	.1228459737	33413
23		268762		3244	272006	.1116781581	30377
24		268762		3260	272022	.1015255987	27617
25		268762		3275	272037	.0922959980	25108

TOTAL PRESENT VALUE 15667762

PLAN F-A

FLATLAND CONCEPT A

INVESTMENT(1982\$) 9478468

O+M 283812

ELEC USE, KWH 92668

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	9478468	0	0	9478468	1	9478468
1		283812	3422	287434	.9090909092	261304
2		283812	3439	287451	.8264462809	237563
3		283812	3457	287469	.7513148008	215980
4		283812	3674	287486	.6830134552	196357
5		283812	3692	287504	.6209213228	178517
6		283812	3710	287522	.5644739298	162299
7		283812	3728	287540	.5131581179	147553
8		283812	3746	287558	.4665073799	134148
9		283812	3764	287576	.4240976181	121960
10		283812	3782	287594	.3855432891	110880
11		283812	3800	287612	.3504938992	100806
12		283812	3818	287630	.3186308174	91648
13		283812	3836	287648	.2896643794	83321
14		283812	3855	287667	.2633312540	75752
15		283812	3873	287685	.2393920490	68870
16		283812	3892	287704	.2176291355	62613
17		283812	3911	287723	.1978446686	56924
18		283812	3929	287741	.1798587896	51753
19		283812	3948	287760	.1635079906	47051
20		283812	3967	287779	.1486436278	42777
21		283812	3986	287798	.1351305709	38890
22		283812	4005	287817	.1228459737	35357
23		283812	4024	287836	.1116781581	32145
24		283812	4044	287856	.1015255987	29225
25		283812	4063	287875	.0922959980	26570

TOTAL PRESENT VALUE 12088730

PLAN F-B
FLATLAND CONCEPT B

INVESTMENT(1982\$) 8102490
O+M 282229
ELEC USE, KWH 65363

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	8102490	0	0	0	8102490	1	8102490
1		282229		2555	284784	9090909092	258894
2		282229		2567	284796	8264462809	235369
3		282229		2579	284808	7513148008	213981
4		282229		2592	284821	6830134552	194536
5		282229		2604	284833	6209213228	176859
6		282229		2617	284846	5644739298	160788
7		282229		2629	284858	5131581179	146177
8		282229		2642	284871	4665073799	132894
9		282229		2655	284884	4240976181	120818
10		282229		2667	284896	3855432891	109840
11		282229		2680	284909	3504938992	99859
12		282229		2693	284922	3186308174	90785
13		282229		2706	284935	2896643794	82535
14		282229		2719	284948	2633312540	75036
15		282229		2732	284961	2393920490	68217
16		282229		2745	284974	2176291355	62019
17		282229		2758	284987	1978446686	56383
18		282229		2771	285000	1798587896	51260
19		282229		2785	285014	1635079906	46602
20		282229		2798	285027	1486436278	42367
21		282229		2812	285041	1351305709	38518
22		282229		2825	285054	1228459737	35018
23		282229		2839	285068	1116781581	31836
24		282229		2852	285081	1015255987	28943
25		282229		2866	285095	09222959980	26313

TOTAL PRESENT VALUE 10688338

PLAN F-C
FLATLAND CONCEPT C

INVESTMENT (1982\$) 7476324
O+M 272739
ELEC USE, KWH 65901

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	7476324	0	0	7476324	1	7476324
1		272739	2576	275315	9090909092	250286
2		272739	2588	275327	8264462809	227543
3		272739	2601	275340	7513148008	206867
4		272739	2613	275352	6830134552	188069
5		272739	2626	275365	6209213228	170980
6		272739	2638	275377	5644739298	155443
7		272739	2651	275390	5131581179	141319
8		272739	2664	275403	4665073799	128477
9		272739	2676	275415	4240976181	116803
10		272739	2689	275428	3855432891	106190
11		272739	2702	275441	3504938992	96540
12		272739	2715	275454	3186308174	87768
13		272739	2728	275467	2896643794	79793
14		272739	2741	275480	2633312540	72543
15		272739	2754	275493	2393920490	65951
16		272739	2768	275507	2176291355	59958
17		272739	2781	275520	1978446686	54510
18		272739	2794	275533	1798587896	49537
19		272739	2808	275547	1635079906	45054
20		272739	2821	275560	1486436278	40960
21		272739	2835	275574	1351305709	37238
22		272739	2848	275587	1228459737	33855
23		272739	2862	275601	1116781581	30779
24		272739	2876	275615	1015255987	27982
25		272739	2890	275629	0922959980	25439

TOTAL PRESENT VALUE 9976229

PLAN F-D
FLATLAND CONCEPT D

INVESTMENT (1982\$) 7006434
O+M 266233
ELEC USE, KWH 55149

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	7006434	0	0	7006434	1	7006434
1		266233	2156	268389	.9090909092	243990
2		266233	2166	268399	.8264462809	221817
3		266233	2176	268409	.7513148008	201660
4		266233	2187	268420	.6830134552	183334
5		266233	2197	268430	.6209213228	166674
6		266233	2208	268441	.5644739298	151528
7		266233	2218	268451	.5131581179	137758
8		266233	2229	268462	.4665073799	125240
9		266233	2240	268473	.4240976181	113859
10		266233	2251	268484	.3855432891	103512
11		266233	2261	268494	.3504938992	94106
12		266233	2272	268505	.3186308174	85554
13		266233	2283	268516	.2896643794	77780
14		266233	2294	268527	.2633312540	70712
15		266233	2305	268538	.2393920490	64286
16		266233	2316	268549	.2176291355	58444
17		266233	2327	268560	.1978446886	53133
18		266233	2338	268571	.1798587896	48305
19		266233	2350	268583	.1635079906	43915
20		266233	2361	268594	.1486436278	39925
21		266233	2372	268605	.1351305709	36297
22		266233	2384	268617	.1228459737	32998
23		266233	2395	268628	.1116781581	30000
24		266233	2407	268640	.1015255987	27274
25		266233	2418	268651	.0922959980	24795
TOTAL PRESENT VALUE						9443329

PLAN F-E
FLATLAND CONCEPT E

INVESTMENT(1982\$) 6425405
O+M 259874
ELEC USE, KWH 44943

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	6425405	0	0	0	6425405	1	6425405
1		259874		1757	261631	.9090909092	237846
2		259874		1765	261639	.8264462809	216231
3		259874		1774	261648	.7513148008	196580
4		259874		1782	261656	.6830134552	178715
5		259874		1791	261665	.6209213228	162473
6		259874		1799	261673	.5644739298	147708
7		259874		1808	261682	.5131581179	134284
8		259874		1817	261691	.4665073799	122081
9		259874		1825	261699	.4240976181	110986
10		259874		1834	261708	.3855432891	100900
11		259874		1843	261717	.3504938992	91730
12		259874		1852	261726	.3186308174	83394
13		259874		1861	261735	.2896643794	75815
14		259874		1870	261744	.2633312540	68925
15		259874		1878	261752	.2393920490	62661
16		259874		1887	261761	.2176291355	56967
17		259874		1897	261771	.1978446686	51790
18		259874		1906	261780	.1798587896	47083
19		259874		1915	261789	.1635079906	42805
20		259874		1924	261798	.1486436278	38915
21		259874		1933	261807	.1351305709	35378
22		259874		1943	261817	.1228459737	32163
23		259874		1952	261826	.1116781581	29240
24		259874		1961	261835	.1015255987	26583
25		259874		1971	261845	.0922959980	24167
TOTAL PRESENT VALUE							3800824

PLAN F-F
FLATLAND CONCEPT F

INVESTMENT(1982\$) 8600617
O+M 300600
ELEC USE, KWH 65719

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	8600617	0	0	8600617	1	8600617
1		300600	2569	303169	.9090909092	275608
2		300600	2581	303181	.8264462809	250563
3		300600	2593	303193	.7513148008	227794
4		300600	2606	303206	.6830134552	207094
5		300600	2618	303218	.6209213228	188275
6		300600	2631	303231	.5644739298	171166
7		300600	2644	303244	.5131581179	155612
8		300600	2656	303256	.4665073799	141471
9		300600	2669	303269	.4240976181	128616
10		300600	2682	303282	.3855432891	116928
11		300600	2695	303295	.3504938992	106303
12		300600	2708	303308	.3186308174	96643
13		300600	2721	303321	.2896643794	87861
14		300600	2734	303334	.2633312540	79877
15		300600	2747	303347	.2393920490	72619
16		300600	2760	303360	.2176291355	66020
17		300600	2773	303373	.1978446686	60021
18		300600	2787	303387	.1798587896	54567
19		300600	2800	303400	.1635079906	49608
20		300600	2813	303413	.1486436278	45100
21		300600	2827	303427	.1351305709	41002
22		300600	2840	303440	.1228459737	37276
23		300600	2854	303454	.1116781581	33889
24		300600	2868	303468	.1015255987	30810
25		300600	2882	303482	.0922959980	28010

TOTAL PRESENT VALUE 11353351

PLAN F-C
FLATLAND CONCEPT G

INVESTMENT(1982\$) 11414793
O+M 252885
ELEC USE, KWH 68391

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	11414793	0	0	0	11414793	1	11414793
1		252885		2673	255558	909090992	232326
2		252885		2686	255571	8264462809	211216
3		252885		2699	255584	7513148008	192024
4		252885		2712	255597	6830134552	174576
5		252885		2725	255610	6209213228	158714
6		252885		2738	255623	5644739298	144292
7		252885		2751	255636	5131581179	131182
8		252885		2764	255649	4665073799	119262
9		252885		2778	255663	4240976181	108426
10		252885		2791	255676	3855432891	98574
11		252885		2804	255689	3504938992	89618
12		252885		2818	255703	3186308174	81475
13		252885		2831	255716	2896643794	74072
14		252885		2845	255730	2633312540	67342
15		252885		2859	255744	2393920490	61223
16		252885		2872	255757	2176291355	55660
17		252885		2886	255771	1978446686	50603
18		252885		2900	255785	1798587896	46005
19		252885		2914	255799	1635079906	41825
20		252885		2928	255813	1486436278	38025
21		252885		2942	255827	1351305709	34570
22		252885		2956	255841	1228459737	31429
23		252885		2970	255855	1116781581	28573
24		252885		2984	255869	1015255987	25977
25		252885		2999	255884	0922959980	23617

TOTAL PRESENT VALUE 13735399

PLAN F-H
FLATLAND CONCEPT H

INVESTMENT(1982\$) 8954100
O+M 275682
ELEC USE, KWH 88154

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	8954100	0	0	0	8954100	1	8954100
1		275682		3446	279128	.9090909092	253752
2		275682		3462	279144	.8264462809	230698
3		275682		3479	279161	.7513148008	209738
4		275682		3496	279178	.6830134552	190682
5		275682		3512	279194	.6209213228	173358
6		275682		3529	279211	.5644739298	157607
7		275682		3546	279228	.5131581179	143288
8		275682		3563	279245	.4665073799	130270
9		275682		3580	279262	.4240976181	118434
10		275682		3597	279279	.3855432891	107674
11		275682		3615	279297	.3504938992	97892
12		275682		3632	279314	.3186308174	88998
13		275682		3649	279331	.2896643794	80912
14		275682		3667	279349	.2633312540	73561
15		275682		3685	279367	.2393920490	66878
16		275682		3702	279384	.2176291355	60802
17		275682		3720	279402	.1978446686	55278
18		275682		3738	279420	.1798587896	50256
19		275682		3756	279438	.1635079906	45690
20		275682		3774	279456	.1486436278	41539
21		275682		3792	279474	.1351305709	37765
22		275682		3810	279492	.1228459737	34334
23		275682		3828	279510	.1116781581	31215
24		275682		3847	279529	.1015255987	28379
25		275682		3865	279547	.0922959980	25801

TOTAL PRESENT VALUE 11488905

PLAN F-I
FLATLAND CONCEPT I

INVESTMENT(1982\$) 9211128
O+M 306225
ELEC USE, KWH 72869

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	9211128	0	0	0	9211128	1	9211128
1		306225		2848	309073	.9090909092	280976
2		306225		2862	309087	.8264462809	255444
3		306225		2876	309101	.7513148008	232232
4		306225		2889	309114	.6830134552	211129
5		306225		2903	309128	.6209213228	191944
6		306225		2917	309142	.5644739298	174503
7		306225		2931	309156	.5131581179	158646
8		306225		2945	309170	.4665073799	144230
9		306225		2959	309184	.4240976181	131124
10		306225		2974	309199	.3855432891	119209
11		306225		2988	309213	.3504938992	108377
12		306225		3002	309227	.3186308174	98529
13		306225		3017	309242	.2896643794	89576
14		306225		3031	309256	.2633312540	81437
15		306225		3046	309271	.2393920490	74037
16		306225		3060	309285	.2176291355	67309
17		306225		3075	309300	.1978446686	61193
18		306225		3090	309315	.1798587896	55633
19		306225		3105	309330	.1635079906	50578
20		306225		3119	309344	.1486436278	45982
21		306225		3134	309359	.1351305709	41804
22		306225		3150	309375	.1228459737	38005
23		306225		3165	309390	.1116781581	34552
24		306225		3180	309405	.1015255987	31413
25		306225		3195	309420	.0922959980	28558

TOTAL PRESENT VALUE 12017550

PLAN F-J
FLATLAND CONCEPT J

INVESTMENT(1982\$) 10774018
O+M 247603
ELEC USE, KWH 76553

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	10774018	0	0	10774018	1	10774018
1	247603	247603	2992	250595	.9090909092	227814
2	247603	247603	3007	250610	.8264462809	207115
3	247603	247603	3021	250624	.7513148008	188298
4	247603	247603	3036	250639	.6830134552	171189
5	247603	247603	3050	250653	.6209213228	155636
6	247603	247603	3065	250668	.5644739298	141495
7	247603	247603	3079	250682	.5131581179	128640
8	247603	247603	3094	250697	.4665073799	116952
9	247603	247603	3109	250712	.4240976181	106326
10	247603	247603	3124	250727	.3855432891	96666
11	247603	247603	3139	250742	.3504938992	87884
12	247603	247603	3154	250757	.3186308174	79899
13	247603	247603	3169	250772	.2896643794	72640
14	247603	247603	3184	250787	.2633312540	66040
15	247603	247603	3200	250803	.2393920490	60040
16	247603	247603	3215	250818	.2176291355	54585
17	247603	247603	3230	250833	.1978446886	49626
18	247603	247603	3246	250849	.1798587896	45117
19	247603	247603	3262	250865	.1635079906	41018
20	247603	247603	3277	250880	.1486436278	37292
21	247603	247603	3293	250896	.1351305709	33904
22	247603	247603	3309	250912	.1228459737	30823
23	247603	247603	3325	250928	.1116781581	28023
24	247603	247603	3341	250944	.1015255987	25477
25	247603	247603	3357	250960	.0922959980	23163

TOTAL PRESENT VALUE 13049681

PLAN F-K
FLATLAND CONCEPT K

INVESTMENT(1982\$) 8066124
O+M 257121
ELEC USE, KWH 51674

PROJECT YEAR	NON RECURRING COSTS	O+M	RECURRING COSTS	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	8066124	0	0	0	8066124	1	8066124
1		257121		2020	259141	.9090909092	235583
2		257121		2029	259150	.8264462809	214174
3		257121		2039	259160	.7513148008	194711
4		257121		2049	259170	.6830134552	177017
5		257121		2059	259180	.6209213228	160930
6		257121		2069	259190	.5644739298	146306
7		257121		2079	259200	.5131581179	133010
8		257121		2089	259210	.465073799	120923
9		257121		2099	259220	.4240976181	109934
10		257121		2109	259230	.3855432891	99944
11		257121		2119	259240	.3504938992	90862
12		257121		2129	259250	.3186308174	82605
13		257121		2139	259260	.2896643794	75098
14		257121		2149	259270	.2633312540	68274
15		257121		2160	259281	.2393920490	62070
16		257121		2170	259291	.2176291355	56429
17		257121		2181	259302	.1978446686	51301
18		257121		2191	259312	.1798587896	46640
19		257121		2202	259323	.1635079906	42401
20		257121		2212	259333	.1486436278	38548
21		257121		2223	259344	.1351305709	35045
22		257121		2233	259354	.1228459737	31861
23		257121		2244	259365	.1116781581	28965
24		257121		2255	259376	.1015255987	26333
25		257121		2266	259387	.0922959980	23940

TOTAL PRESENT VALUE 10419030

PLAN F-L
FLATLAND CONCEPT L

INVESTMENT(1982\$) 9243594
O+M 268762
ELEC USE, KWH 74702

PROJECT YEAR	NON RECURRING COSTS	RECURRING COSTS	O+M	ENERGY	ANNUAL COSTS	PRESENT VALUE FACTOR	PRESENT VALUE
0	9243594	0	0	0	9243594	1	9243594
1		268762		2920	271682	.9090909092	246984
2		268762		2934	271696	.8264462809	224542
3		268762		2948	271710	.7513148008	204140
4		268762		2962	271724	.6830134552	185591
5		268762		2976	271738	.6209213228	168728
6		268762		2991	271753	.5644739298	153397
7		268762		3005	271767	.5131581179	139459
8		268762		3019	271781	.4665073799	126788
9		268762		3034	271796	.4240976181	115268
10		268762		3048	271810	.3855432891	104795
11		268762		3063	271825	.3504938992	95273
12		268762		3078	271840	.3186308174	86617
13		268762		3093	271855	.2896643794	78747
14		268762		3107	271869	.2633312540	71592
15		268762		3122	271884	.2393920490	65087
16		268762		3137	271899	.2176291355	59173
17		268762		3152	271914	.1978446886	53797
18		268762		3167	271929	.1798587896	48909
19		268762		3183	271945	.1635079906	44465
20		268762		3198	271960	.1486436278	40425
21		268762		3213	271975	.1351305709	36752
22		268762		3229	271991	.1228459737	33413
23		268762		3244	272006	.1116781581	30377
24		268762		3260	272022	.1015255987	27617
25		268762		3275	272037	.0922959980	25108

TOTAL PRESENT VALUE 11710637

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