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THE ECONOMICS OF APPLYING SUPPRESSIVE SHIELDING TO THE M483A1 IMPROVED
CONVENTIONAL MUNITION LOADING, ASSEMBLING, AND PACKING FACILITY

by

Kevin P. Nelson

Manufacturing Technology Directorate

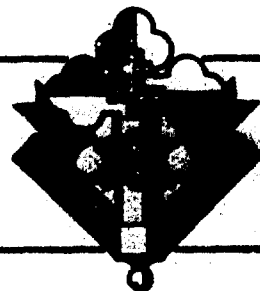
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PREFACE

The work described in this interim report was authorized under MMT Project 5761264, Advanced Technology for Suppressive Shielding of Hazardous Production and Supply Operations. This work was started in 1973 and is continuing.

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THE ECONOMICS OF APPLYING SUPPRESSIVE SHIELDING TO THE M483A1 IMPROVED CONVENTIONAL MUNITION LOADING, ASSEMBLING, AND PACKING FACILITY

I. INTRODUCTION.

The purpose of this study is to evaluate proposed layouts for the loading, assembling, and packing of improved conventional munitions (ICM) and develop alternative layouts using suppressive shielding technology around hazardous explosive operations. The goal is to determine the most economic facility that will meet production requirements both for peak production and for guaranteed production in case of an accidental detonation. Insurance of a safe environment in the facility is also desirable.

Proposed layouts for the M483A1 ICM loading, assembling, and packing facility were developed by Picatinny Arsenal engineers¹ and evaluated by Kaiser engineers² for the US Army Corps of Engineers, Huntsville, Alabama. Data from these analyses are used in this report to determine layout concepts of the proposed facility and to determine costs of various alternatives and are assumed to be correct.

This report is divided into five sections. The first section briefly describes the processes for loading, assembling, and packing of ICM's and the layout alternatives proposed by Picatinny Arsenal. Section II deals with various facility layouts using suppressive shielding technology. Section III lists the benefits, the cost savings and tradeoffs, and the safety comparisons of the Picatinny Arsenal layouts versus the suppressive shielding layouts. Sections IV and V give conclusions and recommendations, respectively.

II. 155-MM M483A1 INTEGRATED IMPROVED CONVENTIONAL MUNITION FACILITY PROCESSES, DESCRIPTIONS, AND PROPOSED LAYOUTS.

The integrated ICM facility, in its conception, was to manufacture all metal parts and to load, assemble, and pack the M483A1 projectile at a monthly production rate of 120,000 units on a 500-hour basis. The facility encompasses all support and storage buildings, utilities, process equipment, ancillary equipment, ramps, walkways, and material handling equipment. Only the loading, assembling, and packing area is considered in this report.

The M483A1 projectile is a 155-mm round with a payload of 88 shaped-charge M42/M46 grenades. These grenades are expelled from the projectile in flight by an M10 propellant expelling charge, scattering them over a large area. Each grenade contains a 31-gram shaped charge of A-5 explosive and functions as both an antipersonnel and an antimateriel device. The grenades are cylindrical (1.25 inch in diameter and 1.5 inch high) with a fuze extending from one end and a brass cone inserted into the other to form the shaped charge.

¹ Picatinny Arsenal, Dover, New Jersey. Draft Design Criteria; Load, Assemble, and Pack Facility for Projectile, 155-mm: HE, M483A1. October 1975.

² Kaiser Engineers. Report No. 76-19-RE. 155-mm M483 ICM Complex: Load, Assembly, and Pack Facility Alternatives Evaluation. Prepared for US Army Corps of Engineers. February 1976.

The following explosive-handling processes occur in the loading, assembling, and packing area, inert handling being omitted. (Figure 1 is a schematic of the facility layout.) A-5 explosive is received by truck in 60-pound fiber drums in a separate receiving building. These drums are opened by hand and emptied into a machine which in turn places 25 pounds of A-5 explosive on an enclosed flanged belt conveyor. Explosive in the receiving building is limited to 10,000 pounds.

The explosive is moved by this conveyor to a screening building (or buildings) where dual screening takes place to insure proper grain size. The screening building is a totally remote operation controlled from the receiving building. The screening building has a 1,000-pound limit if one building is used or a 500-pound limit if two buildings are used. In either case, it is a Category III (critical) hazard (MIL-STD-882).

The screened explosive is moved in buckets in 15-pound increments by an overhead trolley conveyor to the loading, assembling, and packing buildings. The first operation in the loading, assembling, and packing building is a surge and inspection hold for the screened A-5 explosive with a limit of 2,000 pounds if one loading, assembling, and packing building is used or 1,000 pounds if two loading, assembling, and packing buildings are used. A reinforced concrete wall will be used to protect this explosive from any detonation that may occur elsewhere in the loading, assembling, and packing building.

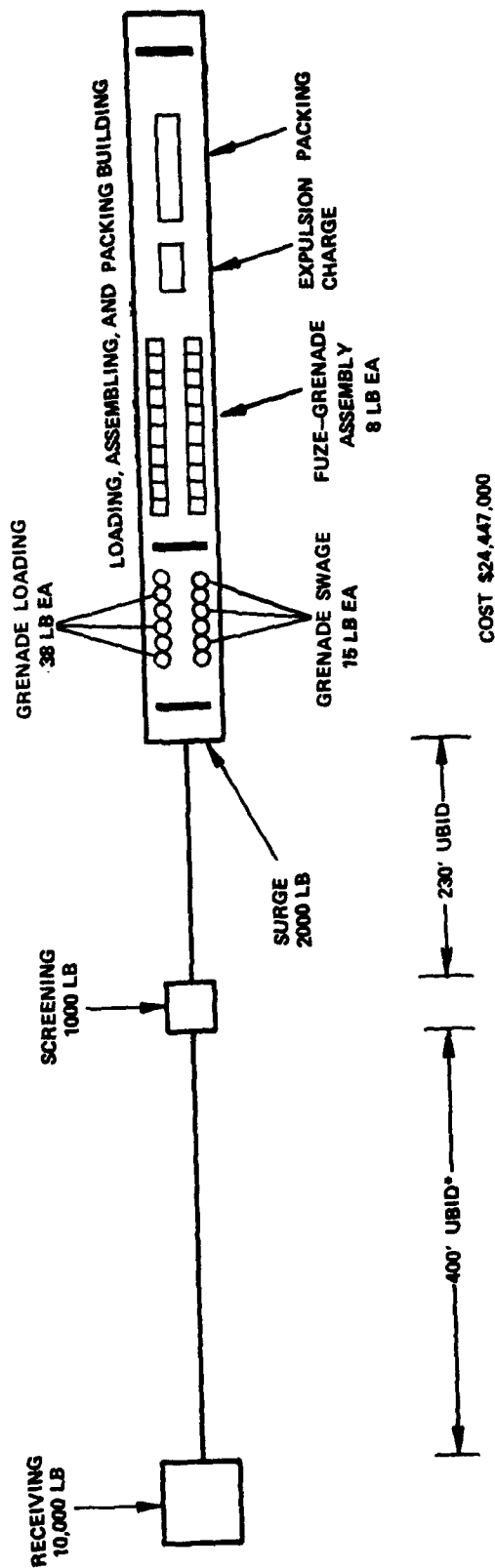
After acceptance by quality control, the explosive is automatically moved to the grenade loading area (Category III hazard) and dumped into the hopper of a press loading machine (38-pound limit). This machine presses the A-5 explosive into the grenade to a predetermined level. The grenades are then moved to a separate bay (15-pound limit) where a brass cone is swaged into the base of the grenade to make it a shaped charge (Category III, hazard). A 5-ton press is used to assure that no air gap exists between the cone and the explosive. Six each of the grenade load and swage stations are needed to meet production requirements.

The loaded grenades are assembled onto trays (48 per tray) and 64 trays are placed on a cart (206-pound net explosive). These carts are moved by driverless tractor to an 8-hour hold in a nearby building while quality checks take place. Upon acceptance, the carts are returned to the loading, assembling, and packing building for fuze assembly.

Fuzes are attached to the grenade by a large (approximately 16-foot by 16-foot) machine that completes the entire fuzing operation. An 8-pound explosive limit has been established for each of the 20 machines needed for this operation. After fuzes have been attached, the grenades are once more loaded onto carts and moved by driverless tractor to a 40-hour hold for quality assurance inspection. After inspection, the grenades are returned to the loading, assembling, and packing building for continued processing.

The next operation is the loading of the grenades into the 155-mm projectile. The round is placed nose down in a fixture, with a flat-topped hydraulic ram inserted up into the round. A layer of eight grenades, held in position by a plastic spacer, is loaded into the base of the round. The ram is lowered one notch and a second layer of grenades is inserted, the fuzes of the second layer fitting into the cone-shaped charge of the first. Eleven layers are added in this way with a twelfth spacer layer being added. A base plate closes the base of the round.

The expulsion charge, a 51-gram bag of M10 propellant prepared in a separate building, is now inserted into an expulsion cup placed in the nose of the projectile. A lifting plug is threaded into the nose of the projectile and the projectile is marked, palletized, and shipped out.



• UNBARRICADED INTRALINE DISTANCE.

Figure 1. Current One-Building Design

Three areas in the loading, assembling, and packing building as conceived by Picatinny Arsenal engineers were shielded by TM 5-1300-type walls. The grenade loading and swaging cubicles are 15 by 16 by 10 feet and 10 by 16 by 10 feet, respectively. These cubicles are shielded by concrete walls on three sides and the roof, the fourth side being open to a frangible outer wall. The fuze-to-grenade cubicle (20 by 20 by 10 feet) has all four walls of concrete which continues as steel up to a frangible roof. In addition, TM 5-1300-type walls separate various portions of the loading, assembling, and packing building so that an incident in one area has less severe effects in the next area. Distances between buildings as specified in AMC Regulation 385-100 are sufficient to prevent major damage in case of an explosion.

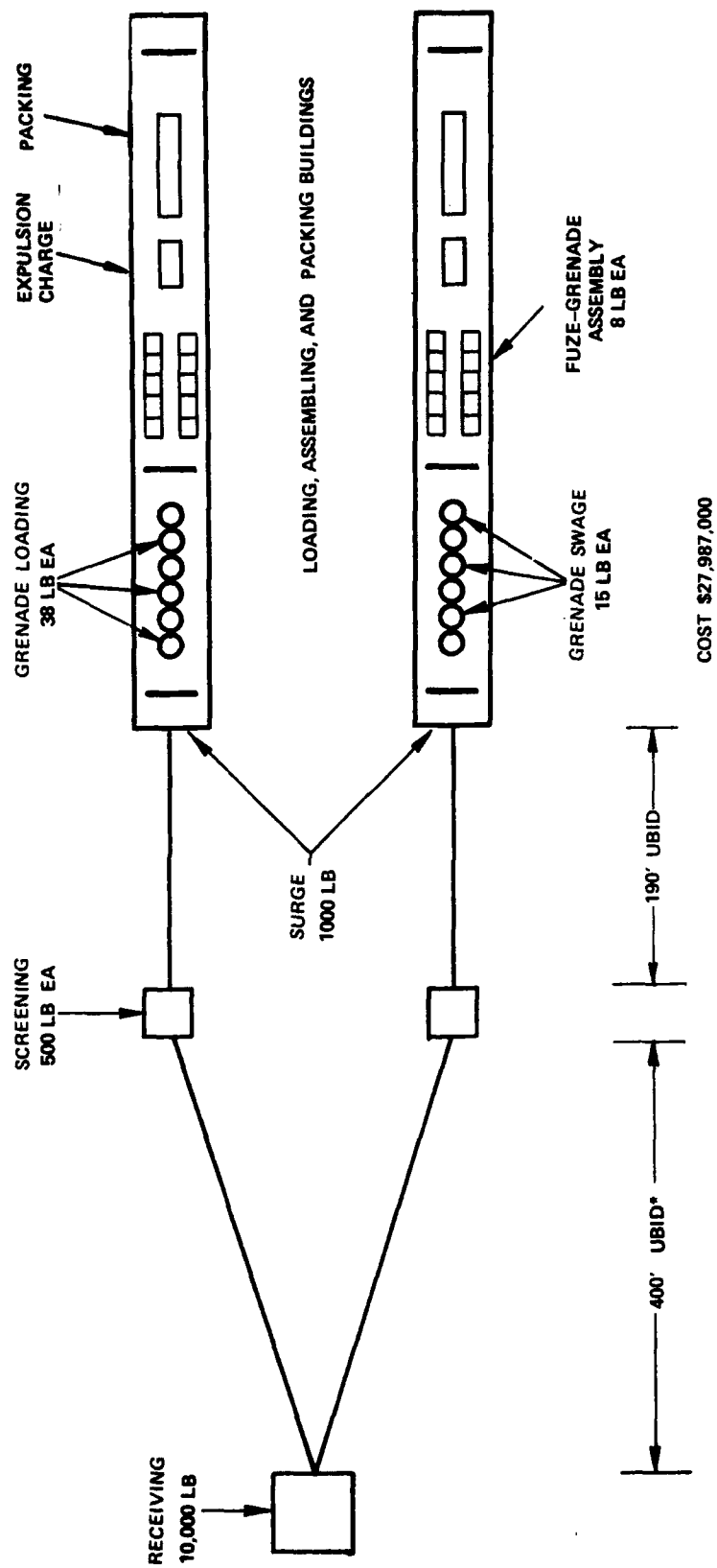
Three layout designs were established by Picatinny Arsenal for further evaluation. The first, a one-building design shown in figure 1, has the advantage of being the lowest cost design (\$24,449,000). Figure 2 shows a two-building layout which is the most expensive design (\$27,987,000) but guarantees 50 percent production capability while repairs are occurring from an accidental detonation anywhere in the facility. This layout merely separates the one-building layout into two mirror image lines with half the production occurring on each. The three-building layout, shown in figure 3, costs \$25,768,000 and will suffer less damage from an explosion than the one-building layout. The three-building layout separates the loading, assembling, and packing building of the one-building design into three loading, assembling, and packing buildings, one each for grenade load and swaging, fuze-to-ground assembly, and projectile cargo loading. Thus an incident in one building initiates little damage in the other two. Production is stopped in the event of an explosion. Cost estimates for each layout as developed for the Corps of Engineers, Huntsville, by Kaiser Engineers are presented in appendix A.

III. LAYOUTS USING SUPPRESSIVE SHIELDING TECHNOLOGY.

All locations where explosives are handled in the loading, assembling, and packing portion of the facility were investigated as potential areas for suppressive shielding applications. All but four were eliminated because they involved very large quantities of explosives or because the probability of an incident was extremely low. The four locations investigated in depth were the screening operation, the grenade loading area, the grenade swaging area, and the fuze-to-grenade assembly area.

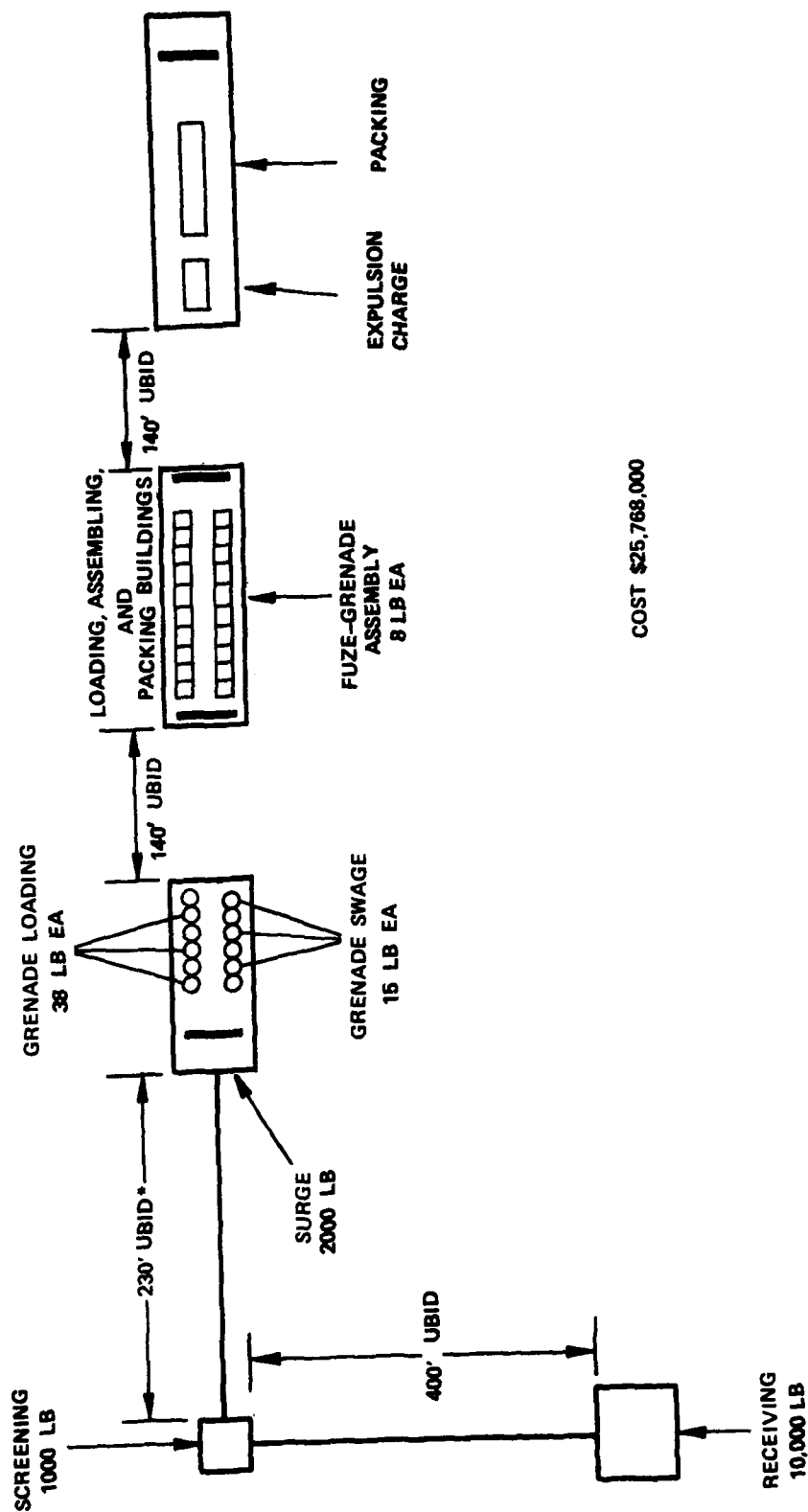
In performing the analysis of the facility layouts using suppressive shields, it was assumed that the design was required to guarantee 50 percent production in case of an accident at the lowest initial cost possible. The two-building layout must therefore be used as this is the only design guaranteeing 50 percent production.

Along with the principle that 50 percent production must be maintained, two screening buildings, each having an explosive limit of 500 pounds and performing half the work, would be necessary. The most cost effective shield to perform this function would be a scaled-up version of the shield shown in figure 4. This shield would be cylindrical, having vertical interlocked I-beam walls as shown in figure 5, and laced, reinforced concrete roof and foundation. The shield dimensions would be approximately 32 feet in diameter by approximately 31 feet high. This shield would completely contain all fragments and would reduce pressures outside so that 3.5 psi (equivalent intraline distance pressure) would occur about 6 feet from the shield. This shield is estimated to cost \$439,830 and it would replace the entire screening building. Detailed cost estimates for suppressive shields are located in appendix B.



*UNBARRICADED INTRALINE DISTANCE.

Figure 2. Current Two-Building Design



* UNBARRICADED INTRALINE DISTANCE.

Figure 3. Current Three-Building Design

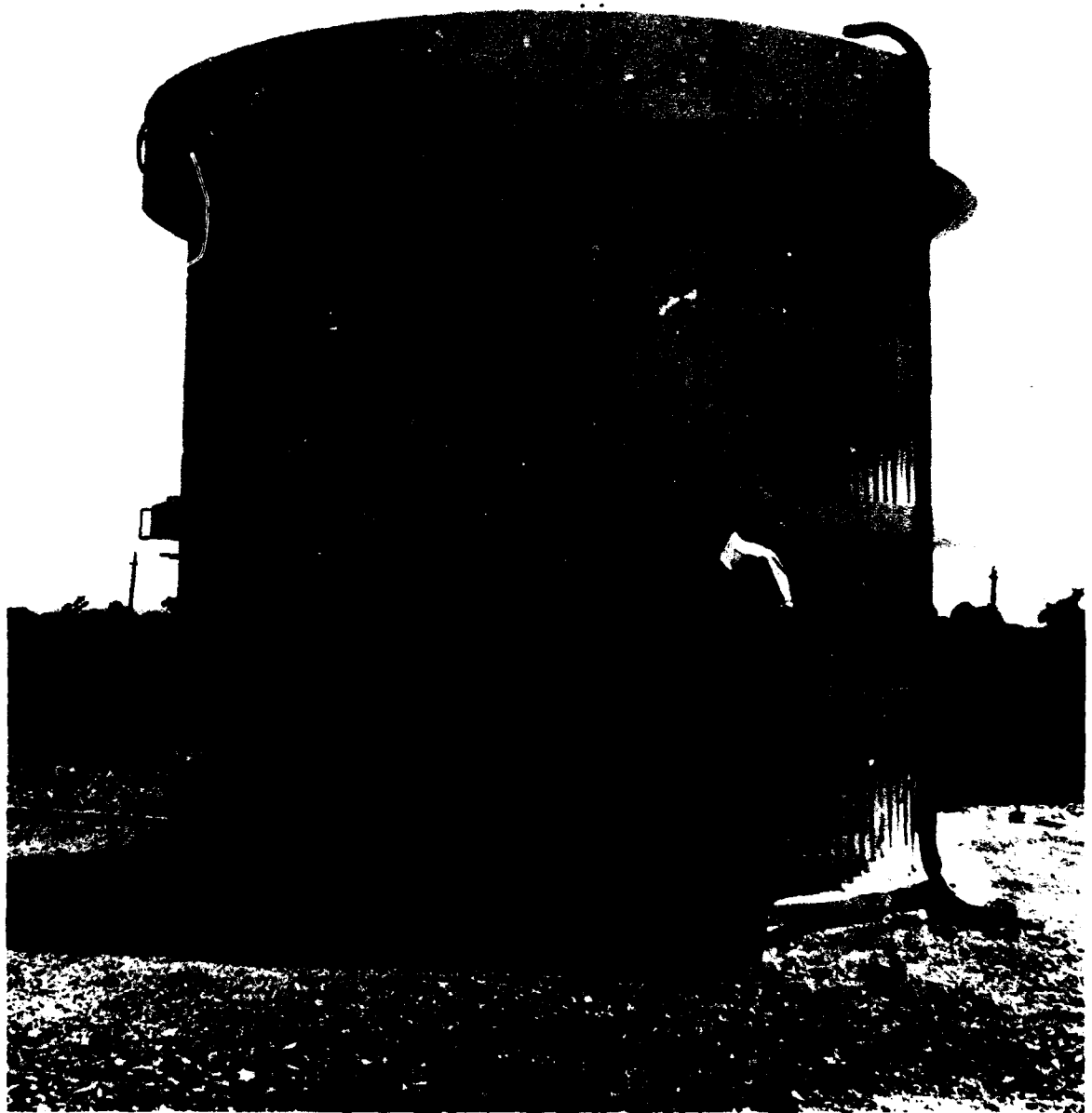


Figure 4. Grenade Loading Shield

**I-BEAM CONFIGURATION SHOWING OPTIONAL
ADDITION OF CLOSURE STRIPS AND DOUBLE LINER**

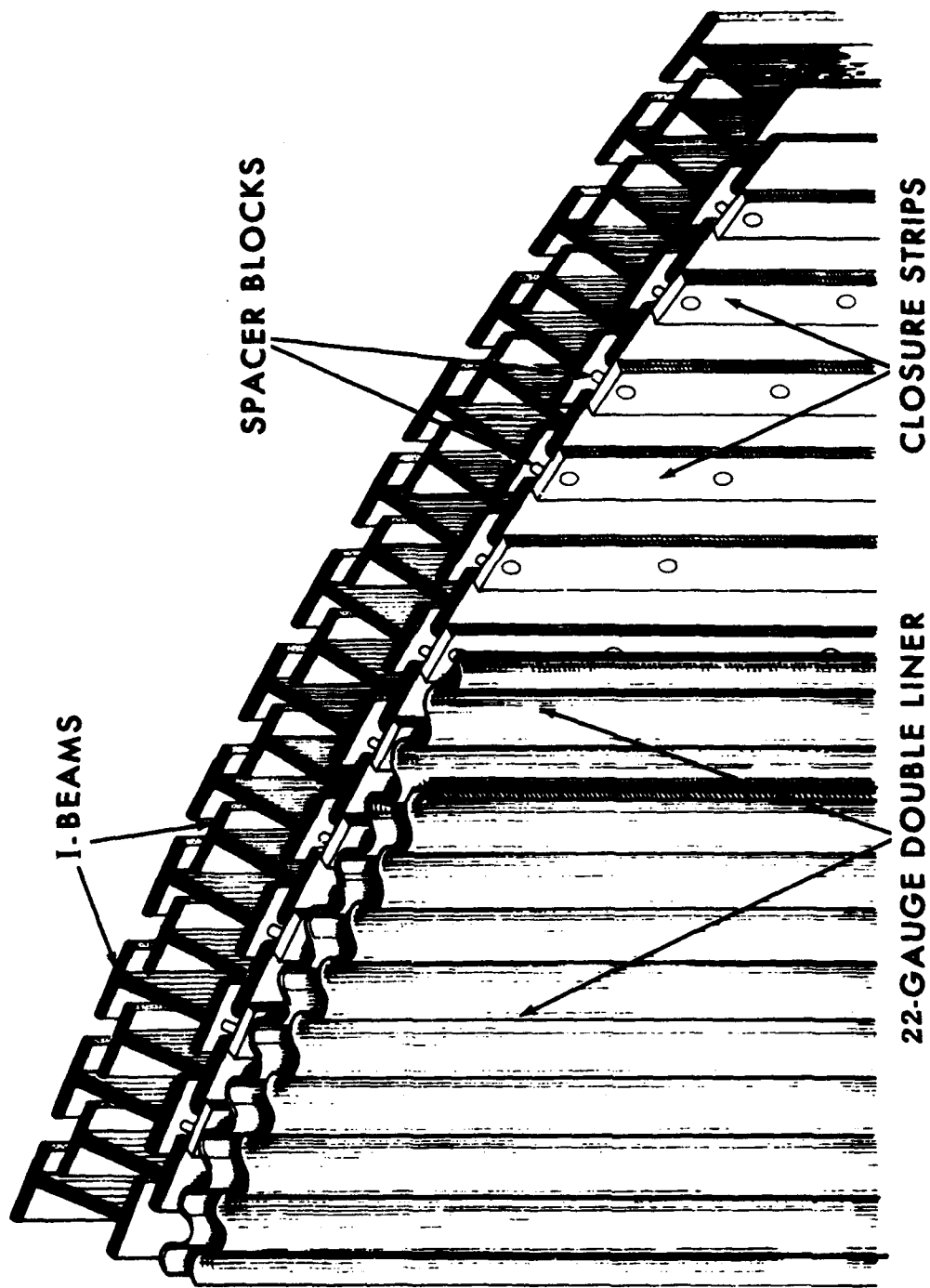


Figure 5. I-Beam Configuration

Surrounding the grenade loading operation would be an existing safety approved shield. This shield is similar in every respect to the screening building shield which is shown in figures 4 and 5. The grenade loading shield, which would be approximately 13 feet high by 13 feet in diameter, has been tested with 45.7 pounds of explosive and has an estimated cost of \$56,316. This and all subsequent shields described limit the effects of an accidental explosion to an acceptable level.

Shielding the grenade swaging area would be a rectangular structure consisting of I-beams configured as shown in figure 6 to take the load from the blast effects of a 15-pound explosion. I-beam frames are constructed and placed adjacent to each other to form a box. Vertical beams are added at each end to enclose the shield. End beams and side beams are added to hold the ends on the shield and the I-beam frames in place in case of an explosion. A steel sheet internal liner would be added to improve blast pressure suppression. The shield would be 10 by 16 by 10 feet and would cost approximately \$21,852.

The fuze-to-grenade assembly area is shielded by an I-beam shield very similar in design to the grenade swaging area shield. This shield, however, is larger (20 by 20 by 10 feet); but, because of the lower charge weight (8 pounds), it would be of lighter construction and would cost \$31,780.

The first suppressive shield layout incorporates shields at all four locations previously described, as shown in figure 7. The following list of facts was used in designing this layout:

1. Overpressures from an explosion in a suppressive screening building are reduced sufficiently so that no damage will result to the other screening building if the two buildings are placed side by side.
2. Overpressures from an explosion in a screening building are reduced so that no structural damage will result to other buildings 10 feet from the screening buildings.
3. Calculations made by the US Army Corps of Engineers, Huntsville, Alabama, indicate that the screening buildings are strong enough to act as a barricade for the 10,000 pounds in the receiving building if they are placed within 40 feet of the receiving building. (Requirements for barricades are described in AMC Regulation 385-100.³) In this way, barricaded intraline distance can be used between the receiving and the loading, assembling, and packing buildings instead of unbarricaded intraline distance, thus cutting the conveyor lengths in half.
4. The effects of an explosion in the grenade loading operation, the grenade swaging operation, or the fuze-to-grenade assembly operation would be limited to one small area. Thus, five-sixths production (five of six grenade loading or swaging machines would remain in operation) could always be maintained. The less expensive one-building design could then be used and have all the advantages of the two-building layout.
5. The loading, assembling, and packing building used could be an inexpensive preengineered-type steel frame building because overpressures from an explosion in the loading, assembling, and packing building would be greatly reduced. The hardened concrete-type loading, assembling, and packing building presently required for all the Picatinny Arsenal design alternatives would be unnecessary to survive any accident in the building. Detailed costs of suppressive shield loading, assembling, and packing building are in table 1.

³ AMC Regulation 385-100. Safety; Safety Manual. April 1970.

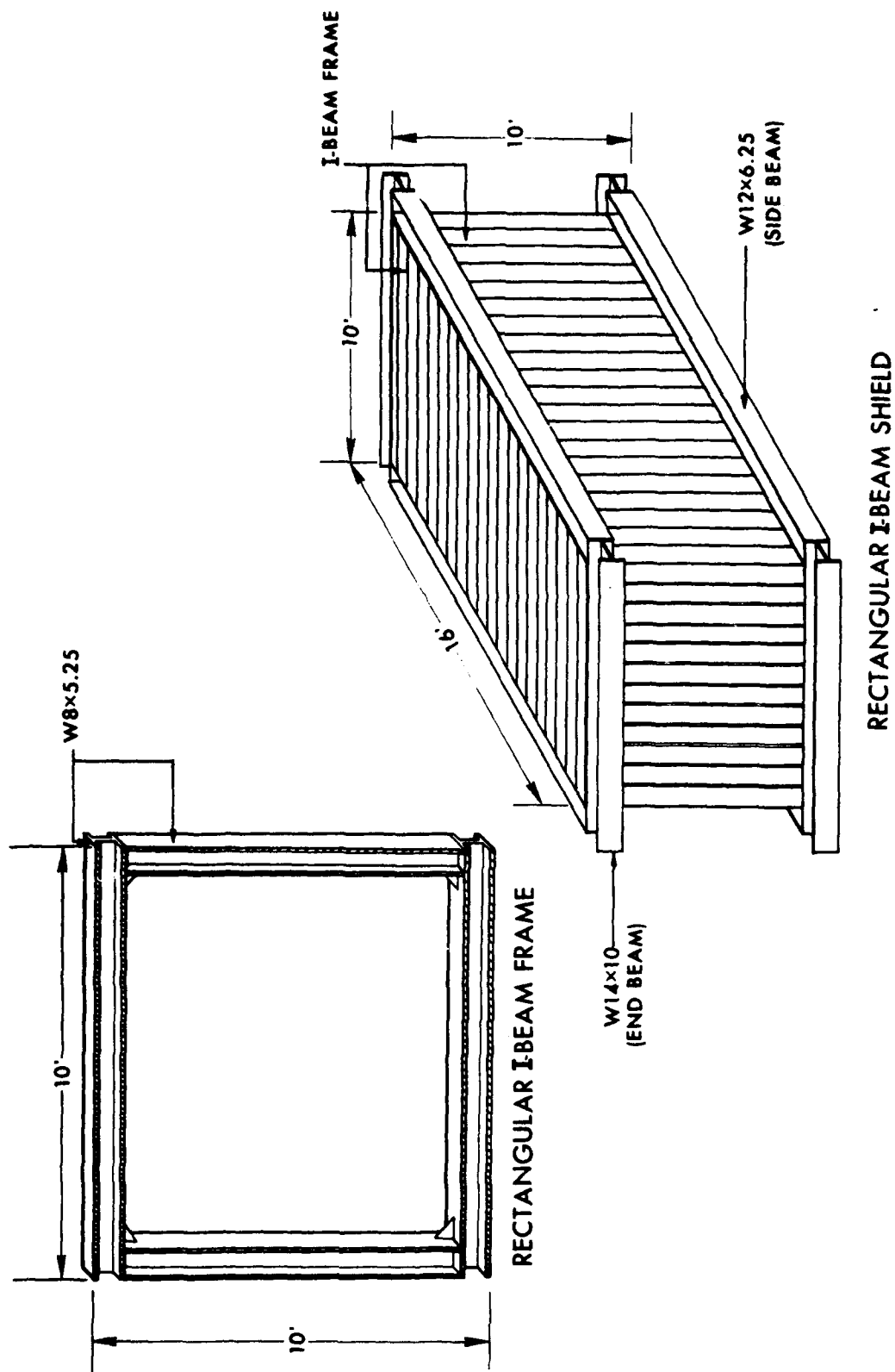


Figure 6. Rectangular I-Beam Shield and Frame

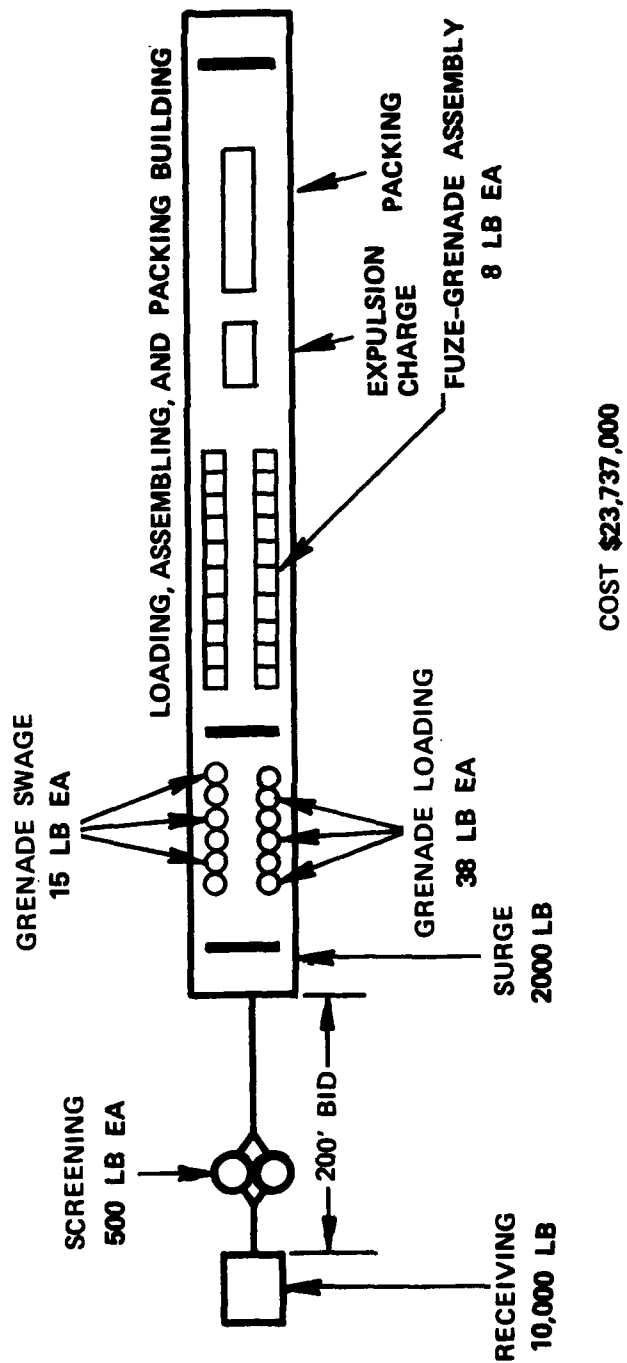


Figure 7. Suppressive Shield Alternative 1

**Table 1. Suppressive Shielding Loading, Assembling, and Packing
Building Cost Estimation**

Item	Cost
Foundation concrete	\$ 269,800
Floor slab concrete	214,200
Compacted fill	72,400
Aggregate under slab	27,100
Acoustical ceiling	3,800
Vinyl floor tile	2,600
Ceramic floor tile	1,600
Doors, 3 by 7 feet	34,700
Rollup doors, 16 by 12 feet	30,700
Rubber doors	3,000
Vault doors	19,500
Plumbing	30,000
Heating, ventilation, and air conditioning } Mechanical fire protection }	1,581,000
Electrical building	720,000
Building lighting	292,500
Communications	24,400
Roof insulation	58,500
Insulated wall panels	149,200
Building (\$5.29/sq ft)*	449,000
	\$3,984,000

* US Army Corps of Engineers, Huntsville Division. HNDTR-75-23-ED-SR. Overpressure Effects on Structures. Prepared for AMC Project Manager for Munitions Production Base Modernization and Expansion. 1 February 1976.

Cost reductions would be obtained from this alternative by reducing the conveyor lengths from the receiving building to the screening building and from the screening building to the loading, assembling, and packing building. Savings would also result because only one loading, assembling, and packing building instead of two is required to guarantee survivability and this building could be of a less-expensive construction. Conveyor cost in the loading, assembling, and packing building would be reduced from that of the two-building design to that of the one-building design.

Higher costs would result from the increased cost of the screening buildings and the increased cost of the shields at the grenade loading, swaging, and assembly areas.

Two designs using suppressive shielding were evaluated in detail. Suppressive shield alternative 1 is shown in figure 7. In this design, two screening buildings and one loading, assembling, and packing building are used to guarantee production. The two screening buildings are used as barricades on the 10,000-pound receiving building, thus reducing the distance from the receiving building to the loading, assembling, and packing building to the barricaded intraline distance of 200 feet. This alternative costs \$23,736,568, resulting in a savings of \$710,432 compared to the one-building design and \$4,250,432 compared to the two-building design. Detailed cost data are summarized in table 2.

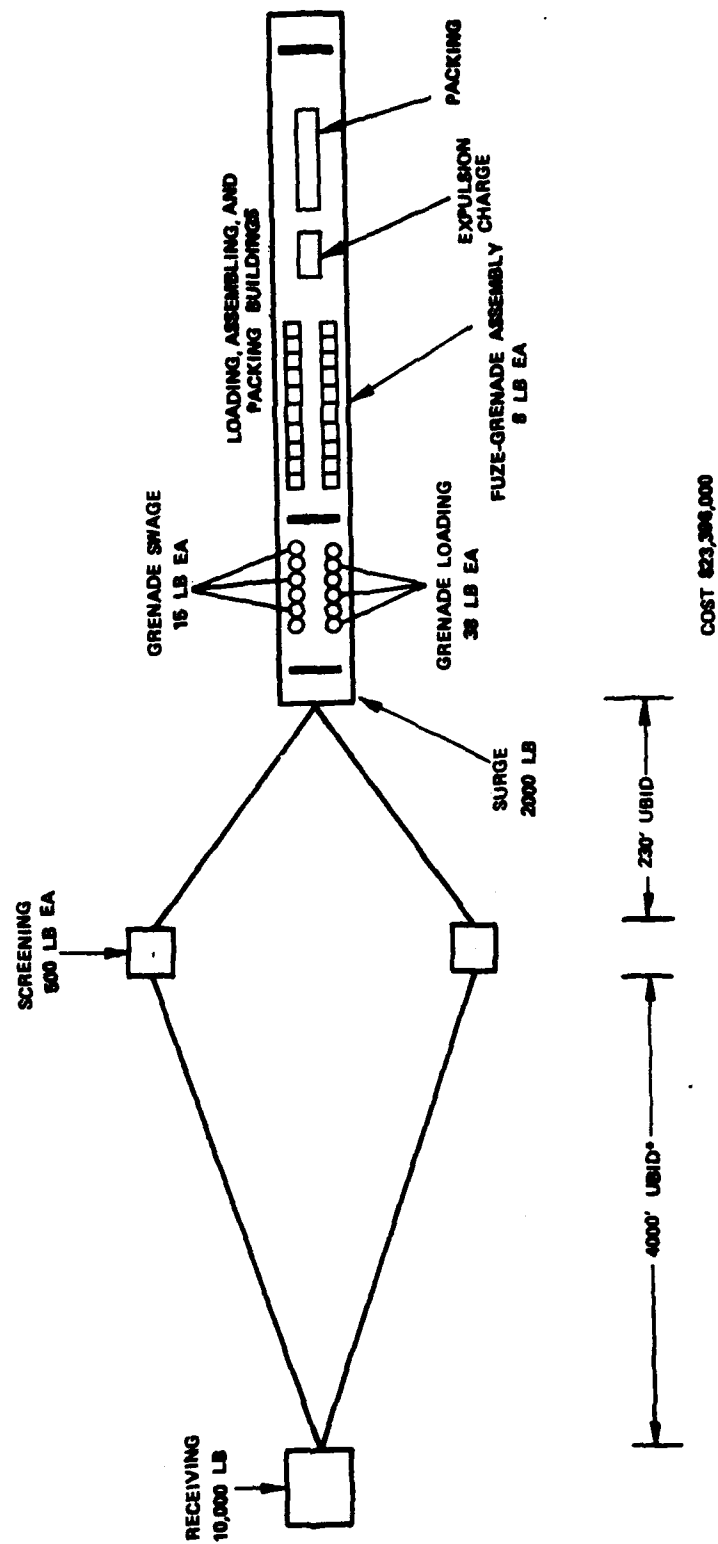
Suppressive shield alternative 2 (figure 8) is very similar to alternative 1 except no shield surrounds the screening operation. No conveyor lengths are reduced from receiving to screening buildings or from screening to loading, assembling, and packing buildings because the screening buildings are not used as barricades. In fact, conveyor lengths are doubled because conveyors must run to each of the two screening buildings. The cost of the second screening building adds \$144,000. The shield costs in the loading, assembling, and packing building still increase by the same amounts and the loading, assembling, and packing building costs are the same as those in the alternative 1 layout. Alternative 2 costs \$23,395,608 (table 3) which saves \$1,051,392 compared to the one-building design cost and \$4,591,309 compared to the two-building design cost.

IV. CONCLUSIONS.

Suppressive shield alternative 2 is the most cost effective layout using suppressive shields. This alternative maximizes safety for employees in the loading, assembling, and packing area because the shields here completely contain all fragments and reduce overpressures to an operator safe level in the immediate proximity of the shield. Production is guaranteed at five-sixths the full production rate if an accident occurs at one of the three areas in the loading, assembling, and packing building or at one-half the full production rate if an incident occurs in the screening building.

The initial cost of the facility is \$23,395,608, which is \$4,591,309 less than the two-building layout whose 50-percent production rate guarantee it exceeds. It is also more cost effective than the less desirable one-building layout by \$1,051,392. The cost of the shielded screening building is too high to be offset by savings from reduced conveyor lengths and therefore the building should not be developed.

In addition to the cost savings itemized above, the use of suppressive shields in place of concrete cubicles allows greater flexibility in the loading, assembling, and packing building layout. Should a revised layout be required in the future, the suppressive shields may be moved about but the concrete cubicles would be unusable.



* UNBARRICADED INTRALINE DISTANCE.

Figure 8. Suppressive Shield Alternative 2

Table 2. Cost Summary for Suppressive Shield Alternative 1

Item	Cost	Cost saving
One-building design cost (appendix A)	\$24,447,000	
Screening building		
Two suppressive shields – \$439,830 per shield	879,660	
Original screening building	<u>144,000</u>	
		(\$735,660)
Grenade press loading (six shields)		
\$56,316 per suppressive shield	337,896	
\$13,600 per original cubicle	<u>81,600</u>	
		(\$256,896)
Grenade swage (six shields)		
\$21,852 per suppressive shield	131,112	
\$10,500 per original cubicle	<u>63,000</u>	
		(\$68,112)
Fuze-to-grenade assembly (20 shields)		
\$31,780 per suppressive shield	635,600	
\$15,100 per original shield	<u>302,000</u>	
		(\$333,600)
Conveyors		
Receiving to screening – 350 feet at \$670 per foot		\$234,500
Screening to loading, assembling, and packing – 90 feet at \$180 per foot		\$16,200
Loading, assembling, and packing building		
Original loading, assembling, and packing building (appendix A)	5,838,000	
Preengineered loading, assembling, and packing building (table 1)	<u>3,984,000</u>	
		\$1,854,000
Cost of suppressive shield alternative 1	\$23,736,568	
Suppressive shield alternative 1 versus one-building design		\$ 710,432
Suppressive shield alternative 1 versus two-building design		\$ 4,250,432

Table 3. Cost Summary for Suppressive Shield Alternative 2

Item	Cost	Cost saving
One-building design cost (appendix A)	\$24,447,000	
Screening building		
One additional building		(\$144,000)
Grenade press loading (six shields)		
\$56,316 per suppressive shield	337,896	
\$13,600 per original cubicle	<u>81,600</u>	
		(\$256,896)
Grenade swage (six shields)		
\$21,852 per suppressive shield	131,112	
\$10,500 per original cubicle	<u>63,000</u>	
		(\$68,112)
Fuze-to-grenade assembly (20 shields)		
\$31,780 per suppressive shield	635,600	
\$15,100 per original shield	<u>302,000</u>	
		(\$333,600)
Loading, assembling, and packing building		
Original loading, assembling, and packing building (appendix A)	5,838,000	
Preengineered loading, assembling, and packing building (table 1)	<u>3,984,000</u>	
		\$1,854,000
Cost of suppressive shield alternative 2	\$23,395,608	
Suppressive shield alternative 2 versus one-building design		\$1,051,392
Suppressive shield alternative 2 versus two-building design		\$4,591,309

V. RECOMMENDATIONS.

This analysis indicates a substantial cost savings by applying suppressive shielding technology to the M483A1 ICM loading, assembling, and packing facility. The magnitude of the cost reductions possible while maintaining production and safety guarantees warrants that suppressive shields be used on the ICM loading, assembling, and packing facility. An in-depth analysis of other new facilities is recommended to determine the cost effectiveness of applying suppressive shielding technology.

APPENDIX A

COST ESTIMATES OF LOADING, ASSEMBLING, AND PACKING LAYOUTS

U.S. ARMY ENGINEER DIVISION HUNTSVILLE
CORPS OF ENGINEERS
HUNTSVILLE, ALABAMA

PRELIMINARY COST ESTIMATE

DATE PREPARED:

REVISED 3/23/75

SHEET 1 OF 1

PROJECT

155 MM ICM

LAP AREA

LOCATION

MISS/SS/PP/ ARMY AMMUNITION PLANT

ARCHITECT ENGINEER

KAISER ENGINEERS

CWE

PROGRAMMED

LINE	ITEM NO.	OR CAT.	CODE NO.	QTY	UNIT	PRICE	AMOUNT	TAX	TOTAL
1	100			1	EA	10.00	10.00	0.00	10.00
2	200			1	EA	20.00	20.00	0.00	20.00
3	300			1	EA	30.00	30.00	0.00	30.00
4	400			1	EA	40.00	40.00	0.00	40.00
5	500			1	EA	50.00	50.00	0.00	50.00
6	600			1	EA	60.00	60.00	0.00	60.00
7	700			1	EA	70.00	70.00	0.00	70.00
8	800			1	EA	80.00	80.00	0.00	80.00
9	900			1	EA	90.00	90.00	0.00	90.00
10	1000			1	EA	100.00	100.00	0.00	100.00
11	1100			1	EA	110.00	110.00	0.00	110.00
12	1200			1	EA	120.00	120.00	0.00	120.00
13	1300			1	EA	130.00	130.00	0.00	130.00
14	1400			1	EA	140.00	140.00	0.00	140.00
15	1500			1	EA	150.00	150.00	0.00	150.00
16	1600			1	EA	160.00	160.00	0.00	160.00
17	1700			1	EA	170.00	170.00	0.00	170.00
18	1800			1	EA	180.00	180.00	0.00	180.00
19	1900			1	EA	190.00	190.00	0.00	190.00
20	2000			1	EA	200.00	200.00	0.00	200.00
21	2100			1	EA	210.00	210.00	0.00	210.00
22	2200			1	EA	220.00	220.00	0.00	220.00
23	2300			1	EA	230.00	230.00	0.00	230.00
24	2400			1	EA	240.00	240.00	0.00	240.00
25	2500			1	EA	250.00	250.00	0.00	250.00
26	2600			1	EA	260.00	260.00	0.00	260.00
27	2700			1	EA	270.00	270.00	0.00	270.00
28	2800			1	EA	280.00	280.00	0.00	280.00
29	2900			1	EA	290.00	290.00	0.00	290.00
30	3000			1	EA	300.00	300.00	0.00	300.00
31	3100			1	EA	310.00	310.00	0.00	310.00
32	3200			1	EA	320.00	320.00	0.00	320.00
33	3300			1	EA	330.00	330.00	0.00	330.00
34	3400			1	EA	340.00	340.00	0.00	340.00
35	3500			1	EA	350.00	350.00	0.00	350.00
36	3600			1	EA	360.00	360.00	0.00	360.00
37	3700			1	EA	370.00	370.00	0.00	370.00
38	3800			1	EA	380.00	380.00	0.00	380.00
39	3900			1	EA	390.00	390.00	0.00	390.00
40	4000			1	EA	400.00	400.00	0.00	400.00
41	4100			1	EA	410.00	410.00	0.00	410.00
42	4200			1	EA	420.00	420.00	0.00	420.00
43	4300			1	EA	430.00			

ESTIMATOR

J. D. BROWN

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APPVD. BY

ITEM NO	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
	<u>LAP AREA</u>	<u>ONE-</u>	<u>BUILDING</u>	<u>CONFIGURATION</u>	
	LAP BUILDING	84,882	SF		\$ 5,838,000
	BULK EXPLOSIVE BLDG.	3,750	SF		199,000
	SCREENING BUILDING	3,000	SF		144,000
	BODY LOADING & HOLD BLDG	3,300	SF		160,000
	GRENADE HOLDING ICLOOS 6ea	20,160	SF		939,000
	SHIPPING BUILDING	4,400	SF		96,000
	EXPULSION CHARGE BLDG.	1,800	SF		95,000
	CHEMICAL LAB BLDG.	2,500	SF		148,000
	X RAY BUILDING	2,000	SF		106,000
	DEMIL. BUILDING	4,900	SF		237,000
	OFFICE, CHANGE RM, CAFETERIA	21,664	SF		785,000
	COVERED RAMPS	33,060	SF		886,000
	CONCRETE PAVING	56,150	SF		67,000
	ASPHALT PAVING	485,000	SF		315,000
	SHELL PAVING	13,500	SF		5,000
	FENCE	7,500	LF		60,000
	RAILROAD	5,805	LF		290,000
	YARD ELECTRICAL	1-Job	-		315,000
	YARD UTILITIES	1-Job	-		1,026,000
	GUARD HOUSE (GATE)	80	SF		3,000
	TOTAL DIRECT COST				11,714,000
	INDIRECT COSTS & ADDITIVES			108.7%	12,733,000
	TOTAL PROJECT COST				\$ 24,447,000
	SINGLE BUILDING CONCEPT				

U.S. ARMY ENGINEER DIVISION HUNTSVILLE CORPS OF ENGINEERS HUNTSVILLE, ALABAMA						
PRELIMINARY COST ESTIMATE				DATE PREPARED: REVISED 2/13/76		SHEET 1 OF 1
PROJECT: 155 MM ICM LAP AREA						
LOCATION: MISSISSIPPI ARMY AMMUNITION PLANT						
ARCHITECT ENGINEER: KAISER ENGINEERS				CWE		PROGRAMMED:
LINE ITEM NO. OR CAT. CODE NO.		ESTIMATOR J. D. BROWN		CHECKED BY: S E R		APPVD. BY
ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT	
<u>LAP AREA TWO BUILDING CONFIGURATION</u>						
	LAP BUILDINGS 2 EA.	97,440	SF		\$ 6,890,000	
	BULK EXPLOSIVE BLDG.	3,750	SF		199,000	
	SCREENING BLDG. 2 EA.	3,000	SF		144,000	
	BODY LOADING HOLD 2 EA.	3,300	SF		160,000	
	GRENADE HOLD IGLOOS 6 EA.	20,160	SF		939,000	
	SHIPPING BUILDING	4,400	SF		96,000	
	EXPULSION CHG. BLDG	1,800	SF		95,000	
	CHEMICAL LAB BLDG.	2,500	SF		148,000	
	X-RAY BUILDING	2,000	SF		106,000	
	DEMIL. BUILDING	4,900	SF		237,000	
	OFFICE, CHANGE RM, CAFETERIA	21,664	SF		785,000	
	COVERED RAMPS	45,000	SF		1,206,000	
	CONCRETE PAVING	52,000	SF		62,000	
	ASPHALT PAVING	565,000	SF		367,000	
	SHELL PAVING	13,500	SF		5,000	
	FENCE	7500	SF		60,000	
	RAILROAD	6900	LF		345,000	
	YARD ELECTRICAL	1-Job			446,000	
	YARD UTILITIES	1-Job			1,117,000	
	GUARD HOUSE (GATE)	80	SF		3,000	
	TOTAL DIRECT COST				13,410,000	
	INDIRECT COSTS & ADDITIVES			108.7%	14,577,000	
	TOTAL PROJECT COST				\$ 27,987,000	
	TWO BUILDING CONCEPT					

U.S. ARMY ENGINEER DIVISION HUNTSVILLE
CORPS OF ENGINEERS
HUNTSVILLE, ALABAMA

PRELIMINARY COST ESTIMATE

DATE PREPARED:

REVISED 2/13/76

SHEET 1 OF 1

PROJECT:

ISS MM ICM

LAP AREA

LOCATION:

MISSISSIPPI ARMY AMMUNITION PLANT

ARCHITECT ENGINEER:

Kaiser Engineers

CWE

PROGRAMMED

LINE ITEM NO. OR CAT. CODE NO.

ESTIMATOR:

J. D. BROWN

CHECKED BY:

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APPVD. BY

ITEM NO	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
	LAP AREA THREE BUILDING CONFIGURATION				
	GRENADE ASSEMBLY	30,100	SF		\$ 2,444,000
	BODY LOADING BLDG.	30,100	SF		1,957,000
	ASSEMBLY & SURGE BLDG.	35,700	SF		1,971,000
	BULK EXPLOSIVES BLDG.	3,750	SF		199,000
	SCREENING BLDG.	3,000	SF		144,000
	BODY LOADING HOLD BLDG.	3,300	SF		160,000
	GRENADE HOLD IGLOOS 6EA.	20,160	SF		939,000
	SHIPPING BUILDING	4400	SF		96,000
	EXPULSION CHG. BLDG.	1800	SF		95,000
	CHEMICAL LAB BLDG.	2500	SF		148,000
	X-RAY BUILDING	2000	SF		106,000
	DEMIL BUILDING	4900	SF		785,000
	OFFICE, CHANGE RM, CAFETERIA	21,664	SF		237,000
	COVERED RAMPS	40,200	SF		1,077,000
	CONCRETE PAVING	61,900	SF		74,000
	ASPHALT PAVING	22,8000	SF		148,000
	SHELL PAVING	33,000	SF		13,000
	FENCE	7700	SF		62,000
	RAILROAD	5665	LF		283,000
	YARD ELECTRICAL	1-506			327,000
	YARD UTILITIES	1-506			1,079,000
	GUARD HOUSE (GATE)	80	SF		3,000
	TOTAL DIRECT COST				12,347,000
	INDIRECT COST AND ADDITIVES			108.7%	13,421,000
	TOTAL PROJECT COST				
	3 BUILDING CONCEPT				\$ 25,768,000

APPENDIX B

COST ESTIMATES OF SUPPRESSIVE SHIELDS

3-1-50

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 6 APR 76		SHEET 2 OF 3	
PROJECT GRENADE PRESS LOADING				BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☒ OTHER (Specify) STUDY			
LOCATION MISSISSIPPI AAP							
ARCHITECT ENGINEER HND (E. WILLIAMS, ED-CH)							
DRAWING NO. 6000 thru 6004		ESTIMATOR DT		CHECKED BY CRJ			
SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	PER UNIT	LABOR TOTAL	PER UNIT	MATERIAL TOTAL	TOTAL COST
CONCRETE (ROOF & FDN) (5000 PSI)	16	Yd ³	20 ⁰⁰	320	32 ⁰⁰	512	832
REINFORCING (ROOF & FDN) (FY=60,000 PSI)							
#4 BARS (MAIN REIN)	3	T	200 ⁰⁰	600	300 ⁰⁰	900	1500
#4 STIRRUPS	2	T	200 ⁰⁰	400	300 ⁰⁰	600	1000
PIPE SLEEVES (ASTM A53) FOR A.B. (ROOF & FDN)							
3/4" SCH 40 PIPE X 15' LG	.5	T	W/CAGE ASSM.	400 ⁰⁰		200	200
EMBEDDED PLATE (ASTM A-36) IN CONG. (ROOF & FDN.)	1.1	T	"	"	400 ⁰⁰	440	440
ANCHOR BOLTS (ROOF & FDN) ASTM A 325							
3/4" Ø X 20" LG	592	EA	0 ²⁵	444	2 ⁹⁰	1717	2161
W/NUT & 2 WASHERS							
STEEL FIBERS 200#/Yd ³	1.6	T	W/CAGE ASSM.	400 ⁰⁰		640	640
FRAGMENT SHIELD (ASTM A-36) ON ROOF	.2	T	"	"	400 ⁰⁰	80	80
A.B. FOR FRAGMENT SHIELD 5" L 3/4" ASTM A-307	46	EA	"	"	5 ⁰⁰	230	230
LIFTING LUGS (ASTM A307)	.2	T	"	"	400 ⁰⁰	80	80
THIS SHEET				1764		5399	7163

CONSTRUCTION COST ESTIMATE					DATE PREPARED 6 APR 76		SHEET 3 OF 3	
PROJECT GRENADE PRESS LOADING					BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☒ OTHER (Specify) <u>STUDY</u>			
LOCATION MISSISSIPPI AAP								
ARCHITECT ENGINEER HND (E. WILLIAMS, ED-CH)								
DRAWING NO. 6000 thru 6004			ESTIMATOR DT		CHECKED BY CRJ			
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
EXCAVATION, MACH	17.5	Yd ³	-	-	2 ⁵⁰	44	44	
SAND LEVELING CURB	3.5	Yd ³	5 ⁵⁰	19	5 ⁰⁰	18	37	
BACK FILL	8	Yd ³	5 ⁵⁰	44	-	-	44	
CAGE (ASTM A-36)								
I-BMS	8.5	T	T		T			
GUSSETS FOR I-BMS	.75	T						
BASE PL FOR I-BMS	1	T						
CLOSURE STRIPS	1	T						
RING BMS	2.2	T						
DOOR FRAME	.2	T						
DOOR	.3	T						
BOLTS FOR DOOR 3/4" X 4 1/2" LG	4	EA						
TOTAL STEEL	18	TONS	V	-	400 ⁰⁰	7200	7200	
LABOR REQ'D TO CUT	2800	MH	8 ⁵⁰	23800		-	23800	
STEEL & ASSM. CAGE								
EDGE FORMS FDN & TOP	125	SF	4 ⁰⁰	500	2 ⁵⁰	312	812	
PAINT CAGE w/PRIMER & 1 COAT PAINT	18	SQ YD	25 ⁰⁰	450	15 ⁰⁰	270	720	
CONSUMABLE ITEMS	4300	LBS	-	-	0 ³⁹	1677	1677	
THIS SHEET				24813		9521	34334	

SHEET / OF 3

PROJECT

BASIS FOR ESTIMATE

LOCATION☐ CODE A (No design completed)

ARCHITECT ENGINEER

☐ CODE B (Preliminary design)☐ CODE C (final design)☐ OTHER (Specify) _____☒ OTHER (Specify) STUDY

DRAWING NO.

ESTIMATOR

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KPN

17

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CONSTRUCTION COST ESTIMATE				DATE PREPARED 13 MAY 76		SHEET 2 OF 3	
PROJECT SUPPRESSIVE SHIELD SCREENING BLDG LOCATION MISSISSIPPI AAP ARCHITECT ENGINEER EWA K.P. NELSON (SAREA-17T-TS) DRAWING NO.				BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☒ OTHER (Specify) <u>STUDY</u>			
ESTIMATOR KPN				CHECKED BY 			
SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	TOTAL	MATERIAL PER UNIT	TOTAL	TOTAL COST
CONCRETE (ROOF & FDN) (5000 PSI)	225	Yd ³	20 ⁰⁰	4500	32 ⁰⁰	7200	11700
REINFORCING (ROOF & FDN)							
#4 BARS (MAIN REINF)	42	T	200 ⁰⁰	8400	300 ⁰⁰	12600	21000
#4 STIRRUPS	28	T	200 ⁰⁰	5600	300 ⁰⁰	8400	14000
PIPE SLEEVES (ASTM-A53) FOR A.B. (ROOF & FDN)							
1.8" Ø SCH 40 PIPE X 3.6' LG	1.5	T	W/CAGE ASSM	400 ⁰⁰		600	600
EMBEDDED PLATE IN CONC. (ROOF & FDN)	15	T	"	"	400 ⁰⁰	6000	6000
ANCHOR BOLTS (ROOF & FDN) 1.8" Ø X 4' LG W/ NUT & 2 WASHERS	592	EA.	12 ⁵	1036	16 ⁷⁰	9888	10924
STEEL FIBERS 200 #/Yd ³	22.5	T	W/CAGE ASSM	400 ⁰⁰		9000	9000
FRAGMENT SHIELD ON ROOF (A-36)	2.75	T	"	"	400 ⁰⁰	1100	1100
A.B. FOR FRAG SHIELD ASTM A 307	46	EA.	"	"	12 ⁰⁰	522	522
LIFTING CLUCKS	2.75	T	"	"	400 ⁰⁰	1100	1100
THIS SHEET				17536 12600		56410	75946

CONSTRUCTION COST ESTIMATE				DATE PREPARED 13 MAY 76		SHEET 3 OF 3	
PROJECT SUPPRESSIVE SHIELD SCREENING BLDG.				BASIS FOR ESTIMATE			
LOCATION MISSISSIPPI AAP				☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☒ OTHER (Specify) <u>STUDY</u>			
ARCHITECT ENGINEER WNA K.P. NELSON (SAREA-MT-TS)				CHECKED BY <u>AKF</u>			
DRAWING NO.		ESTIMATOR KPN					
SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
EXCAVATION, MACH.	245	Y ³	—	—	2 ⁵⁰	613	613
SAND LEVELING, COARSE	50	Y ³	5 ⁵⁰	275	5 ⁰⁰	250	525
BACK FILL	115	Y ³	5 ⁵⁰	633	—	—	633
CAGE (ASTM A-36)							
I-BMS (W8 28)	107	T	—	—	—	—	—
GUSSETS FOR I-BMS	9.5	T	—	—	—	—	—
BASE PL. FOR I-BMS	13	T	—	—	—	—	—
CLOSURE STRIPS	12.5	T	—	—	—	—	—
RING BMS	27.5	T	—	—	—	—	—
DOOR FRAME	3	T	—	—	—	—	—
DOOR	3	T	—	—	—	—	—
Bolts	10	T	—	—	—	—	—
Total Steel	185.5	TONS	—	—	400 ⁰⁰	74200	74200
LABOR REQD TO CUT	16200	MH	8 ⁵⁰	137,700	—	—	137700
STEEL & ASSEMBLE CAGE							
EDGE FORMS F'DN	1740	SF	4 ⁰⁰	6960	2 ⁵⁰	4350	11310
& TOP							
PAINT CAGE w/PRIMER	100	GAL	25 ⁰⁰	2500	15 ⁰⁰	1500	4000
& 1 COAT PAINT							
CONSUMABLE ITEMS	60000	lbs	—	—	0 ³⁹	23400	23400
THIS SHEET				148068		104313	252381

SHEET 1 OF 2

2011

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