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PANTEX STAGING STUDY
NEAR-TERM ALTERNATIVES

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ABSTRACT

As the result of bilateral treaties to reduce the number of weapons in the nuclear stockpile, the U.S. Department of Energy must now address the requirements for additional storage of the plutonium components (pits) from the retired weapons at Pantex until the components' final disposition. Because of the critical need to take action, Pantex has initiated two related efforts: Project Stage Right and this Staging Study.

While support of Project Stage Right is a key objective of this study, the scope covers a broader range of activities and aspects of the pit staging problem. This study provides estimates of worker radiation exposures under the current scenario as well as estimated radiation exposure for workers under four alternative staging scenarios. An important objective of this study also identifies and recommends for future study other activities related to staging where radiation safety and overall efficiency can be improved.

SUMMARY

Strategic arms negotiations between the United States and the former U.S.S.R. have resulted in bilateral treaties to reduce the number of weapons in the nuclear stockpile. In addition, President Bush ordered further unilateral reductions of the stockpile in 1992. Prior to these actions, the United States routinely dismantled nuclear weapons from the stockpile as weapons were retired by the president.

The U.S. Department of Energy (DOE) now must address the requirements for additional storage of the plutonium components (pits) from the retired weapons at Pantex to meet the dismantlement schedule until capabilities can be developed for final disposition. Under the current storage configuration, with the current retirement schedule, Pantex is expected to run out of storage capacity in December 1992. In response to this need, Pantex has initiated two related efforts: Project Stage Right and this Staging Study.

Project Stage Right allows for Pantex to increase the pit storage capacity, using visiting facilities, while keeping radiation exposure to workers as low as reasonably achievable (ALARA).

This staging study report addresses the near-term alternatives for meeting the pit staging requirements, and focuses on the solutions that are to be developed and implemented over the next 6 to 12 months. This study supports Project Stage Right with analysis and tradeoff studies as needed, and focuses on providing Pantex with the following information:

- Estimated dose rates from various sources to be used as a baseline in evaluating the current and alternative staging scenarios.
- Description and evaluation of current and alternative staging solutions in terms of the staging requirements.
- Discussion of logistics issues related to the overall staging process.
- Examination of safeguards and security issues.
- Exploration and analysis of the public and political acceptability of pit staging at Pantex.

- Significant conclusions and specific recommendations for actions critical to the successful implementation of Project Stage Right.

The study covers activities beginning when loaded pit drums are transported from disassembly cells to a Zone 12 special nuclear materials (SNM) staging vault, loaded into an enclosed trailer, transported from Zone 12 to Zone 4 storage igloos, storage in the igloos, and subsequent inventory and audit activities. The study reviews current operations, defines and evaluates alternatives for meeting the increased staging requirements (including the need to reconfigure the existing pit inventory), and also addresses present inventory and handling requirements.

STAGING DESIGN OBJECTIVES

The study has used four main objectives dictated by Project Stage Right for staging pits at Pantex. These involve capacity demand requirements, radiation safety concerns, and safeguards (material control and accountability). The objectives are as follows:

- Pantex must have the capacity for storing a minimum of 15,000 pits, currently projected to arrive at a rate of 2,000 per year beginning in FY93 continuing through FY20.
- At a minimum, Pantex must hold plant and personnel radiation exposures to the current levels. The ALARA principles will be maintained in the evaluation of the alternatives.
- Pantex must be able to inventory and audit any or all pits on demand.
- All 18 modified Richmond igloos and up to 20 of the SAC igloos may be available for pit storage.

TECHNICAL EVALUATION

Four alternatives for meeting Zone 4 staging capacity requirements within the 18 modified Richmond igloos and 42 SAC igloos have been evaluated as part of this study. A summary of the expected performance of staging alternatives is presented in Table S.1 and Table S.2.

Table S.1 summarizes each alternative in terms of staging capacity performance. The alternatives are defined as follows:

TABLE S.1. Number of Modified Richmond Igloos and SAC Igloos Required to Stage 15,000 Pits for Each Staging Alternative[a]

Alternative	Pits Per Richmond	Pits Per SAC	Number of SACs Required
1. Current Staging Method	240	240	45 SACs
2. Pallet, No Precision Stack	400	312	25 SACs[b]
3. Pallet, Precision Stack	440	348	21 SACs[b]
4. Stacked Drums, No Pallet	504	428	14 SACs

(a) Each alternative requires all 18 modified Richmond igloos.
(b) Assumes that the front of the SAC igloos can be used for pit staging.

1. Current Method - Individual containers standing upright, not stacked, on the floor of the igloo.

2. Pallet, No Precision Stack - Pallets are not precisely lined up.

3. Pallet, Precision Stack - Same as alternative 2 but pallets are now precisely lined, enabling additional pallet stacks in each igloo.

4. Stacked Drums, No Pallet - Containers are placed on their sides and stacked without the use of pallets.

While the estimated igloo staging capacity associated with the pallet design has yet to be confirmed, it appears as if the pallet can meet the 15,000-pit staging requirement and come close to meeting the 20-SAC-igloo design criteria. Table S.1 also shows the substantial capacity associated with the no pallet concept, should this alternative be chosen.

Table S.2 summarizes each alternative in terms of expected personnel radiation exposure. The alternatives reviewed incorporate the use of various types of equipment to accomplish the stacking and inventory functions associated with the staging configurations described above. The equipment includes:

- A manually operated forklift, with and without radiation shielding.

TABLE S.2. Estimate of Yearly Personnel Radiation Exposure for Staging Alternatives[a]

Alternative	Zone 12 Handling (Person-Rems/year)	Zone 4 Handling (Person-Rems/year	Zone 4 Inventory (Person-Rems/year)
1. Current Staging Method	10	3	5
Implementation Exposure		0	
2. Pallet, No Forklift Shielding	9	2	1
Implementation Exposure		9	
3. Pallet, With Forklift Shielding	9	1	0[b]
Implementation Exposure		2	
4. Stacked Drums, No Machine Shielding[c]	10	4	1
Implementation Exposure		7	
Relabeling Existing Pit Drum Inventory		2	

(a) Exposure figures represent estimated based on worst case exposures for various weapons programs. Exposures have been rounded for readability.
(b) Dose is <.1.
(c) Total annual exposure reduces from 14 person-rem/yr to 10 person-rem/yr with the addition of machine shielding (assuming a factor of 8 reduction, actual reduction is expected to be a factor of 29).

- A pallet mounted with a barcode reader and video camera system to allow inventorying of igloos.
- Manually operated handling equipment for handling individually stacked containers.

These estimates of exposure are based on conservative (i.e., high) estimates of dose rates, and actual exposure is expected to be somewhat lower. A significant finding from Table S.2 is that all alternatives that mechanize the process of taking pit inventories (i.e., alternatives 2-4) result in significant reduction in exposure due to the inventory process, including

those without forklift shielding. A second significant finding is that substantial personnel exposure related to staging occurs in Zone 12. Although the study focused on Zone 4, the exposure resulting from Zone 12 handling was higher. The study quantified Zone 12 radiation exposure and identified opportunities for exposure reduction (e.g., eliminating usage of the Zone 12 vault).

The ability of the new pallet (alternatives 2 and 3) to meet staging requirements using pallets for stacking is largely dependent upon the spacing maintained between the pallets and the usable space within the SAC igloo. Information available at this time regarding the best potential performance of the pallet design indicates a minimum of 21 SACs will be needed (see Table S.1).

The ALARA requirements dictate that exposures to personnel be as low as reasonably achievable. Many paths exist and are being considered to achieve ALARA requirements, and each has associated tradeoffs in areas such as safety, time to implement, cost, etc. The reduction in expected personnel exposure resulting from completely enclosing the operator in shielding is significant for the pallet design (from 12 to 10 person-rems total plant exposure, assuming lead apron protection). However, it should be noted that gains in forklift operator visibility, ventilation, and access can be achieved by using only partial or no shielding and still significantly decrease employee risk and total plant exposure from current levels. This results from reducing the number of workers in the igloo to a single equipment operator and by providing distance from the source terms via drum handling and inventorying equipment.

Given the implementation of forklifts and other equipment that can operate inside of the igloos, most remaining personnel exposure due to staging activities occurs in Zone 12 and not Zone 4, indicating that Zone 12 handling should also be a target of ALARA improvements. Drum-handling equipment that could assist in implementing the new staging pallet alternatives is the same equipment that would be required for the stacked drum/no pallet staging alternative, highlighting the need to investigate suitable drum-handling equipment as soon as possible. Following successful ALARA gains, staging alternatives

need to be reviewed in terms of cost, Occupational Safety and Health Act (OSHA) safety, efficiency, and other considerations.

CONCLUSIONS

The following conclusions are based on the observations and information collected over the course of the study:

- Implementing forklifts/equipment inside the Richmond igloos/SAC igloos will greatly reduce employee exposure.
- The new pallet (alternatives 2 and 3) will likely meet the design objectives.
- Zone 12 exposure from pit drum handling and palletization needs to be targeted for reduction.
- Improved inventory capability will greatly assist in identifying the exact location of a pit within an igloo.
- The ability of the turret forklift operator (working in a shielded cab and with uneven igloo floors) to meet the pallet alignment requirements associated with the precision stacking alternative needs to be confirmed.
- The feasibility of the stacked drum/no pallet alternative should be investigated to determine if this is a viable alternative.
- Drum-handling equipment is essential to efficient operations under any of the alternatives and Pantex should acquire it.
- The feasibility of an armored lowboy to transport pits between Zone 12 and Zone 4 needs to be investigated.

RECOMMENDATIONS

It should be noted that our study of staging operations at Pantex represents a "snapshot" that captures our recommendations at a certain time, and activities to address some of these issues may be going on already. With this in mind we recommend that Pantex take the following actions:

- If the number of SAC igloos to be used is an important criterion, a working team consisting of staging equipment design participants needs to be convened to determine a definitive estimate of SAC staging capacity. Estimates for SAC stacking pallet heights and the maximum number of pallet stacks that can be accommodated need

to be reviewed and verified. The ability to use forklift-mounted inventory equipment to successfully inventory pit drums that do not have rail access (i.e., pallets in the front outer rows of the SAC igloos) also needs to be investigated, as well as the safety of operating the forklift in these confined areas with loaded pallets nearby.

- Modify operations in the Zone 12 staging area (e.g., eliminating vault storage) to achieve substantial reductions in radiation exposure.

  - This recommendation results from the finding that Zone 12 radiation exposure from handling loaded pit drums is higher than radiation exposure in Zone 4. Zone 12 radiation exposure by activity step is quantified in the appendixes. This information can be used to estimate exposure reduction achieved by bypassing the Zone 12 vault storage and other handling improvements.

  - It is also recommended that the Zone 12 dose characterization be extended to quantify radiation exposure resulting from bay and cell disassembly activities. Extending the quantification of dose by activity for bay and cell activities would provide Pantex with a comprehensive dose model for the entire plant, which would support plant-wide alarm/dose reduction improvement initiatives.

- Pursue modifications and repairs and the development of ramps for Richmond igloo and SAC igloo floors.

- Label loaded pit drums from disassembly with the new barcodes that are going to be used by the new inventorying process as soon as possible.

- Develop a transition plan to empty several SAC igloos as soon as practical in order to facilitate the implementation of new staging alternatives.

- Develop a contingency plan to ensure sufficient near-term staging capacity if the implementation of staging improvements is delayed. This may consist of plans for staging pits in the SAC igloos as they are currently staged in the Richmond igloos, and/or backfilling existing Richmond aisles (if feasible).

- Design igloo inventorying equipment such that the inventorying process (i.e., scanning the barcodes on the pit drums) can be accomplished in one "in and out" pass of the equipment.

- Take a 1/4-inch lead "disc" and either press it into the lid of new pit drums, or lay it on the top of the packing inside the drum. It will not reduce exposure much during disassembly or transport, but will greatly reduce the exposure in the igloos. This is because the drums will be stored horizontally. It, in effect, places a 1/4-inch lead wall shield between the workers and the drums.

CONTENTS

FIGURES

1.0 INTRODUCTION

Strategic arms negotiations between the United States and the USSR have resulted in bilateral treaties to reduce the number of weapons in the nuclear stockpile. In addition, President Bush ordered further unilateral reductions of the stockpile in 1992. Prior to these actions, the United States routinely dismantled nuclear weapons from the stockpile as weapons were retired by the president.

To meet the dismantlement schedule until capabilities can be developed for final disposition, the DOE now must address the requirements for additional storage of the plutonium components (pits) from the retired weapons at Pantex. Under the current storage configuration, with the current retirement schedule, Pantex is expected to run out of storage capacity in December 1992. Pantex has initiated two related efforts, Project Stage Right and this Staging Study, in response to this need.

Project Stage Right is intended to implement a staging procedure in Zone 4 which, through the use of automated equipment and newly developed staging and inventory techniques, will allow Pantex to increase the pit storage capacity to meet the increased demand using existing facilities, while keeping radiation exposure to workers as low as reasonably achievable (ALARA). The project will provide the procurement, design, demonstration and deployment of a manually operated, shielded forklift/pallet arrangement for use in the staging operation in the near term and examine the feasibility of using an automated guided vehicle to accomplish the staging activities over the longer term.

Pantex initiated the Staging Study in conjunction with Project Stage Right. The Staging Study is intended to work in parallel with Project Stage Right, drawing upon information derived from Stage Right activities and providing Stage Right with information needed for its design activities.

While support of Project Stage Right is a key objective of the Staging Study, the scope of the study covers a broader range of activities and aspects of the pit staging problem. In support of Project Stage Right, the study provides estimates of worker radiation exposures under the current scenario as

well as estimated dose rates for workers under a variety of alternative staging scenarios. Beyond the Stage Right support, the study considers aspects of staging, including safeguards, cost/efficiency, technical risk and maintainability, and the public/political acceptability of increased plutonium storage at Pantex. This report is the first deliverable of the Staging Study. It addresses near-term solutions, focusing on activities to be taken in the next 6 to 12 months. A second report will address the long-term, pit storage requirements.

The primary purpose of this report is to identify alternative pit staging configurations that will allow Pantex to keep up with the near-term demand for pit storage within the existing facilities while adhering to current safety and security standards and criteria. A detailed review of four possible staging alternatives is provided. These alternatives involve various configurations for stacking pit containers (i.e., with pallets and without pallets), and various forklift arrangements (i.e., shielded/unshielded). Information about the pallet designs, shielding designs, and forklift capabilities were provided through Project Stage Right. Another purpose of this study is to identify and recommend for future study other activities related to staging where improvements could be achieved in radiation safety and overall efficiency.

The objectives associated with the evaluation of near-term pit staging alternatives at Pantex are as follows:

- Increase the storage capacity of the existing igloos to take care of the expected returned pits during the period between the present time and the year 2000. The total staging design requirement has been given as 15,000 pits.

- Acceptable personnel exposure levels must not be exceeded. Maintaining acceptable personnel exposure levels by only increasing and rotating the number of workers completing exposure related activities is not an acceptable ALARA practice. A key performance measure for staging alternatives is the effect on total plant exposure in person-rem per year.

- Pits must be able to be inventoried on demand and able to be properly identified by "footprint."

- Any alternative evaluated may use all 18 of the modified Richmond igloos and up to 20 of the SAC igloos for pit storage.

Additional performance measures of staging alternatives include:

- Safeguards
- Cost and Efficiency
- Public/Political Acceptability
- Technical Risk and Maintainability.

The remainder of this report presents the results of this Staging Study. Chapter 2.0 contains a detailed comparison of four staging alternatives currently under consideration in terms of staging capacity; radiation safety; cost, efficiency and implementation characteristics; and technical risk and maintainability. Chapter 3.0 discusses the logistics involved in the pit staging activities and identifies areas where improvements could be made. Chapter 4.0 reviews the requirements for safeguards and security related to increased pit staging. Chapter 5.0 provides insight into issues regarding the political and public acceptability of the increased activity at Pantex.

2.0 NEAR-TERM STAGING ALTERNATIVES

Near-term staging alternatives refer to options available to increase Zone 4 staging capacity within the next 12 months. These alternatives consist of the current system, pallet design alternatives to facilitate pit drum stacking, and pit drum stacking without pallets. All of these alternatives are subject to the following requirements to varying degrees:

- Stage pit drum inventorying is an ongoing requirement.
- Selected alternatives will require floor repairs, rail installation, and ramp design and development to facilitate material-handling equipment operation within the Richmond igloos and SAC igloos.
- The transition to the new method of storage requires that multiple SAC igloos will have to be emptied to be available to stage pits.
- Pits that are currently staged will have to be relabeled to support a new inventory process and possibly reconfigured to support new staging methodologies.
- Individual pit drums will have to be available for gamma spectrography.

All staging alternatives, with the exception of the current system, make use of forklift-mounted visual and barcode scanners for completing igloo inventorying. Since the drums are stored in a horizontal position with barcode information facing towards the aisle, cameras on the forklift can videotape drum tampering indicator devices (TIDs) for viewing in a remote "radiation free" environment, and barcode scanners can read the barcodes. The forklift driver will make a slow pass down the length of the igloo, with the fixed mounted cameras and barcode scanners reading drums on both sides of the aisle. It is expected that this system will have the capability to read multiple layers of drums at a time. Thus, in one pass down the aisle, moving from the front of the igloo to the back, all drums on one side would be read. Reversing the forklift and moving from the back to the front of the igloo would read the other side.

The evaluation of staging alternatives is based on how each alternative varies in terms of storage capacity, worker exposure, efficiency, cost, and

risk as compared to current staging methods. Staging alternatives and estimated performance are provided in the following sections.

2.1 ALTERNATIVE 1: CURRENT STAGING METHOD

Current staging methods, for the purpose of evaluating alternatives, include all activities from when loaded pit drums are transported from disassembly cells to a Zone 12 special nuclear materials (SNM) staging vault (i.e., 12-26 vault), loaded into an enclosed trailer, transported from Zone 12 to one of the 18 Modified Richmond igloos in Zone 4, and loaded within an igloo. Additional activities include the monthly serialized inventory sampling and the 100 percent inventory taken each year.

Pits are containerized into pit drums (loaded weight approximately 97 lbs), that are 20 inches in diameter and 30 inches high. Loaded pit drums leaving Zone 12 are stacked and strapped 5 on a pallet in a vertical orientation. Current strapping of a pit pallet is accomplished by wrapping one adjustable strap around all 5 drums, then placing 3 straps over the top. The dimensions of a loaded pit pallet are 48 inches wide by 48 inches long by approximately 38 inches high. A diagram of a typical pit drum and loaded pit drum pallet is shown in Figure 2.1.

Pit drums are initially loaded onto the pallets within the disassembly cells. Following loading, pit drums are placed 5 on a pallet, strapped down, and stored within the cell (or small holding area within the air lock) until transfer to a Zone 12 staging vault. The cell-to-vault transfer is then completed by forklift with one of the material handlers driving and the other walking along as a spotter.

Upon arrival at the vault, the SNM tracking system is updated to reflect the new location and to transfer custody to production stores. Two receiving personnel are also at the vault to reverify the shipment.

At the Zone 12 vault, workers put on lead aprons and one worker checks the TID, as well as checking the serial number on the drum with the serial

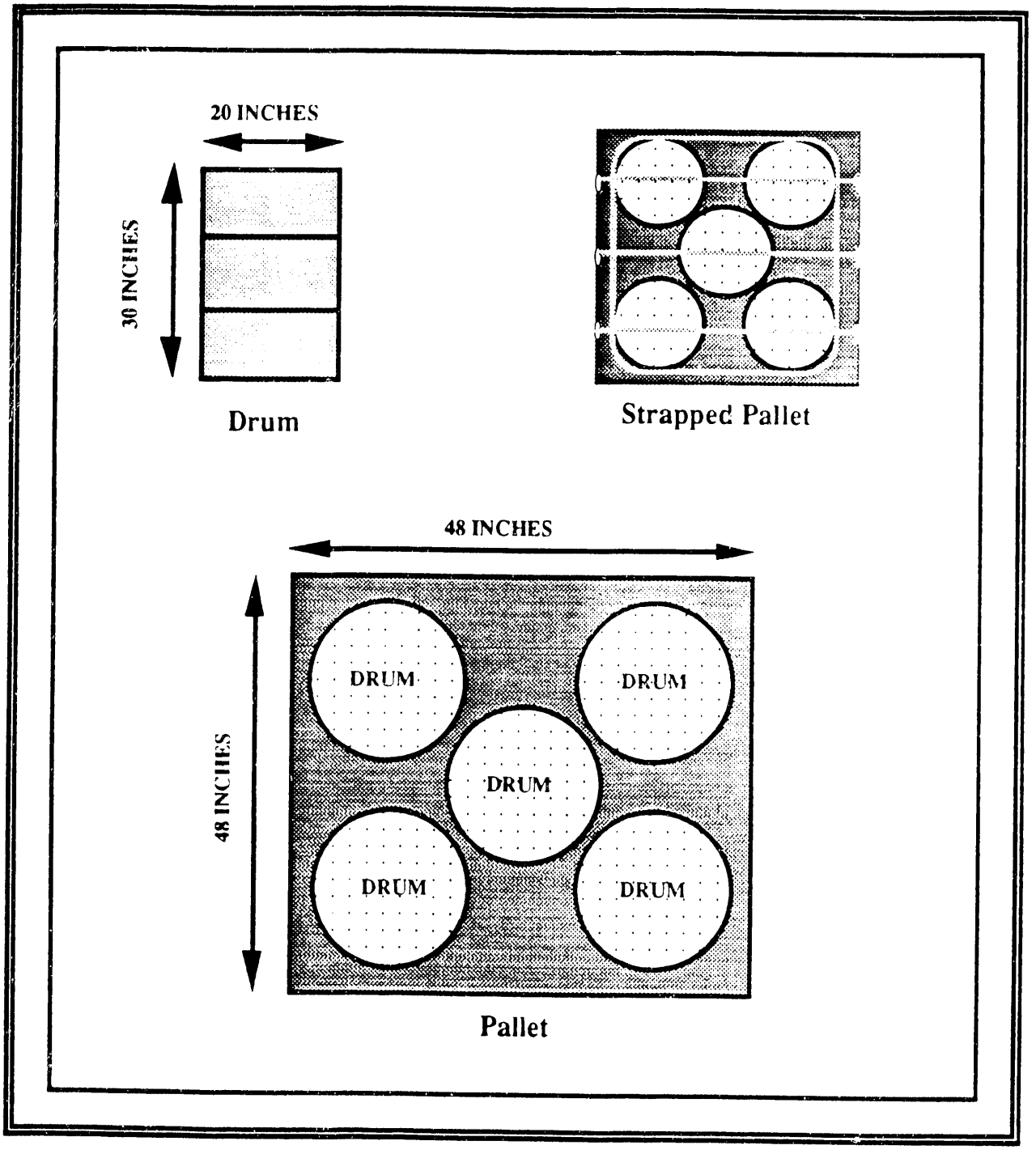


FIGURE 2.1. Typical Pit Drum and Loaded Pit Drum Pallet

number on the TID. Drums are then unstrapped from the pallet and two workers manually walk individual drums into the vault, leaving the empty pallets outside of the vault area.

Pit drums are transferred from the Zone 12 vault to Zone 4 in batches of 40 (i.e., 8 pallets carrying 5 drums each). The same dispatch-move-receive procedures as described in the cell-to-vault move are employed here also. Workers wearing lead aprons open the vault and roll the drums outside onto a pallet. Drum information is checked/recorded, and the drums are strapped down. A forklift then picks up the loaded pallet and places it in a trailer for transport. The pallets are tied down within the trailer by two workers. A diagram of the 12-26 vault and loading dock is shown in Figure 2.2.

Transport of loaded pit drums from Zone 12 to Zone 4 is accomplished by a tractor-trailer carrying loaded pit pallets. Loaded trailers are positioned in front of modified Richmond igloos for unloading as shown by Figure 2.3. Igloo-loading preparation activities consist of removing the 25,000-lb concrete entry barriers by a lift vehicle servicing Zone 4, opening the secured igloo door, positioning a support flat bed trailer (i.e., float) and 4,000-lb capacity forklift, and delivering a 4,000-lb capacity apron forklift.

After two workers remove the tie-downs securing the loaded pit drum pallets within the transport trailer or float, the forklift on top of the support trailer moves a pallet from the transport trailer to the turntable area of the support trailer. The turntable is not needed for the existing pallet because it can be picked up from the side when placed within the transport trailer at the Zone 12 loading dock. A worker holds the pallet in place while the ground-level forklift picks up the positioned pallet from the support trailer. The ground-level forklift then sets the pallet down near the front of the igloo door. Three ground-level workers then unstrap the pallet and manually roll the drums into the igloo. Barcode information is then put in place by one of the workers inside the igloo.

Once the 40 drums have been placed inside the igloo, two workers complete a radiation survey of the igloo interior by surveying 10 pre-selected areas in the interior of the igloo. A diagram of a Richmond igloo side is

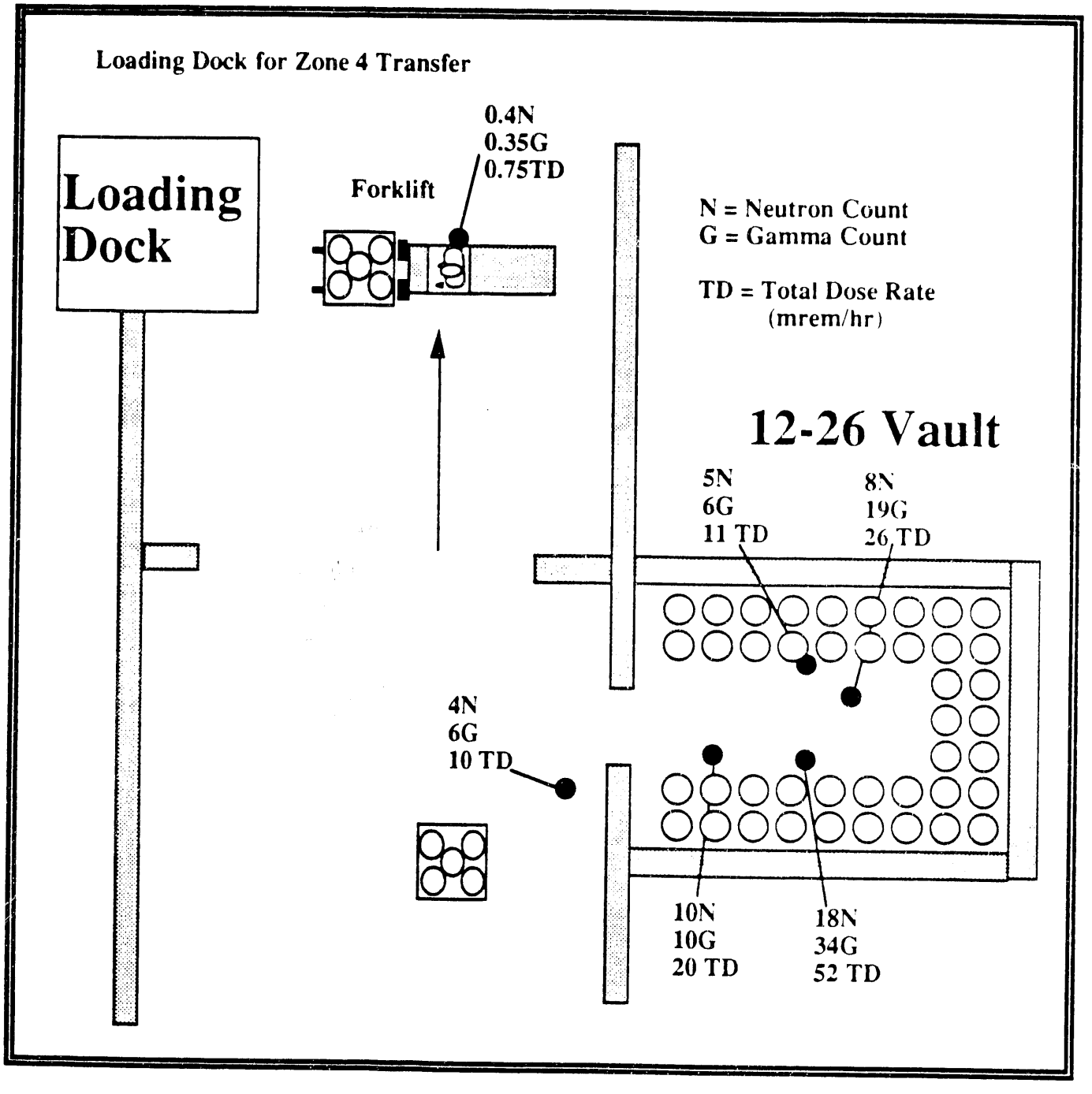


FIGURE 2.2. Zone 12 Vault Staging Area

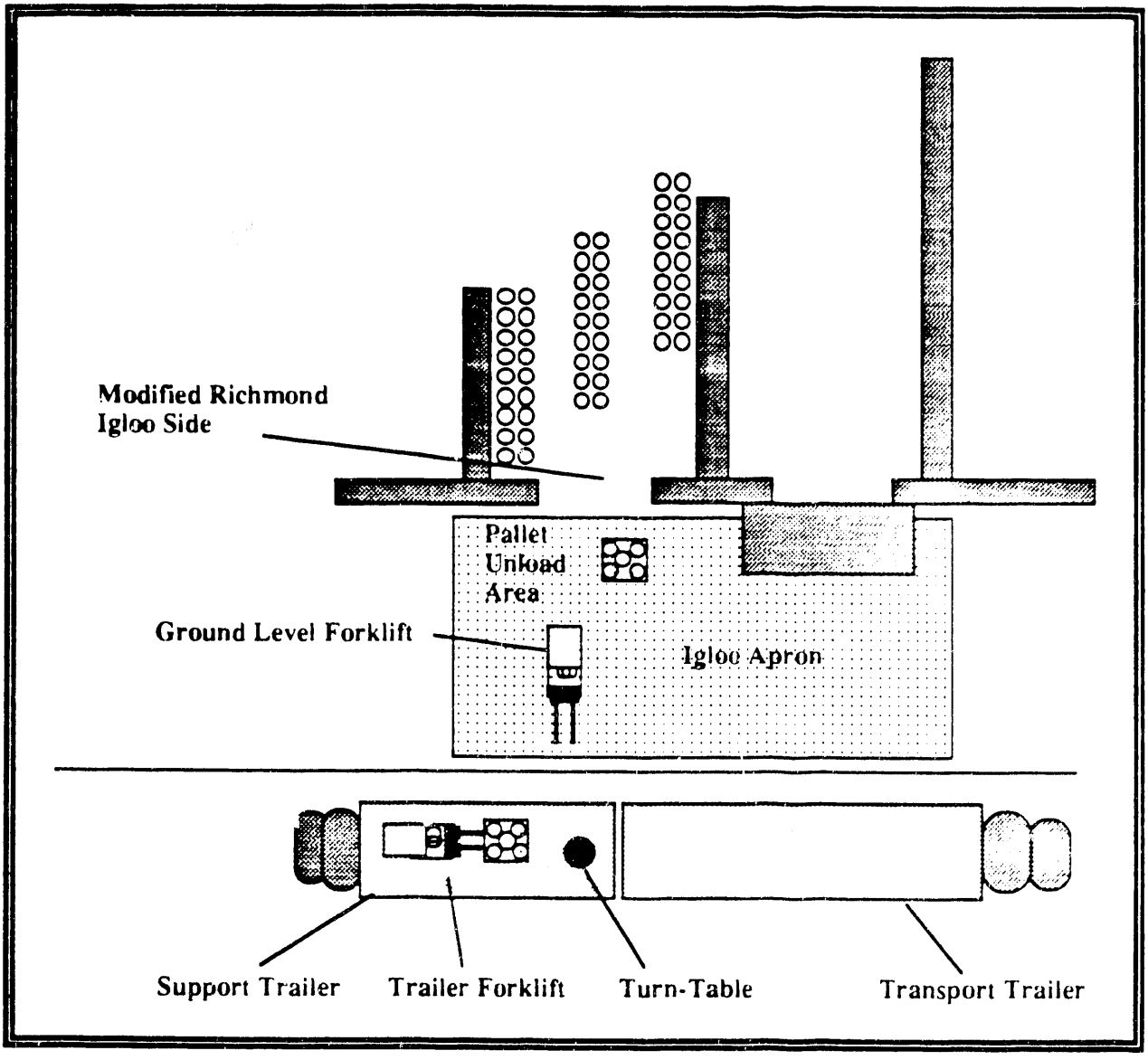


FIGURE 2.3. Modified Richmond Igloo in Zone 4

shown in Figure 2.4. The current typical capacity of an igloo side is 120 loaded pit drums, resulting in a total Richmond igloo staging capacity of 240 loaded pit drums. It should be noted that the stacking order varies dramatically within the modified Richmond igloos, and the order shown in Figure 2.4 is for illustrative purposes only. The staging capacity of a SAC igloo (without stacking) is estimated in Figure 2.5. The maximum SAC igloo capacity without stacking is estimated at 240 loaded pit drums.

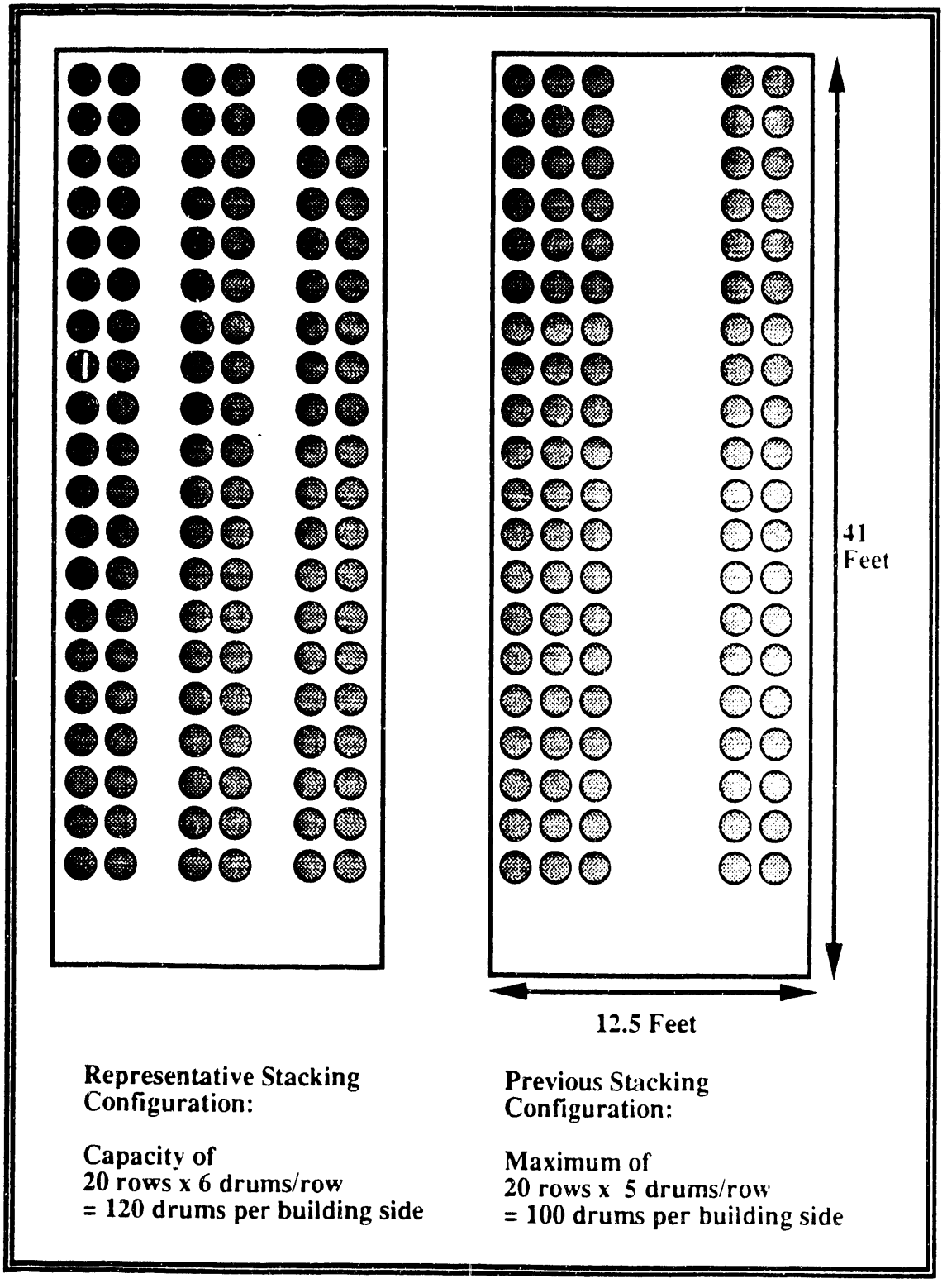


FIGURE 2.4. Current Modified Richmond Igloo Side Storage Capacity

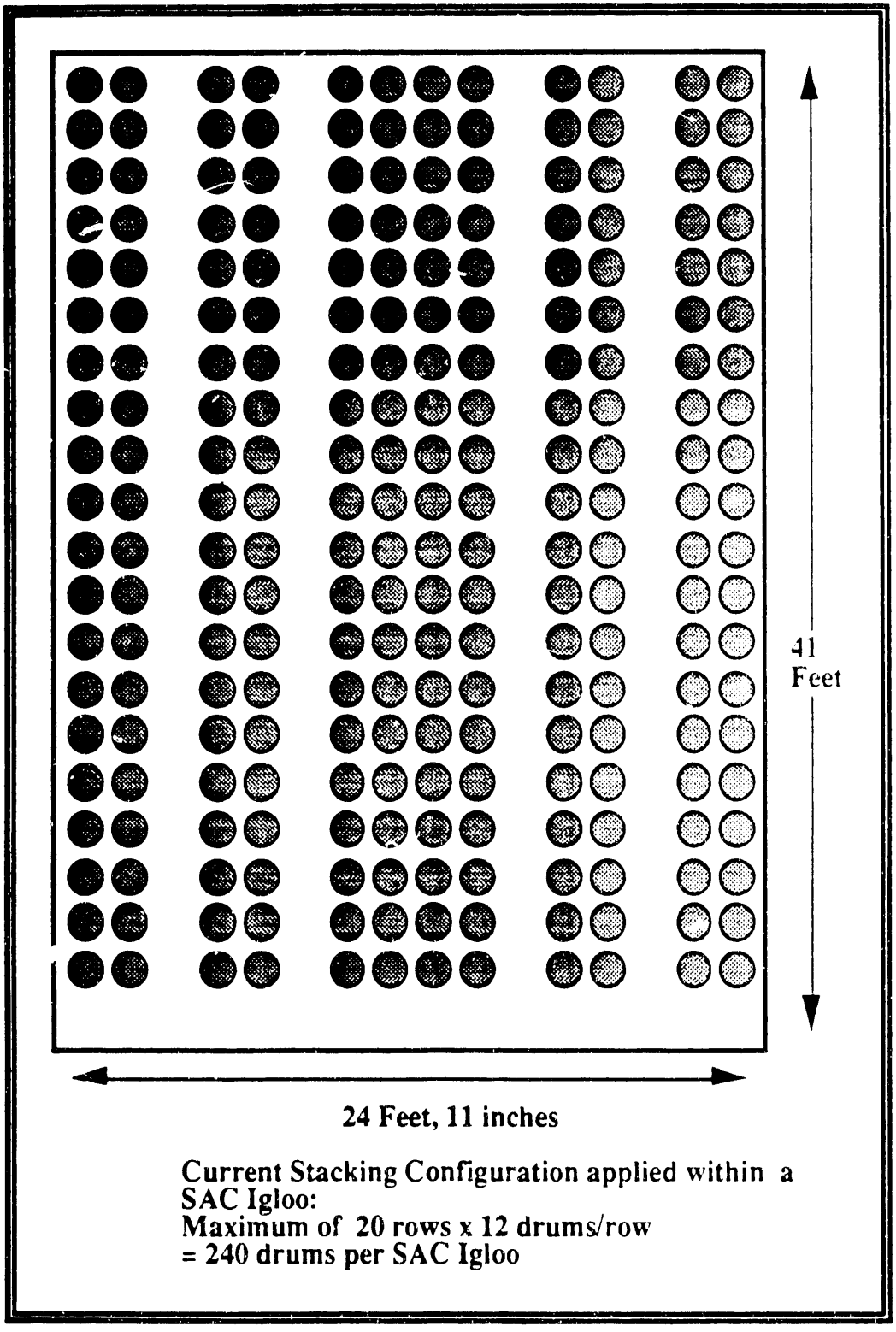


FIGURE 2.5. Estimated SAC Igloo Staging Capacity Without Stacking

Staging activities after igloo loading consist of taking periodic igloo inventories and an annual 100 percent inventory. Inventory activities consist of two individuals entering the igloo with portable barcode readers. Verification activities include pulling out the barcode card on top of the barrel, scanning in the part number and serial number on the card, scanning in the TID number on the can, and verifying the integrity of the TID device by pulling on it and matching the numbers on both sides of the copper TID cup to the TID numbers on the can and the barcode card. In addition to the periodic igloo inventory, a full inventory is completed once a year. An upper estimate of the number of pit checks is 10,080 per year (some pits are checked more than once).

2.1.1 Staging Capacity

Using existing staging methods results in the following estimate of staging capacity required to meet the 15,000 pit staging requirement:

- 120 drums per modified Richmond igloo side x 2 sides = 240 drums per modified Richmond igloo
- 240 drums per SAC igloo
- 240 drums x 18 modified Richmond igloos = 4,320 drum staging capacity
- Required SAC staging capacity = (15,000 - 4,320)/240 = 45 SAC igloos required.

2.1.2 Radiation Safety

Estimated exposures (dose rates) to workers from various sources and distances are presented in Appendix A. A time/motion/dose analysis of current staging methods applied to both the modified Richmond igloos and SAC igloos is contained in Appendix B. This analysis is summarized by Figure 2.6 for dose rates based on the use of lead aprons. All exposure estimates are based on 2,000 loaded pit drums staged per year.

The estimate of 17.96 person-rem/yr of exposure (assuming lead apron protection) for the current staging system is distributed across multiple organizations. As it is difficult to manage the distribution of exposure evenly, it is expected that multiple employees would approach the 1 rem/yr

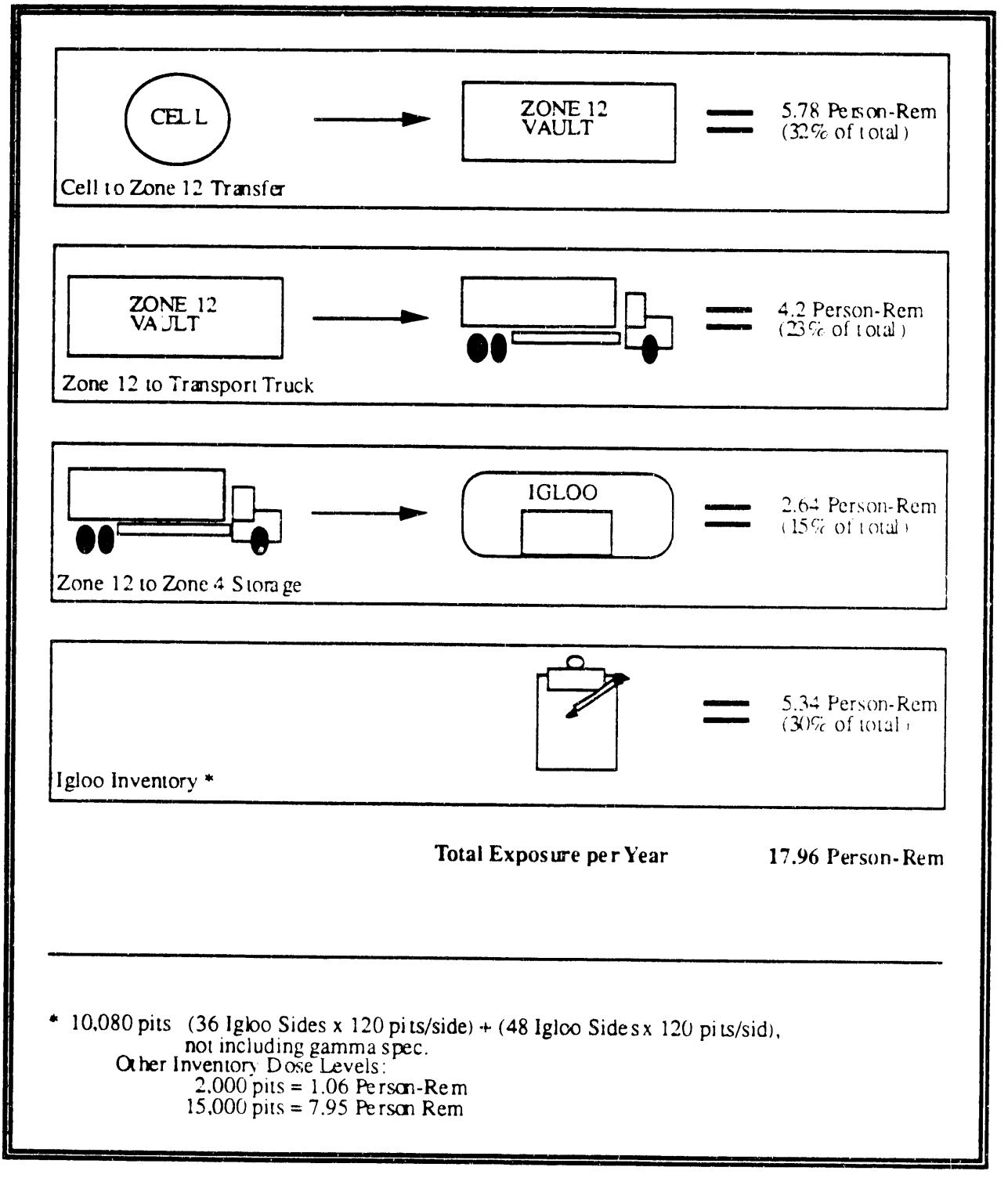


FIGURE 2.6. Current Staging System Data Assuming Lead Apron Protection

Pantex exposure limit. This is particularly true of the less than six individuals assigned to completing inventory activities.

2.1.3 Cost, Efficiency, and Implementation

No capital costs are required with this alternative. One potential labor cost is the cost of removing sand bags and staged material from the SAC igloos. No significant implementation issues other than the emptying of SAC igloos have been identified.

2.1.4 Technical Risk and Maintainability

The current staging method is proven and represents no technical risk. There is also no additional equipment to maintain. However, 45 SAC igloos are not available to meet pit staging requirements. Only 42 SAC igloos exist, and only 20 igloos are being targeted to support pit staging. An additional issue is adhering to current Safety Analysis Report (SAR) minimum-aisle-width requirements.

2.2 ALTERNATIVE 2: PALLET, NO PRECISION STACK

This alternative uses a pallet that can be stacked to increase Richmond igloo and SAC igloo staging capacity. Two pallets are currently being designed to optimize stacking within the igloos: a pallet containing 4 pit drums and a pallet containing 6 pit drums. The two pallet types can be combined in various stacking configurations to ensure effective use of existing vertical space within the Richmond and SAC igloos. This alternative is termed "no precision stack" because the proposed stacking configuration accommodates up to a 5-inch gap between pallet stacks by placing 10 pallets in each row in a Richmond igloo.

The pallets are designed to hold loaded pit drums in a horizontal orientation, with the drum lids facing the aisle. Drums are secured into place within the rack-like structure of the pallet. Once the pallet is loaded, a pallet "lid" is bolted into place, completing the enclosure. The pallet is loaded with the drums in a vertical position. Final design and dimensions of the two pallets are not yet available. A conceptual diagram of the proposed pit drum pallets is shown by Figure 2.7.

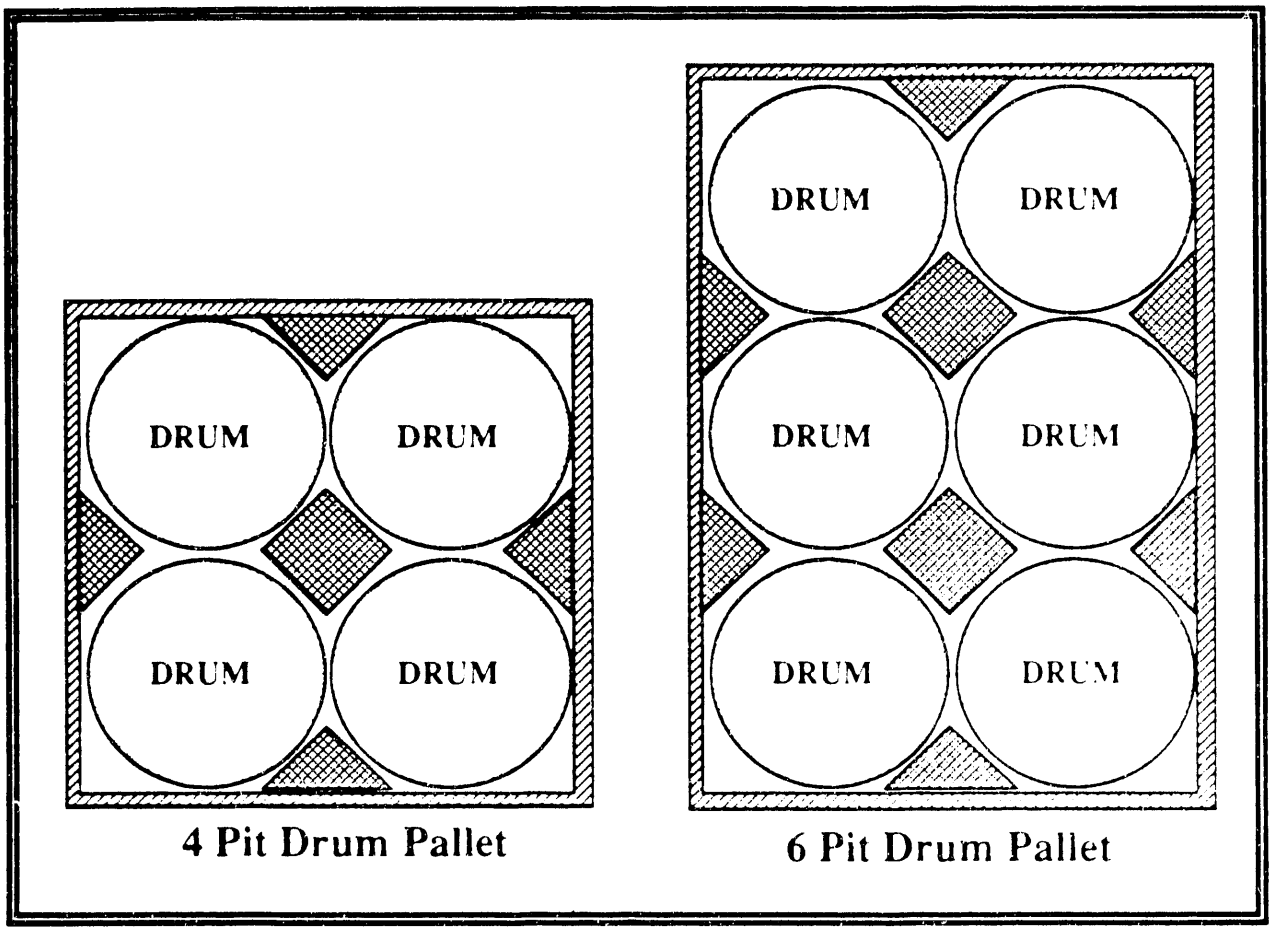


FIGURE 2.7. Proposed Pit Drum Pallets

Pit drum handling activities from the disassembly cells to the Zone 12 vault are identical to the existing system, and make use of the current 5-drum pallet. Loaded pit drums are placed into the pallet when drums are transferred from the Zone 12 vault to the transport trailer. The same dispatch-move-receive procedures as described in the cell-to-vault move (Section 2.1) are employed here also. Workers wearing lead aprons open the vault and roll the drums outside onto a pallet. Drum information is checked and recorded. When the drums are loaded into the pallet vertically, the pallet rack lid is bolted into place. A forklift then picks up the loaded pallet and places it in a trailer for transport. The pallets are then tied down within the trailer by two workers.

Transport of loaded pit drums from Zone 12 to Zone 4 is the same as the current system. One additional Zone 4 preparation activity is the placement of a portable ramp over the apron in front of the Richmond igloo and SAC igloo doors. After two workers remove the tie-downs securing the loaded pit drum pallets within the transport trailer, the forklift on top of the support trailer moves a pallet from the transport trailer to the turntable area of the support trailer. A worker holds the pallet in place while the ground-level forklift picks up the positioned pallet from the support trailer. The loaded pallet is then placed into a pallet rollover device (to be designed) that uprights the pallet such that the drums are lying in a horizontal position. The pallet is now in an indexed location down near the front of the igloo door such that the manual forklift designed to operate within the igloo can access the pallet. Currently, the conceptual design requires three forklifts. This is because the current design assumes that eventually the igloo forklift will be replaced with an automated guided vehicle (AGV) with a range limited to the immediate igloo area, and the functionality of the manually operated forklift system is to match the AGV system as much as possible.

It is assumed that the barcode information will be added in Zone 12 to the pit drums before the loaded pallets are placed within the igloo. It is also assumed that a radiation survey of 10 pre-selected areas in the interior of the igloo will no longer be required.

For Richmond igloos, guide rails extend out onto the ramp outside the door of the apron. The manual machine moves in a straight line in and out of the Richmond igloo between the rails. The rails guide the manual machine to the pallet pickup point outside the Richmond igloo, and then into the igloo. The driver then aligns the pallet on top of an existing pallet or starts a new pallet stack with the aid of instrumentation. The no-precision-stack pallet concept can accommodate 10 stacks of pallets per row along the length of the modified Richmond igloo. The 10-stack assumption results in a 5-inch spacing between pallets. Pallets can be stacked within the modified Richmond igloos 5 drums high by stacking a 6-pack and a 4-pack pallet.

SAC igloo loading is similar; however, guide rails are limited to the back two-thirds of the igloo, and no rail guidance is planned for the turning

area immediately inside the central SAC igloo door. Manual machine drivers are required to drive the equipment into the SAC, and then turn a corner to align with the rails leading into the pallet aisles. The estimated staging capacity of a SAC igloo is less than a Richmond igloo due to the domed ceiling and one central door requiring empty space to turn the equipment to line up with the pallet aisles.

For the purpose of the time/motion/dose analysis presented in Appendix A, the dose rate to the forklift operator has been based on the centerline igloo dose presented in Figure A.1. The actual dose rate to the operator should be significantly less if igloos are consistently loaded from the back of the igloo forward. This is due to the distance of the forklift operator to the stack area, as illustrated by Figure 2.8.

A diagram of a full modified Richmond igloo is shown in Figure 2.9. The maximum staging capacity is 10 drums per pallet stack, 10 stacks per row, 4 rows per igloo, resulting in a total Richmond Igloo staging capacity of 400 loaded pit drums. The staging capacity of a SAC igloo is estimated in Figure 2.10. The maximum SAC igloo capacity, based on two center rows of 8 stacks at 6 drums high and two outer rows of 10 stacks at 3 drums high, is estimated at 312 loaded pit drums.

2.2.1 Staging Capacity

Using the stacked pallet concept with rails as illustrated in Figures 2.9 and 2.10 results in the following estimate of staging capacity required to meet the 15,000-pit staging requirement:

- 200 drums per modified Richmond igloo side x 2 sides = 400 drums per modified Richmond Igloo
- 312 drums per SAC igloo
- 400 drums x 18 modified Richmond igloos = 7,200 drum staging capacity
- Required SAC staging capacity = (15,000 - 7,200)/312 = 25 SAC igloos required.

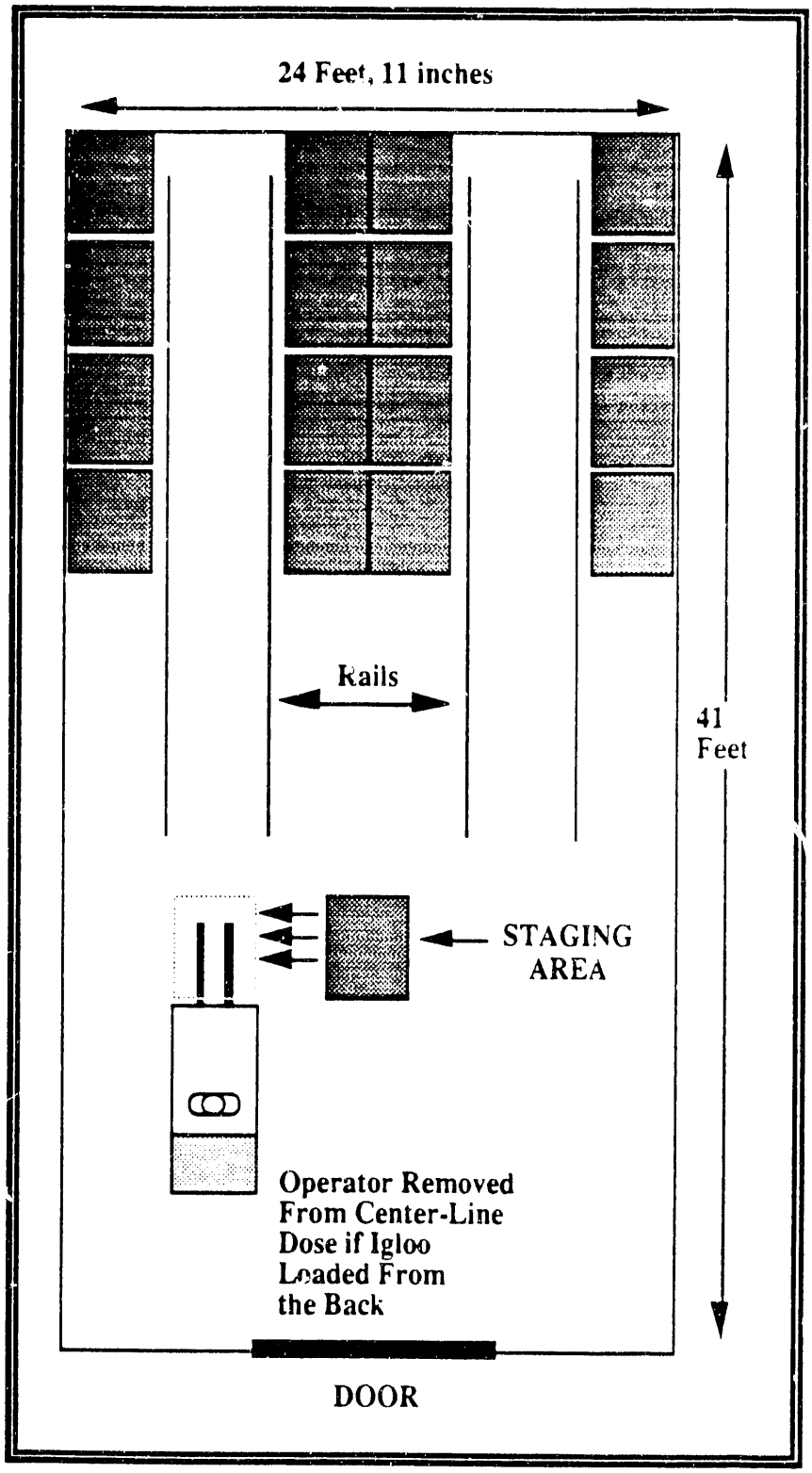


FIGURE 2.8. Distance of Forklift Operator to Stack Area if SAC Igloo Loaded from the Back

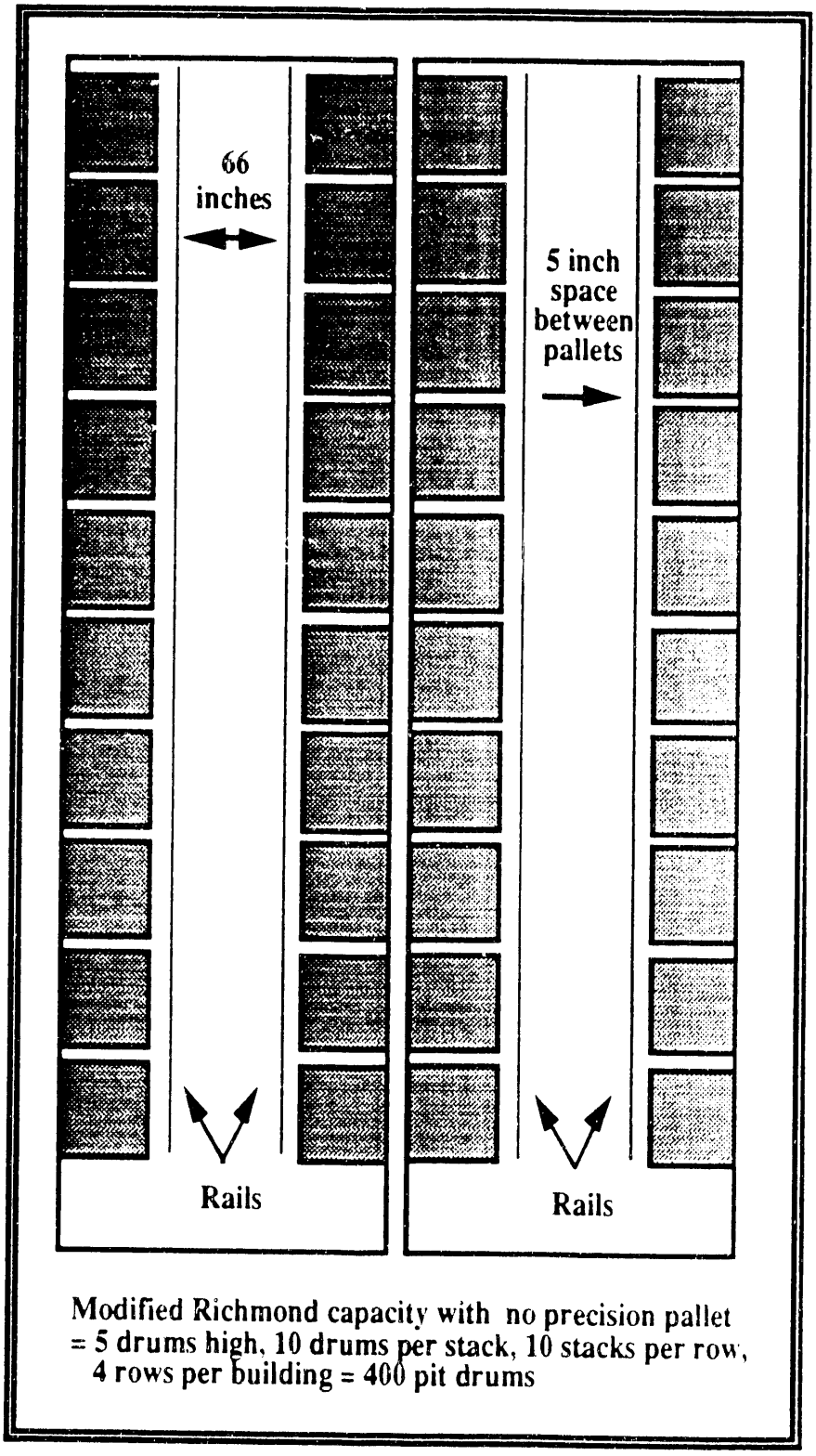


FIGURE 2.9. No Precision Stack, Maximum Richmond Igloo Capacity

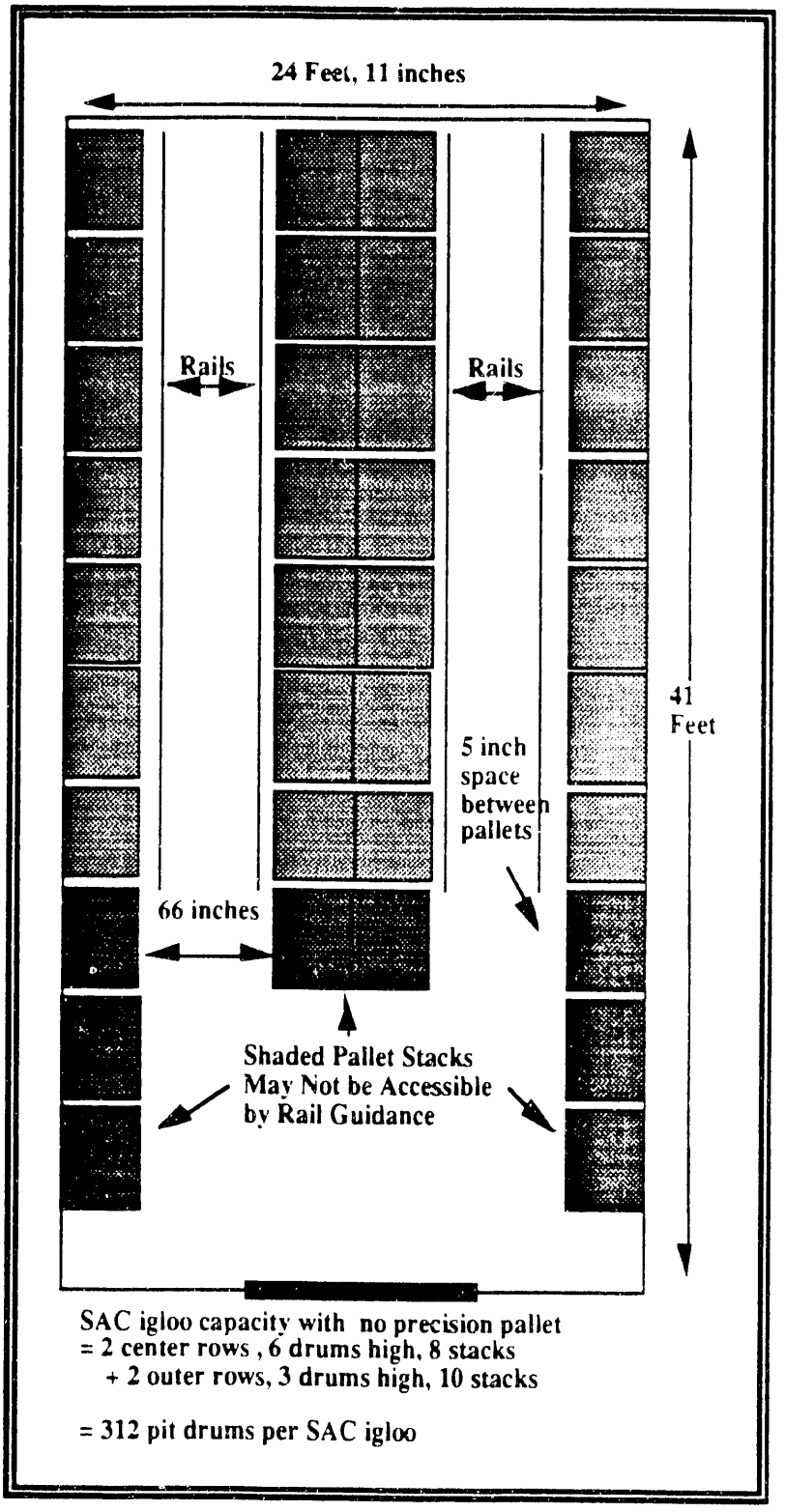


FIGURE 2.10. No Precision Stack, Maximum SAC Igloo Capacity

2.2.2 Radiation Safety

Dose rates for this alternative differ primarily from the current system within the Richmond igloos and SAC igloos. A time/motion/dose analysis of the new, no-precision-stack pallet is contained in Appendix C for an unshielded forklift and in Appendix D for a shielded forklift operating within the igloos. This analysis is summarized by Figures 2.11 and 2.12. All exposure estimates are based n 2,000 loaded pit drums staged per year.

The estimate for the no-precision-stack pallet alternative without forklift shielding is 11.95 person-rem of exposure per year with lead apron protection. The addition of forklift shielding reduces total expected plant exposure to 9.86 person-rem/yr with lead apron protection. It should be noted that the dose associated with igloo loading activities assume the use of the 4-pit drum pallet. The use of the 6-pit drum pallet results in fewer igloo loading trips and lower personnel exposure to the driver.

The estimated exposure required to implement this alternative (consisting of manually removing loaded pit drums currently staged within the modified Richmond igloos, palletizing in the new 6-pack pallet, and transporting and loading them into a SAC igloo) is 9.07 person-rem if no drum handler is used (based on palletizing 18 x 240 = 4,320 pit drums). This calculation assumes the use of lead apron protection and steps similar to Zone 12 to Zone 4 staging activities.

It should be noted that alternatives 2-4 require relabeling barcode information on all existing pit drums. The personnel exposure resulting from this activity per pit drum is estimated at 0.53 person-mrem per pit drum (same estimate as for manual inventory process). Assuming an upper bound of 18 Richmond igloos x 240 pit drums per igloo = 2.29 person-rem for relabeling the pit inventory that is currently staged. The annual inventory of 10,080 pits results in an estimated exposure of 0.45 person-rem/yr assuming no forklift shielding. The addition of forklift shielding reduces annual inventory exposure to 0.06 person-rem/yr.

2.2.3 Cost, Efficiency, and Implementation

Required costs:

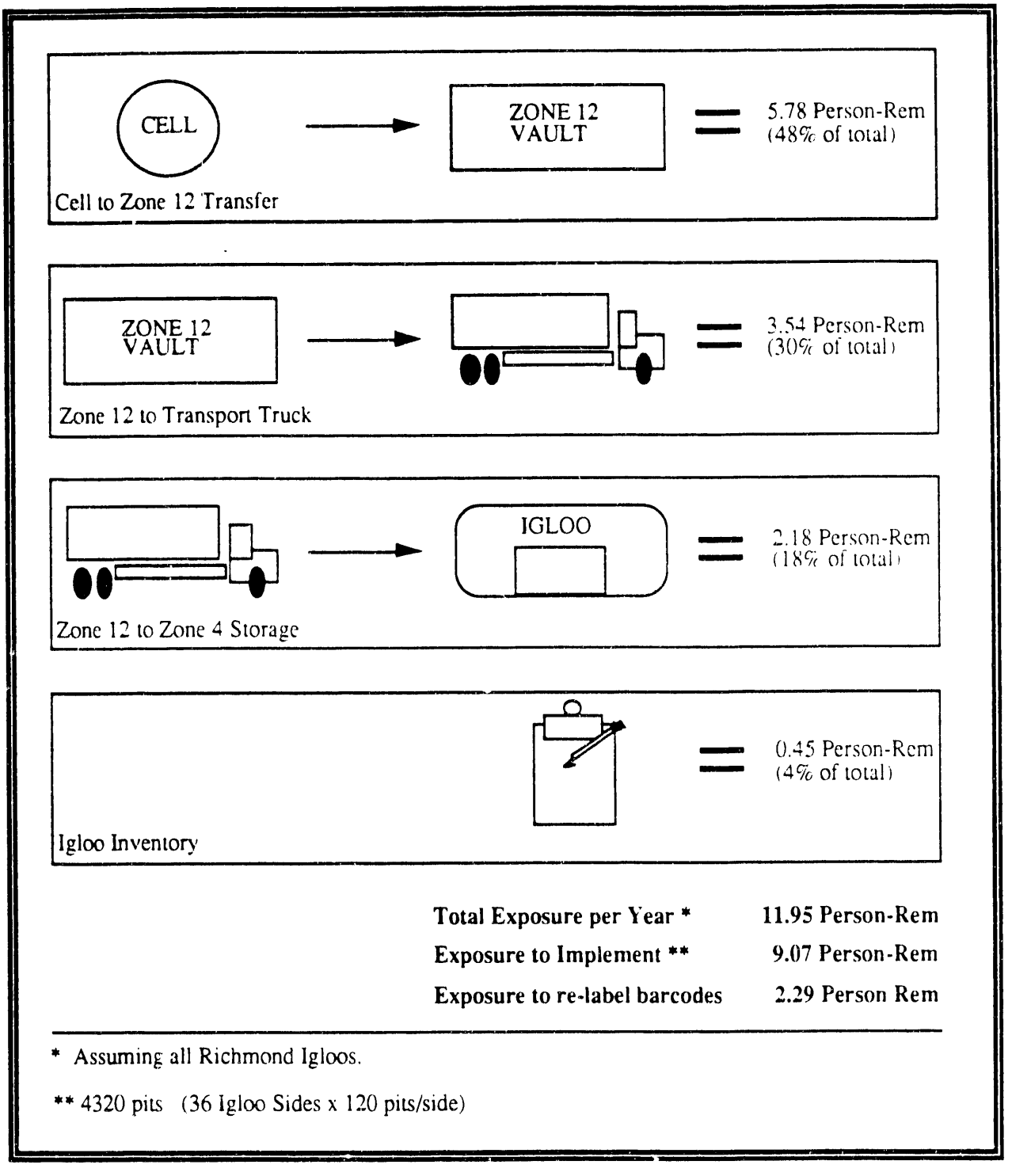


FIGURE 2.11. Pallet, No Precision Stack With No Forklift Shielding Assuming Lead Apron Protection

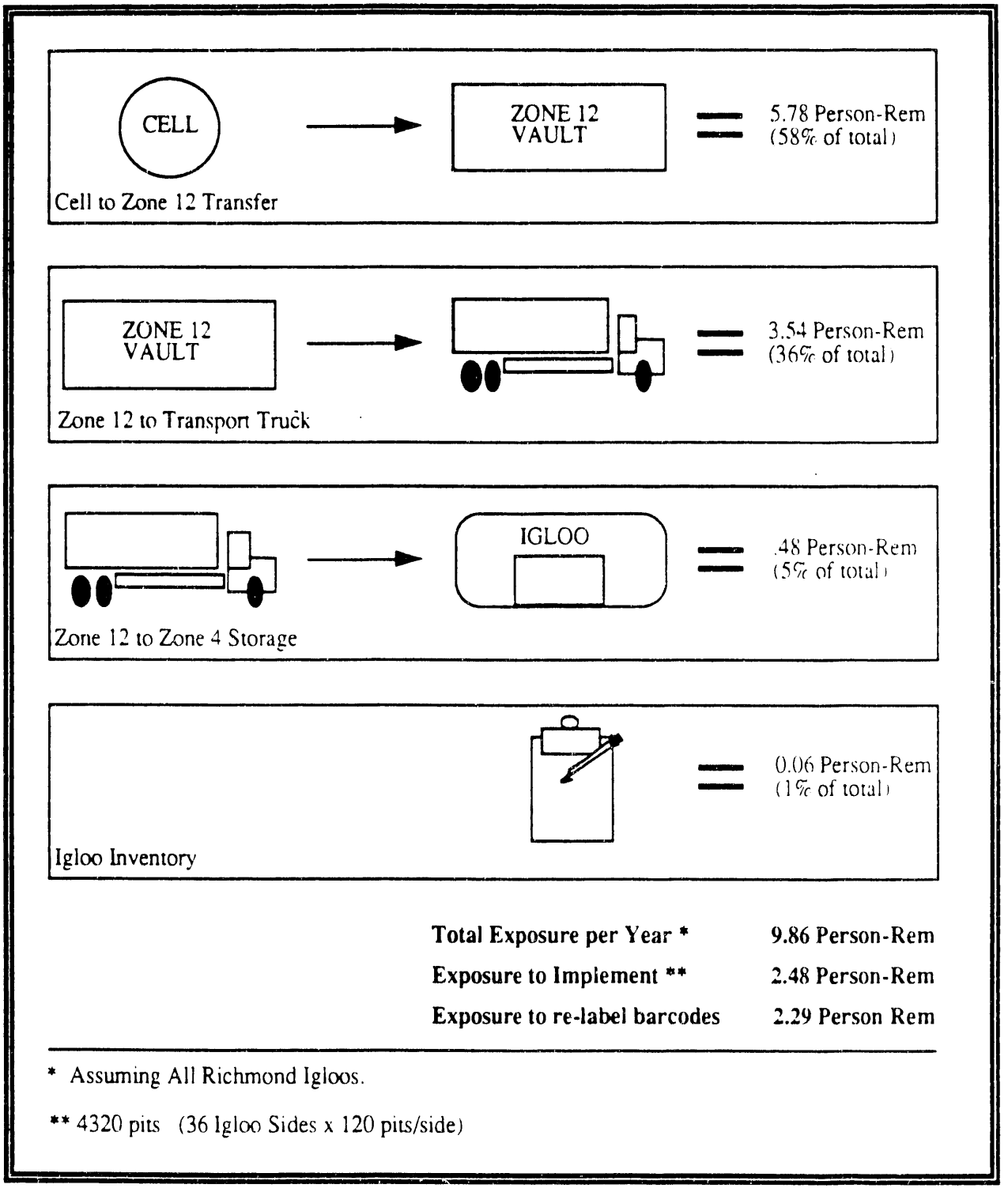


FIGURE 2.12. Pallet, No Precision Stack With Forklift Shielding Assuming Lead Apron Protection

- Pallet design and procurement cost
- Forklift design and procurement cost
- Rail system design, procurement, and installation cost
- Inventory scanner and camera system design, procurement, and implementation cost
- Potential labor cost of removing sand bags in SAC igloos
- Drum handling cost.

Since the implementation of this alternative requires that an igloo be empty to facilitate the installation of guide rails, it is recommended that initial guide rail implementation be completed in SAC igloos that have been emptied. Once the guide rails have been installed within one or more SAC igloos, palletized pit drums can be loaded into the prepared SAC(s) from currently staged pits within the Richmond igloos and from arriving pit drums from Zone 12. One implementation scenario is that existing pits in the Richmond Igloos would be palletized in the new 6-pack pallet and transported to SACs with installed rail guidance systems, and new pits being generated in Zone 12 would be palletized in the new 6-pack pallet and transported to the prepared SACs. This scenario would result in empty Richmond igloos that would then be available for rail installation. Eventually, all existing staged pit drums would be repalletized.

The estimated personnel exposure required to implement this alternative is based on the following process steps:

1. Staged pits in Richmond igloos (assume 18 full igloos or 240 x 18 = 4,320 pits) are removed to the igloo apron.
2. Pit drums are palletized in the new 6-pack pallet on the igloo apron.
3. Pit drums are transported to a prepared SAC igloo and loaded in the same manner as pallets arriving from Zone 12.

2.2.4 Technical Risk and Maintainability

The number of stacks and stack height that can be accommodated within the SAC igloos needs to be reviewed and validated. The ability of the

forklift to take inventory on pallet stacks not supported by rail access in the SAC igloo (i.e., those pallet stacks in the front of the igloo and dark shaded in Figure 2.10) needs to be investigated. Finally, the ability of a forklift to operate in the confined space of the front part of the SAC igloo needs to be reviewed.

2.3 ALTERNATIVE 3: PALLET, PRECISION STACK

This alternative is identical to the previous alternative except that the space between pallet stacks within the igloo is reduced from 5 inches to 1.5 inches. This reduced spacing requires more precision in placing pallets, but increases the number of stacks that can be placed within the modified Richmond igloos from 10 to 11 stacks. An additional stack is also assumed for the inside and outside rows within the SAC igloos. This assumption regarding the SAC igloos results in two center rows, 6 drums high and 9 stacks deep, and two outer rows, 3 drums high and 11 stacks deep. SAC igloo capacity, assuming a precision stack pallet, is 348 pits per igloo. SAC staging capacity will be revisited once additional information becomes available on the required radius to turn the forklift turret and how high the outside row can be stacked.

2.3.1 Staging Capacity

- 220 drums per modified Richmond igloo side x 2 sides = 440 drums per modified Richmond igloo
- 348 drums per SAC igloo
- 440 drums x 18 modified Richmond igloos = 7,920 drum staging capacity
- Required SAC staging capacity = (15,000 - 7,920)/348 = 21 SAC igloos required.

2.3.2 Radiation Safety

Expected radiation safety performance for the precision stacked pallet is assumed to be identical with the previous (no precision stack) alternative, and is presented in Appendix C for the unshielded forklift, and Appendix D for the shielded forklift alternative.

2.3.3 Cost, Efficiency, and Implementation

Required costs:

- Pallet design and procurement cost
- Forklift design and procurement cost
- Rail system design, procurement, and installation cost
- Inventory scanner and camera system design, procurement, and implementation cost
- Potential labor cost of removing sand bags in SAC igloos
- Drum handling cost.

Since the implementation of this alternative requires that an igloo be empty to facilitate the installation of guide rails, it is recommended that initial guide rail implementation be completed in SAC igloos that have been emptied. Once the guide rails have been installed within one or more SAC igloos, palletized pit drums can be loaded into the prepared SAC(s) from currently staged pits within the Richmond igloos and from arriving pit drums from Zone 12. One implementation scenario is that existing pits in the Richmond Igloos would be palletized in the new 6-pack pallet and transported to SACs with installed rail guidance systems, and new pits being generated in Zone 12 would be palletized in the new 6-pack pallet and transported to the prepared SACs. This scenario would result in empty Richmond igloos that would then be available for rail installation. Eventually, all existing staged pit drums would be repalletized.

The estimated personnel exposure required to implement this alternative is based on the following process steps:

1. Staged pits in Richmond igloos (assume 18 full igloos or 240 x 18 = 4,320 pits) are removed to the igloo apron.
2. Pit drums are palletized in the new 6-pack pallet on the igloo apron.
3. Pit drums are transported to a prepared SAC igloo and loaded in the same manner as pallets arriving from Zone 12.

2.3.4 Technical Risk and Maintainability

Similar to the previous alternative, the number of stacks and stack height that can be accommodated within the SAC igloos needs to be reviewed and validated. The ability of the forklift to take inventory on pallet stacks not supported by rail access in the SAC igloo (i.e., those pallet stacks in the front of the igloo) also needs to be investigated for this alternative, as well as the ability of a forklift to operate in the confined space of the front part of the SAC igloo. Finally, the ability of the forklift operator to align and stack precision pallet stacks needs to be demonstrated prior to implementation.

2.4 ALTERNATIVE 4: STACKED DRUMS, NO PALLET

This alternative increases the staging capacity of modified Richmond and SAC igloos above the capacity of the previous alternatives by eliminating the pallets and using the resulting space for loaded pit drum storage. Drums are stacked horizontally, as before, to enable camera/barcode scanning of drum lids facing the aisle. This alternative requires blocking at the end of the drum rows for support within the SAC igloos. Individual drum retrieval is facilitated by custom lift forks to remove the weight from a stacked drum for retrieval. Figure 2.13 shows a typical SAC igloo side wall showing a stacked drum configuration. The number of drums stacked would differ in a Richmond igloo or the center of a SAC igloo, but the configuration would look the same. Staging capacity using the stacked drum concept is 504 pits per modified Richmond igloo (252 per igloo side) and 428 per SAC igloo.

Staging activities from the disassembly cells through the Zone 1? vault and including depalletizing at Zone 4 igloos are identical to the current system. Drums are then individually picked up by the drum handler and placed within the igloo. Drum inventorying is identical to the remote camera and barcode scanner mounted on the igloo vehicle, as presented within the second alternative (Section 2.2). Efficiencies in drum handling from disassembly to

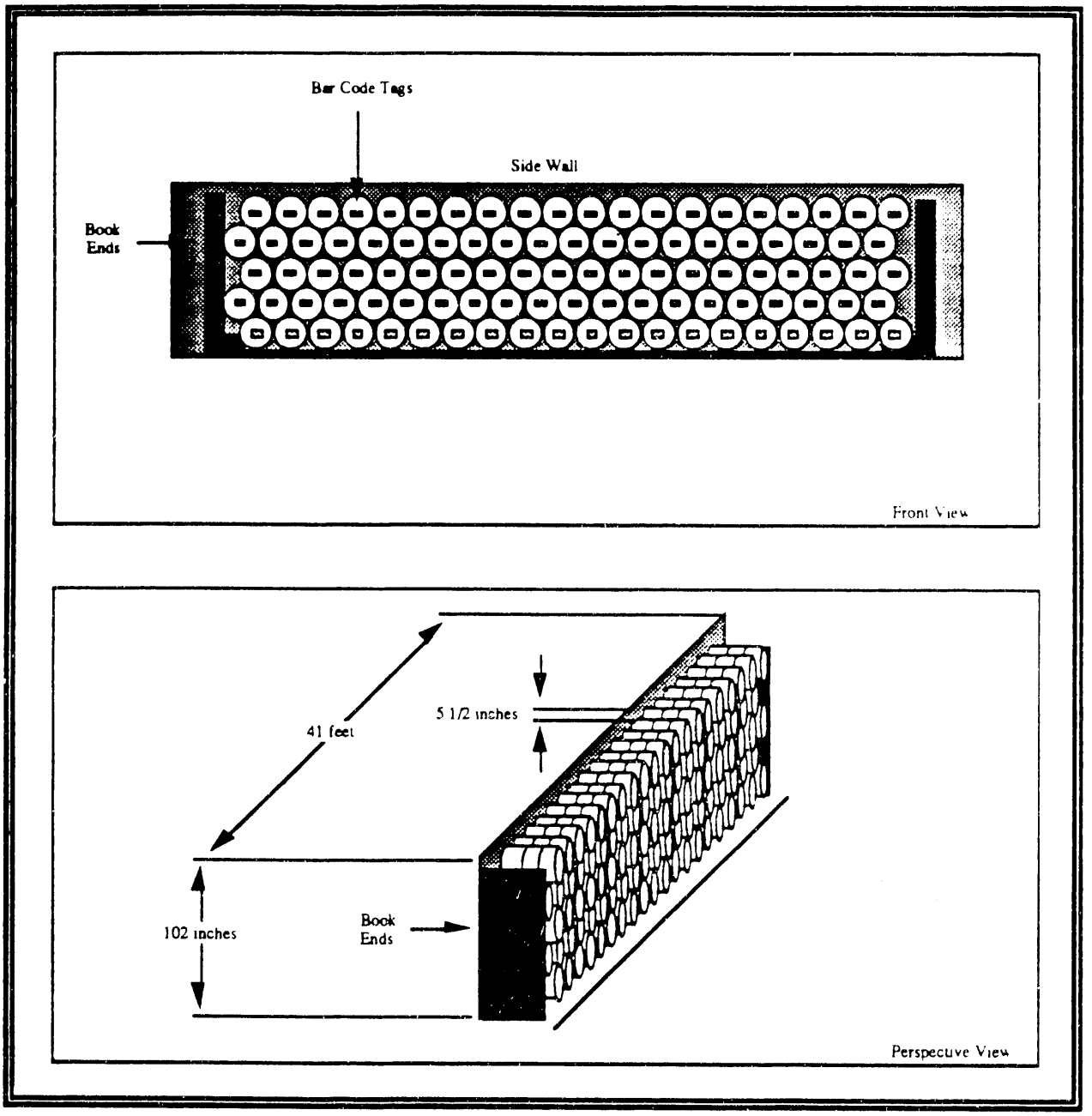


FIGURE 2.13. SAC Igloo Side Wall Showing Stacked Drum, No Pallet Concept

delivery at the storage igloos could provide additional dose reductions. This alternative eliminates the requirement to empty all the existing pits from Richmond igloos.

2.4.1 Staging Capacity

The following estimate of staging capacity required to meet the 15,000 pit drum staging requirement for the stacked drum concept is:

- 252 drums per modified Richmond igloo side x 2 sides = 504 drums per modified Richmond igloo
- 428 drums per SAC igloo
- 504 drums x 18 modified Richmond igloos = 9,072 drum staging capacity
- Required SAC staging capacity = (15,000 - 9,072)/428 = 14 SAC igloos required.

2.4.2 Radiation Safety

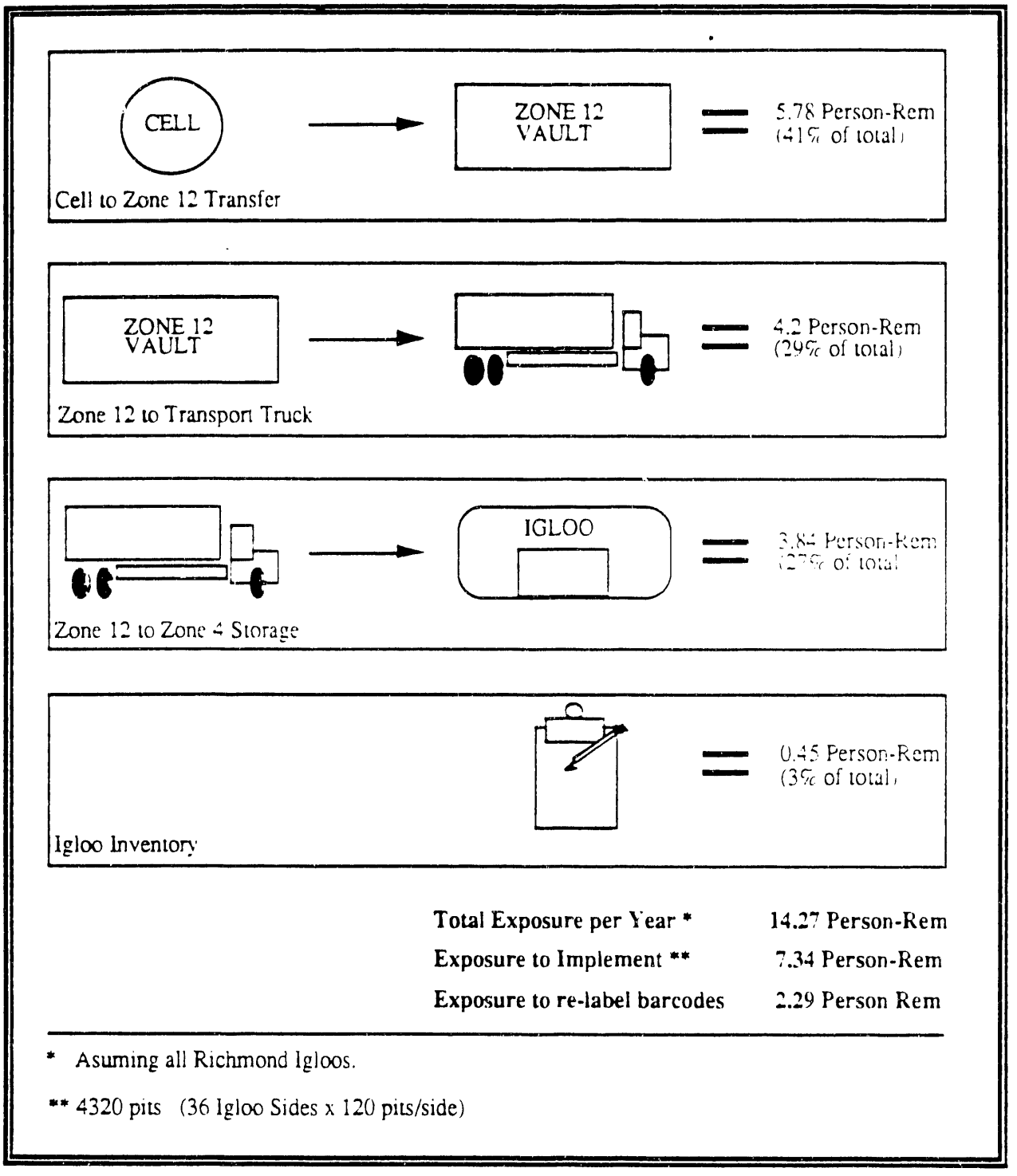
A summary of expected radiation exposure to personnel on an annual basis using the stacked drum/no pallet concept is shown by Figure 2.14 and Figure 2.15. All exposure estimates are based on 2,000 loaded pit drums staged per year. The estimate of yearly exposure to Pantex Plant personnel for this alternative is 14.27 person-rem per year assuming lead apron protection and unshielded drum-handling equipment, and 10.26 person-rem per year assuming lead apron protection and shielded drum-handling equipment. The estimated personnel exposure required to implement this alternative is 7.34 person-rem. Detailed time/motion/dose calculations are presented in Appendix E.

2.4.3 Cost, Efficiency, and Implementation

Required costs:

- Drum handling cost
- Blocking cost
- Potential labor cost of removing sand bags from SAC igloos.

Implementation requirements consist of clearing out sufficient floor space to begin stacking. This can be accomplished by either using the same

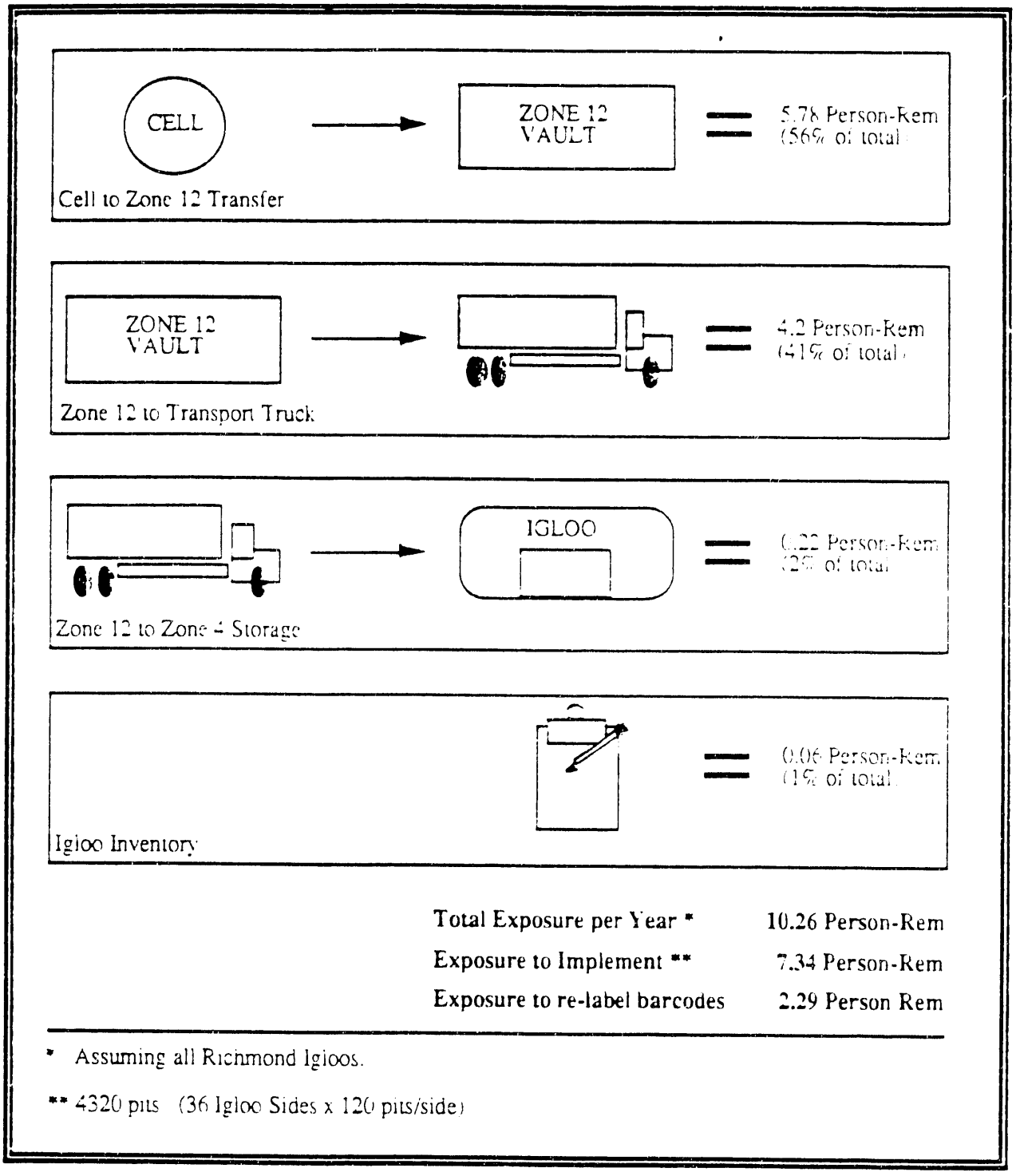


Total Exposure per Year *	**14.27 Person-Rem**
Exposure to Implement **	**7.34 Person-Rem**
Exposure to re-label barcodes	**2.29 Person Rem**

* Asuming all Richmond Igloos.

** 4320 pits (36 Igloo Sides x 120 pits/side)

FIGURE 2.14. No Pallet, Stacked Drum Data Using Unshielded Drum Handling Equipment Assuming Lead Apron Protection



Total Exposure per Year *	**10.26 Person-Rem**
Exposure to Implement **	**7.34 Person-Rem**
Exposure to re-label barcodes	**2.29 Person Rem**

* Assuming all Richmond Igloos.

** 4320 pits (36 Igloo Sides x 120 pits/side)

FIGURE 2.15. No Pallet, Stacked Drum Data Using Shielded Drum Handling Equipment Assuming Lead Apron Protection

drum-handler used for igloo loading, by manual methods, or by a combination of manual and drum-handling equipment. Possible scenarios include manual placement of the first horizontal row of drums, after which the drum-handling equipment restacks the remaining Richmond igloo contents. Another possible scenario is that the drum handler starts restacking from the front of the Richmond igloo, working towards the back. The estimated personnel exposure required to implement this alternative is approximately equivalent to the exposure expected from loading pit drums within a igloo.

2.4.4 Technical Risk and Maintainability

Key issues associated with this concept are:

- The drum handler for this alternative is the same drum handler that could assist in the implementation of the stacked staging pallet alternative, highlighting the need to investigate suitable equipment as soon as possible.
- The need for and the ease of retrieving a stacked drum needs to be investigated for this alternative.

3.0 LOGISTICS

One of the objectives of the study is to review the logistics of the pit staging operations from the time that the pit is removed from the weapon through the time that the pit is deposited into storage. The purpose of this review is to identify opportunities where efficiency improvements could be made and to identify the issues to be addressed in developing an approach to making those improvements, including safety, security, technical feasibility, and the costs, benefits, and risks associated with the change in operations. Each of the major steps in the pit storage process is discussed in the following sections.

3.1 ZONE 12 ACTIVITIES

The current pit flow through the Zone 12 area can be summarized broadly as follows:

- Pits are packaged (placed in drums, identified, and secured with TIDs) and strapped 5 together on pallets within the manufacturing cells.
- They are then transported by forklift to the 12-26 vault, unstrapped and stored in the Zone 12 vault,.
- At shipment time, they are retrieved from the vault, restrapped 5 to a pallet and transported by forklift to a trailer for transport to Zone 4. Five to six cells are contributing to the stream of pits placed into storage at a rate of 50-60 pits per week in total.

3.1.1 Opportunities for Improvement

A number of possibilities for improving the process have been identified in the course of conducting the present study. They are not necessarily all meant to be implemented together, but rather offer a number of improvements based on different views. These are as follows:

- Palletize only once in Zone 12 using the "new" pallets.
- Eliminate the need to store pits in the vault by using a "Just-in-Time" (JIT) approach to loading pallets and the trailer. It may be possible that the holding areas adjacent to the disassembly cells could be used to assist in eliminating the need for the Zone 12 vault.

If a JIT approach is not feasible, then stop using the 12-26 vault for interim storage of extra pits and limit it to only those pits that will be transported in a load.

- Widen/heighten the door to the 12-26 vault to allow forklift access.
- Employ barrel handling tools to obtain "space" between pits and personnel.
- Make efficient use of minimal shielding in strategic locations.

3.1.2 Benefits

Benefits from implementing these improvements would include:

- A reduction of approximately 3.33 person-rem per year due to reduced handling requirements.
- Better storage control due to the elimination of the interim storage requirement in the 12-26 vault.
- Removing the extra pits from the 12-26 vault would greatly lower the "non-essential" dosage that workers in the 12-26 vault would take. Ideally, in Zone 12, workers should only be exposed to the dose from the pits they are about to move.
- Widening the door to the 12-26 vault would eliminate the depalletization/repalletization operations that currently take place in Zone 12, thus further reducing the exposure. Total loading time would also be reduced.

3.1.3 Issues

The following issues would need to be addressed before the implementation of any of the above-mentioned improvements could take place:

- The loading of the proposed pallet could present a problem because the drums would have to be lifted approximately 10 inches to clear the sides of the pallet and be lowered into the pallets' internal framework. The disassembly hoist in the cell could be used to perform this operation.
- The question of whether portable shielding could be erected to reduce the extra dose the people in the disassembly cells would be taking.
- The pallet will require that the front panel will be lifted and lowered onto the pallet, then secured. The front panel is quite likely to be heavy and awkward to handle, especially for the

6-pack. Two or more people will be required to perform the operation, and the use of a hoist may be required. Can/will manpower be available for this task?

- A location for storing and process for transporting empty pallets needs to be developed.

- Will there be equipment available to transport the pallets? (The 6-pack is substantially larger than the old pallet.)

- In order to use the 12-26 vault to hold only those pits awaiting movement to Zone 4, room must be made in the SAC/Richmond igloos to hold the extra pits.

- If pits are to be palletized only once, and not removed until they reach Zone 4, then a system needs to be in place to ensure that all of the pits on a pallet or in a shipment are actually going to Zone 4 at the same time. Otherwise, you defeat the purpose by repalletizing unnecessarily.

- Current pallets are partially made of wood and may be unacceptable for use in the 12-26 vault. Can the present pallet design be used to construct metal pallets?

3.2 TRANSPORTATION TO ZONE 4

The current transportation of pits from Zone 12 to Zone 4 can be summarized broadly as follows:

- Palletized pits are transported by forklift to a semi-trailer, where they are secured, 8 pallets to a load.

- A convoy consisting of transportation and security workers moves the trailer from Zone 12 to Zone 4.

- The trailer is met at the appropriate unload point by a flatbed trailer, and the semi is unloaded.

3.2.1 Opportunities for Improvement

A number of opportunities for improvement that could be considered when transporting pits to Zone 4 are the following:

- Developing a new tie-down system for securing pallets within the trailer. Currently, workers are forced into extremely close proximity to the pallets in order to tie them down. Solutions could range anywhere from simply sliding a brace over the top of

the pallets instead of tieing them down, to installing an automatic pallet-securing device in the trailer.

- Using a transportation device that eliminates the need for the flatbed staging trailer at the receiving end in Zone 4. A low-boy trailer, for example, that a forklift could drive into is one possibility, or a modified soft drink truck or trailer (properly outfitted) where the pallets could be put on the sides, secured, and doors rolled down over them.

- Finding the optimal number of pits that can be moved at one time, based on production, security, and scheduling. Currently, pits are shipped in lots of 8 pallets (40 pits), which is the production requirement. Production increases dictate that this lot size be looked at to ascertain if it is adequate, due to the increased demands it may put on scheduling, security, and transportation.

3.2.2 Benefits

Benefits from implementing these improvements would include:

- A reduction (or elimination) of the time that a worker would have to spend aboard a trailer filled with radioactive material. It is estimated that as much as 75% of the dose received during the loading step (2.12 person-rem/yr) could be eliminated if a remote or automatic tie-down system could be implemented.

- Properly matching the transportation lot size to the production, scheduling, and storage aspects will result in an overall faster system.

- Reducing the complexity of the current system, (e.g., forklifts trading pallets on float trailers, workers tieing down pallets, etc.) will result in labor savings and less chance of personal injury.

3.2.3 Issues

The following issues would need to be addressed before implementation of any of the above-mentioned improvements could take place:

- Since transportation is the link between what could be argued as two separate process systems, a careful study of the entire system needs to be done to identify the critical drivers (potential bottlenecks) of the overall process.

- Introduction of new modified equipment needs to be examined with respect to regulations, design time, etc., that would be required.

3.3 ZONE 4 ACTIVITIES

A complete description of both current and alternative Zone 4 activities is covered in Chapter 2.0. The basic activities can be summarized as follows:

- The semi-trailer coming from Zone 12 is unloaded at the igloo.
- Pits are moved into the igloo.
- Inventories are taken.

In addition, future workload dictates that the current igloos be reconfigured to allow for more storage of incoming pits.

3.3.1 Opportunities for Improvement

There are a number of opportunities for improvement that can be considered when viewing the overall activities in Zone 4. Three possible alternatives that address all of the activities listed above are discussed in detail in Chapter 2.0.

3.3.2 Benefits

Benefits for implementing the various alternatives are also discussed in detail under each alternative in Chapter 2.0.

3.3.3 Issues

- In Zone 4 the two big logistics issues that need to be addressed deal with the unloading and repalletizing for storage of the drums coming from Zone 12, and the rearranging and reorganizing of the drums that already stored in Zone 4. In addition, the planning for installing the equipment for pallet stacking within the igloos also needs to be addressed.
- At the present time, a large number of pits are stored individually in a number of igloos in Zone 4. These pits will have to be retrieved, reidentified, loaded into the storage pallets, and transported to the igloo in which they will be stored. It will be necessary to develop a process for accomplishing these tasks efficiently while minimizing radiation exposure to the workers.

3.4 OTHER LOGISTICS CONSIDERATIONS

In addition to the major activities discussed above, a number of other issues must be considered before implementing any changes to the current process. These include:

- Have the equipment requirements for manual machines, forklifts, drum handlers, ramps, transport trailers, etc., been determined?
- Do the computer systems have the capability for handling the new data requirements?
- A plan must be developed for installing the rail system into the Richmond and SAC igloos.
- Two types of pallets are being provided for pit staging: 4-pack and 6-pack pallets. Loading the pallets will have to be arranged so that the appropriate number of each type reaches the storage area in time to allow for efficient loading of the igloo.
- Who will have the ultimate priority in scheduling transportation between Zone 12 and Zone 4? Will transportation have to work around the security schedule, or will security give transportation top priority now that the workload is projected to increase so dramatically?
- Has the possibility of increasing the shielding of the pit drum been examined? How much would the dose be reduced, for example, if 1/4 inch of lead were applied to the top of the drum? This would not drastically increase the weight of the containers, and even if it achieved only a small reduction, when multiplied over the projected number of pits and the total exposure time, would result in substantial exposure savings. Pits that are already containerized represent only a small fraction of the total projected to be stored, and could easily be identified by painting or marking.

3.5 SUMMARY AND RECOMMENDATIONS

The previous sections indicate that there are a number of possible ways to streamline the entire process of pit staging that would make it safer and more efficient. Since most of these improvements are conceptual at this stage, hard data to rate their relative desirability are limited. Furthermore, in many cases, implementing any one of these suggestions is directly dependent on a final determination of how the most critical part of the overall staging process (the storing and configuration of pits in the Zone 4

area) is to be handled. Once this endstate has been determined and approved, an in-depth systems study should be conducted to further explore and ultimately implement enhancements to the staging process.

4.0 SAFEGUARDS AND SECURITY

The United States has routinely retired nuclear weapons from the stockpile for modernization and refurbishing. The capability exists at the current nuclear weapon facilities to fulfill provisions from arms control for dismantlement to safe storage, including appropriate safeguards and security. However, the nuclear weapons complex (NWC) currently is operating with only limited capabilities, primarily due to environmental protection, safety, and health (ES&H) issues. Of specific interest to the problems with storage of pits at the Pantex Plant are the status of arms control measures. More specifically, there is concern over the START treaty and the follow up reductions in the stockpile by President Bush, and the status of the Rocky Flats Plant (RFP) in Golden, Colorado. The arms control measures have resulted in a significant increase in the number of weapons being returned to the Pantex Plant. Plutonium pits removed from nuclear weapons at the Pantex Plant are normally sent to Rocky Flats for processing and recycling of the plutonium. However, the plutonium operations at the RFP have been curtailed since 1989 and are not expected to resume. The DOE is developing plans to reconfigure the NWC, with Record of Decision expected on proposed facilities in August 1993.

To handle the near-term impacts of increased returns and the curtailed operations at Rocky Flats, it has been proposed to use alternative storage arrangements that provide for an increased number of storage spaces in the existing igloos used for staging components for assembly and shipping. One concern is the impacts on safeguards and security.

The pit storage options can be evaluated using the following eight topics of safeguards and security:

- Physical Protection
- Systems Protective
- Forces Material Control and Accounting (MC&A)
- Information Security
- Operational Security (OPSEC)

- Computer Security
- Technical Surveillance Counter Measures
- Personnel Security.

In evaluating the safeguards and security issues, it has been determined that the general security measures will not be affected significantly by the number of pits stored in each location. The primary impacts observed are in the area of MC&A where an increase in staffing will be needed and higher radiation exposures will be encountered. Although the number and categories of the facilities are not expected to change, the protection forces and security systems will need a slight increase in staff to monitor access for MC&A and maintenance activities in the storage areas. There also may be an increase in the needs for protection during reorganization of the existing staging facilities.

The MC&A efforts are generally proportional to the number of items maintained in inventory. MC&A consists of two general elements: material accountability and material controls. Material accountability consists of maintaining accounting records, measurements of the SNM content, physical inventories, material transfers, and analysis of material accounting data to provided indicators of control. Material control consists of access controls, material surveillance, material containment, and detection and assessment activities.

For the pit storage facility a key element is physical inventories that are required bimonthly by DOE Order 5633.3 and also by 10 CFR Part 74. One of the major impacts of the physical inventory requirements is that of staff, and the radiation exposure received by personnel. This may be a significant issue in the site's ability to further ALARA goals for exposure. Preliminary estimates, for the short-term proposal of storing the pits in igloos, indicate a radiation exposure of 10 person-rem per year to conduct the physical inventories. Higher radiation levels will also decrease the MC&A capabilities for confirmatory and verification measurements.

If Category IA SNM items are also stored in the vault, then inventory checks are performed biweekly for physical count and monthly for serial number

verification. It is assumed that storage of Category IA and IB items will be segregated. The DOE's Office of Safeguards and Security is reviewing alternatives for physical inventory requirements, specifically to identify compensatory measures to enhance existing physical security, material control, and personnel security systems as a means to compensate for reducing the frequency of taking inventories. There are several technologies under development in the DOE-sponsored technology base program that will provide continuous knowledge of the inventory.

Another element of MC&A that may affect the short-term pit storage alternatives is the daily administrative checks aspect of material control. The impacts are expected during the reorganization of the staging areas until the staging areas can be sealed from routine daily access.

The future goals for safeguards and security focus on reducing access to SNM, both to reduce radiation exposures for ALARA and to minimize potential vulnerabilities associated with access, and on installing technologies to enhance the assurance that materials are protected should threats change. In addition, the DOE Orders are being revised to reflect technological capabilities to provide solutions to difficult security problems. Some of the issues to be addressed by future enhancements include:

- Remote personnel identification for access control and monitoring surveillance activities such as the two-person rule
- Measurements capabilities, particularly in near-real-time tracking of moving materials in high background radiation areas
- TIDs to ensure item integrity-integrated information systems for analysis and reporting.

5.0 PUBLIC/POLITICAL ACCEPTABILITY

The purpose of this section is to assess the acceptability to the public of near-term staging alternatives for plutonium (Pu) pits recovered from the return of nuclear weapons. The specific near-term staging alternatives are not well enough known to the public in the Amarillo area to constitute distinguishable cases. However, there appears to be widespread awareness on the part of the general public that the dismantling of nuclear weapons made possible by the end of the Cold War constitutes a distinctive mission, and that the storage of Pu pits is a part of this mission. The reason for assessing public acceptability of this mission is to identify public perceptions and concerns that can be responded to by public information and public outreach activities.

Community leaders seem to be quite well informed about the near-term prospects for dismantling thousands of weapons at Pantex over the next few years. They are also quite aware that there is some social controversy over this mission and particularly the storage of Pu. There has been some attention in the local print media to this mission. Stories in the Amarillo papers have covered statements by the U.S. Secretary of Energy about intentions to store Pu from dismantled weapons at Pantex. Stories have also covered charges by local groups and individuals critical of Pantex operations from an environmental safety and health standpoint. Recent media attention has been given to positions taken by the Texas Attorney General, emphasizing the need for environmental compliance and asking the DOE to detail its plans for the future at Pantex. In general, however, media attention to Pantex has decreased compared with a year earlier when there was a great deal of attention given to the possibility that Pantex operations might be substantially expanded as part of the weapons complex reconfiguration. This issue is unresolved and forms a backdrop for the public perception of the current Pu staging mission.

5.1 BACKGROUND

The Pantex Plant has been a feature of the Amarillo area since World War II when it was built in 1942 as a factory to produce conventional

munitions. It was closed briefly and then reopened as part of the nuclear weapons production complex in 1951. Pantex's mission has been the final assembly of nuclear weapons; their maintenance, modification, and reliability testing; and final disassembly of weapons permanently withdrawn from the military stockpile. This latter function is the topic of our current assessment. From the public perspective the new element in the mission is the storage of Pu pits. Over the past several decades the disassembly operations recovered Pu which was stored or "staged" briefly until it could be reused in the manufacture of new weapons. The central public issue associated with Pantex's current mission is the storage of Pu--the crux of this issue is the period of time that Pu is to be stored at Pantex.

Pantex currently employs about 2,800, which makes it one of the largest employers in the area. Estimates place the number of indirect jobs associated with Pantex operations at an additional 2,100. The overall direct and indirect Pantex expenditures in the Amarillo area run to over $300 million each year. In an area where the economic activity has been depressed for a number of years, these are important numbers. As a result, the community leadership is quite strongly supportive of Pantex. This does not mean there is uncritical acceptance of current and future Pantex activities or that all the leadership in the community is supportive, but, in general, Pantex is viewed as an important and valued asset to the area.

Survey data support this conclusion. In May and June 1991, three separate surveys were commissioned in the Amarillo area to test public attitudes toward the proposed expansion of Pantex. Responses to Pantex Plant expansion ranged from 66% positive, in a survey commissioned by Operation Common Sense (which took a generally negative stand on expansion) to 80% positive, in the survey by Panhandle 2000 (a group of expansion supporters.) A survey by the Amarillo Globe - News got 73% positive responses on the same issue. The three surveys, in order, questioned samples of 289, 400, and 400. The main reasons respondents gave for supporting Pantex expansion were to improve the economy and create jobs. The Panhandle 2000 survey also tested attitudes toward DOE and Pantex: "The Department of Energy can be trusted to design, build, and

operate on environmentally safe facility." (Agree 62%, unsure 17%, disagree 21%.) "The Pantex plant is a good corporate citizen." '(Agree 88%, unsure 9%, disagree 4%.)

This general public support for Pantex is not based solely on economic factors. There is a widely held feeling of pride and patriotism about Pantex in the area. The Cold War has been won, and Pantex is considered by most area residents as key to that victory.

Since the intense media attention and community discussion that accompanied the Pantex expansion proposal in the spring and summer of 1991, Pantex has assumed a lower profile. However, there is no reason to think the attitudes expressed a year ago have changed markedly.

5.2 PROPOSED MISSION CHARACTERISTICS

Public acceptance is based in part on the background factors discussed above and in part on the characteristics of the proposed mission. There are several mission features on which the public appears to be basing its opinions. The public perceives that:

- An increased number of weapons are to be disassembled at Pantex (compared to the disassembly operations in the past).
- The expanded disassembly operations will go on for a decade or more.
- Pu pits recovered from weapons disassembly will be stored for an indefinite period.
- Existing structures will be used for storage.
- The number of pits to be stored will require modified configuration of the storage structures.
- Automated material handling machinery may be involved in the storage and inventory operations.

Without additional survey data it is difficult to know the details of public perception about the proposed mission. It is reasonable to assume that most people know of the broad features of the disassembly and Pu pit storage

mission, but that few have a very well-formed perception of the size of the mission, time period of storage, or operational details.

Two additional rumors about the mission were heard:

- Pu storage at Pantex would be permanent, i.e., that Pantex would become a de facto repository for Pu pits.
- Disassembly of weapons from the former Soviet Union would take place at Pantex.

Since these rumors were rarely encountered, they are probably not very important in affecting public acceptance, but they do serve to remind us that public acceptance of a mission is based on public perception of the mission. Public perception of mission characteristics can differ substantially from mission plans as actually proposed.

5.3 SOCIAL CONTEXT

Social acceptance and social conflict over a proposed mission take place partly in response to factors in the immediate situation and partly as a function of the larger social context. Several of the social context factors that bear on Pantex operations are briefly examined in the following.

5.3.1 Changing Priorities in the Weapons Complex

While weapons production with the goal of winning the Cold War was the highest priority for decades, now DOE places much greater emphasis on compliance with environmental regulations and emphasis on safety of operations and protection of public health. This "new culture" has changed the way DOE facilities are operated. It has been accompanied by much greater openness to public scrutiny, release of information previously closely held, and the admission that much improvement in meeting environmental, health, and safety standards is needed. While such improvement is ongoing, the process takes time. These events have generated substantial public criticism of DOE and its operations at many sites.

Pantex operations, however, have not received much criticism and there has been almost no mention in the local media of purported violations of ES&H criteria at Pantex. Nonetheless, there is wide public awareness in Amarillo

of problems at other DOE sites, particularly Rocky Flats. When the public debate over expanded operations at Pantex was on-going in 1991, a major issue in the debate was how much DOE could be trusted. As previously noted, 3 of 5 respondents expressed trust in DOE, 1 in 5 was mistrustful and 1 in 5 was undecided. Issues of trust and credibility, once raised, are never completely forgotten by the public. This will continue to be an important aspect of the social context within which the public makes up its mind about future Pantex operations.

5.3.2 Increasing Public Concern About Environmental Protection

By every measure, Americans have become much more sensitive to environmental protection in recent years. Polls show the majority public view is that our air, soil, and water are rapidly deteriorating. In fact, studies show substantial improvement in air and water quality in most areas of the United States over the past 10-20 years. However, for a variety of reasons, environmental protection has become a very broad-based contemporary American value that forms a general backdrop against which actions that might harm the environment are assessed. This value runs deeper than mere compliance with environmental regulations. Due to the attention given to past environmental problems associated with government agency operations, the public and the media are especially wary of government activities. The National Environmental Policy Act (NEPA) process, the ease with which legal challenge can bring delay, and the vulnerability of the federal government to state intervention have all but rendered meaningless the doctrine of federal preemption.

There has long been a degree of social opposition in the United States to weapons development, but that opposition has been a distinct minority. Yet, in the past several years the nuclear weapons complex has lost its immunity to state intervention. Even before the Cold War ended it was becoming clear through state actions in Ohio, Colorado, Idaho, and Washington State that defense programs would be held to ever more stringent environmental standards. One clear implication of this change in public perceptions is that continuing to operate programs the way they have been operated in the past will no longer be acceptable. This is especially the case when operations

that have been out of the public view for security reasons are now understood, upon public disclosure, to fall short of contemporary standards of environmental protection.

Again, there do not seem to be many in the Amarillo area who feel Pantex has violated environmental standards in the past. Current operations are understood by most members of the public to be in compliance with state air and water quality regulations.

Because the current weapons dismantling and Pu pit storage operations are vital to a strongly valued goal, international peace, and because this mission is integral to an arms reduction policy that enjoys wide public support, there could be a tendency for the public to relax its environmental vigilance. In other words, because the public strongly supports the Pantex mission it could take the view that the end justifies the means. On balance, however, this does not appear likely. At least for the next few years, the national trend toward greater social emphasis on environmental protection is likely to cause Pantex operations to come under increasingly close environmental scrutiny.

5.3.3 Emerging Local and State Social Context Issues

Two additional features of the social context are likely to affect public acceptance of the Pantex mission of disassembly of weapons and Pu pit storage. These are trends in the local economy and the attention given to the Pantex mission by the Texas Attorney General.

The economy in the Texas Panhandle has been somewhat depressed since oil prices dropped in the early 1980s. The local view is that economic stimulus from oil is not likely in the next few years. The area also suffers from the economic recession of the past 3 years. Additionally, cattle feeding is a major agricultural business in the area. This economic sector has been slow partly because beef consumption has been on the decline as a result of long-term changes in Americans' food preferences. There have been significant declines in employment in the Amarillo area over the past 10 years. Indications are that the economic benefit and jobs that Pantex represents in the area will remain an important public priority for a number of years.

A series of letters over the last 9 months from the Texas Attorney General to the U.S. Secretary of Energy has resulted in media attention in the area and has been covered in the NWC newsletters. The substance of the Attorney General's request is for information about the specific intentions of DOE to store Pu at Pantex. Moreover, the Attorney General has expressed the opinion that the proposed Pu storage mission will require a full-fledged environmental impact statement. Aside from the prospects for legal action, a question outside the scope of this section, the Attorney General's action could serve to crystallize determined and widespread public opposition to the proposed mission. However, in the view of experienced observers of area and state politics, this does not seem very likely. For one thing, the Attorney General is viewed as an outsider by the Amarillo public and at present does not have a noticeable following. Secondly, there is at present only a very small number of people in the area who are highly concerned about the issues that the Attorney General has raised. In addition, the mission is recognized to have international prominence in the peace process. Taken together these factors suggest that a major public shift to back the Attorney General's position is not likely.

However, DOE actions must be carefully considered to avoid being perceived as unresponsive. A Gallup Poll conducted nationwide over the period, June 4 - 8, 1992, asked the question, "How much of the time do you think you can trust the government in Washington to do what is right? Just about always, most of the time, or only some of the time?" The results showed a historic high of 75% who felt the government could be trusted only some of the time. By contrast, this figure was only 23% in response to the same question asked in 1964. During the hearings held in Amarillo in July 1991 on the question of Pantex expansion, there were many speakers who detailed DOE's problems with environmental compliance at other sites. A guest column in the Amarillo Daily News on July 24, 1991, was headlined "The DOE Has a Disastrous Environmental Record." Again, local survey data at the time showed that trust in DOE remained strong. However, vulnerability to a deterioration of this trust has been increased by the Attorney General's actions.

5.4 ASSESSMENT APPROACH

Estimating public acceptability of the proposed storage of Pu at Pantex involves identifying public segments that may support or oppose the mission, identifying their current positions on issues of importance, and making estimates of what may happen in coming months.

5.5 RELEVANT PUBLICS

The term "public" includes several diverse groups: local public in the vicinity of the site; elected officials and influential leaders in business, education, and public health; state officials; national and state congressional delegations; and local and national special interest groups. Of relevance to disarmament facilities are groups devoted to environmental protection and anti-weapons advocates. Most existing DOE sites have several groups dedicated to opposing one or more of their operations.

There are also groups or organizations that generally support DOE facility operations. The Panhandle 2000 organization is such a group. It took the lead in 1991 in preparing the Amarillo proposal to expand Pantex. Panhandle 2000 is a coalition of Amarillo area business people, civic leaders, and political interests. Other groups supportive of Pantex operations are the Metal Trades Council which represents 12 Pantex unions, the Amarillo City Commission, the Amarillo Chamber of Commerce, and the city governments of most of the towns in the Pantex area. In addition, in the 1991 expansion discussions, support for Pantex expansion came from the entire Texas congressional delegation, the Texas State Legislature, the Governor, and nearly all local politicians.

Opposition came from several local groups: Operation Common Sense (which stated its position as "neither endorsing or opposing," but is generally perceived to be against expanding Pantex operations); Panhandle Area Neighbors and Landowners (PANAL), a group whose core is made up of landowners near Pantex; the Peace Farm, a group long opposed to weapons production; and the Nuclear Waste Task Force, a group formed to oppose the repository siting effort in nearby Herford, Texas. In addition, farmers' groups and groundwater conservation interests are generally opposed to Pantex expansion. There are

also some vocal residents such as one who has claimed many area cancer deaths have resulted from offsite contamination. A study by the Texas Department of Health (Amarillo Globe-News, May 7, 1992) found no basis for this claim. However, when claims of this kind are made they are invariably reported in the media, and they invariably attract some believers regardless of the facts.

The Pantex expansion hearings in July 1991 also attracted opposition from national groups, e.g., the Natural Resources Defense Council, who have historically been critical of DOE operations.

The current plan to dismantle weapons and store plutonium in the wake of the end of the Cold War has attracted far less public attention than did the Pantex expansion proposal. There is little doubt, however, that most of those who opposed the expansion proposal will oppose the Pu storage plan. A possible exception is the Peace Farm, whose agenda is directly served by the arms reduction nature of this mission.

It is also likely that the economic appeal of the current mission will not attract the broad public support given the Pantex expansion proposal. The current mission is expected to add only about 150 jobs to the Pantex workforce, whereas the Pantex expansion involved a possible doubling, or more, of Pantex jobs. Given these factors, the current mission is likely to attract much less attention, either support or opposition, than was the case with the Pantex expansion proposal.

5.6 ASSESSMENT BASIS

A variety of informational resources have been drawn upon to assess public perceptions of the current mission.

- Discussions were held with community relations professionals associated with Pantex, and with Pantex managers and technical personnel.
- Media coverage of issues related to Pantex expansion and current mission plans has been analyzed by means of a clippings file of local print media over the past year.
- Semi-structured interviews were held with eight community leaders with backgrounds in business, law, medicine, education, religion, and the print media.

- Unstructured interviews were also held with a number of Amarillo residents encountered in restaurants and other service establishments.

- Data were acquired from three public surveys conducted in the Amarillo area in 1991.

- Pantex expansion news in national newsletter sources, such as the Weapons Complex Monitor, has been covered for the past year.

- Various other documents, such as the Pantex plant histories, position papers, SARs, and General Accounting Office reports, have been researched. The conclusions outlined in the next section are based on all these sources.

5.7 PUBLIC ACCEPTANCE ISSUES

Public acceptance of the Pantex mission of weapons disassembly and Pu storage can be viewed within a cost/benefit framework. In the preceding sections we discussed both benefits and public concerns in general terms. In this section we identify and assess the major public issues of concern.

5.7.1 Concern That Plutonium May Contaminate the Area Around Pantex

The Texas Panhandle is a farming and ranching area. Agriculture is a key part of the local economy. At the time of discussions about Pantex expansion there was concern raised by all opponents that somehow Pu would escape into the surrounding area and contaminate grain and livestock. A major part of the Pantex expansion proposal was to move at least some plutonium operations from Rocky Flats to Pantex, and there was public discussion, media attention, and a good deal of public testimony about the problems of offsite contamination at Rocky Flats. Although the current mission does not involve any of the operations that caused problems at Rocky Flats, the general public perceives a connection between Pu and offsite contamination. On the other hand, people who are somewhat knowledgeable about the Pu pit storage mission do not seem much concerned about this issue. However, most members of the public probably have some concerns about this issue even though they cannot articulate them clearly.

A similar issue is direct contamination of neighbors and concern for possible health effects. Again, knowledgeable observers do not give this

concern much credence. Yet, as noted above, there has been one well-publicized recent allegation that Pantex has been contaminating neighbors for years, with many associated cancer deaths.

Plutonium is widely understood to be a very dangerous substance. Media accounts frequently refer to it as "deadly," "highly toxic," or "poisonous." Several of the people interviewed referred to some sort of "rays" that might contaminate children in Amarillo. Such fears are quite unspecified and could probably be overcome by appropriate information and discussion. This kind of vague concern does not usually motivate people to determined opposition because the fear can usually be largely alleviated by information and discussion. Without such an effort, however, there will be a segment of the public that does not want anything to do with Pantex.

5.7.2 Concern That Plutonium Will Contaminate Groundwater

The Ogallala Aquifer is of critical importance to the whole area around Pantex. In interviewing residents, possible contamination of the Ogallala is mentioned by everyone. In fact, it is often the first concern mentioned. This issue figured prominently in the discussions during 1991 on Pantex expansion. However, when this concern was expressed, there was rarely any discussion of a possible mechanism causing the contamination. It was as though the sheer importance of preserving this natural resource made anything that threatened it a serious concern.

Several years ago, when the radioactive waste repository siting effort was under way nearby, concern for the Ogallala was the number one issue of public discussion. Regardless of the risk assessments there was a widespread public perception that over the long term the waste would surely escape and ruin the aquifer. This concern is not as strongly held with the current Pantex mission, as long as the Pu storage is understood to be only a temporary measure.

Pantex is judged by most residents of the area to have a good environmental record. One question in the May 1991 survey of 400 area residents was,

"Pantex has managed its environmental, safety, and health issues properly." Agree or disagree? Seventy-one percent agreed, while 12 percent disagreed. The rest (17%) were unsure.

Studies to date by public health officials have not shown Pantex to have caused deep groundwater pollution. However, given the great importance of the Ogallala there will always be a number of residents who will oppose Pantex operations even if no pollution mechanism appears likely.

5.7.3 Concern That Plutonium Storage at Pantex Might Become Permanent

The assumption behind the current mission is that Pu pit storage at Pantex is a temporary measure. This leaves open two questions: How long will Pu pits be stored at Pantex, and what will be done with them after the storage period at Pantex is finished? Neither question can be answered at present. This gives real substance to the concern that Pantex may become a de facto repository. This concern has been raised by the Texas Attorney General and has been mentioned in several local print media stories. It came up spontaneously in nearly all the interviews conducted. One community leader even predicted that Pantex would in fact become a permanent disposal site for Pu. The significance of this issue is threefold. First, the inability of the Department of Energy to detail its long range plans leaves open to speculation just what might happen. Some, who clearly mistrust the DOE, voice the suspicion that Pu "staging" is just a cynical ruse to turn Pantex into a radioactive waste repository.

Second, the issues of offsite contamination are associated with the length of proposed storage. More knowledgeable residents who understand that the Pu pits are in a solid metal form and will be stored in containers that are in secured areas will easily concede that environmental contamination is not likely. However, if the storage period is conceived to be permanent the concerns became much more serious.

A third implication of Pantex becoming a de facto repository is that the Amarillo area could become the object of social stigma. Critics of radioactive waste planning refer to prospective sites as "national sacrifice zones." As previously noted, Amarillo residents take pride in the

contribution the Pantex Plant has made to national defense. However, when it comes to the question of Pantex becoming the de facto repository for Pu, there would likely be few supporters.

One aspect of the social stigma issue is the concern that beef and grain from the area could be perceived as being tainted regardless of the facts. This is a case where perceived risk carries negative consequences even if the perception is not backed by fact. Similar issues have been raised in connection with wine grapes grown in the Hanford, Washington area and the possible stigma and resulting impact on tourism that could be attached to Las Vegas if the civilian high-level radioactive waste repository is situated nearby. The stigma issue does not seem to be the cause of great alarm at this time. It is mentioned rather as a "what if" issue. In fact, the larger issue of Pantex becoming a de facto repository is viewed as a rather unlikely, but nonetheless, serious potential outcome. If it could be addressed by a clear policy statement, the issue is likely to fade away for all but a few cynics.

5.7.4 Concern About Plutonium Release Scenarios

When area residents discuss the current mission they tend to separate cause and effect. The first two issues discussed above are contamination effects. Many people do not even think, unless explicitly asked, about how plutonium might escape containment and reach the biosphere. There are, however, a number of release scenarios mentioned by interviewees. In order of frequency of mention these are: 1) terrorism, 2) theft of Pu, 3) external accidents (an airplane crash into a storage area was the only one specifically mentioned), and 4) an internal accident.

Terrorism is named by about half the people interviewed as a concern for at least some of the public. No one gave any specifics of how terrorism could occur or what the consequences might be. When asked about terrorism or theft of Pu, most people responded by expressing confidence in the Pantex Plant security. They could not give many specifics, but the Pantex operation has the reputation in the area of being a very secure facility. Few people mentioned theft of Pu as a concern; theft did not seem to evoke the type of "dread" response reserved for contamination scenarios. Perhaps this is because there is no clearly perceived linkage between theft and local contamination.

Several respondents did mention external accidents, specifically, a plane crash into the facility. This accident was also mentioned in the newspaper in 1991 as the "maximum credible accident." One community leader linked terrorism and a plane crash by expressing concern about a suicide attack by crashing a plant into a storage bunker.

Internal accidents that could cause release of Pu were never mentioned in connection with the current mission, although this was a frequently discussed issue connected with the Pantex expansion proposal in 1991. As details of the current mission proposal become better known there could be some public concern over proposals for automated handling of Pu. In general, the public feels more secure knowing people have hands-on control of dangerous operations. The public has no doubt been influenced by the vision of the robot run amuck, a frequently used feature of horror fiction.

In general, the people who suggested and discussed release scenarios were somewhat more knowledgeable than was the average citizen about Pantex. The release scenarios were described as things some people worry about, but like the issue of Pantex becoming a de facto repository, there was not a lot of emotional energy attached to this set of issues.

5.7.5 Occupational Exposure and Worker Safety

There was very rarely any unprompted mention of this issue by interviewees, and little attention even in the press stories about the 1991 proposal to expand Pantex. Public risk perception usually operates according to a double standard as regards occupational hazards versus hazards to which the general public is exposed. That is, the public is usually much less concerned about occupational than about public exposure. The commonly held view of area residents, one reinforced by the 1991 survey data, is that Pantex has been a well-run operation from a safety standpoint. The current mission is understood by those knowledgeable about its general features to involve no new operations that might pose occupational safety or health problems. Interestingly, not a single informant raised the issue of radiation exposure. As nuclear operations go, the local public's image of Pantex is not much linked to radiation as a hazard.

5.7.6 Transportation, Land and Water Use, Air Quality, and Waste Generation

Limited attention has been given in this assessment to this list of "other issues." They are important determines of public acceptance in many instances, particularly the siting of new facilities. However, in connection with the weapons disassembly and plutonium storage mission they have attracted very little public attention.

Transportation of weapons and SNMs has been a common feature of the Pantex operation for many years. We found no mention of transportation incidents that caused public concern. Transportation, while it is in most cases a major issue with regard to the public acceptance of radioactive waste systems, did not seem to be an issue of public concern in the Amarillo area.

Land and water use issues were the subject of lively discussion in connection with the Pantex expansion proposal, but they have attracted little public mention in connection with the current mission.

Air quality, in connection with the burning of high explosives, has received some public attention. This is one of the issues the Attorney General has mentioned. There has been some discussion of siting an incinerator at Pantex. Incinerator siting, wherever it is proposed, usually attracts public attention. However, since Pantex air quality is monitored regularly and has been found to be in regulatory compliance by Texas state authorities, this issue does not seem serious.

The Texas Attorney General in a letter to the U.S. Secretary of Energy has asked that an environmental impact statement examine the effect the dismantling and storage program will have on the generation of low-level radioactive, mixed, and hazardous waste. However, there was no spontaneous mention of this issue from any of the respondents contacted. When the issue was raised, there was little interest. On balance it appears none of the "other issues" in the above list is generating much public interest at present in the Pantex area. However, if an environmental impact statement is judged to be necessary, it could stir up considerable controversy. These issues are also vulnerable to any occurrence that stimulates concern. A transportation accident, an air quality finding of violation of regulations, a controversy over

land acquisition, or any other issue that comes to public attention as a result of an unusual event will stimulate public concern.

5.8 PRELIMINARY CONCLUSIONS

Most of the information sources examined in this analysis are more relevant to the Pantex expansion proposal of 1991 than to the weapons dismantling and plutonium storage mission under examination. Except for the current interviews, the bulk of the information is also a year or more old. Interviewees were asked to estimate changes in public sentiment regarding Pantex over the past year since survey data were collected. The opinion was that there was either no change or perhaps a small change in the direction of even stronger support for Pantex in the spring of 1992 compared with a year earlier.

From the public perception standpoint, a significant positive factor is the contribution the proposed mission will make to arms reduction and the goal of international peace. A counter-balancing vulnerability of this mission is the greater attention the public now gives to environmental protection. The end of the Cold War has also removed some of the time urgency from Pantex operations. A delay in operations 20 years ago would have been viewed by the public as a threat to national security. A delay now is likely to be viewed as a slipped schedule in complying with the terms of treaties--not a major concern for most of the public.

While none of the issues we have assessed would appear to pose such severe public acceptance problems that the mission would be severely hampered, there are several important vulnerabilities. Perhaps the most troublesome is Issue 3, the concern that Pantex could become a de facto nuclear waste repository. This issue obviously interacts with Issues 1 and 2, the concerns about offsite contamination. In fact, the prospect of permanent storage casts most of the issues in a much more difficult form. In discussing this issue of long-term storage of Pu with interview respondents, the question was asked, "How long is too long?" Three choices were given: 3 to 5 years, 10 years, or 20 years. Most respondents said more that 3 to 5 years storage period would be unacceptable to the public. Several said 10 years would be a maximum. All agreed that a proposal to store Pu at Pantex for 20 years would not be

acceptable. Recognizing the significance of these views, it would seem very useful to public acceptance to make a policy statement that storage of Pu at Pantex is a temporary measure. The Texas Attorney General has stated his concerns much more forcefully, but for most of the public, assurances that the mission is safe and temporary would go far toward winning acceptance.

APPENDIX A

ESTIMATED EXPOSURES (DOSE RATES) TO WORKERS FROM VARIOUS SOURCES AND DISTANCES

APPENDIX A

ESTIMATED EXPOSURES (DOSE RATES) TO WORKERS FROM VARIOUS SOURCES AND DISTANCES

Dose rates for evaluating staging alternatives were prepared by Pantex Plant radiation safety personnel. Dose rates for current staging activities are based on measured "worst case" values. Dose rates for proposed staging alternatives are based on a combination of measured and calculated values and are conservative (i.e., based on weapon programs with the highest dose rates).

Observations and interviews with plant personnel indicate that lead aprons are used throughout the staging process (except where exposure is minimal). Various staging alternatives have therefore been based on personnel wearing lead aprons for all activities. Dose rates from various sources at various distances to personnel are summarized in Figures A.1 and A.2 for people both wearing and not wearing aprons. A comparison of the tables indicates that wearing lead aprons reduces gamma radiation exposure to personnel by approximately 66%. Since gamma radiation accounts for approximately two-thirds of the total exposure a person receives from a source, wearing lead aprons reduces the overall exposure to a source by approximately 50%. This is important when considering shielding characteristics of materials that could be used to enclose such devices as forklifts or drum-handling equipment.

The dose rate information shown in Figure A.1 has been combined with time and motion activity steps for each staging alternative to develop dose estimates of expected personnel exposure. These calculations, contained in the appendixes, are summarized in Chapter 2.0 for each alternative.

REFERENCE NUMBER	SOURCE OF EXPOSURE	CENTERLINE/ SURFACE			1 FOOT			6 FOOT			10 FOOT		
		N	Γ	Σ	N	Γ	Σ	N	Γ	Σ	N	Γ	Σ
U1	Pit in Drum	4	33	37	2	12	14	0.6	1.1	1.7	< .1	0.4	0.4
U2	5 - Pit Pallet	8	76	84	4.5	30	34.5	2.5	6.6	9.1	0.6	1.7	2.3
U3	4 Pit 2 Stack Pallet	7.2	48	55.2	4.6	14.5	19.1	1	2.5	3.5	0.3	0.7	1
U4	Forklift Driver	0.4	0.4	0.4									
U5	Zone 12 Vault	25	50	73									
U6	Zone 12 Vault Staging Area	12	16.6	26.6	2.5	3	5.5						
U7	Interior of Semi Trailer	5	35	40									
U8	Richmond Bldg. Apron	3.1	5.7	8.8	1.7	2.3	4	0.9	0.5	1.4	0.2	0.1	0.3
U9	Richmond Bldg (Current)	15.4	65	80									
U10	Richmond Bldg (Proposed)	30	160	190									
U11	SAC Igloo (Proposed)	35	210	245									

NOTE: All numbers represent mrem/hr exposures

FIGURE A.1. Estimated Dose Rates to Personnel Wearing Lead Apron Protection

REFERENCE NUMBER	SOURCE OF EXPOSURE	CENTERLINE/ SURFACE			1 FOOT			5 FOOT			10 FOOT		
		N	Γ	Σ	N	Γ	Σ	N	Γ	Σ	N	Γ	Σ
S1	Pit in Drum	4.0	12.2	16.2	2.0	4.4	6.4	0.6	0.4	1.0	< .1	0.1	0.1
S2	5 - Pit Pallet	8.0	28.1	36.1	4.5	11.1	15.6	2.5	2.4	4.9	0.6	0.6	1.2
S3	4 Pit 2 Stack Pallet	7.2	17.8	25.0	4.6	5.4	10.0	1.0	0.9	1.9	0.3	0.3	0.6
S4	Forklift Driver	0.4	0.4	0.8									
S5	Zone 12 Vault	25.0	22.0	47.0									
S6	Zone 12 Vault Staging Area	12.0	6.1	16.1	2.5	1.1	3.6						
S7	Interior of Semi Trailer	5.0	15.4	20.4									
S8	Richmond Bldg Apron	3.1	2.1	5.2	1.7	0.9	2.6	0.9	0.2	1.1	0.2	< .1	0.2
S9	Richmond Bldg (Current)	20.0	26.6	48.6									
S10	Richmond Bldg (Proposed)	30.0	70.4	100.4									
S11	SAC Igloo (Proposed)	35.0	92.4	127.4									

NOTE: All numbers represent mrem/hr exposures

FIGURE A.2. Estimated Dose Rates to Personnel Wearing No Lead Apron Protection

APPENDIX B

CURRENT STAGING METHOD TIME/DOSE/MOTION SUMMARY

Cell to Zone 12 Vault Transfer - Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem/ (Pallet)	Current Units	Desired Units (Pallet)	Conversion Factor
1.0 Palletize in cell	2 mh	6.00	**12.00**	1	6.4	S1	**1.3**	pallet	pallet	1
2.0 Forklift to 12-26 vault	1 dr	5.00	**5.00**	Forklift	0.8	S4	**0.1**	pallet	pallet	1
	1 obs	5.00	**5.00**	10	1.2	S2	**0.1**	pallet	pallet	1
3.0 Compare serial nos. TIDs to paperwork	1 mh	6.00	**6.00**	1	15.6	S2	**1.6**	pallet	pallet	1
4.0 Unstrap Pallet	2 mh	2.00	**4.00**	Vault Staging	18.1	S6	**1.2**	pallet	pallet	1
5.0 Load Vault	1 worker	1.66	**1.66**	Vault	47	S5	**1.3**	pallet	pallet	1

Total Labor Hours: **0.56 hr/pallet**

Total Dose accumulated: **5.51 person-mrem/pallet**

Zone 12 Vault to Trailer Transfer - Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose (p-mrem)	Current Units	Desired Units (Pallet)	Conversion Factor
6.0 Prepare for vault/trailer transfer:										
Pers access log	1 ps	1	0.13	N/A				Load	Pallet	1/8
wait on pallets	1 ps	10	1.25	N/A				Load	Pallet	1/8
into lead aprons	12 w	2	3.00	N/A				Load	Pallet	1/8
unlock door	2 w	2	0.50	N/A				Load	Pallet	1/8
security/open	1 ps	1	0.13	N/A				Load	Pallet	1/8
7.0 Remove 5 pits and palletize:										
roll drums out	1 wh	1.66	1.66	Vault	47	S5	1.3	Pallet	Pallet	1
comp serial nos, TIDs to paperwork	1 clerk	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
	1 wh	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
	1 snm	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
palletize 5 pits	2 mh	1	2.00	Vault Staging	18.1	S6	0.6	Pallet	Pallet	1
strap down pits	2 mh	4	8.00	Vault Staging	18.1	S6	2.4	Pallet	Pallet	1
8.0 Transport by forklift to trailer	1 dr	2.5	2.50	Forklift	0.8	S4	0.0	Pallet	Pallet	1
9.0 tiedown pallet within trailer	2 trans	2.5	5.00	Trailer	20.4	S7	1.7	Pallet	Pallet	1

Total Labor Hours per Pallet: 0.55 hr/pallet
Total Dose accumulated: 8.77 person mrem/pallet

Trailer to Richmond Igloo Using Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.13	N/A				load	pallet	1/8
unlock igloo	1 sec	1	0.13	N/A				load	pallet	1/8
11.0 Untie pallet trailer tie downs	2 supervisors	0.4	0.80	Trailer	20.4	S7	0.3	pallet	pallet	1
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.50	Forklift	0.8	S4	0.0	pallet	pallet	1
move pallet to igloo apron	1 driver	1	1.00	Forklift	0.8	S4	0.0	pallet	pallet	1
	1 mh	1	1.00	1	15.6	S2	0.3	pallet	pallet	1
unstrap pallet	2 mh	1.5	3.00	1	15.6	S2	0.8	pallet	pallet	1
roll 5 pits in	2 mh	1	2.00	in igloo	48.6	S9	1.6	pallet	pallet	1
remove pallet	1 driver	0.5	0.50	10	0.2	S8	0.0	pallet	pallet	1
coil straps	2 mh	0.5	1.00	10	0.2	S8	0.0	pallet	pallet	1
replace pink bar codes on drums	1 trans	16	2.00	in igloo	48.6	S9	1.6	load	pallet	1/8
13.0 Radiation Safety Survey:	2 rad	10	2.50	in igloo	48.6	S9	2.0	load	pallet	1/8
14.0 Close up Richmond Building:										
load pallets and straps	1 trans	2	0.25	N/A				load	pallet	1/8
lock doors	1 trans	7	0.88	N/A				load	pallet	1/8

Total Labor Hours: 0.26 hr/pallet
Total Dose accumulated: 6.60 person mrem/pallet

Richmond Fit Inventory - Manual

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pit)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pit)	Current Units	Desired Units (pit)	Conversion Factor
14.0 Read barcodes, compare serial nos, TIDs to paperwork	2 workers	0.33	0.66	In Igloo	48.6	S9	0.5	pit	pit	1

Total Labor Hours: 0.01 hr/pit
Total Dose accumulated: 0.53 person mrem/pit

APPENDIX C

NEW PALLET DESIGN TIME/DOSE/MOTION SUMMARY
NO FORKLIFT SHIELDING

Cell to Zone 12 Vauot Transfer - Current Pallets

Activity	Number/Type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem/ (Pallet)	Current Units	Desired Units (Pallet)	Conversion Factor
1.0 Palletize in cell	2 mh	6.00	**12.00**	1	6.4	S1	**1.9**	pallet	pallet	1
2.0 Forklift to 12-26 vault	1 dr	5.00	**5.00**	Forklift	0.8	S4	**0.1**	pallet	pallet	1
	1 obs	5.00	**5.00**	10	1.2	S2	**0.1**	pallet	pallet	1
3.0 Compare serial nos, TlDs to paperwork	1 mh	6.00	**6.00**	1	15.6	S2	**1.8**	pallet	pallet	1
4.0 Unstrap Pallet	2 mh	2.00	**4.00**	Vault Staging	18.1	S6	**1.2**	pallet	pallet	1
5.0 Load Vault	1 worker	1.66	**1.66**	Vault	47	S5	**1.9**	pallet	pallet	1

Total Labor Hours: **0.56 hr/pallet**

Total Dose accumulated: **5.51 person-mrem/pallet**

Zone 12 Vault to Trailer Transfer - New Pallet Configuration

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose (p-mrem)	Current Units	Desired Units (Pallet)	Conversion Factor
6.0 Prepare for vault/trailer transfer:										
Pers. access log	1 ps	1	0.10	N/A				Load	Pallet	1/10
wait on pallets	1 ps	10	1.00	N/A				Load	Pallet	1/10
into lead aprons	12 w	2	2.40	N/A				Load	Pallet	1/10
unlock door	2 w	2	0.40	N/A				Load	Pallet	1/10
security/open	1 ps	1	0.10	N/A				Load	Pallet	1/10
7.0 Remove 4 pits and palletize:										
roll drums out	1 wh	1.33	1.33	Vault	47	S5	1.0	Pallet	Pallet	1
comp. serial nos. TIDs to paperwork	1 clerk	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
	1 wh	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
	1 snm	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
palletize 4 pits	2 mh	0.8	1.60	Vault Staging	18.1	S6	0.5	Pallet	Pallet	1
strap down pits	2 mh	1.6	3.20	Vault Staging	18.1	S6	1.0	Pallet	Pallet	1
8.0 Transport by forklift to trailer	1 dr	2.5	2.50	Forklift	0.8	S4	0.0	Pallet	Pallet	1
9.0 tiedown pallet within trailer	2 trans	2.5	5.00	Trailer	20.4	S7	1.7	Pallet	Pallet	1

Total Labor Hours per Pallet: 0.31 hr/pallet
Total Dose accumulated: 4.46 person mrem/pallet

Trailer to Richmond Igloo - New Pallet Configuration Using Unshielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.10	N/A				load	pallet	1/10
unlock igloo	1 sec	1	0.10	N/A				load	pallet	1/10
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.80	Trailer	20.4	S7	0.3	pallet	pallet	1
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.50	Forklift	0.8	S4	0.0	pallet	pallet	1
move pallet to igloo apron	1 driver	1	1.00	Forklift	0.8	S4	0.0	pallet	pallet	1
	1 mh	1	1.00	1	10	S3	0.2	pallet	pallet	1
place pallet in igloo	1 driver	2.33	2.33	In Igloo	100.4	S10	3.9	pallet	pallet	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.70	N/A				load	pallet	1/10

Total Labor Hours: 0.11 hr/pallet
Total Dose accumulated: 4.36 person mrem/pallet

Trailer to SAC Igloo - New Pallet Configuration Using Unshielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.10	N/A				load	pallet	1/10
unlock igloo	1 sec	1	0.10	N/A				load	pallet	1/10
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.80	Trailer	20.4	S7	0.3	pallet	pallet	1
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.50	Forklift	0.8	S4	0.0	pallet	pallet	1
move pallet to igloo apron	1 driver	1	1.00	Forklift	0.8	S4	0.0	pallet	pallet	1
	1 mh	1	1.00	1	10	S3	0.2	pallet	pallet	1
place pallet in igloo	1 driver	2.33	2.33	In Igloo	127.4	S11	4.9	pallet	pallet	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.70	N/A				load	pallet	1/10

Total Labor Hours: 0.11 hr/pallet
Total Dose accumulated: 5.41 person mrem/pallet

Richmond Pit Inventory - New Pallet Configuration Using Unshielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (side)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (side)	Current Units	Desired Units (side)	Conversion Factor
14.0 Forklift reads barcodes going 40 ft four times at .5 ft/sec	1 driver	5.33	5.33	In igloo	100.4	S10	8.9	side	side	1

Total Labor Hours: 0.09 hr/side

Total Dose accumulated: 8.92 person mrem/side

Richmond Re-palletization of Drums to New Pallets Using Unshielded Drum Handling Equipment

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
14.0 Use drum handling equipment										
to unload igloo	1 driver	3	3.00	In Igloo	48.6	S9	2.4	pallet	pallet	1
15.0 Palleuze										
put 4 pits to a pallet	1 driver	2	2.00	Forklift	0.6	S4	0.0	pallet	pallet	1
strap down pits	2 mh	1.6	3.20	1	10	S3	0.5	pallet	pallet	1

Total Labor Hours: 0.14 hr/pallet

Total Dose accumulated: 2.99 person mrem/pallet

Richmond Manual Re-palletization of Drums to New Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
14.0 Roll drums out onto apron	4 workers	1	4.00	in igloo	48.6	S9	3.2	pallet	pallet	1
15.0 Palletize:										
put 4 pits to a pallet	2 worker	0.8	1.60	1	6.4	S1	0.2	pallet	pallet	1
strap down pits	2 mh	1.6	3.20	1	10	S3	0.5	pallet	pallet	1

To.al Labor Hours: 0.15 hr/pallet
Total Dose accumulated: 3.94 person mrem/pallet

APPENDIX D

NEW PALLET DESIGN TIME/DOSE/MOTION SUMMARY
FORKLIFT SHIELDING

Cell to Zone 12 Vault Transfer - Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem/ (Pallet)	Current Units	Desired Units (Pallet)	Conversion Factor
1.0 Palletize in cell	2 mh	6.00	12.00	1	6.4	S1	1.3	pallet	pallet	1
2.0 Forklift to 12-26 vault	1 dr	5.00	5.00	Forklift	0.8	S4	0.1	pallet	pallet	1
	1 obs	5.00	5.00	10	1.2	S2	0.1	pallet	pallet	1
3.0 Compare serial nos. TIDs to paperwork	1 mh	6.00	6.00	1	15.6	S2	1.6	pallet	pallet	1
4.0 Unstrap Pallet	2 mh	2.00	4.00	Vault Staging	18.1	S6	1.2	pallet	pallet	1
5.0 Load Vault	1 worker	1.66	1.66	Vault	47	S5	1.3	pallet	pallet	1

Total Labor Hours: **0.56 hr/pallet**

Total Dose accumulated: **5.51 person-mrem/pallet**

Zone 12 Vault to Trailer Transfer - New Pallet Configuration

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose (p-mrem)	Current Units	Desired Units (Pallet)	Conversion Factor
6.0 Prepare for vault/trailer transfer:										
Pers. access log	1 ps	1	0.10	N/A				Load	Pallet	1/10
wait on pallets	1 ps	10	1.00	N/A				Load	Pallet	1/10
into lead aprons	12 w	2	2.40	N/A				Load	Pallet	1/10
unlock door	2 w	2	0.40	N/A				Load	Pallet	1/10
security/open	1 ps	1	0.10	N/A				Load	Pallet	1/10
7.0 Remove 4 pits and palletize:										
roll drums out	1 wh	1.33	1.33	Vault	47	S5	1.0	Pallet	Pallet	1
comp. serial nos. TIDs to paperwork	1 clerk	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
	1 wh	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
	1 snm	0.26	0.26	Vault Staging	18.1	S6	0.1	Pallet	Pallet	1
palletize 4 pits	2 mh	0.8	1.60	Vault Staging	18.1	S6	0.5	Pallet	Pallet	1
strap down pits	2 mh	1.6	3.20	Vault Staging	18.1	S6	1.0	Pallet	Pallet	1
8.0 Transport by forklift to trailer	1 dr	2.5	2.50	Forklift	0.8	S4	0.0	Pallet	Pallet	1
9.0 bedown pallet within trailer	2 trans	2.5	5.00	Trailer	20.4	S7	1.7	Pallet	Pallet	1

Total Labor Hours per Pallet: 0.31 hr/pallet
Total Dose accumulated: 4.46 person mrem/pallet

Trailer to Richmond Igloo - New Pallet Configuration Using Shielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.10	N/A				load	pallet	1/10
unlock igloo	1 sec	1	0.10	N/A				load	pallet	1/10
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.80	Trailer	20.4	S7	0.3	pallet	pallet	1
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.50	Forklift	0.8	S4	0.0	pallet	pallet	1
move pallet to igloo apron	1 driver	1	1.00	Forklift	0.8	S4	0.0	pallet	pallet	1
	1 mh	1	1.00	1	10	S3	0.2	pallet	pallet	1
place pallet in igloo	1 mh	2.33	2.33	In Igloo	12.6	S10/8	0.5	pallet	pallet	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.70	N/A				load	pallet	1/10

Total Labor Hours: 0.11 hr/pallet

Total Dose accumulated: 0.95 person mrem/pallet

Trailer to SAC Igloo - New Pallet Configuration Using Shielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pallet)	Current Units	Desired Units (pallet)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.10	N/A				load	pallet	1/10
unlock igloo	1 sec	1	0.10	N/A				load	pallet	1/10
11.0 Untie pallet trailer tie downs	2 supervisors	0.4	0.80	Trailer	20.4	S7	0.3	pallet	pallet	1
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.50	Forklift	0.8	S4	0.0	pallet	pallet	1
move pallet to igloo apron	1 driver	1	1.00	Forklift	0.8	S4	0.0	pallet	pallet	1
	1 mh	1	1.00	1	10	S3	0.2	pallet	pallet	1
place pallet in igloo	1 driver	2.33	2.33	In Igloo	15.9	S11/8	0.6	pallet	pallet	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.70	N/A				load	pallet	1/10

Total Labor Hours: 0.11 hr/pallet
Total Dose accumulated: 1.08 person mrem/pallet

Richmond Pit Inventory - New Pallet Configuration Using Shielded Forklift

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (side)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (side)	Current Units	Desired Units (side)	Conversion Factor
14.0 Forklift reads barcodes going 40 ft. four times at .5 ft/sec	1 driver	5.33	5.33	In igloo	1[illegible].6	S10/8	1.1	side	side	1

Total Labor Hours: 0.09 hr/side

Total Dose accumulated: 1.12 person mrem/side

Cell to Zone 12 Vault Transfer - Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem/ (Pallet)	Current Units	Desired Units (Pallet)	Conversion Factor
1.0 Palletize in cell	2 mh	6.00	**12.00**	1	6.4	S1	**1.3**	pallet	pallet	1
2.0 Forklift to 12-26 vault	1 dr	5.00	**5.00**	Forklift	0.8	S4	**0.1**	pallet	pallet	1
	1 obs	5.00	**5.00**	10	1.2	S2	**0.1**	pallet	pallet	1
3.0 Compare serial nos. TIDs to paperwork	1 mh	6.00	**6.00**	1	15.6	S2	**1.6**	pallet	pallet	1
4.0 Unstrap Pallet	1 mh	2.00	**2.00**	Vault Staging	18.1	S6	**0.6**	pallet	pallet	1
5.0 Load Vault	1 worker	1.66	**1.66**	Vault	47	S5	**1.3**	pallet	pallet	1

Total Labor Hours: **0.53 hr/pallet**
Total Dose accumulated: **4.91 person-mrem/pallet**

APPENDIX E

STACKED DRUM SCENARIO WITH NO PALLETS TIME/DOSE/MOTION SUMMARY

Zone 12 Vault to Trailer Transfer - Current Pallets

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (min) (Pallet)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose (p-mrem)	Current Units	Desired Units (Pallet)	Conversion Factor
6.0 Prepare for vault/trailer transfer:										
Pers access log	1 ps	1	0.13	N/A				Load	Pallet	1/8
wait on pallets	1 ps	10	1.25	N/A				Load	Pallet	1/8
into lead aprons	12 w	2	3.00	N/A				Load	Pallet	1/8
unlock door	2 w	2	0.50	N/A				Load	Pallet	1/8
security/open	1 ps	1	0.13	N/A				Load	Pallet	1/8
7.0 Remove 5 pits and palletize:										
roll drums out	1 wh	1.66	1.66	Vault	47	S5	1.3	Pallet	Pallet	1
comp serial nos, TIDs to paperwork	1 clerk	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
	1 wh	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
	1 snm	3	3.00	Vault Staging	18.1	S6	0.9	Pallet	Pallet	1
palletize 5 pits	2 mh	1	2.00	Vault Staging	18.1	S6	0.6	Pallet	Pallet	1
strap down pits	2 mh	4	8.00	Vault Staging	18.1	S6	2.4	Pallet	Pallet	1
8.0 Transport by forklift to trailer	1 dr	2.5	2.50	Forklift	0.8	S4	0.0	Pallet	Pallet	1
9.0 tiedown pallet within trailer	2 trans	2.5	5.00	Trailer	20.4	S7	1.7	Pallet	Pallet	1

Total Labor Hours per Pallet: 0.55 hr/pallet
Total Dose accumulated: 8.77 person mrem/pallet

Trailer to Richmond Igloo - No Pallets in Igloo Using Unshielded Drum Handling Equipment

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pit)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pit)	Current Units	Desired Units (pit)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.03	N/A				load	pit	1/40
unlock igloo	1 sec	1	0.03	N/A				load	pit	1/40
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.16	Trailer	20.4	S7	0.1	pallet	pit	1/5
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.10	Forklift	0.8	S4	0.0	pallet	pit	1/5
move pallet to igloo apron	1 driver	1	0.20	Forklift	0.8	S4	0.0	pallet	pit	1/5
	1 mh	1	0.20	1	10	S3	0.0	pallet	pit	1/5
unstrap pallet	2 mh	1.5	0.60	1	15.6	S2	0.2	pallet	pit	1/5
place drum in igloo	1 mh	2	2.00	In Igloo	100.4	S10	3.3	pit	pit	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.18	N/A				load	pit	1/40

Total Labor Hours: 0.06 hr/pit
Total Dose accumulated: 3.59 person mrem/pit

Trailer to SAC Igloo - No Pallets in Igloo Using Unshielded Drum Handling Equipment

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pit)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pit)	Current Units	Desired Units (pit)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.03	N/A				load	pit	1/40
unlock igloo	1 sec	1	0.03	N/A				load	pit	1/40
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.16	Trailer	20.4	S7	0.1	pallet	pit	1/5
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.10	Forklift	0.8	S4	0.0	pallet	pit	1/5
move pallet to igloo apron	1 driver	1	0.20	Forklift	0.8	S4	0.0	pallet	pit	1/5
	1 mh	1	0.20	1	10	S3	0.0	pallet	pit	1/5
unstrap pallet	2 mh	1.5	0.60	1	15.6	S2	0.2	pallet	pit	1/5
place drum in igloo	1 driver	2	2.00	In Igloo	127.4	S11	4.2	pit	pit	1
15.0 Close up Richmond Building:										
lock doors	1 trans	7	0.18	N/A				load	pit	1/40

Total Labor Hours: 0.06 hr/pit
Total Dose accumulated: 4.49 person mrem/pit

Trailer to Richmond Igloo - No Pallets in Igloo Using Shielded Drum Handling Equipment

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pit)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pit)	Current Units	Desired Units (pit)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.03	N/A				load	pit	1/40
unlock igloo	1 sec	1	0.03	N/A				load	pit	1/40
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.16	Trailer	20.4	S7	0.1	pallet	pit	1/5
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.10	Forklift	0.8	S4	0.0	pallet	pit	1/5
move pallet to igloo apron	1 driver	1	0.20	Forklift	0.8	S4	0.0	pallet	pit	1/5
	1 mh	1	0.20	1	10	S3	0.0	pallet	pit	1/5
unstrap pallet	2 mh	1.5	0.60	1	15.6	S2	0.2	pallet	pit	1/5
place drum in igloo	1 mh	2	2.00	In Igloo	12.6	S10	0.4	pit	pit	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.18	N/A				load	pit	1/40

Total Labor Hours: 0.06 hr/pit

Total Dose accumulated: 0.67 person mrem/pit

Trailer to SAC Igloo - No Pallets in Igloo Using Shielded Drum Handling Equipment

Activity	Number/type of Workers	Activity Time (min)	Total Act. Time (pit)	Distance From Source	Dose Rate (mrem/hr)	Reference	Total Dose p-mrem (pit)	Current Units	Desired Units (pit)	Conversion Factor
10.0 Prepare for trailer - igloo transfer:										
open trailer	1 trans	1	0.03	N/A				load	pit	1/40
unlock igloo	1 sec	1	0.03	N/A				load	pit	1/40
11.0 Untie pallet trailer tie-downs	2 supervisors	0.4	0.16	Trailer	20.4	S7	0.1	pallet	pit	1/5
12.0 Load pits into Richmond Building:										
move pallet to float trailer	1 driver	0.5	0.10	Forklift	0.8	S4	0.0	pallet	pit	1/5
move pallet to igloo apron	1 driver	1	0.20	Forklift	0.8	S4	0.0	pallet	pit	1/5
	1 mh	1	0.20	1	10	S3	0.0	pallet	pit	1/5
unstrap pallet	2 mh	1.5	0.60	1	15.6	S2	0.2	pallet	pit	1/5
place drum in igloo	1 driver	2	2.00	In Igloo	15.9	S11	0.5	pit	pit	1
13.0 Close up Richmond Building:										
lock doors	1 trans	7	0.18	N/A				load	pit	1/40

Total Labor Hours: 0.06 hr/pit
Total Dose accumulated: 0.78 person mrem/pit

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