INEL-95/0619

September 1995

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R. Bannister
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Evaluation of Retrieval Activities and Equipment for Removal of Containers from the Transuranic Storage Area Retrieval Enclosure

**R. Bannister
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Published September 1995

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**Prepared for Lockheed Idaho Technologies Company
Under Subcontract No. C95-175553
and for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-94ID13223**

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	TITLE RETRIEVAL EVALUATION REPORT		Rev. 0 Date: September 5, 1995
SIGN-OFF SHEET			
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EXECUTIVE SUMMARY

1. Evaluation of the retrieval methodology and equipment is based on an information package which included documents, dated between 1990 and 1995, provided by LITCO. The methodology described referred mainly to retrieval of containers from Pad R, which is where contamination is known to exist. The methodology for the retrieval of containers which are contaminated, damaged or structurally unsound, is not described in any detail.
2. As required by the contract, this report includes an assessment of the methodology and equipment, as described in the documentation provided, for the normal and abnormal retrieval of containers. In addition, where the supplied documentation is lacking in detail, a methodology has been developed to provide a more comprehensive description of the retrieval methodology and equipment.
3. The main conclusions and recommendations identified are:
 - The retrieval strategy should be based on the removal of containers from areas with the least potential for contamination first and those from areas with the most potential for contamination last.
 - The excavator is over-utilized and retrieval operations are dependant on it for virtually all activities, including overburden removal and the handling of all types of containers. Other equipment should be specified to perform some of the operations or be available in the event of unscheduled maintenance being required on the excavator or its end effectors.
 - The excavator is considered unsuitable for removal of overburden due to the limited viewing capability and the potential for container damage by the arm. It is considered that the top surface of the stored containers will not be level. A small Bobcat type excavator has been recommended for this operation which will provide a more controlled removal of the overburden.
 - The Isolation Unit specified is too costly and lacks the flexibility for removal of contaminated and damaged containers under all the potential scenarios which include location, type of container, extent of contamination, etc. It is recommended that a temporary enclosure should be erected around any contaminated soil or containers during the removal operation. The enclosure should preferably be an engineered modular construction which can be easily decontaminated and re-used.
 - The dump trailer or container transport should not be brought into the retrieval enclosure due to the potential for the spread of contamination to the outside and the difficulty in decontaminating the trailer. Containers should be surveyed, monitored and bar coded within the RE before being transferred to the trailer in the airlock area attached to the building.

- The drum grab attachment has the potential for puncturing or crushing the drum during the retrieval operation. It also prevents inspection of much of the drum surface. A grapple, attached to a crane hook, which lifts drums from the top rim is recommended to replace the grab. This will enable drums to be visually inspected while on the crane hook, rotation on the hook will also enable complete access to the surface of drums. The crane hook for the grapple can either be suspended from a crane or excavator/forklift attachment.
 - Consideration should be given to adapting the cranes which are currently identified for shroud relocation only. This would be preferable for handling a drum grapple and would further reduce dependency on the excavator.
 - It is recommended that the sideburden is removed using the Mobile Vacuum System. This will provide a controlled method of soil removal which can keep pace with the retrieval of containers. It is considered advantageous to retain sideburden for the support of containers for as long as possible.
 - Removal of contaminated soil or containers should be performed within a temporary enclosure
4. The level of detail provided in the report is dictated by the information available at the present time. Further investigation will determine more precisely, the extent and location of contamination, condition of the drums, radiation source term, anticipated dose exposure and throughput. This definition will determine which of the methods and equipment will be appropriate for retrieval operations, in both normal and off normal situations.

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ACRONYMS AND DEFINITIONS

Acronyms:

ALARA	As Low As Reasonably Achievable
CAM	Continuous Air Monitor
CH	Contact Handled
DE	Drum Equivalent
DOE	Department of Energy
LLW	Low Level Waste
MLLW	Mixed Low Level Waste
RADCON	Radiation Control
RAM	Radiation Area Monitor
RCRA	Resource Conservation Recovery Act
RE	Retrieval Enclosure
TRU	Transuranic
TSA	Transuranic Storage Area
WAMAC	Waste Monitoring and Compaction
WIPP	Waste Isolation Pilot Plant
WPEP	Waste Packaging and Encapsulation Plant
WRAP	Waste Receiving and Processing
WTC	Waste Treatment Complex

Definitions:

Bobcat

A common brand name of small tractors. Used here to describe a small front loading excavator used for soil removal.

Drum Grab

Term used to describe a type of drum lifting device that lifts the drum by applying a 'grabbing' force around the body of the drum.

Drum Grapple

Term used to describe a type of drum lifting device that lifts the drum by applying 2 - 4 (normal) opposing forces around the clamp ring of the drum.

Containers

Generic term used throughout the report to include drums, boxes and cargo containers.

1.0 INTRODUCTION

1.1 Overview

A number of reports have been supplied to BNFL Inc. for review and comment describing the methodology and equipment proposed by LITCO for retrieval of drums and boxes from a storage facility at the INEL site. The contract for this review requires two main issues to be addressed. First, the adequacy of equipment and methodology for the retrieval of containers which have been breached, lost structural integrity, or are otherwise damaged. Second, to review the strategies and equipment for retrieval of intact waste containers. These issues are presented in the following report along with additional detail in the methodology to complete the description of the operations required for retrieval under most operational scenarios.

The documentation reviewed is considered to be at an interim stage and is therefore expected to be subject to the development of the methodology from the existing level of detail with input from the facility operators. This review aims to anticipate some of this development by providing suggested detailed methods of retrieval and equipment for both normal and abnormal operations.

1.2 Background

Since 1970, the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering Laboratory (INEL) has accepted over 55,000 cubic meters of Transuranic contaminated hazardous waste for interim storage. The waste has been neatly stored in "cell" configurations on adjoining, above ground asphalt pads at the Transuranic Storage Area (TSA). There are eight cells in TSA Pad 1, three cells in TSA Pad 2, and three cells in TSA Pad R. **Table 1** shows the types and numbers of containers located in the three Pads (1, 2 and R).

The waste containers were topped with wood and polyvinyl (geofabric) sheeting followed by a minimum of 2ft of soil cover above the highest container of the cell. Soil over some of the containers may exceed 4ft. Sideburden soil was added to reduce the grade angle. The depths of the sideburden soil average 16ft at the edge of the stored waste containers. There is a potential that a breach of waste containers has occurred with the possibility for contaminant migration into the overburden/sideburden soil. The underlying soil is protected by asphalt pads. To date, no indications of any contamination have been detected from containers in the cell areas overlain by soil. However, a spill of transuranic contaminated material from a container(s) stored on TSA-R is known to exist.

To facilitate retrieval operations a fully engineered enclosure is being constructed (See **Figure 1**). The enclosure will encompass the storage pads to allow the safe removal of the stored wastes. When completed, the structure will be 1,200ft long (north - south) and 200ft wide (east - west) with an attached wing approximately 425ft long (north - south) and 185 ft wide (east - west) which will enclose Pad 2. Two movable shrouds within the building will be erected to isolate the retrieval operations work area and to provide a temperature-controlled environment.

The retrieved waste containers will be transported to the newly constructed Waste Storage Facility nearby. At present, seven of the Waste Storage Facility buildings have been constructed. Storage of containers in compliance with RCRA will be achieved within the buildings.

1.3 BNFL Experience

BNFL have experience in design, construction and operation of projects both in the US and UK, which are similar to the retrieval operations proposed described by LITCO in the referenced documentation. This experience includes the handling of plutonium contaminated waste, container handling, retrieval operations, waste repackaging and decontamination.

The lessons learned from this experience is applied to the evaluation of the retrieval strategy. The main lessons learned from this experience are:

- Planning of the strategy in advance is the most cost effective way of avoiding problems and costly delays during the operational phase of the project.
- A HAZOP type review of the methods and equipment proposed ensure that detailed safety and operability issues are resolved at the design stage.

It is BNFLs experience, from actual retrieval operations, that failure to identify and resolve these issues at the design stage results in major additional costs and disruption during the operational phase of the project.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions

1. The evaluation of the LITCO methodology and equipment for the retrieval of containers provides a sound basis on which the operating procedures can be established.
2. The overall retrieval strategy should not include removal of containers from the contaminated Pad R before containers have been removed from clean Pads 1 & 2. This could lead to a the spread of contamination to clean areas of the facility.
3. The excavator is over-utilized, particularly in Pads 1 & 2, where it is proposed to be used for both overburden removal and container retrieval operations.
4. Bulk overburden should not be removed using the excavator. This has a high potential for damage of the containers due to the position of the end effector and the limited viewing capability of the operator.
5. The dump trailer should not be allowed into the retrieval enclosure due to the potential for spread of contamination to the outside of the building and the need to

decontaminate the vehicle if it became contaminated.

6. The drum grab attachment to the excavator has a potential for crushing and puncturing drums during the retrieval operation. It also prevents access to the drum for adequate inspection due to the arms of the grab covering the drum around the center section.
7. The Isolation Unit is too costly and will probably be ineffective in reducing both the spread of contamination and worker dose exposure. The scenarios for the retrieval of contaminated containers must take account of the location of the containers and the potential for contamination of the surrounding area. This requires the retrieval method to be flexible in size and construction to meet the specific needs of the situation. The Isolation Unit is not sufficiently flexible to meet these requirements.

2.2 Recommendations

The following recommendations are made based on the current level of knowledge of the facility, waste storage configurations and methodology. The methodology and equipment is partly described in the supplied information and partly on the additional methodology provided by BNFL in the report.

1. The retrieval strategy should follow the principle of removal of the least contaminated areas first and the most contaminated areas last.
2. The use of a small 'Bobcat' type excavator is recommended for the clean bulk overburden removal. This should be used in conjunction with a conveyor for transferring the excavated soil from a central location in the shrouded area to the dump trailer outside the RE building. This depth of the overburden should be regularly checked by holes manually made in the overburden soil to establish the tops of the containers at various locations within the removal area.
3. It is recommended that clean side burden be removed using the Mobile Vacuum System. The vehicle will be parked outside the building, only the vacuum hose will penetrate the RE wall. This provides a controlled method of soil removal at a rate which allows the soil to remain in place to support the sides of the container stack until the next row of containers are ready for removal.
4. Small areas of contaminated soil should be enclosed by an isolation structure before the removal operations commence. This will prevent the further spread of contamination.
5. Containers should be checked for contamination immediately before transfer from the RE to prevent the spread of contamination. The location for the contamination check should also be used for application of the barcode. This would be done immediately after the container was verified as clean.
6. An investigation should be made into the practicality of achieving a stagger of the

containers during the retrieval procedure. This will be dependant on the available access and reach of the retrieval equipment specified. The stagger will limit the damage from a container dropped from the upper tiers.

7. Vertical drums should be handled using a grapple, lifting from the top rim of the drum, rather than a grab, which clamps the sides of the drum. Horizontal drums should be removed using a fork attachment on the excavator to lower to the asphalt level. The drum should be lowered into a cradle which would rotate the drum to the vertical position where it can be handled by the grapple.
8. The Isolation Unit should be replaced by a temporary confinement system. This could be an ad-hoc system of plastic sheeting over a support frame, however an engineered solution would be preferable. A re-usable modular system is recommended which can be easily decontaminated using strippable coatings on the internal surfaces.
9. Additional equipment should be considered for the retrieval operations to decrease the utilization of the excavator. Dependence on the excavator will result in interruption in retrieval operations if the excavator or its end effectors require unscheduled maintenance.
10. It is strongly recommended that further investigation and planning work should be carried out to accurately determine the methodology and specification of appropriate equipment. These investigations should include the topics identified in Section 6.0 of this report, i.e.;
 - Source Term
 - Radiation Safety
 - Extent of Contamination in Pad R
 - Detailed Block Flow Diagram
 - Time and Motion Study

Time spent on these activities at the design stage will be invaluable for;

- selecting suitable equipment
- assessing worker dose exposure
- determining throughput
- identifying retrieval bottlenecks
- anticipating operational and design problems
- determining an economic methodology

Determination of these items before the start of retrieval operations will help in avoiding costly changes during the operational phase of the project.

3.0 BASIS FOR REPORT

3.1 Scope

The scope of this report is to review project documentation made available by LITCO and to provide an assessment of the adequacy of the strategies, equipment and building systems proposed for the normal retrieval of waste containers and for the retrieval of containers which are breached, have lost structural integrity or are otherwise damaged. The areas assessed in this report include:

A. Methodology:

- Soil Removal
- Vertically Stacked Drum Retrieval
- Horizontally Stacked Drum Retrieval
- Box Retrieval
- Cargo Container Retrieval

B. Equipment:

- Retrieval Enclosure (RE)
- Excavator
- Fork Trucks
- Vacuum Systems
- Man Lift
- Dump Truck
- Isolation Unit

Section 7.0 lists the project documentation provided by LITCO for the purposes of this report. Aspects of the project that may require further consideration by LITCO are given in Section 6.0.

3.2 Objectives

The objective of this report is to address and comment on the operational and design issues described in the provided documentation. This objective was met in the following ways:

- Identifying areas of the design that are considered in need of further evaluation.
- Identifying and describing any changes and/or additions considered necessary to the operational methodology and/or equipment design.
- Making recommendations and/or suggestions that would help to enhance the efficiency, reliability and/or safety of operations.

3.3 Criteria

The general criteria used for this assessment are based upon the adopted and/or developed design and operational practices of BNFL, Inc. and the experience, as described in Section 1.3, that has proven their worth. These practices and the below listed general categories form the criteria used in this assessment. The general categories of design review used for this assessment are:

1. General health and safety of workers and the public

This is the ability of the physical and operational design to effectively protect workers and the public. Areas considered included:

- Radiological Safety
- Contamination Control
- General, Non-Radiological Safety

2. Operability of Design:

This is the ability of the equipment and methods to adequately and efficiently perform identified operations. Areas evaluated include:

- Operational Methodology
- Equipment Selection and Design

3. Flexibility of Design:

This is concerned with the flexibility of the facility and equipment design to be able to:

- Effectively handle off normal events.
- Assist and/or replace other pieces of equipment in tasks not normally assigned.

In addition to the above, throughput goals and cost effectiveness are important aspects to any design and were considered in the assessment, however, they were not specifically evaluated in this report.

3.4 Assumptions

The following assumptions form a portion of the basis for this assessment:

- The documentation furnished by LITCO was the full extent of relevant project documentation that was available for review at the time of the performance of this report.
- Detailed documentation regarding retrieval operations planning and methodology will be produced before December 1996.
- The vast majority of waste containers are structurally intact and do not exhibit any external contamination.
- Breached containers (if any) on Pads 1 and 2 will present local contamination control problems only.
- No mechanism for the migration of known contamination on Pad R will exist until retrieval activities for Pad R commence.
- Due cognizance of radiation hot spots was given during the establishment of the average surface radiation for a waste container.
- The general process description provided for Pad R is applicable to Pads 1 and 2.
- Criticality is not considered a credible event.

4.0 ASSESSMENT OF THE NORMAL RETRIEVAL STRATEGIES

The assessment consists of two parts. Firstly, the LITCO operations are summarized in **Section 4.1.1** and the BNFL descriptions in **Section 4.1.2**, this provides a complete picture for each of the methods and equipment described. References are provided with the headings for the BNFL Sections, for cross reference, where a direct comparison is possible. Secondly, descriptions of equipment suggested by LITCO are summarized in **Section 4.2.1**. Each of the descriptions are followed by a BNFL evaluation on the proposed equipment.

This format makes it easier to compare each of the LITCO and BNFL operations as a whole. For equipment it is considered more appropriate for the comments and descriptions to be in the same location.

It is recognized that the LITCO documentation provided for evaluation refers to operations on Pad R only. However, the BNFL descriptions provided are applicable to all storage areas within the retrieval facility.

4.1 Operations

4.1.1 Proposed LITCO Operations

A. Overall Retrieval Strategy describes the proposed LITCO overall retrieval strategy for waste from TSA Pads 1,2 and R based upon **Reference 5**. **B. Operational Descriptions** describes the LITCO retrieval process based upon the operations described in **Reference 1** and to a lesser extent in the other documentation provided to BNFL.

A. Overall Retrieval Strategy

The retrieval will begin in Pad 2, cell 1, and proceed south to north. After Pad 2 retrieval is completed, operations will begin at the south end of Pad R, cell 3 and proceed north (See **Figure 1**). Based upon **Reference 5**, this is considered the best overall strategy of retrieval. This strategy would allow for the retrieval of newer drums first and thus less off-normal operations or events are anticipated. This would help personnel to gain confidence in the performance of the operations. This is also believed to supply potential feed stock to WIPP. The contamination problems in Pad R, considered a priority, would next be dealt with followed by retrieval of Pad 1.

B. Operational Description

Clean Soil Removal

Clean soil, either side burden or overburden, will be removed using the excavator fitted with a bottom dump bucket end effector followed up by the mobile vacuum system. When removing soil from the face of the waste stack, the area which is exposed for retrieval is limited by the approximate 10 ft reach of the excavator.

Contaminated Soil Removal

Removal of contaminated soil is considered an off-normal event and the soil will be removed manually (**Reference 9, Section 7**). The residual contaminated soils will be vacuumed by the hot vacuum system as described in **Reference 9, Section 4.3.2**. The hot vacuum system consists of a commercially available, self contained vacuum system mounted on a cart with HEPA filters and a 55 gallon container.

Plywood/Geofabric Removal

Clean plywood will be manually stacked on pallets on top of the waste stack and lowered, using the excavator, to floor level or placed directly on a flatbed trailer. Clean fabric will be manually sized reduced in place and put on pallets and then lowered to floor level or placed directly on a flatbed trailer. Contaminated fabric, timber and plywood will be decontaminated or size reduced in place and put in appropriate waste containers, which will be removed from the top of the waste stack by the excavator. Interstitial soils encountered will be removed by the mobile vacuum system.

Waste Container Retrieval

Waste containers will be removed from the stack using the appropriate container lifting features and the excavator fitted with the appropriate end effector. After each container is removed from the waste stack a detailed inspection, additional surveying including a contamination check and bar code labeling will be completed. Decontamination and overpacking will be done, if required. The excavator is then used to load the waste containers onto the nearby transport vehicle. The waste stack is expected to be stable during retrieval operations. This stability will be further enhanced by retrieving containers in a stairstep (stagger) fashion (Reference 1, Section 3.3.2.1.9).

Retrieval Rate

The target retrieval rate is 10,000 Drum Equivalents (DE)/year. This rate is based upon a variety of operational considerations, most notably, the target close date for the WIPP. The 10,000 DEs/yr translates to approximately 50 DE/day based upon 17 days of retrieval operations per month.

Waste Transport

No material or equipment will be released from the work area unless it has been surveyed and determined to be clean. The clean overburden materials, mainly soil, will be removed via dump trucks and trailers while any materials in containers, such as waste stack containers, boxes filled with overburden materials (contaminated or clean) and overpacked waste containers, will be removed via flatbed trailers.

Before vehicles exit the work area, they are surveyed by radiological control technicians (RCTs) who use equipment located in the RADCON trailer to measure their survey swipes. Once approved for release, the RE door is opened and the vehicle moved into the airlock. The RE door is closed and the vehicle is driven out. At no time during this process will the RE door and the airlock outer door be open at the same time.

Work Area Relocation

The RE is designed to advance the work area, defined by the movable walls (shrouds), sequentially through the facility, south to north. When the current work area has been cleared of all stored waste/overburden materials and declared clean, the facility will be prepared to relocate the walls to the next retrieval location. No nuclear operations will occur during the work area relocation period. To ready the facility for transition, all unnecessary equipment will vacate the work area, remaining equipment will be positioned to facilitate wall movement, and sections of utility services disconnected. To accomplish relocation of the movable walls, they must first be disconnected from the interior bulkheads and maneuvered, via dedicated bridge cranes, to the next preselected location. Although disconnecting the movable walls renders the HVAC ducting system inoperative, other systems and components remain online, e.g., fire protection, CAMs/RAMs and industrial hygiene instrumentation. The airlock will also be repositioned in coordination with the work area relocation. After operational readiness of the

new work area location is confirmed the retrieval process begins again.

4.1.2 BNFL Assessment

It is recognized that the documentation on which this assessment is based upon was completed over approximately a 5 year period. During this time aspects of the design have changed, most notably, the overall retrieval strategy. Also, due to the anticipated length of this project, many of the operational and design details were not determined for areas of the TSA retrieval that would not be active for many years (Pads 1 & 2). Therefore, in the course of this assessment very little detail regarding a variety of operations was identified within the provided documentation. For some areas that were found to be lacking detail and considered to be important in regards to this assessment and the project, a methodology has been provided and/or recommendations are made.

A. Overall Retrieval Strategy

The strategy identified in the LITCO methodology report (**Reference 5**) recommended starting with TSA-2, proceeding from North to South. Given, that Pad R is known to be contaminated the below strategy sequence which is based upon the principle of 'least contaminated first and most contaminated last' is recommended.

- **BNFL Recommended Retrieval Strategy:**
 1. Start at the south end of Pad 2
 2. Proceed northwards through Cells 2, 1A, and 1 of Pad 2
 3. Move across to retrieve containers from Cell 1 of Pad 1 northwards
 4. Upon completion of retrieval from Pad 1 commence retrieval from Pad R
 5. Retrieve containers from Cell 3, Pad R from south to north

This would result in the lowest levels of contamination of retrieval equipment, containers and building structure and therefore the lowest potential worker exposure to contamination from retrieval and maintenance operations. This strategy is contingent on the knowledge that, with the RE in place, the contamination in Pad R does not have a readily available migration path until Pad R retrieval operations commence. As such, this approach is likely to have the advantage of providing the highest sustained removal rate for drums which in turn means a higher sustained rate of potential feed stock for WIPP. This is due to the possibility that contamination issues could slow or halt operations in Pad R causing considerable delays in retrieval operations. It should be noted that several of the recommendations made in this assessment are designed to minimize or completely eliminate these types of delays and effectively reduce or eliminate the need for this recommended change in the retrieval strategy.

B. Operational Details

Clean Soil Removal Operations

1. Initial Soil Removal for Access to the Containers

Removal of the overburden soil down to the asphalt level, is required for the initial access of retrieval equipment. If this soil is uncontaminated, a dump trailer can be driven into the retrieval building for loading with the overburden by the excavator although this is not recommended (See **Section 4.1.2.7 Access Control**). For the particular operation of removal of soil from asphalt on Pad R the suggested use of the excavator may be considered reasonable. However, the below suggestions regarding overburden and sideburden removal and access control should be considered.

2. Removal of Overburden and Sideburden from Containers

- **Overburden Removal**

The proposed method of bulk overburden removal using the excavator inherently has a variety of potential problems. It is recognized that this system of overburden removal was originally described for removal of the overburden from a relatively level surface (the cargo containers) in Pad R and that the quantities to be removed are much less than would be expected in Pads 1 and 2. It is therefore recommended that LITCO investigate alternative means of removing soil overburden. Below is an assessment of the potential problems and a proposed alternative that is believed to meet the required amount of overburden removal while enhancing the efficiency and the reliability of operations.

- (i) **Excavator Bucket Control**

The reliable control of the excavator bucket at the elevated position is believed to be questionable. The uneven nature of the waste stack makes it difficult to easily determine and control the depth of the soil overburden. The unreliable control of this operation could lead to the tearing of the geofabric and damage to the waste containers. The reach of the excavator may also impair this operation if a stagger of the waste stack is required to be maintained.

(ii) Dust Suppression

Although a system for dust suppression is planned for, dust will still likely be generated when the excavator picks up the soil (soil will always be lost from the sides of the bucket), and dust will certainly be caused when the soil is placed into the dumper trucks. Further evaluation should be done regarding the effectiveness of the dust suppression system. Also, consideration should be given to the effect of dust on the local CAM's.

- **Alternate Method for Overburden Removal**

An alternative method of excavating the soil overburden could be provided by means of a small "Bobcat" type excavator working on the overburden itself, with a conveyor system used to transfer the excavated soil from the RE (see **Figures 2 and 3**). Load spreading methods, e.g., timber sections or sheets, could be used in conjunction with this excavator to further minimize damage to the containers. This method or one similar, would 'free' the excavator from this task and allow for a greater portion of its operating time to be used for the retrieval of containers. It may also reduce the possibility of accidental damage to the containers given the greater ease of control based on improved direct visual contact of the smaller system.

Locating Holes

In addition to the above, it is believed that personnel will be needed to manually dig locating holes to identify the depth to which the larger mechanical systems may safely dig. This is necessary given the very uneven nature of the waste stack. Without some system of markers indicating depth, it would seem relatively easy for containers to become damaged during overburden removal.

- **Sideburden Removal**

For sideburden removal it is recommended that the cold vacuum system be used. Since it is likely that a definable slope will need to be maintained for safety reasons and that the side burden will need to remain in place as long as practical for support, it is likely that side burden removal will occur relatively infrequently compared to overburden removal. Due to vegetation or packed soil it may be necessary to mechanically assist the vacuum system (manually or otherwise) but this system should be able to easily handle the amount of material required by this task in addition to the lower overburden removal operation. This and the above suggestions for overburden removal would allow for the exclusion of the dump trailer from the RE and thus reduce the possibility for the spread of contamination due to this vehicle's movements.

Contaminated Soil Removal

The amount of contaminated soil to be encountered during operations in Pad R is not well defined in the documentation provided to BNFL. However, based on the process description for the removal of these soils and discussions with the LITCO cognizant engineer, it would seem that only small quantities of contaminated soil are expected to be encountered. If this is the case then the proposed hand methods may be adequate as long as due consideration is given to the relevant safety issues in regards to limiting the spread of the contamination and personnel protection.

If large quantities of contaminated soil are found to exist, it would seem impracticable to continue with a manual means of removing the soil. The largest difficulty with the manual methods is maintaining control over the spread of contamination. With smaller quantities of soil, only one or two workers should be needed in order to remove the soil in a timely fashion. The risks associated with the operation (i.e., further spreading of contamination, increased worker risk to internal radiation exposure, dust creation, etc) can be reasonably managed. However, these problems can become easily unmanageable with the larger number of workers required for the manual cleanup of large areas of contaminated soil. The use of a small excavator may be reasonable if the cost of the equipment and /or the decontamination of the equipment can be justified for this off normal usage.

A second possible solution would be to give consideration to the use of the cold vacuum system. This method of removal would likely be more controlled and less likely to spread contamination. In order for the design to allow for a minimum amount of modification to the system (both in effort and cost), it may or may not be necessary for additional design features to be included in the cold vacuum system specification if it is deemed justifiable to use this equipment for the removal of contaminated soil.

It is highly recommended that an isolating structure such as described in **Section 5.3.1** be provided over the contaminated areas, whether large or small, during cleanup operations in order to prevent the spread of contamination. This will allow for the continuation of normal retrieval operations without undue interference from the cleanup operations.

Plywood/Geofabric Removal

1. Removal of Geofabric Cover

The LITCO methodology for this operation requires workers to manually cut away and remove the geofabric cover. This puts them in close proximity to the stored containers and therefore has a potential for high dose exposure. It is not practical to make this operation remote which means therefore that the manual method described is the only realistic option.

It may be possible to minimize dose exposure using a method which distances workers from the source, e.g., if the operation is performed from a manlift, with long reach cutting and handling tools. This method would only be considered if dose rates or

contamination levels were exceptionally high at a particular location.

2. Removal of Supports and Plywood Staging

This operation, as described in the methodology, requires workers to manually cut away and remove the supports and plywood staging. Consideration should be given to using the power tools at a location away from the containers to minimize damage to containers from the size reduction operations. This could be achieved by transferring the supports and staging to a location on the ground level away from the stored containers where the size reduction operations could be performed more safely and with reduced dose exposure.

Waste Container Retrieval

1. Contamination Checks

Although, contamination checks are mentioned as being done prior to loading onto the transport vehicle, it is felt that more detail regarding where and how these checks will be accomplished is needed. It is accepted that these may be forthcoming design details, however, the contamination checking of each container will require personnel to be within the immediate vicinity of the waste stack and therefore subject to dose rates that may be higher than currently acceptable limits. Also, a certain amount of instrumentation and equipment will need to be readily available with an appropriate work area (i.e., survey instrumentation, swipes, possibly a shielded box to allow counting of swipes there at the station, etc.).

Given the above, it is recommended that a set down area for contamination checks be designated and further consideration be given to the possible need for personnel shielding. It is also recommended that a second contamination check of each package be performed just prior to exiting the RE. This adds a higher degree of confidence that the container is free of contamination when it leaves the RE. This second check may be difficult to perform due to possible access problems created by the arrangement of containers on the transport truck. This problem is resolved with the recommended conveyor for removing containers from the RE in discussed under **Access Control**.

2. Bar Code Labeling

The LITCO methodology of bar code labeling being done prior to loading containers onto the transport vehicle is agreed with. However, it is felt more desirable to move this task away from the retrieval face and the associated operations. This is recommended in order to reduce dose rates encountered by personnel assigned to this task and to potentially raise the level of industrial safety for these personnel by removing them from the vicinity of the retrieval equipment. If the recommended conveyor system for removing containers from the RE is adopted, this would provide a convenient area for the bar code labeling activity in a much more controlled environment than the one found near the retrieval face.

3. Stagger of Waste Stack

A stagger, as described in the LITCO methodology, will be maintained in order to assure the reasonable stability of the waste package array. This is reasonable and agreed with, particularly for single drums, however, it does not appear to be incorporated to any significant degree in the operational plan. A stagger should be maintained, for drums in particular, to help minimize the extent of damage of a container due to a fall from an extensive height and to assure the safety of workers near or on the waste stack. It is believed that maintaining an acceptable stagger (in regards to safety) may prove particularly difficult given the differences in waste packages and stacking arrangements. It may be found that the excavator reach at the elevation of the top tier may not be adequate to retrieve containers at the distances required by the creation of a stagger or that extra operations such as the cutting of the geofabric, etc. are needed. This is highly dependent upon site safety standards and may or may not be a significant concern. A minimum 10 foot horizontal reach is needed in order to maintain a stagger for vertically stacked drums. This stagger is such that a drum can fall no more than two drum heights for drums stacked five high.

4. Vertical Drum Retrieval

The attachment proposed for removing vertical drums is a clamp type drum grab end effector for the excavator. This requires space around the drum diameter to engage the grab and also puts pressure on the drum during the lifting operation. Drums in the storage configuration are tightly packed and some manhandling is necessary to separate the drums to allow access for the arms of the grab. Otherwise the grab will need to be forced between the drums, risking damage and possible puncturing. Consideration should be given to the use of a grapple which operates on the top rim of the drum (See **Figure 4**). Sufficient room exists on the drum rim diameter between the tightly packed drums to engage the grapple onto the rim. This method is also more tolerant of partially corroded drums since there is only a small gripping force and this occurs at the strongest part of the drum structure, i.e., the top rim.

The drum grab attachment described does not lend itself well to any type of inspection of the drum and, if the drum is contaminated, will likely become a mechanism for spreading contamination. It is considered and recommended that a visual inspection of the drum be conducted prior to moving the drum any great distance from the retrieval face. This can be accomplished with the grapple and a rotating hook. The drum could be lifted only a matter of inches from its stack position and rotated 360 degrees to allow for a complete visual inspection. This would assure the drum's integrity prior to any significant movement of the drum. If the drum is later found to be contaminated, the much smaller gripping surface of the grapple will make any necessary decontamination much easier.

Some of the vertically stacked drums may be on pallets of four drums. The drums are held in place on the pallet using metal bands which must be removed to retrieve individual drums. Extreme care should be exercised when removing these bands to

avoid dropping the drum. Photographs of these drums taken at the time of storage indicate that the pallets may be unstable, if necessary, temporary supporting of the drums should be considered before removal of the bands.

5. Horizontal Drums

Horizontal drums are stacked in the configuration shown in **Figure 5**. The drum grapple described for vertical drums cannot be used with drums in this orientation, an alternative method therefore needs to be adopted. Special forks on the excavator which can be inserted into the interstitial spaces between the drums are suggested as a possible solution. Drums could be lifted, on the forks, clear of the stack and lowered to the asphalt level. The forks would preferably be designed to tip the drum slightly towards the excavator before lifting, to prevent sliding off the forks. Drums should preferably be righted to the vertical position for transport. This can be achieved by using a simple rotating cradle located at the asphalt level. Drum handling methods from this point would be the same as for vertical drums.

The stability of the horizontal drum stack is dependant on the ends of the stack being supported. Retrieval of these drums should be such that the ends remain supported at all times, if necessary, by the use of temporary supports placed at the end of the bottom row of drums.

6. Boxes

It is agreed that removal of boxes from the storage location should be performed as described in the LITCO procedures, using the appropriate lifting devices for each type of container. The structural integrity and radiation checks are particularly important due to the larger quantities of material involved.

7. Removal of Drums from inside Cargo Containers

The storage configuration of drums within cargo containers, i.e., vertical, horizontal, clearances, etc., has not been identified. This configuration is important to establishing the handling methods and equipment used. Procedure for retrieval will be similar to removal of vertical drums described above. However, the drum lifting grapple, which operates from the top of the drum will probably not be suitable for removing the top tier of drums from the cargo container if headroom is restricted. A drum clamp attachment, operating on the side of the drum, will therefore be necessary.

Operations in Areas where the Ground is Contaminated

Since, for obvious safety reasons, it would be preferable to clean up or otherwise deal with contamination within the work area as quickly as possible after it is detected, it would seem that uncovering and dealing with contaminated sections of asphalt would be a priority. Due to this and the possibility of relatively large sections of contaminated asphalt in Pad R, operations in Pad R may well be the only time where contaminated ground may cause intrusive problems for the retrieval operations. Further consideration should be given for these potential problems and their needed solutions.

Access Control

The greatest threat to the spread of contamination to the outside environment is the routine passing of large equipment such as the dump trailers and transport vehicles through the RE airlock. If this airlock is truly considered a contamination control barrier then it is recommended that the access to the RE by these vehicles be limited to only off-normal circumstances.

1. Container Removal

For the purposes of container removal a small section of conveyor (large enough to handle all but the cargo containers) and two fork trucks are all that are required to allow the transport vehicle to remain in or just outside the airlock during retrieval operations. This would mean that only the containers themselves would ever routinely cross the containment barrier and assure that the transport vehicle remains clean. The only time that the transport vehicles would need to enter the RE would be to load empty cargo containers.

2. Soil Removal

The suggestions from **Section 4.1.2.2** regarding the small excavator and the cold vacuum system being used for the removal of soil from the RE would eliminate the need for the dump truck to enter the RE during normal operations.

Changing of End Effectors

It appears that there will be a need to frequently change the end effectors for the excavator on a daily basis. The changing of end effectors is generally time consuming and can decrease the safety and efficiency of the operations. It is recommended that alternatives should be sought to minimize the frequency of these changes. This can be done by using equipment other than the excavator, where practical, to perform tasks that would otherwise require changing of the end effector. This is not proposed to restrict the excavator to the use only one effector but may well reduce the number of end effectors needed and the frequency of changes.

4.2 Adequacy of Equipment and Facilities

4.2.1 LITCO Equipment and facility

Retrieval Enclosure

The Retrieval Enclosure (RE) is an engineered metal building designed to cover TSA Pads 1, 2 and R. The largest portion of the building covering Pads 1 and R is approximately 1,175 ft long with a free span of 200 ft. An annex to the main building is provided to cover Pad 2 and is approximately 425 ft long with a free span of 184 ft. The building covers an area approximately 313,000 ft².

Two moving walls (shrouds) are provided within the building to define the work area which is the only ventilated area of the building. These bulkheads provide connections for power, lighting, breathing air and ventilation. Air enters the work area through the trailing shroud and is exhausted from the work area through the leading shroud. Exhaust out of the building goes through a baghouse and a high-efficiency particulate air (HEPA) filter. The airflow is directed from the trailing shroud area to the potentially contaminated area for protection of the workers and contamination control. The work area is also provided with breathing air stations in the event an off-normal event occurs. The enclosure is provided with a monitoring station. Overburden soils and waste containers will be removed inside the work area defined by the two shrouds.

Utilities include the 120, 480/277 and 4160 V electrical distribution systems; standby power system; the propane heating system; the lighting system; the instrument air system; the telephone/voice paging system; the closed circuit television system; the data acquisition system; potable water and sewer system.

BNFL Comments:

- **Alternative Enclosure**

The topography of the area and the Pads lend themselves to the construction of a movable sprung fabric structure. This could be made to provide year round working, which seems to have been a major driver in the design of the facility.

- **Overhead Cranes**

Cranes are identified specifically for relocation of the shroud. These should be considered for drum retrieval, since they provide the operating flexibility for transfer of drums to different locations within the retrieval enclosure. The cranes would be ideal for retrieval of drums using the grapple, it also has the advantage of reducing the utilization of the excavator for these operations.

Excavator

The excavator is a track-mounted, electric motor-powered, multiuse 97,000 pound class piece of equipment with a number of interchangeable end effectors used for removing overburden materials covering the waste containers and placing these materials in bottom dump and flatbed trailers, retrieving waste containers from the stack, and moving them from examination areas to a transport vehicle. It can also be used to overpack degraded containers and move other equipment, such as the Cargo Container Work Platform, drum inspection station, small fork lift, and empty cargo containers.

BNFL Comments:

The excavator as specified, with the range of end effectors is considered the most flexible method of handling containers and is capable of performing other general tasks within the retrieval area, e.g., bulk soil removal, transfer of plywood staging, etc. The method of attachment of the end effectors to the excavator arm, is not known in detail. This operation should be designed to minimize the time for operators to make the changeover between end effectors. The specification call For a two minute change time for end effectors. Additional time will be necessary to mobilize workers to perform the operation and to maneuver the excavator arm into position. The use of additional equipment to perform some of the retrieval tasks, as described above will reduce the number of end effector changes.

Overburden Watering

Overburden watering equipment such as portable sprinklers may be used to control the amount of dust generated during the removal of overburden. Dust control is obtained by watering down the overburden before its removal with small amounts of water. The source of the water will be from the Firewater System.

BNFL Comments:

It is necessary to take into account the effectiveness of watering as a means of dust control. This can be achieved in two ways, firstly by spraying the area to be excavated prior to excavation and secondly, spraying during the excavation process. Unless large quantities of water are used, prior spraying will only dampen approximately one inch below the surface, therefore any subsequent disturbance of the soil has the potential to create a dust hazard. Spraying during the excavation operation will be more effective, providing the spray coverage envelopes the volume of soil being removed. Once the soil is dumped into a container or trailer, the non-wetted dust will be free to be spread.

Mobile Vacuum System

The Mobile Vacuum System (MVS) is used in conjunction with the excavator for removing residual soil covering the asphalt, waste containers, and cargo containers, and general housekeeping within the shrouded work area to minimize dust generation.

The system consists of a diesel engine truck and drive train for powering the MVS; vacuum system capable of continuously discharging into a bottom dump trailer; collection system using cyclone separator(s), reverse pulse baghouse(s), and HEPA filtered exhaust; hydraulic system for component movement and control; control system for controlling the operation of the MVS; and operator's cab from which the MVS is operated.

The MVS will be located outside of the RE with the vacuum hose running from the MVS trailer through the RE exterior wall to the work area inside the RE. In addition to the main system, an operator controlled manlift will be used to support and guide the working end of the vacuum hose. A second manlift is available if needed.

The approximate vacuuming rate for the system is 10,000 lb/hr. Vacuumed material is continually discharged into a bottom dump trailer from the cyclone separator. Although intended for noncontaminated soil transfer, features such as HEPA filtration are provided for minimizing the spread of contamination if the system is inadvertently used on contaminated soil. The MVS is self-contained with all power required being obtained from the diesel engine.

BNFL Comments:

The Mobile Vacuum System, as described, provides a cost effective and versatile method of clean soil removal. Consideration should be given to the use of this equipment for the removal of contaminated soils if large volumes are identified from the sampling program. The clean soil system could be used, with some modifications, e.g., moving the separator into the RE for loading contaminated soil containers. For further use with clean soils, the contaminated equipment would need to be replaced and stored or decontaminated in readiness for future contaminated soil removal operations.

Contaminated Vacuum System

The Contaminated Vacuum System (CVS) is used where known contaminated soil areas will be encountered as detected by radiological control field instrumentation. This is a small capacity, self-contained, HEPA filtered, cart mounted vacuum system. The CVS is electrically powered with the supply being obtained from the RE electrical system.

BNFL Comments:

The proposed Contaminated Vacuum System is most suitable for small quantities of contaminated soil. In practice, this is probably all that will be necessary for contaminated soil removal since it is anticipated that soil contamination will be localized. In the event that larger volumes of contaminated soil are identified, e.g., by soil sampling, the use of the Mobile Vacuum System, modified as described above, is recommended.

Cargo Container Work Platform

The Cargo Container Work Platform provides an elevated work area for removing drums from the top layer of cargo containers. It is a portable structure 24 ft square, nominally 8 ft high, which allows access to three cargo containers at a time without having to be repositioned. Repositioning of the platform is accomplished by using the excavator to lift it and move it to the desired location. A small forklift placed on the platform by the excavator will remove drums from the cargo containers and place them at the edge of the platform for subsequent removal.

In addition to operating space for the forklift, the platform provides a staging area for a number of drums. Leveling jacks are provided to compensate for any elevation differences between individual cargo container floors. Ramps are used to bridge the junction between the platform and the cargo containers. Personnel access to the platform is via a permanently attached ladder. Retractable attachments on the deck of the platform interface with the excavator end effector when the platform is raised for repositioning.

BNFL Comments:

This unit provides access to the second level of cargo containers for the small fork lift proposed for drum removal. It is agreed that the equipment and methods described appear suitable for this purpose.

Small Forklift

This 2,500 lb capacity battery operated forklift will be used to remove drums from the cargo containers. Battery recharging will be performed at a battery recharging station mounted on the RE trailing shroud and powered from the RE electrical system.

BNFL Comments:

The battery operated fork lift is required to remove the drums in the cargo container. It is anticipated that the top drums will be too close to the roof of the container for access for the

drum grapple, which is suggested as the preferred method of handling drums, described in the methodology section. Therefore, a small drum grab will be needed for these drums. A hook attachment on the forklift should be provided to allow use of the grapple for drums at the lower levels within the cargo containers.

Retrieval Radiological Control (RADCON) Trailer

The Retrieval RADCON Trailer serves as a portable field office for radiological control personnel who are supporting retrieval operations within the shrouded work area. It is located within the shrouded work area near the RE equipment airlock and is moved, on its own wheeled undercarriage, when the shrouds are repositioned.

A desk, tables, and cabinets are provided for radiological control instrumentation for swipe assays, recordkeeping, and storage for some emergency equipment.

BNFL Comments:

This is an appropriate facility to ensure that monitoring capabilities are available within the retrieval building to prevent the potential spread of contamination to the outside the building.

Personal Survey Shielding Booth

Personal survey shielding is used by personnel performing personal radiological surveys immediately after exiting the zoned working area next to the waste stack. This shielding is in the form of two 3-sided all steel booths approximately 3-½ x 3-½ x 7 ft high. The booths are portable and can be placed near the Retrieval RADCON Trailer or near the access control point near the waste stack.

BNFL Comments:

This is a necessary facility to monitor personnel on exit from the facility to prevent the potential spread of contamination to the outside the building.

4.3 Utilization of Equipment

The flexibility of equipment should be maximized where ever possible to allow for the widest range of possible solutions to off-normal or unforeseen events. This includes unforeseen break downs of equipment such as the excavator. The excavator is the key piece of retrieval equipment and is utilized far more than any other, therefore, other pieces of equipment should be evaluated for their ability to perform the same tasks as the excavator is currently required to. This will help to utilize equipment that currently seems to be excessively idle, increase the overall efficiency of the retrieval process and provide contingencies to allow retrieval operations to continue in the event of an unforeseen breakdown of equipment. **Table 2** shows several of the excavator's tasks and suggested alternate equipment. These alternate solutions will need additional equipment and/or modification to existing equipment in order for these alternatives to be adopted.

5.0 ASSESSMENT OF OFF-NORMAL RETRIEVAL STRATEGIES

The description below of the approach to handling contaminated or breached containers is recognized as being in very general terms, the details of which are assumed to be developed at a later date. No description regarding the handling of structurally suspect containers was found and none is therefore assumed. The proposed approach described below is, in general, agreed with, however, due to the lack of detailed description, the assessment below focuses on the further development of methodologies and presentation of recommendations and suggestions for the retrieval of contaminated, breached or structurally suspect containers. Furthermore, the equipment identified for normal retrieval operations and the Isolation Unit are assessed for their ability to adequately perform these off-normal operations in a timely and safe manner.

5.1 Proposed Operations for Retrieval of Breached/Contaminated Containers

Based upon Reference 1 a container known to be contaminated may be handled in the following ways:

1. Fix, cover or remove the contamination before removing the container from the stack. The safety of the working environment would have to be considered. The container may then be overpacked depending on its condition.
2. If the contaminated area is inaccessible and moving the container will not spread the contamination, then the container may be moved to the asphalt level away from the stack to allow for access to the contamination. As with 1, above, the container may be overpacked depending on its condition.
3. If the container is located in a contaminated area and/or is breached and movement is considered an unacceptable risk for the spread of contamination, then the Isolation Unit is utilized to isolate the container. The excavator is then used to move the container inside for either immediate overpacking or decontamination.

5.2 BNFL Assessment

5.2.1 General Comments

Although the above operational description is primarily directed toward contaminated containers it is assumed to apply, in general, to breached containers. Since the operations for structurally suspect containers can be significantly different from the above described steps, they are not assumed to apply for these containers.

5.2.2 Assessment of Proposed Operations for Retrieval of Breached/Contaminated Containers

A variety of determinations and decisions will need to be made before a contaminated.

breached or structurally suspect container can be properly dealt with. These determinations and decisions are highly dependent upon a variety of factors including:

- **Extent of Contamination**

If contamination is detected on a container in the stack, then the extent, amount and type of contamination needs to be determined. The contamination, for example, may have spread to or from adjacent containers.

- **Container Condition**

The physical condition of the container needs to be assessed in order to determine if the container is breached, if the damage can be repaired and if the container can be safely moved. This includes a determination as to the container's structural integrity.

- **Isolation Needed**

After a reasonable understanding of the extent of contamination and/or the container's condition is achieved then a decision should be made regarding the need for isolation.

- **Container Location**

The container location will help to determine what can be done to the container while it remains in the waste stack. It will also help determine, along with the above, if surrounding containers will need to be removed in order to gain needed access to the target container.

- **Type of Container**

This will help to determine what types of repairs, decontamination, contamination covering and lifting procedures will be appropriate and effective. The types overpacks and lifting devices needed can also be determined.

- **Need for Overpacking**

With the above information, a determination whether or not the container should be overpacked can be made. If other methods used for eliminating the contamination and safety concerns are considered adequate enough, then the container may be considered clean. It should be noted that if a contaminated or breached container is found, this is likely not to be the case.

5.2.3 Specific Considerations and Recommendations

Isolation of Containers

It would be expected that the vast majority of containers requiring off-normal handling due to

contamination and/or damage will not require physical isolation from the rest of the waste stack in order to safely handle the container. When a container has been identified as breached, with suspect structural integrity or otherwise damaged the potential for the spread of contamination should be assessed and a determination regarding the need for isolation made at that point. If isolation is deemed necessary the use of a temporary isolation structure described in the BNFL comments in **Section 5.3.1** is recommended. Adjacent containers should be removed, if possible and as needed, to improve accessibility and minimize the time for handling and removal. Containers which are breached, with suspect structural integrity or otherwise damaged should be handled and moved the least amount possible before at least being stabilized for further movement (i.e., overpacked, patching of a breach, reinforcing the structure, decontaminating, etc.).

Access Control and Remote Methods

During these operations the minimum number of personnel should be in the operating area to reduce the potential for dose exposure and contamination. Access to the damaged containers should be restricted and more remote methods of performing the handling tasks should be considered. This could be by the use of automated equipment, e.g., an automatic drum grab.

Fixing, Covering or Removing of Contamination and/or Repairs of Containers

As suggested in the above general methodology, the contamination and/or repair of containers should be dealt with as soon as possible after discovery. This implies that, if possible problems should be resolved while the container remains in the waste stack. This helps to minimize if not eliminate a variety of problems that can occur with the movement of contaminated, breached or otherwise damaged containers. The exact method used will be dependent on the nature of the location, condition and the type of container.

Severity of the Situation

The degree to which the area is isolated and remote systems utilized is dependent upon the severity of the situation. A container that is contaminated but otherwise undamaged will not require the same degree of effort to safely move it from the waste stack as one that is structurally unsound. Nor are the types of precautions needed necessarily the same. It may not be necessary to remove surrounding containers in order to safely move one contaminated container, however, if several are contaminated or severely damaged the need to isolate these containers from the rest of the waste stack becomes increased.

Overpacking of Containers

1. Vertical Drums

Vertically stacked drums which have been determined to need overpacking should be overpacked as close to the storage location as possible to minimize the potential for contamination spread. The generally accepted method of overpacking drums is with

a larger size drum. A tote which can be lifted with the drum contained inside may be utilized if the structural integrity of the drum is in question or to provide a secondary means of preventing the spread of contamination.

Using a larger size drum as an overpack requires the stored drum to be lifted into the overpack using a grapple. To minimize the drum lift, the overpack should be located as close to the array as possible. If possible and if allowed under site safety standards, the overpack should be placed on the next lower level. This will require the stored drum to be lifted only approximately 2" above the platform level for the travel to the overpack where it is lowered into position. This is done to help minimize further damage to a suspect drum in the event of an accidental drop. The external surface of the overpack should be protected to minimize contamination during the operations within the building and therefore avoid lengthy decontamination before routing to the storage facility. Also, a liner should be used for the inside of the overpack and the drum secured within before the overpack lid is placed on. This is to prevent the inside of the overpack from becoming contaminated during movement and to allow the overpack to be opened at some later with a minimized risk of exposing personnel immediately to the contamination.

The tote method, used for structurally suspect drums, requires the tote to be laid adjacent to the stored drum which is then lifted approximately 2" and moved over onto the tote. Plastic sheeting can be laid on the tote to allow the drum to be overpacked, before the tote is lifted, to contain any material during transfer. The tote with the drum is then lifted using the hoist on the excavator arm and transferred to the asphalt level where both tote and drum are overpacked.

Drums which are too structurally unsound to be moved will require emptying at the stored location using manual methods within a temporary enclosure.

2. Horizontal Drums

Horizontally stacked drums which are suspected of being damaged or breached should also be overpacked at as close to the storage location to minimize the potential for contamination spread. Horizontal drums need to be rotated to the vertical position for loading into the overpack. The method used for rotating sound drums should be used, a liner of plastic sheeting on the rotating mechanism will protect it from any contamination being released from the drum. This sheeting can then be used to overpack the drum to contain any material during transfer.

Once the drum is raised to the vertical position, the methods of overpacking described for vertically stored drums can be used.

3. Boxes

As with the drums, above, boxes that are determined to need overpacking should be overpacked as close to the storage location as possible. The 'cake box' type overpack

seems to be a very appropriate design for this activity and should be utilized. The overpack base, where possible, can be placed adjacent to the box to overpacked. This will enable the lift to be again restricted to approximately 2" above the base surface which will reduce the risk of further damage due to handling. A plastic sheet should be placed over the overpack base and used as an inner wrap of the container to help minimize and prevent the spread of contamination to the inside of the overpack. This operation should be performed as carefully as possible to avoid further damage to the box.

4. Structurally Unsound Containers

If a container is found to be structurally unsound then the contents of the container and the container itself will need to be manually repackaged in a structurally sound and clean container. The container should be isolated from the rest of the waste stack in order to prevent the spread of contamination. The container could be isolated from the other containers under the structure by means of plastic sheeting. Personnel working in the structure will need the appropriate protection from contamination. This includes anti-contamination clothing, appropriate ventilation and respiratory protection, etc.

A plastic lined tote laid next to the container can be used to collect the removed waste and then transport to an appropriate drum or box for storage. When sufficient waste has been removed, the container can if determined safe, be lifted into an overpack. Otherwise, all of the waste will have to be removed and the container should be overpacked (size reduced is necessary). After the structurally unsound container and its contents are repacked into a clean container it may then be handled in the normal fashion.

5.3 EQUIPMENT DESCRIPTION

5.3.1 Isolation Unit

It is anticipated that breached containers and contaminated soils will be encountered during retrieval operations, therefore, the Isolation Unit is used as a temporary enclosure to isolate contaminated soil and/or waste containers to prevent the potential spread of airborne contamination during retrieval. It is portable and will be ventilated to keep contamination inside. It will also have HEPA filtered exhaust. The unit will enable decontamination and safe retrieval. Fire or explosion in the unit due to hydrogen buildup is not considered a credible scenario.

BNFL Comments:

Flexibility is one of the most important attributes that the confinement structure will require. The proposed Isolation Unit does not afford this. The nature of retrieval, particularly at the TSA, is that a number of scenarios will occur during the lifetime of the project. It is improbable that all of these scenarios can be planned for in detail, and consequently equipment expected to deal with these will need to reflect this. Additionally, the equipment will need to be portable. A view on how the equipment will be transferred into position also needs to be established. A number of materials could be used for the construction of a temporary structure, and more than one may be procured. The main driver with regard to the structure material and roof support will be span; This in turn will be dependant on the contamination/breached container(s) scenario revealed.

Given this, it is recommended that more simplistic and flexible equipment be used to isolate breached containers in place of the proposed isolation unit. The equipment recommended to be procured in place of the isolation unit prior to the commencement of operations is:

1. Ventilation fan with appropriate ducting and HEPA filter bank, or a temporary connection to the shroud ventilation ductwork.
2. Temporary confinement structure system (This could be re-usable modular confinement system which could be made available for this purpose, or a simple welded plastic sheeting tent with a lightweight roof support structure). The re-usable modular confinement system can be easily decontaminated if strippable coatings are applied to the internal surfaces.
3. Electrical power will be required within the confinement structure for lighting and small tools. A larger source of power will be required for the ventilation unit.

The handling equipment to be used within the confinement structure will be dependant on the contamination scenario. The structure should not be required to be sized to suit incorporation of the excavator. A means of temporarily avoiding the stagger should be established for this reason and fork trucks used for their greater mobility.

6.0 SUBJECTS RECOMMENDED FOR FURTHER STUDY

6.1 Source Term

In several documents the surface dose rates of containers are discussed. Two give 'less than' figures; Reference 1 states that "the average container has a contact dose rate of less than 5 mrem/hr." , Reference 6 states that "Greater than 90 % of the waste containers exhibit a surface exposure rate of 10 mR/hr. Reference 2, Appendix I, shows the average field measurement (GM) being 1.1 mrem/hr for the average waste BOX based upon information from the RWMIS system. These three may not be inconsistent, however, if there is a significant percentage of ALL packages with surface dose rates greater than 2 or 3 mrem/hr, then the basis for Reference 2 could be suspect.

A study of the source term to determine and develop the appropriate average source term and surface dose rates for the various packages and locations would be highly useful in performing further radiological safety assessments. This study should consider all the sources of possible information (RWMIS, present retrieval surveys (if applicable), etc.). It should further consider the effects of time on the older data including the decay of nuclides and the ingrowth of daughter products (Am-241 in particular). From the information provided, it seems evident that a large portion of this has been accomplished in various documents. This information seems to need no more than to be pulled together and supplemented, where necessary into one document. This would assure future radiological safety assessments of being consistent with one another and improve the accuracy of these assessments.

6.2 Radiation Safety

The need for a rigorous radiation safety assessment is believed paramount to assuring that the project can be successfully carried out and workers will not generally exceed dose limits. It is further needed to assure that radiation the protection measures are adequate. These include shielding, access restrictions and contamination control measures (i.e., access control, containment procedures and equipment, personnel protective clothing, ventilation, etc.). The evaluation should be based upon a definitive BFD and Time and Motion Study and should include the following:

- Determination of workers' average annual dose with an emphasis on those operations that will require the workers to be in close proximity to the waste stack (i.e., cutting of the geo fabric, removal of timber and plywood, etc.).
- An evaluation of doses (both external and internal) from off normal events/operations occurring during retrieval (particularly for Pad R). These include the decon of waste packages and equipment, the removal of contaminated soil and asphalt, the removal of damaged packages and the various accident scenarios (some of this has already been accomplished in Reference 4).
- An evaluation of the adequacy of any radiation protection features provided (i.e., shielding, contamination control, etc.).

6.3 Extent of Contamination in Pad R

Throughout the documentation the contamination in Pad R is put forth as a serious problem for operations. These problems include an increase in decontamination of packages, the removal and/or replacement of large sections of contaminated asphalt and the increased possibility of contaminated soil. These off normal operations have been accounted for, in general, in the Operations Plan for Pad R. However, the amount and extent of the contamination does not seem to be well defined nor consistent with the documentation. It is recommended that a study to better quantify the contamination issue in Pad R be completed.

Based upon the documents reviewed by BNFL, Inc., the extent of the contamination in Pad R does not seem to agree with the apparent accident scenario as reported in the TSA SAR (Reference 1). This document suggests that a very significant amount of contamination occurred due to 'two small holes in a waste box'. From these two small holes enough material was released to contaminate 'two chairs and personnel clothing ... the south third of the C&S building and the TSA-R storage Pad..'. Given the size of the C&S building and Pad R, the above seems to be inconsistent. From the information provided, there appears to be no definitive answer regarding the current extent of contamination in Pad R. Also, based upon conversations with the LITCO cognizant engineers a suspected breached container remains in the stack array. The contaminated area from this suspect container appears to be narrow at the south end of the Pad and widens as it approaches the location of the suspected breached container. The suspect container is believed to be either at the northern end of Cell

2 or the extreme southern edge of Cell 1. It is reasonable to assume that the containers placed in the migration path of the contamination will have at least their bottom surfaces contaminated.

From the documentation it is noted that a sizable campaign of soil sampling will be accomplished prior to the start of operations at the initial retrieval site and that the campaign will likely continue throughout the retrieval process. It is also understood that radiological surveys will be conducted in the working areas during operations to locate contamination and prevent its spread. However, the soil samples are not likely to determine the amount nor the extent of the contamination in Pad R that remains covered by the containers and/or the geofabric. In some way, through measurements and/or based upon past information or another means, the amount and the extent of contamination in Pad R should be quantified (in at least general terms). This, with the results of the soil sampling, will provide operations with a reasonable gauge as to the amount of off-normal operations (i.e., removal of contaminated asphalt, decontaminating boxes and equipment, contaminated soil removal, etc.) they may expect. It is noted that these operations are, to some degree, accounted for in Reference 9, however, the basis is unclear.

6.4 Detailed Block Flow Diagram (BFD)

A BFD (circa 1990) was provided for operations in Pad R. For the most part this BFD is considered complete. However, given the changes in strategy, a BFD needs to be completed for Pads 1 and 2. The differences in the retrieval of Pads 1 and 2 compared to Pad R are many and include:

- The need to remove soil from an uneven container surface becomes a real concern for Pads 1 and 2. This was not a concern for Pad R since the cargo containers are the only portion of the pad covered and they provide an even surface.
- A much larger quantity of soil will need to be removed from Pads 1 and 2 after the commencement of retrieval operations. A large quantity of the soil is planned to be removed from Pad R prior to the commencement of retrieval operations.
- Both vertically and horizontally stacked drums are found outside of cargo containers throughout Pads 1 and 2. The drum grab for the excavator was designed with Pad R operations in mind. In Pad R a drum will be initially retrieved by a fork truck then set in a clear area for the excavator grab. This grab will not work as the initial tool for retrieval of drums in Pads 1 and 2 without first maneuvering the drum clear of adjacent drums.

6.5 Time and Motion

A rigorous Time and Motion study based upon a detailed BFD. is recommended. A Time and Motion study will:

- Show that the design and its associated operational methodologies can meet operational goals (i.e., the 10,00 DE/yr retrieval rate).
- Show areas where 'bottle necks' in the operation occur. This in turn will allow for further or redevelopment of these areas, if necessary, to improve efficiency and can eliminate the time consuming and often costly practice of 'back fitting' a design.
- Show that the correct number and type of personnel have been identified for the job. May show that certain individuals will not be able to perform assigned tasks in the allotted time or, conversely, it may show that certain personnel or excessively idle.
- Show that the identified equipment is not excessively utilized and helps to account for down time of equipment and the effect of this on the retrieval rate.

For all the above listed reasons, a Time and Motion study can be seen to assist both the design and operations teams to maximize the efficiency of the project.

7.0 REFERENCES

1. TSA Retrieval Enclosure Safety Analysis Report, Draft, INEL, June 1995
2. TSA Waste Retrieval Personal Shielding Calculations, S. MacLeod, SEM-02-91, August 29, 1991
3. Empirical Distributions of Radionuclides, from RWMIS Data, Atwood and Schlafman, INEL, EGG-RAAM-10741, April 1993
4. Dose Calculations From Design Basis Accidents, Schofield, EG&G, RE-014, Rev. 1, September 18, 1990
5. Contact Handled Transuranic Waste Retrieval and Drum Venting Strategy, Carpenter, Jamison and Wixson, INEL, EGG-WM-11461, September 1994
6. TSA Retrieval Enclosure Health and Safety Plan, Mac Leod, INEL-95/0210, Rev. 1, July 1995
7. Hazardous Stored TRU Waste Source Term for the RWMC's TSA, Gratson, RE-021, February 7, 1990
8. Quality Assurance Project Plan and Sampling and Analysis Plan for TSA Retrieval Enclosure Operations Soil Sampling, Lugar, INEL-94/0220, Rev. 0, February 1995
9. Operations Methodology Plan for the Retrieval Process at the Radioactive Waste Management Complex TSA Pad R, Carpenter, EGG-WM-10884, August 1993

TABLES

TABLE 1: CONTAINER TYPES AND QUANTITIES LOCATED IN PADS 1, 2 AND R

PAD	55 GAL DRUMS	30 GAL DRUMS	83 GAL DRUMS	WOOD BOXES (24 X 48 X 84)	FRP BOXES (84 X 48 X 48)	ODD SIZED FRP CONTAINERS	OVERSIZE FRP BOXES (84 X 48 X 52)	WOOD BOXES (84 X48 X48)	SAND TYPE - 1 (84 X 48 X 48)	METAL BINS (48 X 60 X72)	ODD SIZED CONTAINERS
1	63,065	122	1,840	0	3,554	255	0	897	0	83	28
2	17,242	0	0	8	1,886	0	0	0	0	0	20
R	17,113	0	0	0	1,914	0	29	0	827	450	209
TOTAL	97,420	122	1,840	8	7,354	255	29	897	827	533	257

TABLE 2 : Selected Excavator Tasks with Suggested Alternatives

TASKS	LITCO PROPOSED EQUIPMENT	BNFL SUGGESTED ALTERNATE EQUIPMENT
Soil Removal	Excavator with Bucket Attachment	'Bobcat' Type Vehicle with Conveyor System
Retrieval of Vertically Stacked Drums	Excavator with Drum Grab Attachment	Crane with Grapple
Retrieval of Horizontally Stacked Drums	Excavator with Special Fork Attachment	Fork Truck with Appropriate End Effector
Rotation of Horizontal Drums	Not Specified	Drum Rotator

FIGURES

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4

FIGURE 5