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PROCEEDINGS OF THE US DOE/UK AEA WORKSHOP ON FACILITY DESIGN

OCTOBER 27-29, 1986

ALBUQUERQUE, NEW MEXICO

DEPARTMENT OF ENERGY

ROCKWELL INTERNATIONAL

WESTINGHOUSE

JOINT INTEGRATION OFFICE

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Prepared for the
United States Department of Energy
United Kingdom Atomic Energy Authority
Under the Auspices of the
Bilateral Technical Exchange Agreement
in the Field of Waste Management

FOREWORD

This document contains the proceeding of a Workshop on Facilty Design that was held between the United States Department of Energy and the United Kingdom Atomic Energy Authority, Albuquerque, New Mexico, October 27-29, 1986. The intention of the workshop was to display relevant design criteria and to demonstate for various US and UK facilities, current and projected criteria and how these criteria have been satisfied by facility design. Specific examples concern small plants, large plants, and waste stores.

Principal Coordination was provided by E. Delaney (USDOE/HQ) and R. Flowers, (UKAEA). Technical Coordination was provided by G. Daly (USDOE/HQ) and C. Tanner (BNFL). The Agenda and arrangements were provided by C. Tanner, C. Kent (JIO/AL) and L. Morton (JIO/AL). As is shown in the Attendee List, participation included 7 UK and 16 US technical specialists.

In conjuction with the workshop, the UK participants also visited several sites to review waste management technology and to attend special informational exchange meetings:

1. LANL to review waste management technology on size reduction, incineration, non-destructive assay, and liquid waste treatment; October 31, 1986.

2. WIPP site in Carlsbad, New Mexico, to tour the underground storage facility; November 3, 1986.

3. RFP representatives in Boulder, Colorado, to exchange information on the treatment and disposal of alpha-bearing waste as related to a nuclear weapons program. Specifically, to discuss waste processing facility design principles in the area of safety operation, maintenance, and decontamination; November 3, 1986.

4. INEL to tour the SWEPP/PREPP facilities and to review various waste management technologies relating to the reduction, incineration, and treatment of TRU generated waste; November 4, 1986.

5. SRP to review the development work on a Telerobot system, Savannah River Ecology Laboratory, TNX - Cold TRU Waste Development Program and Plutonium Incinerator, Beta-Gamma Incinerator, Burial Ground Facilities, and Defense Waste Processing Facilities; November 7, 1986.

FOREWORD

(Continued)

This document contains the following sections:

1) Executive Summary
2) Agenda
3) List of Participants
4) Synopsis of Individual Presentations
5) Presentations, Visuals, and Handouts.

It is not the intention of this document to be a total record of the meeting, but an identification of sources of information that may be available. If the reader has specific questions concerning the material, he may refer to C. Tanner (BNFL) or L. Morton (JIO/AL) who have been responsible for each of the individual sections.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

OVERVIEW AND STATUS OF WASTE MANAGEMENT

Opening presentations concentrated on recent changes in the UK political and regulatory scene (C. Tanner), and the requirement for and status of BNFL, UKAEA, and MOD waste management plants (J. Critchley, R. Thomas, and S. Hunter). A common theme was continued regulatory uncertainty following the suspension of sea-dump operations for categories of waste falling within LSC criteria. There are differing incentives for plutonium recovery from HL waste in the civil and defense areas of the nuclear industry, but the favored process options for the initial stages of waste treatment are essentially similar. The later stages of plutonium recovery and recycle to the fuel or weapons cycle are not specified. It may be acceptable in practice to terminate waste treatment at the point where an enriched, inert, low volume Pu residue can be returned to store, to await further treatment in the indefinite future. In all cases, regulatory requirements are leading to substitution of remote-handling techniques for manual intervention.

During the wrap-up session, it was expressed by the representatives of both countries, that the workshop was of value, and that the informational transfer should be continued under the bilateral agreement. A review of past exchange activities showed considerable informational exchange in the areas of size reduction, incineration, waste minimization, waste immobilization, and facility design.

For the future it was proposed that exchanges in specific technical areas should proceed on the initiation of the topical subject specialists concerned, while remaining within the scope of the US/UK waste management agreement.

That in the future, emphasis be placed on the exchange of information in the area of operational experience. Within this concept, a proposal is made that technical specialists representing INEL and BNFL visit each others facilities to review and assist in final acceptance testing of new waste processing facilities (INEL/PREPP and Sellafield WTC Phase-I) in October or November of 1987.

It was also recommended by the technial coordinators that an interim review be held in the Fall of 1987 in the UK to examine options for the recovery of plutonium from wastes in association with waste treatment disposal.

AGENDA

US/UK WORKSHOP AGENDA

DAY 1: MONDAY OCTOBER 27

WELCOME - Dave Lund, DOE-AL
8:00

INTRODUCTION - Charles Tanner, UK/Lee Morton, JIO/Paul Hagan, JIO
8:05 - 8:15

MORNING SESSION - OVERVIEW AND STATUS OF WASTE MANAGEMENT
8:15 - 12:00

UK; Charles Tanner, UK General Status
Jerry Critchley, BNFL Status of Projects and Plans
Robert Thomas, UKAEA Status of Projects and Plans
Sid Hunter, UK Ministry of Defense Status of Projects and Plans

BREAK 15 min

US; Kim Wierzbicki, DuPont - SRP (incl. Storage Areas)
Don Kudera, EG&G - INEL
John Warren, LANL - TRU Waste Processing Overview

SESSION DISCUSSION 30 min

LUNCH BREAK
12:00 - 1:15

AFTERNOON SESSION - RELEVANT DESIGN CRITERIA USED IN WASTE PROCESSING AND HANDLING
1:15 - 4:00

UK; David Swale, BNFL Sellefield - Operators Viewpoint
Robert Thomas, UKAEA Facility Design Criteria
Sid Hunter, UKMOD Facility Design Criteria

BREAK 15 min

US; Steve Mentrup, DuPont - SRP

SESSION DISCUSSION 30 min

DAY 2: TUESDAY OCTOBER 28

<u>MORNING SESSION</u> - APPLICATION OF DESIGN CRITERIA TO SMALL PLANTS
8:00 - 12:00

UK; John Buckle, BNFL
Robert Thomas, UKAEA
Sid Hunter, UKMOD

BREAK — 15 min

US; John Harper, LANL - Size Reduction Facility
Charles Warner, LANL - TRU Incinerator

SESSION DISCUSSION — 30 min

LUNCH BREAK
12:00 - 1:15

AFTERNOON SESSION - APPLICATION OF DESIGN CRITERIA TO LARGE PLANTS
1:15 - 4:15

UK; John Buckle, BNFL
Sid Hunter, UKMOD

BREAK — 15 min

US; Brent Daugherty, DuPont - SRP, TWF
Dave Charlesworth, DuPont - SRP, TWF Component Testing
John Stewart, DuPont - SRP, Pu Incinerator

SESSION DISCUSSION — 30 min

DAY 3: WEDNESDAY OCTOBER 29

MORNING SESSION - APPLICATION OF DESIGN CRITERIA TO LARGE PLANTS (Cont.)
8:00 - 12:00

US; Don Kudera, EG&G - INEL, SWEPP Facility (incl criteria)
Chuck Cargo, EG&G - INEL, PREPP Facility (incl criteria)

- APPLICATION OF DESIGN CRITERIA TO STORAGE FACILITIES

UK; Robert Thomas, UKAEA - PCM Storage Facility
Video Tape (20 min)
Duncan Nielsen, UKAEA - Harwell Storage Facility
Jerry Critchley, BNFL

SESSION DISCUSSION 30 min

LUNCH BREAK
12:00 - 1:15

AFTERNOON SESSION - DISCUSSION AND WRAP-UP
1:15 -

LIST OF PARTICIPANTS

ATTENDANCE LIST

NAME	ORGANIZATION	PHONE NUMBER
H. D. Harmon	DuPont-SRP	803-725-3578
Don Kudera	EG&G Idaho	208-526-6419
Lee Morton	JIO	505-883-7844
Carol Kent	JIO	505-883-7844
Paul Hagan	JIO	505-883-7844
Charles Tanner	BNFL	
Robert Thomas	UKAEA	0925-31244-2637
Dave Lund	DOE/AL	505-883-7844
Chuck Wickland	Rockwell/RFP	303-966-4294
Jerry Critchley	BNFL-Risley	0925-834952
Dave Swale	BNFL Sellafield	0946-65384
Charles Warner	LANL	505-667-7391
Johnny Harper	LANL	505-667-5397
Kim Wierzbicki	SRP	FTS 237-8373
Steve Mentrup	SRP	FTS 237-8806
Brent Daugherty	SRP	FTS 237-8605
John Warren	LANL	
Duncan Neilson	UKAEA	
John Buckle	BNFL	0925-833453
Sid Hunter	AWRE Aldermaston	
Chuck Cargo	EG&G Idaho	208-526-1212
John Stewart	DuPont SRL	803-557-6428
Dave Charlesworth	DuPont SRL	803-557-6329

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Workshop on Facility Design

Held under the UKAEA/USDoE LMFBR Technology Exchange Agreement. Albuquerque N.M. October 1986.

UK Team Members

M.C. (Charles) TANNER

Technical Dept., Spent Fuel Management Division, BNFL, based at Risley HQ., Senior Manager responsible for Divisional technical programmes and budgets, generic development, technical information services and speculative R&D. Chairman of Plutonium Contaminated Materials Working Party (PCMWP) which manages the UK national programme of generic development in this area. Nominated sub-correspondent for PCM matters within the UKAEA/USDoE LMFBR exchange agreement.

R J (Jerry) CRITCHLEY

Waste Management Projects Group, Spent Fuel Management Division, BNFL, based at Risley HQ. Project Manager, plutonium waste treatment plants : responsible for design of Waste Treatment Complex phase I for drummed PCM (sanctioned at £30M) and phase II for crated PCM. Member of PCMWP and provides design services to various Task Forces in the PCM waste management field. Responsible for design studies on PCM storage, incineration and waste washing.

J (John) BUCKLE

Fuel Plants Design Office, Spent Fuel Management Division, BNFL, based at Risley HQ. Qualified Senior Engineer with 11 years service in BNFL principally engaged on design of various plutonium processing and fuel fabrication plants. Started work on PCM - related projects in 1980 : engaged in PCM incinerator design, conception and supervision of various aspects of Waste Treatment Complex phase I (drummed PCM) and all aspects of WTC phase II (crated PCM) including associated development facilities.

D (David) J SWALE

Fuel Plants operations, Spent Fuel Management Division, BNFL, based at Sellafield. Chemical engineer with 8 years service at Sellafield following a period with British Steel. Has been responsible for day-to day operations of Waste Management Group including storage or disposal of Low Level solid waste, PCM and Medium Active beta-gamma waste on site. Also Support Manager (Services), providing technical and safety support to the Waste Management and Decontamination Services areas, now including currently the Waste Treatment Complex (WTC): currently commissioning manager for WTC phase I.

R (Robert) G THOMAS

Engineering Directorate, UKAEA Northern Division, based at Division HQ, Risley. Formerly at Safety and Reliability Directorate UKAEA and currently Principal Engineer leading the Waste Management Section of the European Demonstration Reprocessing Plant (EDRP) design team. Has responsibility for process and engineering design of both solid and liquid radioactive waste facilities, including PCM.

J D (Duncan) NEILSON

Industrial Chemistry Group, Chem. Eng. Division UKAEA, Harwell. Formerly at UKAEA, Dounreay engaged in active R&D work and waste management operations. Currently with Industrial Chemistry Group at Harwell as manager, solid waste treatment centre with responsibility for operations on PCM wastes and specification of new facilities now at the design stage. Secretary of the Sorting and Packaging Task Force which reports to the PCMWP.

S (Syd) D HUNTER

Chemical Technology Division, MOD, Aldermaston. Has been involved for over 25 years in the specification, design and operation of facilities handling plutonium in one form or another. Was engaged in fast breeder fuel element manufacture until the mid 70's and since 1978 has been Manager, Aldermaston Waste Management Group responsible for collection treatment storage and preparation for disposal of solids, and disposal of treated effluents. Current tasks are to improve the safety of existing facilities and to provide an operator input to the design of new waste treatment facilities now under construction (capital estimate around (£300M).

SYNOPSIS OF INDIVIDUAL PRESENTATIONS

The following is a synopsis of the individual presentations:

Monday, October 27, 1986

Morning Session - Overview and Status of Waste Management

C. Tanner - Overview of Recent U.K. Developments: Political and Regulatory

This opening presentation provided a snapshot of the current background against which specific projects for PCM waste management are being planned, designed, and built. Four topics were addressed:

(1) The report on Best Practicable Environmental Option (BPEO), commissioned by the Department of Environment following voluntary suspension of the NE Atlantic Sea Dump route, and published in March 1986. It was concluded that on grounds of cost and radiological impact, the Sea Dump route was BPEO for low-level PCM and significantly more attractive than any alternative. Continued suspension of this option was a political and not a technical decision.

(2) The report of the Parliamentary Select Committee on the Environment, published in May 1986, concluded "We are convinced that safe final disposal routes are available in the U.K. Indefinite storage presents unacceptable risks." Current experience, however, suggests that some decades may elapse before a repository suitable for PCM becomes available. The government response to this report was robust and supportive to the nuclear industry.

(3) The Seventh Annual Report of the Radioactive Waste Management Advisory Committee (June 1986) summarized an alternative approach to PCM waste management which seeks to recycle plutonium to the fuel cycle rather than commit large quantities to land repositories. A program of technical feasibility studies to this end is in hand.

(4) Recovery operations will generate secondary effluents requiring management. Discharge authorizations at Sellafield are becoming progressively more stringent. The alpha limit is 10 TBq per year from July 1986, applicable to the whole Sellafield site, and BNFL is committed to reduce this to 0.7 TBq per year in the early 1990's. Plutonium waste management operations are likely to be allocated 2% of these targets and Best Practicable Means (BPM) must be applied to reduce discharges ALARA below target levels.

J. Critchley - BNFL Status of Projects and Plans
U.K. Overview of Factors Influencing Facility Design

Facility design is influenced by a number of important factors such as costs, operational and maintenance considerations, decontamination, decommissioning, and not least, safety.

Safety consideration, however, must be a predominant factor and procedures have been set up within BNFL, UKAEA, and MOD to ensure that safety aspects are addressed and implemented.

Under the heading of safety, potential hazards are identified for both normal operating conditions and potential fault conditions.

Under normal operating conditions we need to limit:

1. External radiation to personnel.
2. Internal radiation to personnel.
3. Radiation exposure to the general public.

However, the attainment of the radiological targets for 1, 2, and 3 could be influenced by certain events, described as potential fault conditions such as:

a) Loss of containment
b) Loss of services
c) Criticality
d) Fire and Explosion
e) Extreme Environmental Conditions
f) Failure of Cranes, Lifting and Mechanical Handline Equipment

Since the possibility of such events cannot be entirely ruled out, they are the subject of probability risk assessment to ensure that the risk and consequence of such events is at an acceptable low level.

In the UK presentation which follows, we will review the relevant design criteria as applied to plants currently in design, construction or planned for the future. These are:

BNFL

WTC Phase I	Sorting, shredding and concreting plant for drummed PCM due to commence operation in 1988.
WTC Phase II	Size reduction plant for crated redundant PCM plant and equipment to commence design 1986/7 for operation in 1994.
Engineered Store	For drummed PCM arisings from WTC Phase I and from operating plants to commence design 1986/7 for completion by 1991.

UKAEA

Dounreay PCM Facility	Sorting, handling, drumming and storage of PCM from reprocessing operations. In operation since September 1980.
EDRP PCM Facility	Sorting, handling, volume reduction and storage of PCM from reprocessing and Pu oxide conversion operations. Due to commence operation in about 1996.
Harwell PCM Store	For the storage of shredded and sorted PCM in a non-concreted form. Due for completion late 1988.

MoD

Solid Waste Treatment Plant	Sorting, shredding and concreting plant for drummed PCM, planned for handover in 1990. Will have a small capability for Pu recovery.
Decommissioning (Size Reduction) Facility	Size reduction plant for crated redundant PCM plant and equipment scheduled for operation in the mid-1990's.

R. Thomas - UKAEA Status of Project Plans

PCM is generated from R&D operations at four UKAEA sites. Prior to the international moratorium on deep ocean disposal in 1983, much of the PCM arising could be disposed of via that route. Currently, the UKAEA has in hand a number of schemes in response to the increased requirements for PCM storage at its operational sites.

Harwell

A ventilated store is proposed to be operational by the end of 1987. This will provide capacity for 2000 200-litre drums stacked five high on an industrial racking system.

Dounreay

A PCM handling and drumming system has been in operation for six years, together with a remotely operated drum store which is currently 15% full. No volume reduction is practiced. Shredding equipment is to be provided in the near future, and supercompaction is currently under consideration.

Winfrith

Plans for a purpose-built PCM store are being prepared.

Windscale

It is proposed that PCM arisings will be sent to Dounreay for storage.

S. Hunter - UK Ministry of Defense Status of Projects and Plans

A review of AWRE waste treatment facilities was started in the late 1970's. In 1979, a decision was taken to provide a new plant to treat drummed waste. The stages are assay, sort, shred, and grout with a small capacity for recovery by incineration and washing. The preliminary stages suffered a 2-year hiatus while policy matters were resolved. In 1984, a contract was placed for the design of the plant. Construction is expected to start in this financial year with handover in 1990. Operations with R/A material from 1991.

The need to deal with large items of redundant plant is following on a later time scale. The Decommissioning waste treatment plant will reduce the size of the old plant items so that they can be accommodated in drums or possibly crates. This plant is expected to be handed over in the mid-1990's.

K. Wierzbicki - Overview of the Savannah River Plant

The Savannah River Plant (SRP) has developed a program to permanently dispose of newly generated and retrievably stored Transuranic (TRU) contaminated waste. This program will end interim storage of TRU waste at SRP and provide for permanent disposal of the waste in either low-level waste disposal at SRP or at the Waste Isolation Pilot Plant (WIPP). Two new facilities will be constructed to accomplish the objectives of this program: The Waste Certification Facility (WCF) and the Transuranic Waste Facility (TWF). The first phase of the WCF, which is currently in operation, verified through assay and x-ray, that 55-gallon drums of waste meet WIPP packaging requirements and segregated low-level waste and waste not meeting the criteria. The second phase of the WCF, which will be operational in 1987, will prepare drums for shipment and provide facilities to load drums into the transport container. The TWF will retrieve waste currently in storage and process that waste and the newly generated waste not meeting WIPP requirements. The facility, which is scheduled to be operational in 1994, will include facilities and equipment to size reduce, solidify and repackage waste.

D. Kudera - Overview of INEL Transuranic Waste Management Program and Facilities

This presentation gave an overview of the TRU waste management program and facilities at the INEL. The volume of waste disposed of and stored at the RWMC was presented as well as the various storage techniques used at the INEL in past years. The current programs to dispose of the TRU waste at the INEL were discussed. This included discussion of the SWEPP and PREPP facilities and a program for improved confinement of buried waste by in-situ grouting. Problems with permanent disposal of remote-handled and special-case waste were also discussed.

J. Warren - Overview of TRU Waste Processing at LANL

TRU solid waste inventories generation rates, characteristics, and origins were presented. The WIPP Waste Acceptance Criteria (WAC) requirements were discussed as they affected Los Alamos needs and plans for handling and processing TRU waste for WIPP. Facility requirements to meet these needs include (1) Size Reduction, (2) Controlled Air Incineration, (3) TRU Waste Preparation, (4) Nondestructive Examination/Assay (NDE/NDA), (5) TRU Waste Corregated Metal Pipe (CMP) Saw and Processing, and (6) Transportation. Operation and design of each facility and processes were discussed as waste flowing through the system was followed.

Monday, October 27, 1986

Afternoon Session - Relevant Design Criteria Used in Waste Processing and Handling

D. Swale - Summary of Project Procedure - The Plant Operators Viewpoint

The presentation aimed to give a brief outline of new (PCM) plant project procedures within BNFL, and incorporate within this outline the current BNFL safety standards and criteria for new plants. Safety standards were detailed in the following areas:

1) Normal Operating Conditions

--External and Internal Radiation Exposure to the Workforce
--Liquid Effluent Discharge Criteria
--Aerial Effluent Discharge Criteria

2) Potential Fault Conditions

--Accident Risk Criteria for all Potential Hazards
--Criticality Hazard Criteria
--Seismic Criteria

The formal and informal liaison between the Project Office, various specialist groups, and the plant operators throughout the flowsheeting, construction, installation, testing, and commissioning phases of a new project were emphasized to facilitate operability, maintenance, accountability, and eventual decommissioning of the plant in a safe and effective manner.

R. Thomas - UKAEA Facility Design Criteria

This presentation reviewed the criteria against which plants are designed in the UKAEA.

Radiological protection design criteria used by the UKAEA conform with the Ionizing Radiation Regulations 1985, which have statutory effect under the Radioactive Substances Act 1960, and with additional guidelines published by the National Radiological Protection Board. Use is made of cost benefit analysis where appropriate to assist in judging whether exposures are ALARP.

Radiological risks both to the public and the workforce due to accidents are designed to be no more than a small fraction of the respective routine radiological risks.

In principle, external hazards are included within the overall risk targets. The general approach is to ensure that they make no more than a small additional contribution to the plant risk.

Plants are designed with the aim of minimizing active waste arisings, and with the aim of facilitating decommissioning.

S. Hunter - UKMOD Facility Design Criteria

Although the Ministry of Defense is legally exempt from much of the legislation which regulates the civil nuclear industry, in practice, the MOD operates to similar standards. The prime document used to guide the safety aspects of the operations is entitled "Safety Assessment Principles for Nuclear Chemical Plant" published by HMSO for the HM Nuclear Installation Inspectorate of the Health and Safety Executive. The duty of the NII at AWRE is discharged by the Facilities and Projects Safety Approval Board chaired by an independent member of the AWRE Board of Management.

S. Mentrup - Processing of Transuranic Waste at the Savannah River Plant

Transuranic wastes at the Savannah River Plant (SRP) have been retrievably stored on concrete pads since early 1972. This waste is stored primarily in 55-gallon drums and large carbon steel boxes. Higher activity drums are placed in concrete culverts. In support of a National Program to consolidate and permanently dispose of this waste, a major project is planned at SRP to retrieve and process this waste. This project, the TRU Waste Facility (TWF), will provide equipment and processes to retrieve TRU waste from 20-year retrievable storage and prepare it for permanent disposal at the Waste Isolation Pilot Plant (WIPP) geological repository in New Mexico. This project is an integral part of the SRP Long-Range TRU Waste Management Program to reduce the amount of TRU waste stored at SRP. The TWF is designed to process 15,000 cubic feet of retrieved waste and 6,200 cubic feet of newly generated waste each year of operation. This facility is designed to minimize direct personnel contact with the waste using state-of-the-art remotely operated equipment.

Tuesday, October 28, 1986

Morning Session - Application of Design Criteria to Small Plants

J. Buckle - Application of Design Criteria to Small Facilities
BNFL Waste Treatment Complex Phase I

The presentation gave an indication of the application of design criteria to WTC Phase-I for normal and abnormal operating conditions together with solutions to the ever-present problems of maintenance and decommissioning of active plants. In particular, specific examples of design details of the process gloveboxes, ventilation system, MSM's, drum entry system, explosion prevention and material off-take from the process were given.

R. Thomas - Application of Design Criteria to Small Plants

This presentation reviewed the design of UKAEA small PCM plants.

PCM at Dounreay is transferred by La Calhene containers to a central handling glovebox in which it is transferred to 200-litre storage drums. Organic and inorganic materials are segregated at the point of origin. Extensive use is made of NDA systems based on passive neutron counters and segmented gamma scanners.

The European Demonstration Reprocessing Plant PCM handling facility will be based on the existing Dounreay facility design. Differences relate to the use in EDRP of 500-litre drums with perforated liners, and in the amount of shielding appropriate for the quantity and quality of material being handled. Shredding of soft material and crushing of filters will be practiced. Equipment will be provided within the glovebox for sorting and transporting material in order to minimize operator contact times.

S. Hunter - UKMOD Solid Waste Treatment Plant

This facility will accept drummed waste from backlog or from current arisings. The input and output drums will be assayed using high resolution gamma, spectrometry, passive neutron, and DDT systems. In an essentially hands-on manner, drums will be opened and the liners passed into the line where they will be cut open. Low soft Pu waste will be shredded and passed out to 500 litre drums containing baskets and subsequently filled with an OPC and PFA grout. Inorganic material will bypass the shredder into a separate drum. The recovery sections are small scale incineration of Pu rich cellulosic waste and washing of coarsely shredded rubber and plastic waste with alkaline and recovery of Pu on a filter.

J. Harper - Los Alamos Size Reduction Facility (SRF)

The SRF volume reduces and repackages metallic wastes such as gloveboxes, and has a current gram inventory of 150g weapons grade Plutonium, 10g of heat source Plutonium 238 or 15g Americuim-241. The SRF was built according to national building codes, the DOE order 6430.1 for general plants, ANSI N509 and N510, and the Nucelar Air Cleaning Handbook ERDA 76-21. It has a Final Safety Analysis Report and has been reviewed according to DOE/AL order 5481.1A. The glovebox enclosure houses a positioning table, an electromechanical manipulator, a hoist and a plasma arc cutting head. It is maintained at a negative 0.5 in.w.g. with respect to the building and it receives supply air from the building through HEPA filters. The building is maintained at a negative 0.25 in.w.g. with respect to the environment and air is exhausted through prefilters and a single stage HEPA filter bank. The plasma arc torch uses 20% hydrogen in argon as a primary gas, and water as compressed air as a secondary gas. Waster significantly reduces fumes generated and cools the areas being cut very rapidly. The enclosure is washed down every six months to facilitate entries required for repair or maintenance. All entries require the use of breathing air masks.

C. Warner - LANL TRU Incinerator

An overview of the design concepts for the Los Alamos Controlled Air Incineration Process (CAI) and the Treatment Development Facility (TDF) to assure the safety of the facility and protection of the public during normal operations and under accident conditions.

Areas of discussion included the concepts of containment and confinement of radioactive, toxic, and hazardous materials by structure, ventilation control, and air cleaning. Topics also included engineered safeguards such as automatic shutdown, redundant equipment utilities, and fire protection systems.

Multi-discipline reviews of safety analyses and operational requirements are conducted for major facility or operational changes. On-going operations and process modifications are reviewed internally by the Experiment Review Committee and the Design Review Committee. Representatives of the Safety Group (HSE-3) and the Health Physics Group (HSE-1) sit as members of these committees. Operating Instructions (OI's) are subject to approval by the Waste Management Group and Standard Operating Procedures (SOP's) are reviewed annually by the Health, Safety, and Environment Division.

The incinerator is permitted by the Environmental Protection Agency (EPA) Revision VI for the thermal destruction of polychlorinated biplenyls (PCB's) and has an interim permit from the New Mexico Environmental Improvement Division (EID) for the destruction of certain EPA listed Resource Conservation and Recovery Act (RCRA) compounds. Final EID permitting will allow the incineration process to address mixed waste treatment areas.

Tuesday, October 28, 1986

Afternoon Session - Application of Design Criteria to Large Plants

J. Buckle - Application of Design Criteria to Large Facilities: BNFL Waste Treatment Complex Phase-II

The presentation outlined the concept and design proposals for a facility to size reduce and package crated redundant plant and equipment. Detailed examples of philosophy with regard to operation, ventilation, maintenance, and decommissioning were given, together with an indication of the design principles for items of equipment to be included in the facility.

S. Hunter - AWRE Decommissioning Waste Treatment Plant

The presentation covered the program which is planned to bring this plant into operation in the mid-1990's, maintenance philosophy and the problem of assay of the fissile content of large gloveboxes comtaining heavy equipment. A series of photographs illustrated some of the tools being developed in the "mock-up" of a probable configuration of the main cell. The AWRE approach is based on cold cutting techniques and possible use of a hydraulic "cast crusher"; hot cutting methods in the UK are being developed by BNFL with whom AWRE shares the fruits of development.

B. Daugherty - Processing of Transuranic Waste at the Savannah River Plant

Transuranic wastes at the Savannah River Plant (SRP) have been retrievably stored on concrete pads since early 1972. This waste is stored primarily in 55-gallon drums and large carbon steel boxes. Higher activity drums are placed in concrete culverts. In support of a National Program to consolidate and permanently dispose of this waste, a major project is planned at SRP to retrieve and process this waste. This project, the TRU Waste Facility (TWF), will provide equipment and processes to retrieve TRU waste from 20-year retrievable storage and prepare it for permanent disposal at the Waste Isolation Pilot Plant (WIPP) geological repository in New Mexico. This project is an integral part of the SRP Long-Range TRU Waste Management Program to reduce the amount of TRU waste stored at SRP. The TWF is designed to process 15,000 cubic feet of retrieved waste and 6,200 cubic feet of newly generated waste each year of operation. This facility is designed to minimize direct personnel contact with the waste using state-of-the-art remotely operated equipment.

D. Charlesworth - Incineration at SRP; TWF Component Testing

Incineration is one of the processes available for transforming hazardous chemical and radioactive wastes into forms acceptable for final disposition. Because of the technical issues that must be solved before burning radioactive and hazardous materials (attainment, process control, remote operability, materials of construction, etc.), the Savannah River Plant has several demonstrations of incineration technology in progress.

The Beta-Gamma incinerator was designed to burn low-level solid waste and spent Purex solvent. This unit is in the second phase of development and has completed burning about 130,000 gallons of spent solvent. This experience is being used to design a large scale hazardous waste incinerator, which will burn solid and liquid hazardous chemical, mixed, and low-level radioactive waste in the early 1990's. Smaller scale incineration equipment is also being tested to investigate the feasibility of incinerating Transuranic waste and recovering Plutonium.

J. Stewart - DuPont SRP Pu Incinerator

Non-combustible Pu-238 and Pu-239 waste is generated as a result of normal operation and decommissioning activity at the Savannah River Plant and is being retrievably stored at the site. As part of the long-term plan to process the stored waste and current waste for permanent disposal, a remote size-reduction and material handling process is being tested at Savannah River Laboratory to provide design support for the plant TRU Waste Facility scheduled to be completed in 1993. The process consists of a large, low-speed shredder and material handling system, a remote work-table, a bagless transfer system, and a robotically controlled manipulator, or Telerobot. Initial testing of the shredder and material handling system and a cycle test of the bagless transfer system were completed. Initial Telerobot run-in and system evaluation was completed. User software was evaluated and modified to support complete menu-driven operation. Telerobot prototype size-reduction tooling was designed and successfully tested. Complete nonradioactive testing of the equipment is scheduled to be completed in 1987.

Wednesday, October 29, 1986

Morning Session - Application of Design Criteria to Storage Facilities

D. Kudera - INEL SWEPP Design Criteria

This presentation covered descriptions of the design criteria for the SWEPP facilities. These facilities are:

--The Drum Venting System
--The Swepp Examination Facilities
--The Certified and Segregated Waste
--Storage Building

The design criteria covered codes, standards, requirements, and documentation in the areas of safety, environmental compliance, quality control, utility and structural requirements. A brief description of the drum venting system was also included.

C. Cargo - INEL Process Experimental Pilot Plant (PREPP) Facility

PREPP, a facility to process TRU waste to meet the WIPP Waste Acceptance Criteria, is currently undergoing plant start-up and testing. Construction was completed in March 1986. The process consists of low speed shredding, incineration in a rotary kiln, separation of ash from coarse material, and cementing. All systems that support incinerator operation have been tested and the incinerator was recently heated up using propane to 1000 degrees F. Future tests will include the feed and discharge systems, grouting, and incineration of simulated waste at normal temperatures of 1700 degrees F. Work is continuing on modifications to improve alpha confinement and development of monitoring techniques for radiological and criticality control. The first experimental processing of contaminated waste is scheduled for FY-1988.

R. Thomas - Application of Design Criteria to Storage Facilities
Dounreay PCM Storage Facility (UKAEA)

This presentation reviewed the design and operation of the Dounreay PCM drum store. The store has received almost 1000 200-litre drums of PCM, operating fully remotely. The building is ventilated, operating at a depression, with single stages of HEPA filtration on inlet and extract. It is fully equipped with fire protection systems and criticality incident detection and alarm systems. Operations of the whole facility has resulted in very low contamination levels, so that no personal breathing protection equipment is necessary in any area.

D. Nielson - Harwell Storage Facility

The presentation describes in principle the design, construction and proposed mode of operation of a new store for plutonium contaminated material. It is anticipated that material will have to be held in the store for a period of at least 15 years. Most of the material will be held in 200-litre mild steel drums, but provision will be made for storing larger items. The drums are to be stacked in a warehouse racking system served by a manually operated aisle crane. In this way, it will be possible to inspect them in-situ and by retrieval, and also to withdraw them for redrumming if necessary.

The capacity of the store will be about 2000 drums and the fissile material inventory will be about 25 kg plutonium.

The building will not be continuously manned.

Particular attention is given to safety aspects.

J. Critchley - Application of Design Criteria to Storage Facilities

Due to the continued closure of the sea disposal route and in order to improve storage conditions for drummed and crated waste, BNFL has a requirement to provide additional storage on the Sellafield site.

In order to meet the latest design criteria, particularly in respect to radiation dose uptake to operating personnel and the public, it is likely that the store will require to be remotely operated. This would entail remote placement and recovery of drums, remote inspection and the provision for the over-drumming or redrumming of drums found to be defective. In order to limit the volume of unfiltered and unmonitored aerial effluent discharges to the environment, a building ventilation system would need to be installed with HEPA filtration for plenum and exhaust.

PRESENTATIONS, VISUALS, AND HANDOUTS

PRESENTATIONS, VISUALS, AND HANDOUTS

MONDAY, OCTOBER 27, 1986

OVERVIEW AND STATUS OF WASTE MANAGEMENT

AND

RELEVANT DESIGN CRITERIA USED IN WASTE PROCESSING & HANDLING

CHARLES TANNER, BNFL - UK GENERAL STATUS

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US/UK PCM INFORMATION EXCHANGE : OCTOBER 1986

Overview of recent UK developments

1. The intent of this presentation is to provide a snapshot of the current background against which specific projects for PCM waste management are being planned, designed and built.

The following topics are addressed.

(a) The Sea-dump route and Best Practicable Environmental Option Report (published March 1986).

(b) The Report of the Parliamentary Select Committee on the Environment (Rossi Report) and responses by Industry and Government (Published March 1986).

(c) The Civil Nuclear Industry Strategy for PCM waste management as summarised in the 7th RWMAC Annual Report (Published June 1986).

(d) Recent changes in discharge authorisations (effective 1 July 1986).

Best Practicable Environmental Option (BPEO) fo Management of Low and Intermediate Level Solid Radioactive Wastes

2. It will be recalled that a number of European Countries made use of sea dumping of solid wastes at a site in the NE Atlantic for a number of years up to and including 1982. Waste form and activity content conformed to the requirements of the London Dumping Convention, particularly the limit of 1 alpha Ci per tonne of packaged waste. Table 1 shows the weight and activity of waste dumped by the UK each year from 1955. (Note that packaging normally accounts for about 90% of the weight of each consignment). The total alpha activity disposed of in this way is almost 17000 Ci.

3. At the February 1983 meeting of the London Dumping Convention a resolution was passed calling for a voluntary suspension of sea-dumping operations pending the outcome of an international scientific review. In the same year NIREX (Nuclear Industry Radioactive Waste Executive) was prevented from carrying out a disposal operation through protest action by transport trade unions, which support the voluntary ban. The scientific evidence relevant to the safety of disposal of radioactive waste in the NE Atlantic was reviewed during 1984 by Professor Holliday at UK Government request. The Holliday Report, published in December 1984, recommended that dumping should not be resumed until the international review was completed and that meanwhile the UK Government should publish a comparative assessment of all storage and disposal options with a view to establishing the BPEO. Specifically the Holliday Report recommended that persistent plastics or other buoyant synthetic materials should be excluded from future sea dumping operations.

4. The BPEO study used a multi-attribute analysis procedure as recommended by IAEA and OECD/NEA to compare the options of sea disposal, deep land-based repositories, boreholes under the coastal sea-bed and long-term monitored storage on land. (The option of waste disposal in shallow engineered trenches was not regarded as appropriate for PCM, although this option was retained in the study for the disposal of other types of low level and intermediate level waste arising from nuclear power stations and reprocessing plant). To discriminate between management options the followng parameters were quantified and compared.

(i) costs
(ii) occupational radiological impact
(iii) individual and collective health risks to the public
(iv) collective doses to the public

5. The study concluded that sea disposal of low level PCM (consistent with the 1 alpha Ci per tonne limit imposed under the London Dumping Convention) was the BPEO. Deep land disposal of long level ILW, including PCM at levels greater than this limit, was considered essential, although site-specific assessments and engineering design would be necessary for the BPEO to be identified. Table 2 indicates the spread of costs and environmental impact for the disposal options for low level PCM.

6. Attention has already been drawn to the prohibition on buoyant plastics recommended in the Holliday Report and accepted by the UK Government. Plastics continue to cause difficulty because it has been shown that under certain conditions alpha radiation damage creates degradation products which link with plutonium as soluble chemical complexes which are mobile in groundwater. The environmental consequences for particular deep repository schemes are being assessed and experimental work is in hand to quantify the soluble complex problem.

Report of the Parliamentary Select Committee on the Environment

7. This report was published in May 1986 and covered the full range of radioactive wastes. It made recomendations for the categorisation, storage and disposal of wastes and called for review of reprocessing commitments which generate wastes. Some, but not all, of the specific recommendations are acceptable and government and the nuclear industry have responded accordingly. However the formal government response to these parts of the report which call for wide ranging reviews of nuclear fuel reprocessing (and for its termination of the outcome is less than favourable) has been robust and generally supportive to the nuclear industry.

8. In particular, the Reports first and main conclusion has been highlighted and welcomed by both government and nuclear industry: "We are convinced that safe final disposal routes are available in the United Kingdom. Indefinite storage presents unacceptable risks. On the other hand, any chosen disposal facility will require protracted periods of storage in the facility before final closure". Elsewhere the Report calls for research on a fully constructed deep geological site in the UK and suggests that such a site should be designated as an experimental facility, explicitly excluded from being a potential operational facility. The difficulties now being experienced by NIREX in obtaining access to four sites to conduct experimental drilling for assessment of their suitability for disposal of Low level waste

(ie. below the limit which defines PCM : 4 Bq per cm^2) does not provide confidence that a deep facility suitable for PCM disposal will become available on an early timescale.

Civil Nuclear Industry Strategy for PCM Waste Management

9. CNIS proposals are summarised in the 7th annual report of the Radioactive Waste Management Advisory Committee, an independent and authoritative committee whose function it is to advise ministers on major issues relating to the development and implementation of an overall policy for the management of civil radioactive waste.

10. The report notes that the Waste Treatment Complex now under construction at Sellafield was designed to sort PCM and package it for either sea disposal or long term storage pending disposal in a deep land repository. The sea dump route is not at present available and encapsulation of PCM in cement has been withheld due to uncertainty regarding packaging requirements in view of present doubts about the eventual disposal route for PCM. The unsuitability of Drigg is noted, as are the difficulties in segregating potentially buoyant plastics, which would become a requirement of the sea disposal route ever became available again. Adverse environmental effects consequent upon degradation of organic waste in a deep repository are being investigated and may make it necessary to place a limit on the concentration of organics in waste consigned to a land repository.

11. Although the technical need for reduction of plutonium in PCM waste destined for either sea or land disposal has not been established it is considered by the Civil Nuclear Industry that there may be advantages in doing this. A number of routes for plutonium retrieval from PCM are under study to establish their technical feasibility and the ranking order of cost and environmental impact, bearing in mind that the treatment of these wastes will generate secondary wastes and effluents and will entail dose uptake by operators and, to a degree the general public. These studies, now in progress, will enable decisions to be made in about 2 years time on whether plutonium removed from PCM is on balance justified. The amount which might be retrieved from PCM is of the order of a tonne. RWMAC and Regultory Bodies have given these proposals their support.

Recent Changes in Discharge Authorisations

12. BNFL is authorised by Regulatory Bodies to discharge wastes from the Sellafield site subject to conditions and limitations which have recently become more stringent in response to public pressure. In particular, the commissioning of plant which controls and reduces the level of radioactivity in discharges to the Irish Sea has provided the opportunity for Regulatory Bodies to impose new limits which reflect the capability of these plants. Moreover the discharge limits are now expressed on a 2-day and a quarter-year basis as well as an annual basis as previously.

13. The relevant limits for alpha activity are

0.3 TBq in a 2-day period
5 TBq in a quarterly period
10 TBq in an annual period

These limits apply to Sellafield site as a whole, where fuel reprocessing operations are expected to continue at around 1400 tu per year for Magnox (uranium metal) fuel and not less than 600 tu per year for LWR and AGR fuel (uranium oxide) during the 1990's. Local management allocates a proportion of the discharge limit to each major plant complex. The allowance for the Waste Treatment Complex is in fact one fiftieth of the total, ie 0.2 TBq per year.

14. It is a further condition that best practicable means (BPM) shall be used to control discharges to level below the specified limits. (BPM has a legal significance in terms of UK industrial case law). It can be seen therefore that the discharge authorisation places severe constraint on the selection of processes and plant to treat PCM, and discourages the adoption of processes liable to generate secondary effluents which will themselves require treatment before discharge.

15. It is to be noted that BNFL has undertaken to reduce alpha discharges in the early 1990s to about 0.7 TBq per year. The allocation of targets to individual plants has yet to be made but it would be reasonable at this time to expect an order of magnitude reduction to apply to the WTC plants (comparing future performance with current authorised limit). When the time comes it may be expected that Regulatory Bodies will adjust their authorised limits downwards, reflecting BNFL success in ~~retrieving~~ achieving its stated discharge targets. Thus it seems likely that WTC plants will be constrained to discharge not more than 0.02 TBq (alpha) per year.

Sea disposal of low-level radioactive waste by the United Kingdom, 1955–82

Year	Weight (tonnes)	Activity (a) alpha	(curies) (b) beta/ gamma*
1955	2617	47	77
1956	1038	44	33
1957	5941	1064	969
1958	3705	753	1142
1959	1198	4	74
†1960	2551	74	218
1961	6327	583	1938
‡1962	1697	22	239
1963	7352	371	7115
1964	4392	444	15 090
1965	1759	114	13 754
1966	1044	78	2742
1967	722	91	1682
1968	3164	731	74 837
1969	1878	390	17 590
1970	1674	233	20 224
1971	1434	323	8615
1972	1885	674	19 049
1973	1453	739	11 641
1974	1256	399	94 126
1975	1350	704	52 481
1976	2269	789	49 777
1977	2140	930	74 830
1978	2080	814	69 307
1979	2014	1381	81 080
1980	2693	1791	106 079
1981	2517	2032	104 709
1982	2697	1264	101 512

* including tritium.
† includes 289 tonnes from Belgian sources.
‡ includes 438 tonnes from Belgian sources.

Economic and Radiological Impacts of Different Management Options for Plutonium Contaminated Material (At a Level Suitable for Sea Disposal)

Impact parameter	Management option: Sea disposal	Shallow burial	Engineered trench disposal (10 yr storage)	Deep cavity disposal (15 yr storage)	Deep cavity disposal (45 yr storage)	Off-shore borehole disposal (15 yr storage)	200 yr storage then deep cavity disposal
COST (£M (1985))							
storage cost	0	Not assessed because of activity constraints		17	20	17	78
disposal cost	4.1			23	23	23	23
OCCUPATIONAL DOSE (man Sv)							
storage	0			0.4	0.9	0.4	1.8
disposal	0.3			0.7	0.5	0.03	0.3
SHORT-TERM EXPECTATION VALUE OF COLLECTIVE DOSE TO THE PUBLIC (man Sv)							
from storage	0			0.0015	0.0045	0.0015	0.02
LONG-TERM COLLECTIVE DOSE (man Sv)							
Local							
up to 1000 y	<0.01			0	0	0	0
100 to 10,000 y	<0.01			0	0	0	0
beyond 10,000 y	<0.01			inland 4.0	4.0	<0.01	4.0
				coastal <0.01	<0.01		<0.01
Regional							
up to 1000 y	<0.01			0	0	0	0
1000 to 10,000 y	<0.01			0	0	0	0
beyond 10,000 y	<0.01			inland 0	0	<0.01	0
				coastal 0.02	0.02		0.02
Global							
up to 1000 y	<0.01			0	0	0	0
1000 to 10,000 y	<0.01			0	0	0	0
beyond 10,000 y	0.6			inland 0	0	<0.01	0
				coastal 0.04	0.04		0.04
MAX INDIVIDUAL RISK IN A YEAR (y^{-1})							
Radionuclide migration	9.8×10^{-15}					3.6×10^{-14}	
– inland site				2.1×10^{-12}	2.1×10^{-12}		2.1×10^{-12}
– coastal site				3.1×10^{-15}	3.1×10^{-15}		3.1×10^{-15}
Intrusion	3.2×10^{-14}			3.2×10^{-8}	3.2×10^{-8}	3.2×10^{-8}	3.2×10^{-8}

JERRY CRITCHLEY, BNFL - STATUS OF PROJECTS AND PLANS
UK OVERVIEW OF FACTORS INFLUENCING
FACILITY DESIGN

Engineered Store

For drummed PCM arisings from WTC Phase I and from operating plants to commence design 1986/7 for completion by 1991.

UKAEA

Dounreay PCM Facility

Sorting, handling, drumming and storage of PCM from reprocessing operations. In operation since Sept 1980.

EDRP PCM Facility

Sorting, handling, volume reduction and storage of PCM from reprocessing and Pu oxide conversion operations. Due to commence operation in about 1996.

Harwell PCM Store

For the storage of shredded and sorted PCM in a non concreted form. Due for completion late 1988.

MoD

Solid Waste Treatment Plant

Sorting, shredding and concreting plant for drummed PCM, planned for handover in 1990. Will have a small capability for Pu recovery.

Decommissioning (Size Reduction) Facility

Size reduction plant for crated redundant PCM plant and equipment scheduled for operation in the mid 1990's.

R J Critchley

16 October 1986

However, the attainment of the radiological targets for 1, 2 and 3 could be influenced by certain events, described as potential fault conditions such as:

Loss of containment

Loss of services

Criticality

Fire & Explosion

Extreme Environmental Conditions

Failure of Cranes, Lifting and Mechanical Handling Equipment

Since the possibility of such events cannot be entirely ruled out, they are the subject of probability risk assessment to ensure that the risk and consequence of such events is at an acceptable low level.

The UKAEA is exempt from the nuclear site licence requirements of the Nuclear Installations Act 1965 (as amended), and therefore does not require to seek approval from the Nuclear Installations Inspectorate of the design and operation of its plants. However a Direction issued in 1960 under Section 3 of the UKAEA Act 1954 has the effect of requiring the UKAEA to operate its nuclear installations so far as practicable in accordance with safety requirements equivalent to those imposed on licenced sites by the Health and Safety Executive.

The proposed European Demonstration Reprocessing Plant, however (referred to later in the presentation) is a joint venture between the UKAEA and BNFL together with European partners and will be subject to NII licensing requirements.

The Secretary of State for Defence is responsible for the work at Aldermaston which is not subject to inspection by the Nuclear Installations Inspectorate and is exempt from the Radioactive Substances Act of 1960.

In practice however exempt Departments of State are expected to conform to similar standards to those imposed by the Regulatory Bodies for civil establishments. For example, where BNFL is subject to an Authorisation of a discharge level by MAFF and DoE, the MoD at Aldermaston negotiates an Agreement with these bodies. The function of the NII is undertaken internally by a Facilities and Projects Safety Approval Board, which is chaired by the Safety Member of the Aldermaston Board of Management. This is not dissimilar to the UKAEA position.

In the UK presentation which follows, we will review the relevant design criteria as applied to plants currently in design, construction or planned for the future. These are:-

BNFL

WTC Phase I	Sorting, shredding and concreting plant for drummed PCM due to commence operation in 1988.
WTC Phase II	Size reduction plant for crated redundant PCM plant and equipment to commence design 1986/7 for operation in 1994.

Notwithstanding the above, safety considerations however must be a predominant factor influencing facility design and particular procedures have been set up within the UK, and within BNFL in particular, to ensure that safety aspects are addressed and implemented.

Within the UK there are three organisations charged with the responsibility for design, construction and operation of plants for the processing of transuranic materials. These are the United Kingdom Atomic Energy Authority (UKAEA), British Nuclear Fuels plc (BNFL) which has its origins in the UKAEA, and the Ministry of Defence (MoD).

BNFL, as a civil organisation, is licensed under the Radioactive Substances Act 1960 to operate nuclear installations on the various sites. The watchdog body, who monitor BNFL's compliance with the conditions of the site licence are the Nuclear Installations Inspectorate (NII) who are part of the Health and Safety Executive which in turn report to the Government's Department of the Environment. (Nuclear Installations Act 1965).

Laid down procedures require designers and operators of nuclear installations to produce relevant documentation during the design, construction, commissioning and operations of plant. This documentation includes a Specification which is also passed to NII. This, plus any supporting documents referenced in the Specification, give NII the opportunity to examine plant proposals and, when satisfied, to grant notification of no objection to construction. Notification of no objection to commissioning and ultimately, consent to operate the plant are granted later following the submission of further documentation.

Within this documentation, particular weight is given to design and operational safety measures. We need to demonstrate to the Regulatory Bodies that due consideration has been given to the safety arguments before design has proceeded too far. This is achieved by comparing the safety features of the plant against our own established safety criteria and by following our own Reprocessing Engineering Division project procedures which ensure, for instance, that a Functional Specification (FS) for a proposed plant is prepared and endorsed by a formally constituted Safety Working Party. Alternative processes to satisfy the Functional Specification are then subjected to a HAZOP I study to eliminate the potentially less safe practices and a Preliminary Design Safety Appraisal (PDSA), showing how the designer intends to meet the Functional Specification, is also prepared and subsequently endorsed by the Safety Working Party. In addition to the FS and PDSA, all formal safety documents are accepted by Safety Working Parties and subsequently sent to the NII.

Under the headings of safety, potential hazards are identified for both normal operating conditions and potential fault conditions.

Under normal operating conditions we need to limit:-

1. External radiation to personnel

2. Internal radiation to personnel

3. Radiation exposure to the general public.

This can be achieved, for example, by the provision of shielding, adequate primary and secondary containment, and control of aerial and liquid effluent discharges respectively, within authorisations issued by MAFF and DoE.

WORKSHOP ON FACILITY DESIGN

Held under the UKAEA/USDOE LMFBR Technology Exchange Agreement, Albuquerque

October 1986

UK OVERVIEW OF FACTORS INFLUENCING FACILITY DESIGN

by

R J CRITCHLEY

The information in this presentation is largely drawn from BNFL experience and practice. Where information applies to other establishments within the UK, this is indicated.

In discussing the topic of Facility Design, as applied to plants dealing with plutonium contaminated material (PCM) at this Workshop, we recognise that such design is influenced by a number of important factors such as costs, operational and maintenance considerations, decontamination and decommissioning and, not least, safety.

Costs, which could be said to be an obvious factor influencing facility design may be largely determined by the ultimate choice of flowsheet for the plant process which in turn, is likely to have been selected based mainly on safety considerations. Consequently, for the purpose of our presentation, cost aspects have been relegated to the normal economics of design, manufacture, construction and installation and have not been included in our presentations.

Operation and maintenance philosophy significantly affect facility design. Whether, for instance, a plant will be designed for remote operation, with "hands on" maintenance will often be a conscious safety consideration. Nevertheless, within the UK there is a considerable reservoir of experience of operation and maintenance activities and, in order to ensure that this experience is included in the proposed designs, close communication between design staff, operators and maintenance personnel is maintained throughout the design, construction, installation and plant testing stages.

There is an increasing awareness of the problems likely to be encountered during the decommissioning phase of redundant plant. Consequently new plant proposals now require a decommissioning philosophy to be included. It is our experience that in carrying out a plant decommissioning study to facilitate eventual plant decommissioning, the plant design has been improved, particularly in the areas of plant maintenance. Other examples include the provision for local lifting beams, segregation of services from active areas, and ultimately the potential reduction of the quantity of PCM for disposal.

ROBERT THOMAS, UKAEA - STATUS OF PROJECTS AND PLANS

STATUS OF UKAEA PROJECTS AND PLANS

Harwell

PCM is sorted, with soft waste being shredded, in a pressurised suit enclosure. Until 1983, the waste was then enclosed in a concrete jacket for sea disposal.

The backlog is now about $150m^3$, of which about two thirds by weight is combustible. 50% of the total (by weight) is PVC. Arisings of raw waste are about $50m^3$ pa.

A ventilated store is now proposed, to take 2000 200 l drums stacked 5 high on an industrial racking system, with retrieval by an aisle crane. This is due to be operational by the end of 1987.

Financial provision has been made for a PCM immobilisation plant at about the turn of the decade, but the specification for this awaits NIREX decisions. In view of the continuing uncertainty about the organics issue, financial provision has also been made for a PCM incinerator in the first half of the 1990s.

Dounreay

Dounreay generates and handles wastes of all categories. Those in the low β category are subdivided as follows, reflecting the disposal authorisation for LLW (Slide 3).

Category	m Ci/m^3 α	m Sv/h
LLW	< 20	< 7.5
PCM	> 20	< 7.5

PCM waste is sorted and segregated at source into combustible (80%) and incombustible, and transferred to the central PCM handling facility in 25 l (270 mm diameter) La Calhene containers.

NDA systems, based on BF_3 passive neutron counters and segmented gamma scanners, are used routinely to maximise recategorisation of waste to LLW.

The waste is repacked to 200 l drums in the handling facility (2 categories: combustible and incombustible). According to the Pu content, the drums are consigned to either:

a. Shallow land burial at Dounreay (LLW) (about 30% of suspect PCM is able to be reclassified as LLW) (Slide 13), or

b. Sea disposal (65% of arisings), or

c. Retention in the PCM store if the Pu content is too high for (b) (5% of arisings).

Dounreay arisings of PCM are about $16m^3$ pa. At present, the PCM store (capacity 5000 x 200 l drums) is about 5% full. However the moratorium on sea dumping, and the transfer of about 6600 x 200 l drums of UKAEA - attributable PCM from Sellafield to Dounreay means that the store will be full by 1990.

No shredding of the combustible component is practised at present. Shredding equipment will be provided soon, and may then extend the life of the store to about 1995. A further store will then be required if national disposal facilities are not available.

Winfrith

Winfrith PCM up to 1982 was sent for sea disposal (via Harwell, after package preparation at Winfrith) where it met the IAEA activity criteria, or else was retained at Winfrith. Ad hoc provision is currently made for retaining all this material on site (in the Fissile Material Store), and there are plans for a purpose-built store in due course.

Windscale

Until recently, Windscale PCM was handled by BNFL Sellafield. Present proposals are that the 200 l drums will be sent to Dounreay for storage. Current arisings are about $20m^3$ pa.

SID HUNTER - UK MINISTRY OF DEFENSE STATUS OF PROJECTS AND PLANS

"ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON: STATUS OF PROJECTS AND PLANS FOR SOLID WASTE TREATMENT PLANTS"

Atomic Weapons Research Establishment

Aldermaston

Status of Projects and Plans for

Solid Waste Treatment Plants.

History

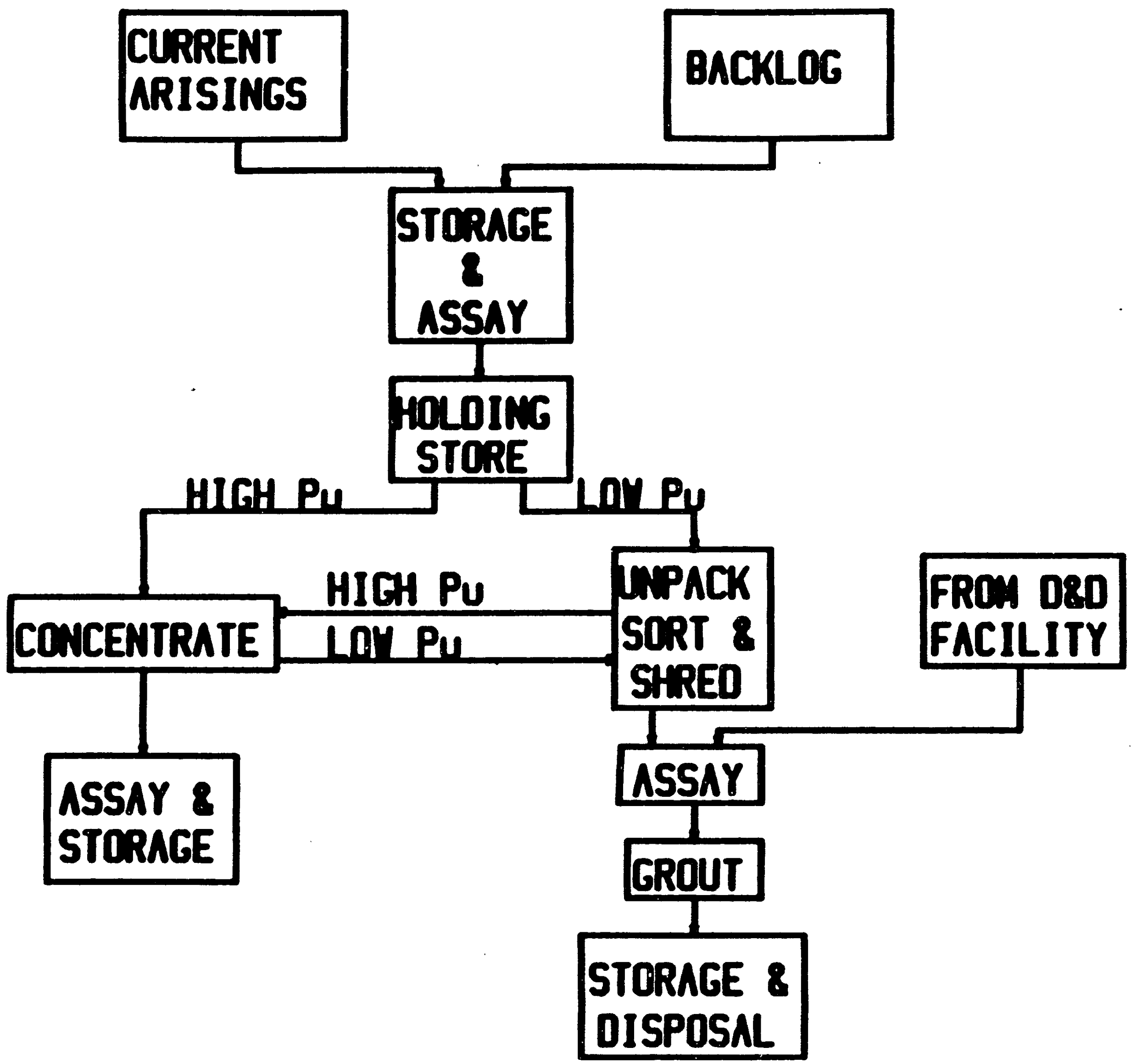
1976 Review of the existing arrangements.

1979 Decision to proceed with a plant to sort, shred and grout for sea dumping.

1982 Last sea dump in north east Atlantic.
Decommissioning and size reduction being addressed.

Solid Waste Treatment Plant

1979–84	Definition of requirements.
1984	Contract placed for design of the plant, Foster Wheeler Energy Ltd.
	In parallel, development of boxline transfer system, Xray, shredder, washing and incineration.



SWTP, A89. 3, SIMPLIFIED BLOCK FLOW DIAGRAM

Solid Waste Treatment Plant - mid 1986

Building approx. 40m x 41m.

Process plant on two floors.

Services on third floor.

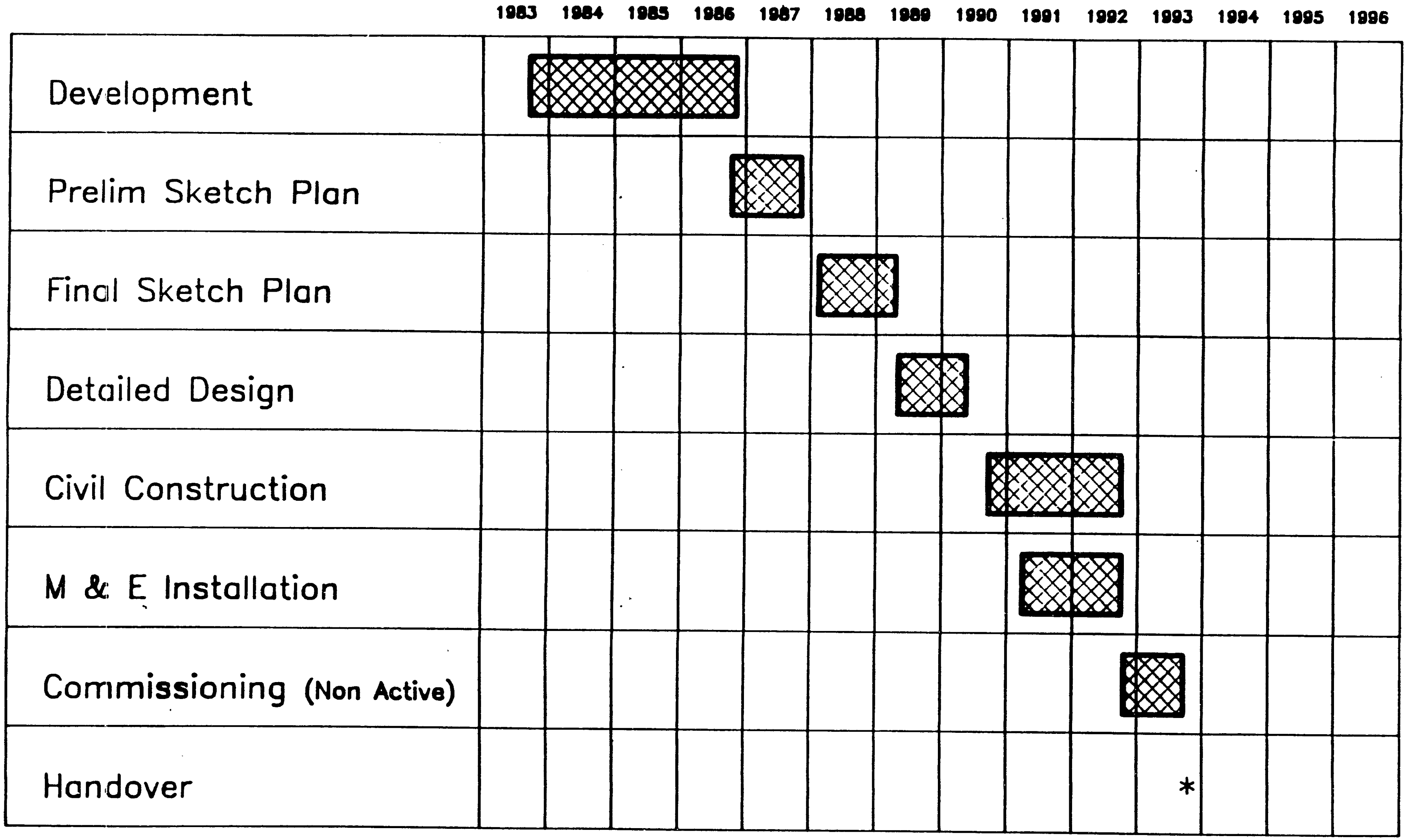
Throughput 55 tonne/year.

Development items substantially complete.

Cost = 27.5 million Pounds Sterling
40 million Dollars U.S.

Handover 1990

DECOMMISSIONING WASTE TREATMENT PLANT PROGRAMME



Decommissioning Waste Treatment Plant

Cost = 63 million Pounds Sterling

- based on an early estimate from the User Requirement Study

Handover - 1993 but likely to fall back to 1995

KIM WIERZBICKI - SRP

SAVANNAH RIVER PLANT
TRU WASTE MANAGEMENT PROGRAM

SAVANNAH RIVER PLANT
TRU WASTE MANAGEMENT PROGRAM

K. S. WIERZBICKI

OCTOBER 27, 1986

TRU WASTE STORAGE HISTORY

PERIOD	EVENT
1953–1964	ALL CONTAMINATED WASTE BURIED IN TRENCHES
1965–1974	SEGREGATED INTO NONRETRIEVABLE AND RETRIEVABLE (>0.1 Ci/PKG PUT IN CONCRETE CONTAINERS OR ENCAPSULATED IN CONCRETE MONOLITHS)
1974–PRESENT	>10 nCi/g SEGREGATED AND STORED

TRU WASTE ISOTOPES

- Weapons Grade Plutonium- Pu-239

Pu-239	94 %
Pu-240	6 %
Pu-238, 241, 242, AM-241	< 1 %

- Heat Source Plutonium- Pu-238

Pu-238	83 %
Pu-239	17 %
Pu-240, 241	< 1 %

- Other

  Cm-244, Am-241, Np-237, Cf-252

TRU WASTE INVENTORY

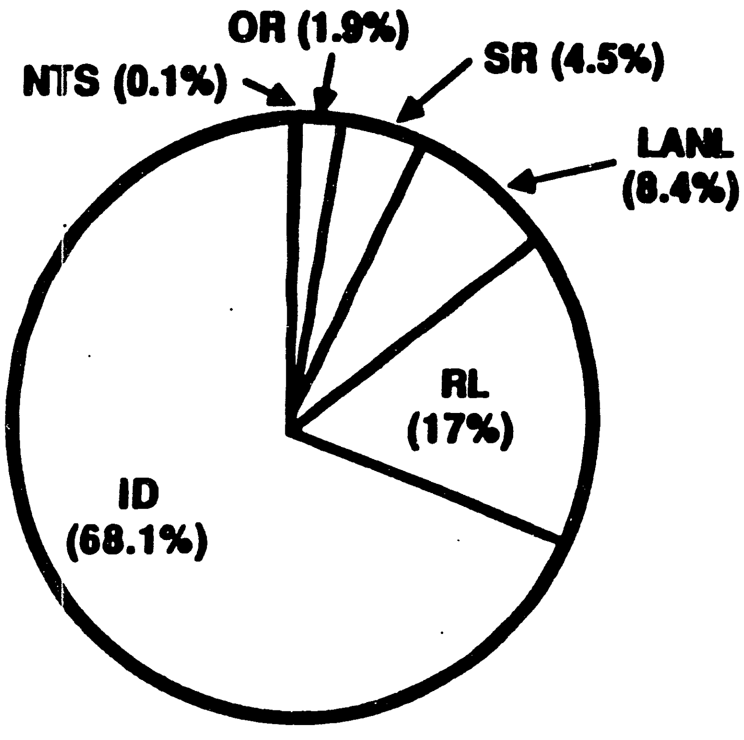
(12/31/85)

	VOLUME (FT^3)	ACTIVITY (Ci)
Pu-239	69,476	35,379
Pu-238	54,880	514,942
Other	19,467	22,991
Total	143,823	573,312

Projected Yearly Generation Rate: 30,000 ft^3

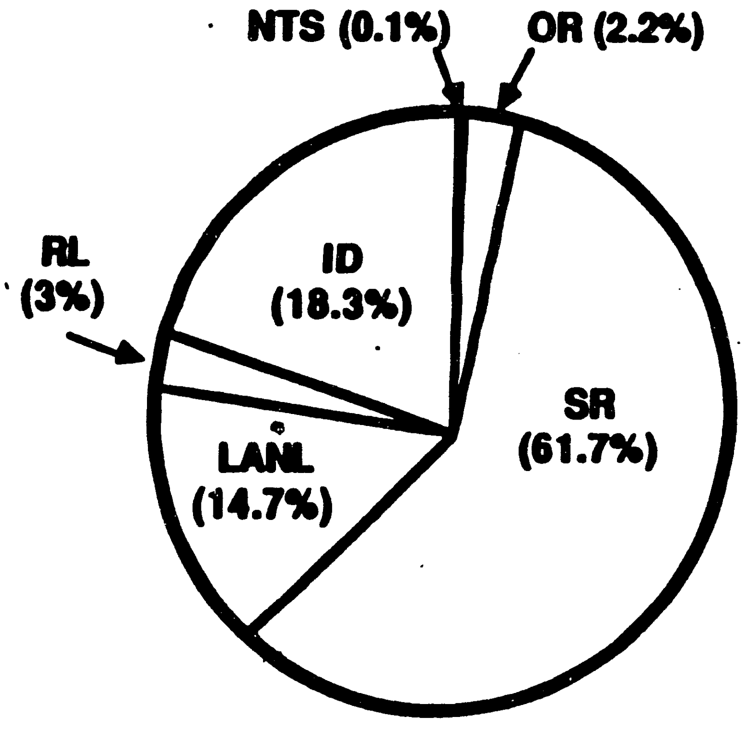
TRANSURANIC WASTE INVENTORY

VOLUME AT SITES
(75,000 m^3 total)



RICHLAND	RL
SAVANNAH RIVER	SR
IDAHO	ID

RADIOACTIVE CONTENT
(942,000 Ci total)



LOS ALAMOS	LANL
OAK RIDGE	OR
NEVADA TEST SITE	NTS

TRU WASTE STORED ON CONCRETE PADS

(12/31/85)

CONTAINER	NUMBER
55-Gallon Drums (< 0.5 Ci)	10,291
Culverts	452
55-Gallon Drums (> 0.5 Ci)	4,873
Polyethylene Boxes	488
SRL Casks	122
Metal Boxes	108
Other*	63

* Plexiglass, Fiberglass & Concrete Boxes

PERMANENT TRU WASTE DISPOSAL

$\geq$ 100 nCi/g	Waste Isolation Pilot Plant (WIPP)
$<$ 100 nCi/g	Low Level Waste Disposal

SR TRU Program Objectives:

- Phase out indefinite storage
- Dispose of SR TRU waste

TRU WASTE MANAGEMENT FACILITIES

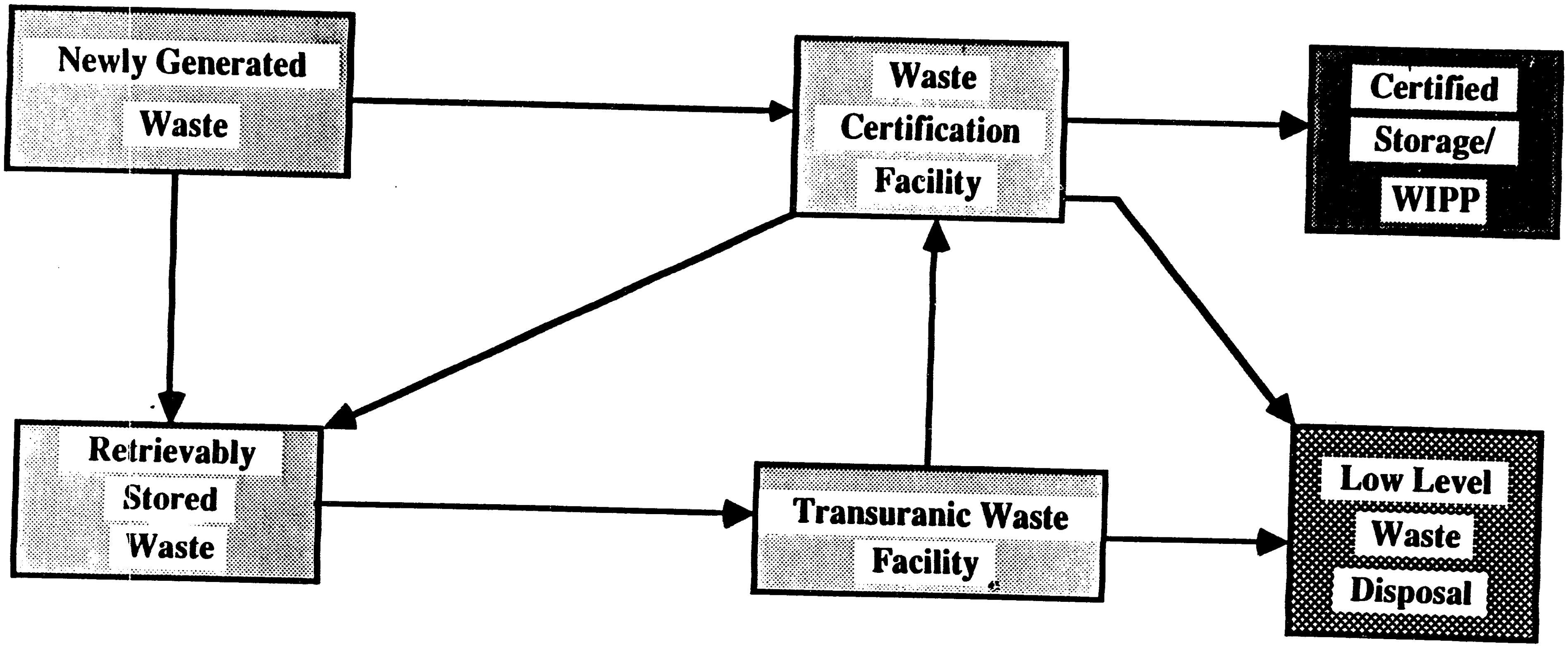
Waste Certification Facility (WCF)

- Certify waste for shipment to WIPP
- Identify LLW and waste requiring further processing
- Prepare drums for shipment

TRU Waste Facility (TWF)

- Retrieve and process stored waste
- Process noncertifiable newly generated waste

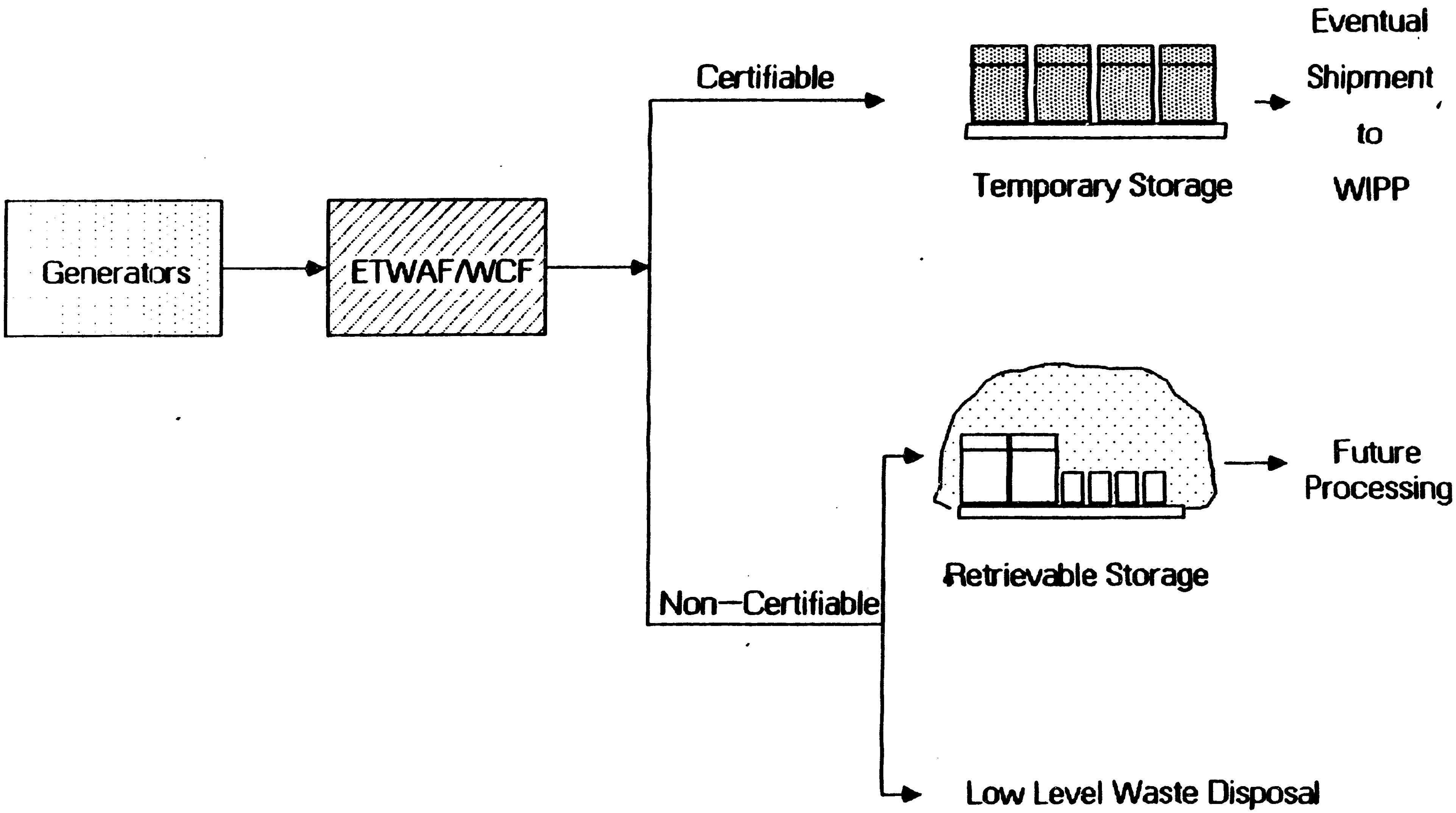
SRP TRU WASTE MANAGEMENT PLAN



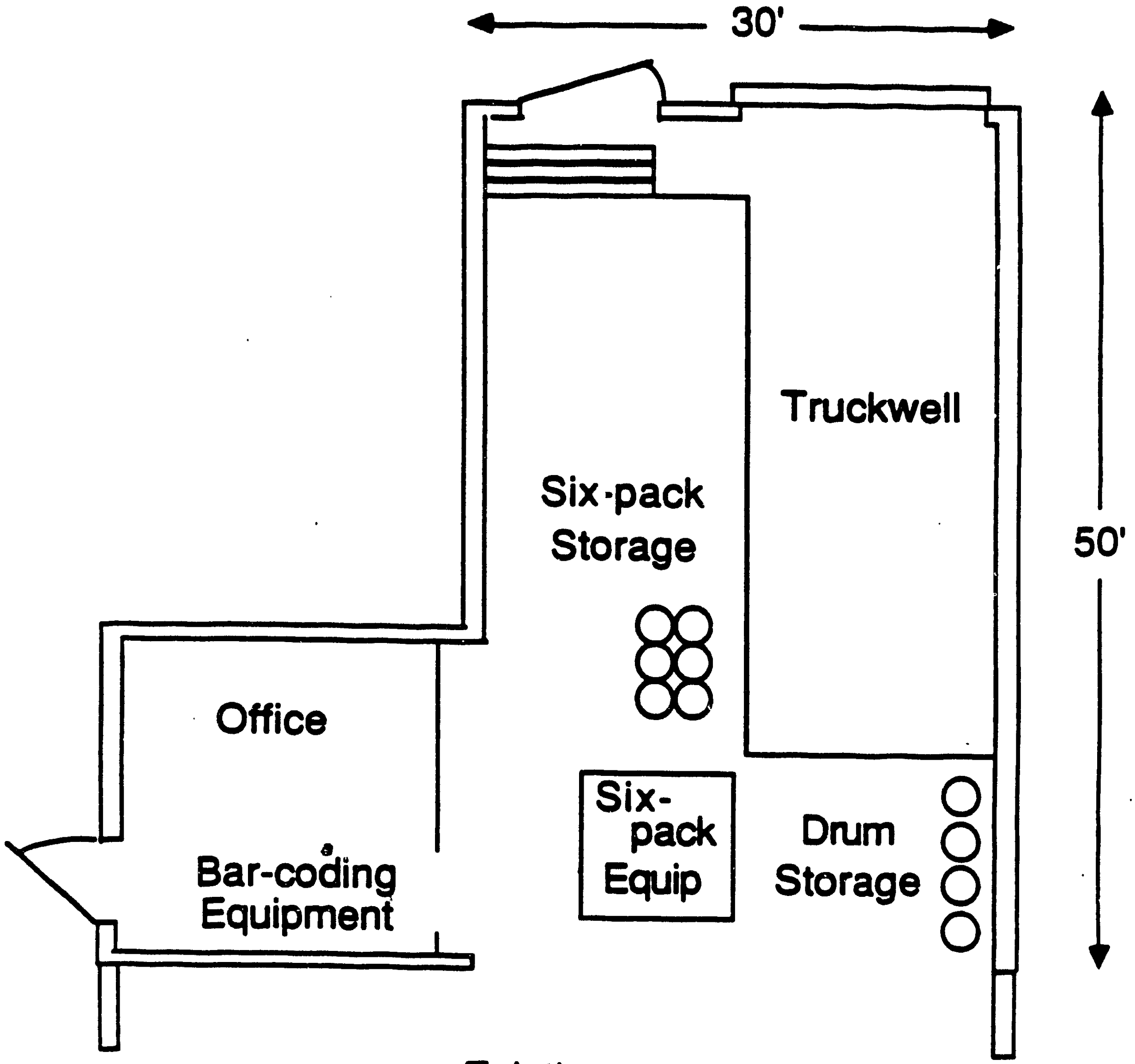
SR OBJECTIVES FOR NEWLY GENERATED TRU WASTE

- Package certifiable waste
- Transfer waste to disposal site
- Reduce waste generation

NEWLY—GENERATED TRU WASTE



WASTE CERTIFICATION FACILITY



Existing
Experimental Transuranic Waste Assay Facility

DON KUDERA - INEL

TRANSURANIC WASTE MANAGEMENT PROGRAM AND FACILITIES

Idaho National Engineering Laboratory

Transuranic Waste Management Program and Facilities

T. L. Clements, Jr.

EG&G Idaho, Inc.

C6 1136

A major objective of the U.S. Department of Energy Nuclear Waste Management Program is safe management of defense-generated transuranic (TRU) waste.

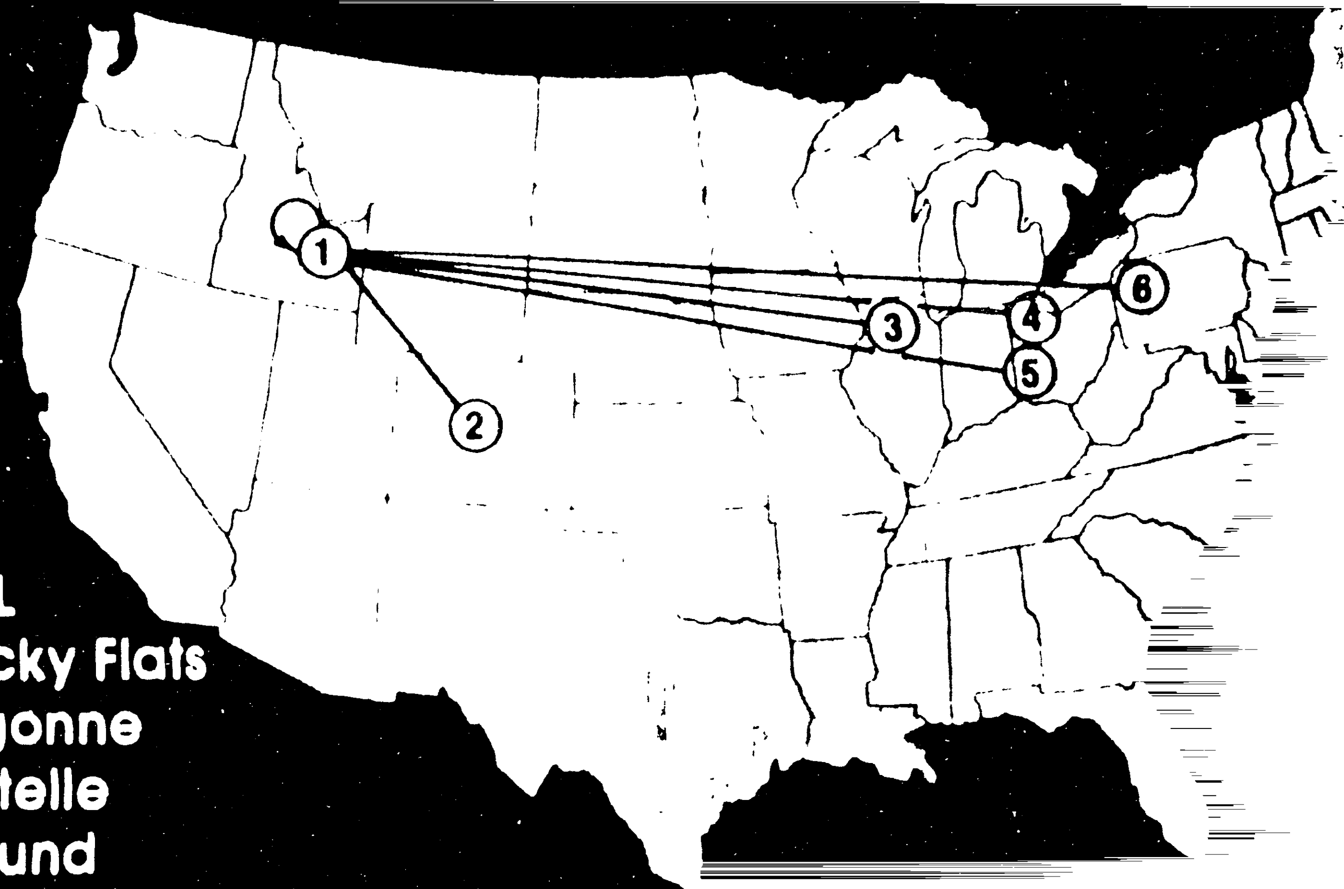
This presentation gives an overview of the Transuranic Waste Management Program and facilities at the Idaho National Engineering Laboratory.

C8 1137

Since 1954, the Idaho National Engineering Laboratory has served as a major burial and storage site for defense-generated TRU wastes.

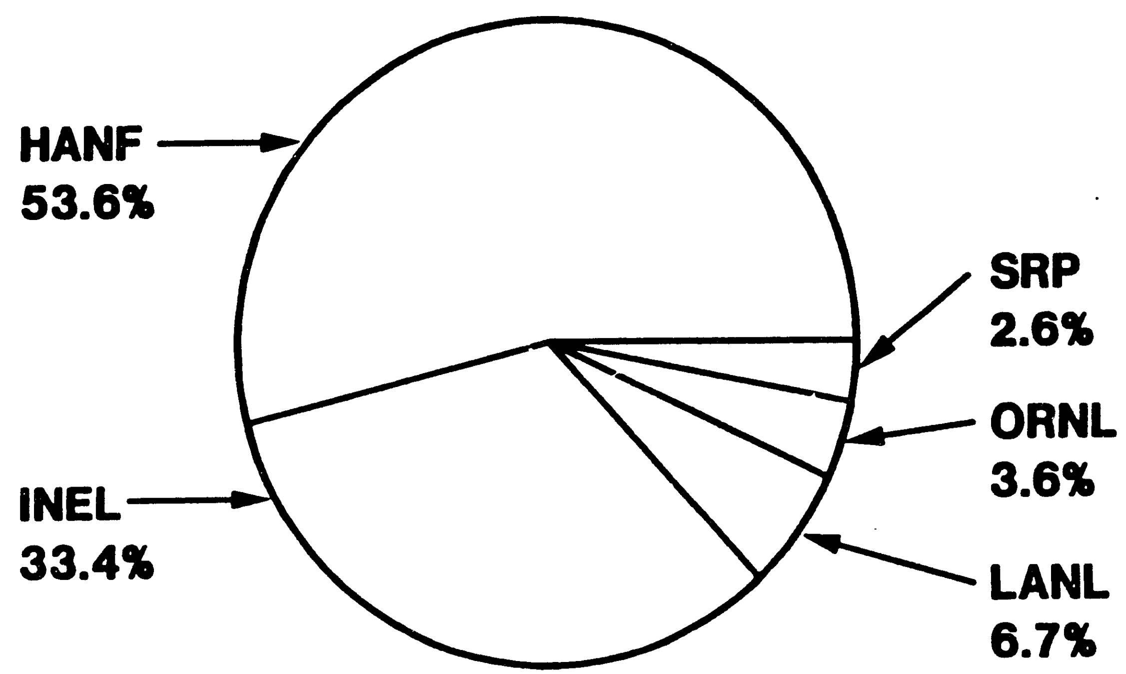
C6 1138

INEL TRU waste comes from several defense and research operations



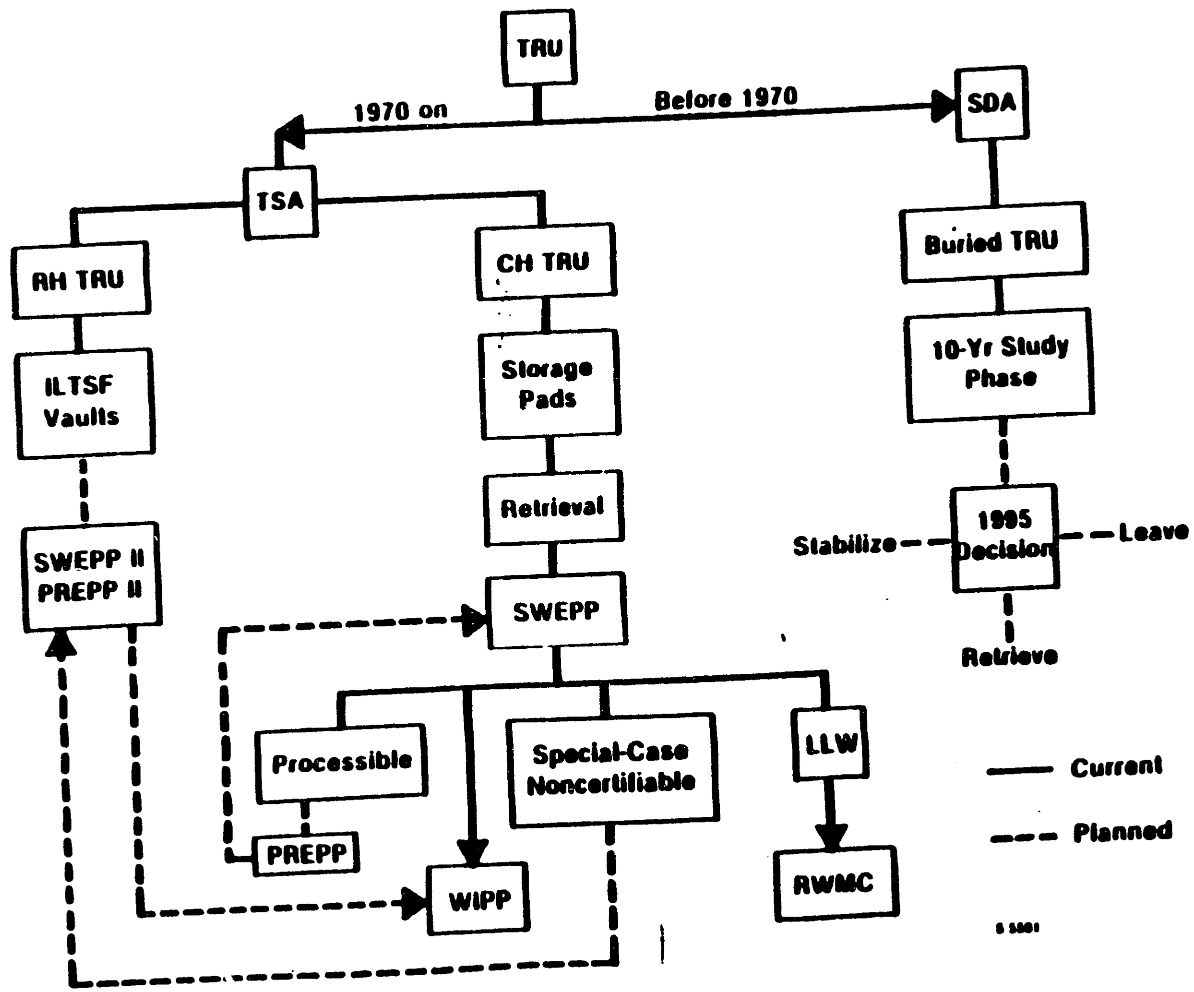
1 INEL
2 Rocky Flats
3 Argonne
4 Battelle
5 Mound
6 Bettis

Prior to 1970, over 2.0 million cubic feet of TRU waste were disposed of by shallow-land burial.

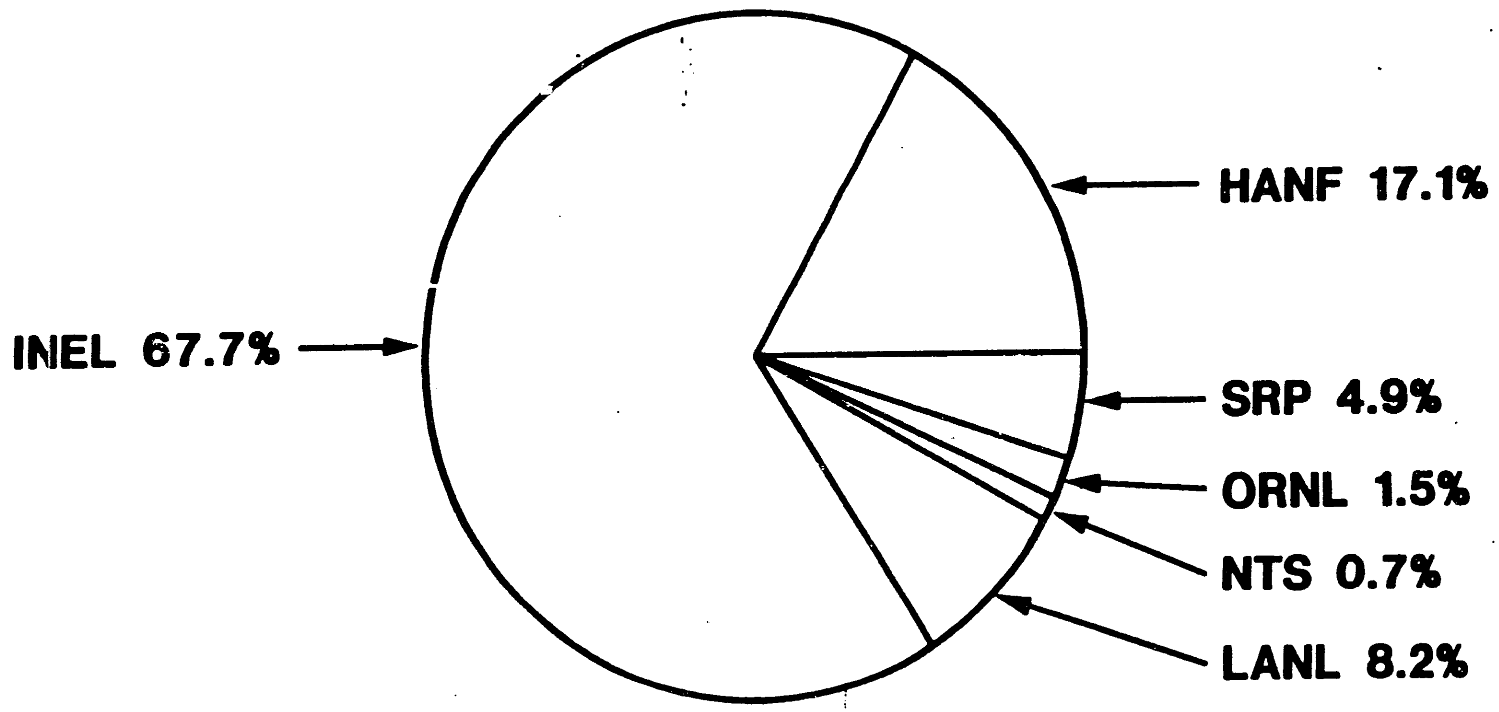


C6 1139

TRU Waste Management Programs



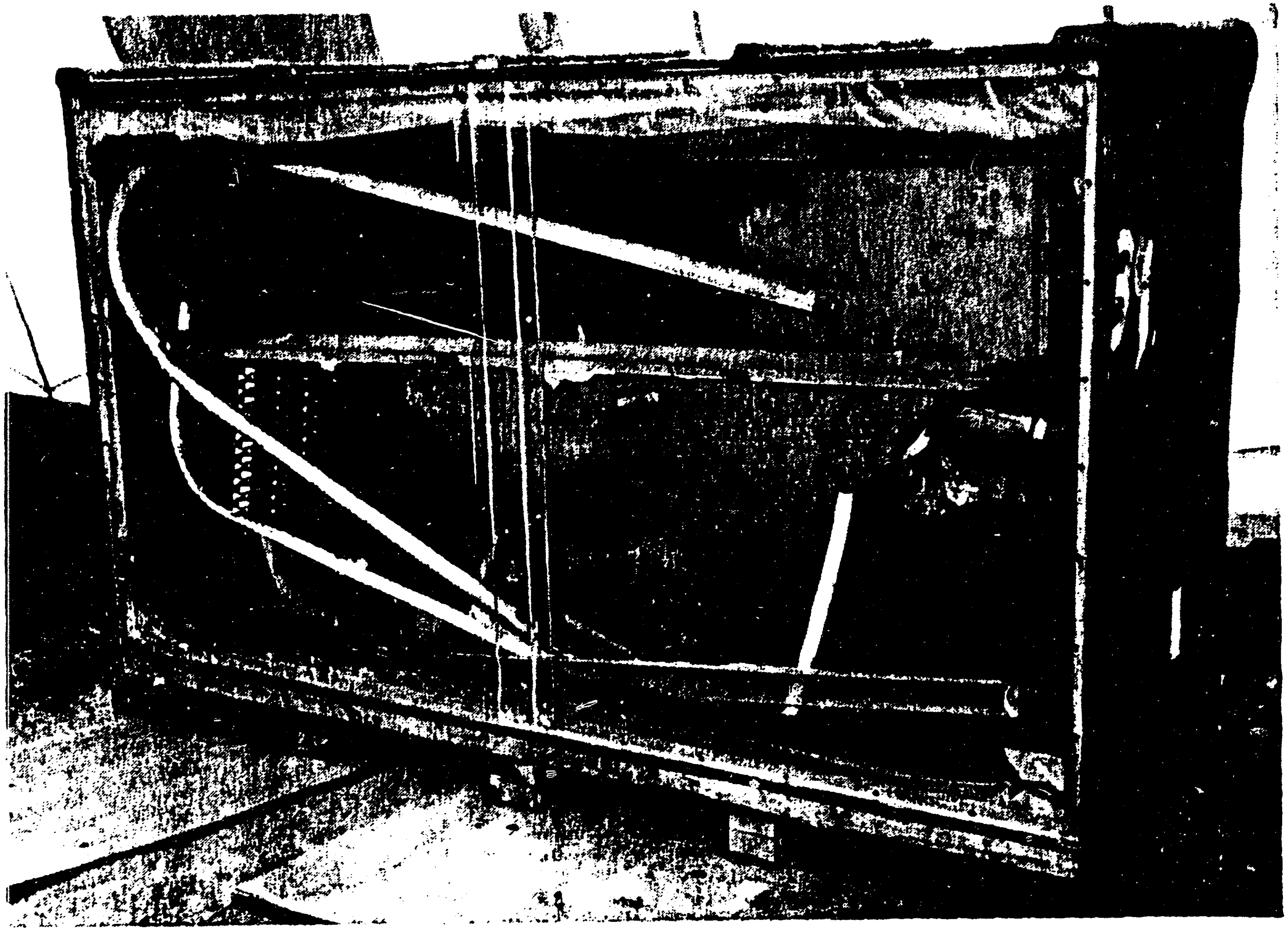
Since 1970, over 2.1 million cubic feet of TRU waste have been placed in aboveground retrievable storage.



C6 1140

Fifty-five-gallon drums of TRU waste contain protective clothing, plastic, metals, glass, and process sludges.

Fiberglass-Coated Plywood Boxes Contain Non-Compactible TRU Wastes



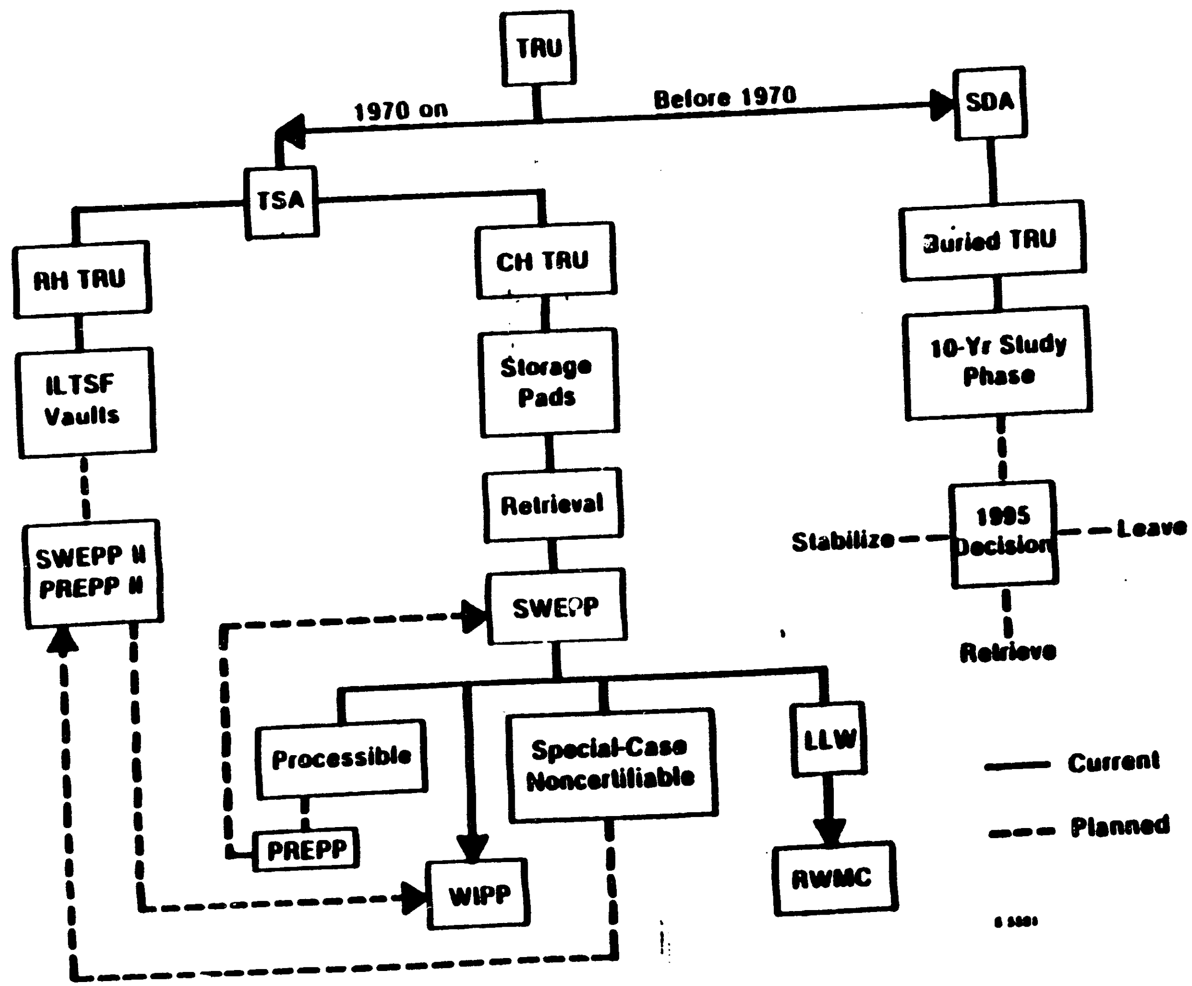
S3 0986

The objectives of the INEL TRU Waste Management Program are to:

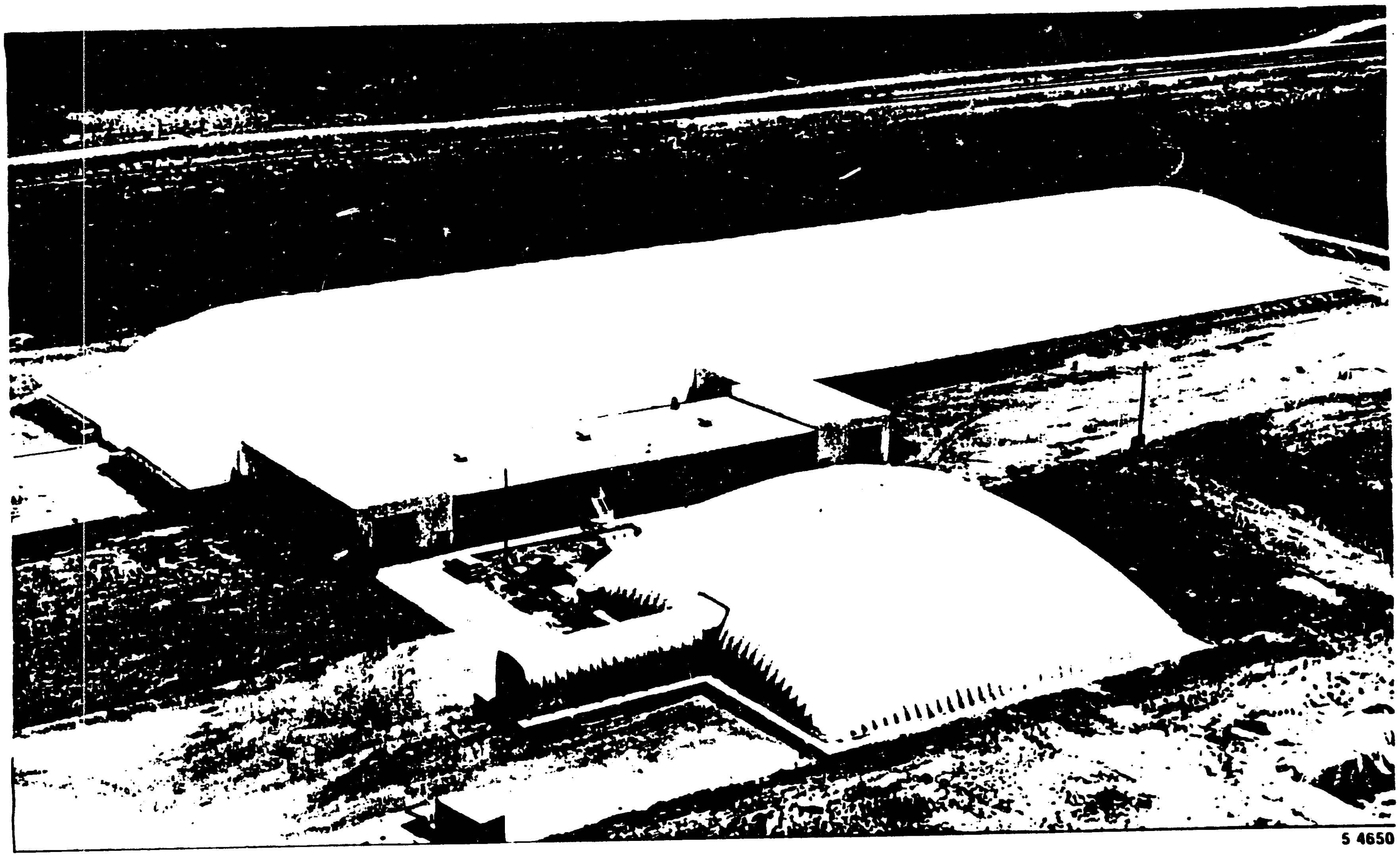
- Operate all TRU Waste Management facilities safely and in accordance with DOE orders and applicable Environmental Protection Agency (EPA) regulations
- End interim storgae of TRU waste and achieve permanent disposal at WIPP
- Reach a decision on long-term management of buried TRU waste

C8 2722

TRU Waste Management Programs

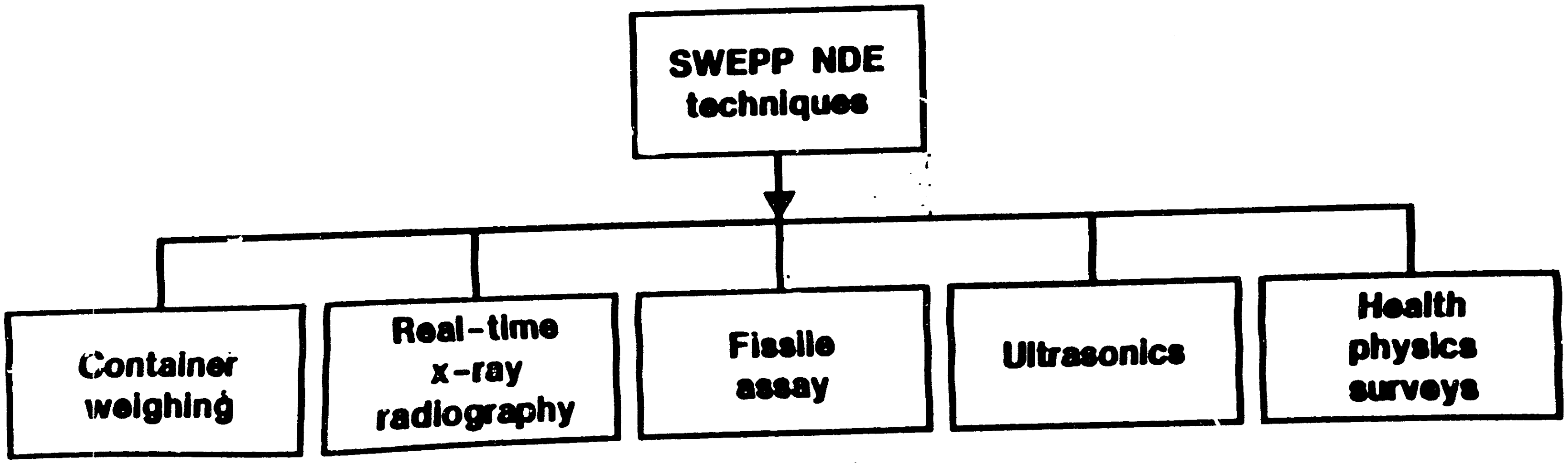


SWEPP Facility



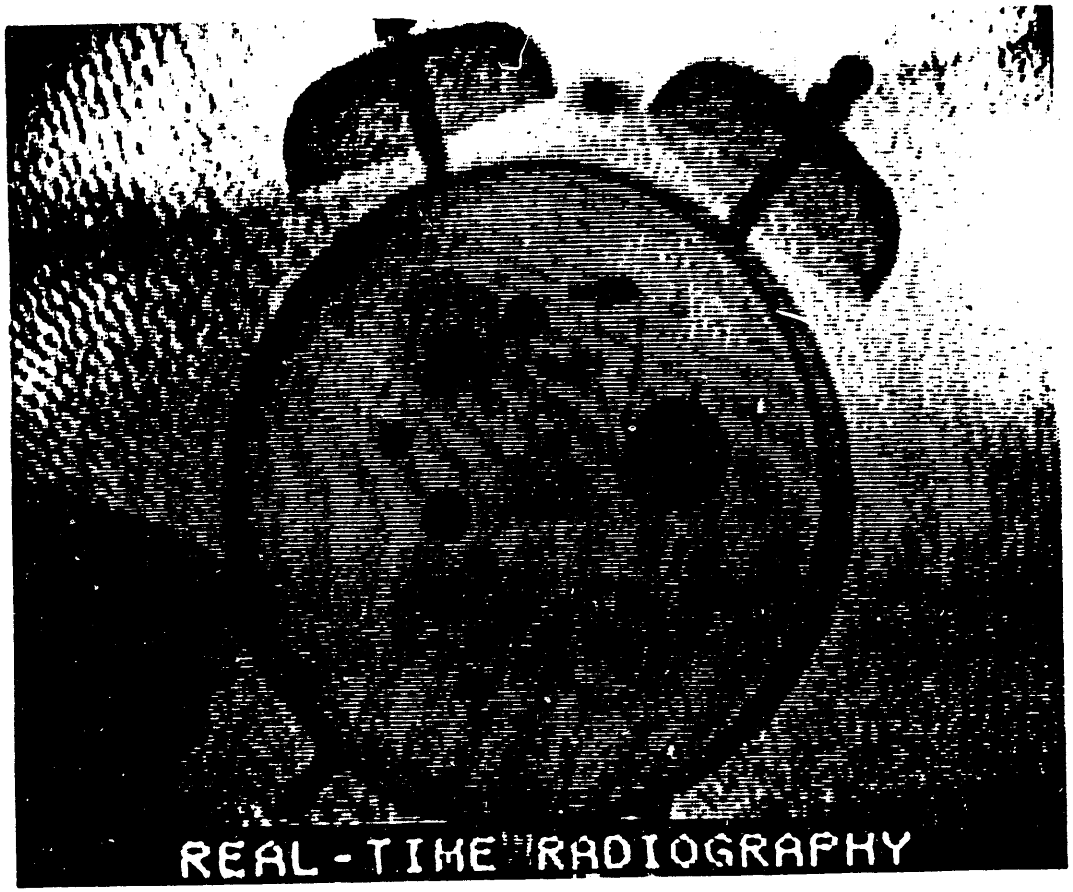
S 4650

SWEPP will certify contact-handled stored TRU waste using nondestructive examination techniques.



CS 1142

Photo of Object Inside a 55 Gallon Drum Using the Real-Time Radiography Technique



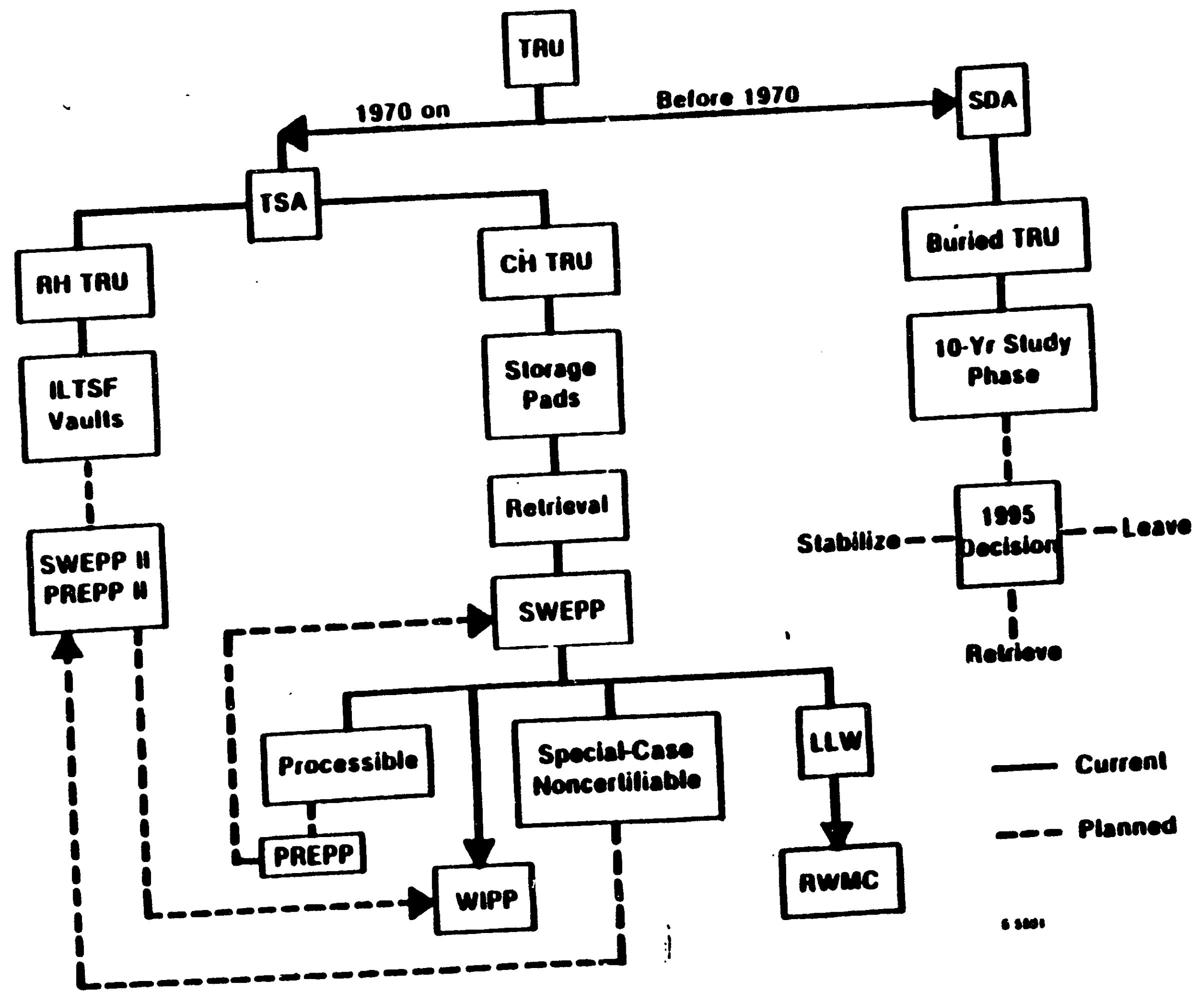
S3 2227

Projected Annual SWEPP Output

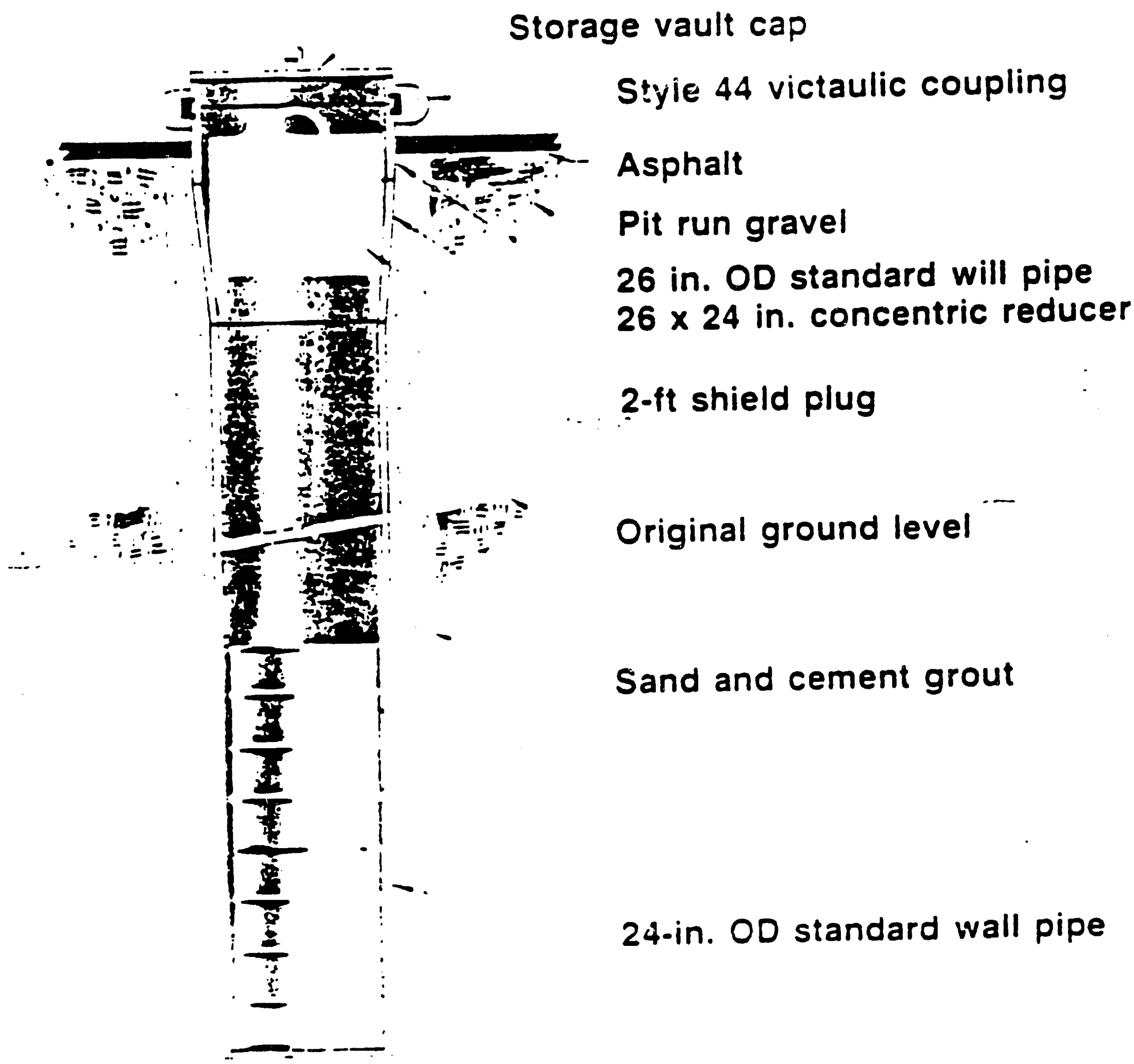
Year	Drums	Boxes
FY-85	100	0
FY-86	1900	0
FY-87	7000	0
FY-88	8400	500
FY-89 and beyond	8400	850

5 10 9/9

TRU Waste Management Programs



ILTSF 24 Inch OD Storage Vaults

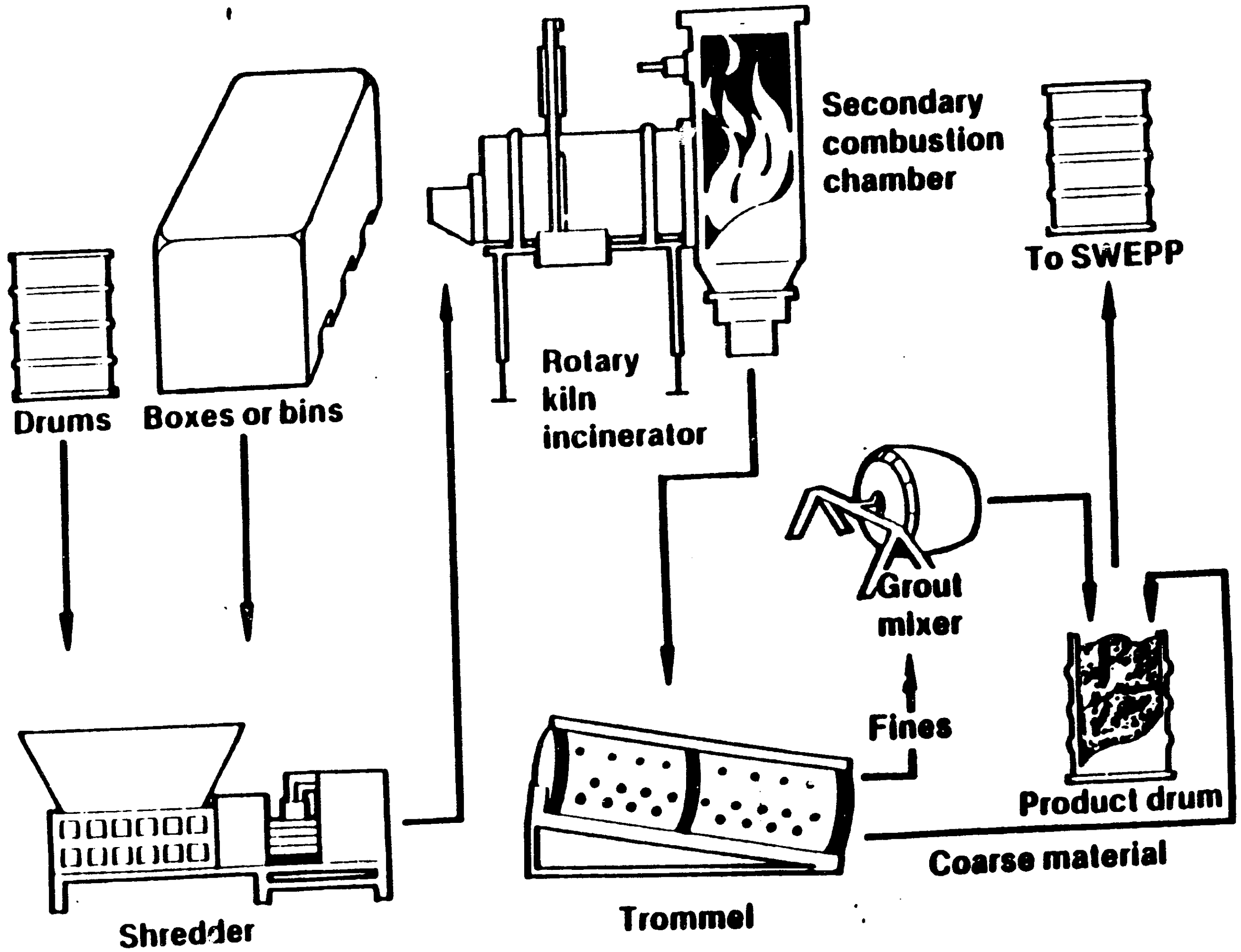


5 10 896

PREPP will provide full-scale experimental processing of TRU waste into a certifiable waste form for disposal at WIPP.

CS 1143

PREPP Process Flow Is:

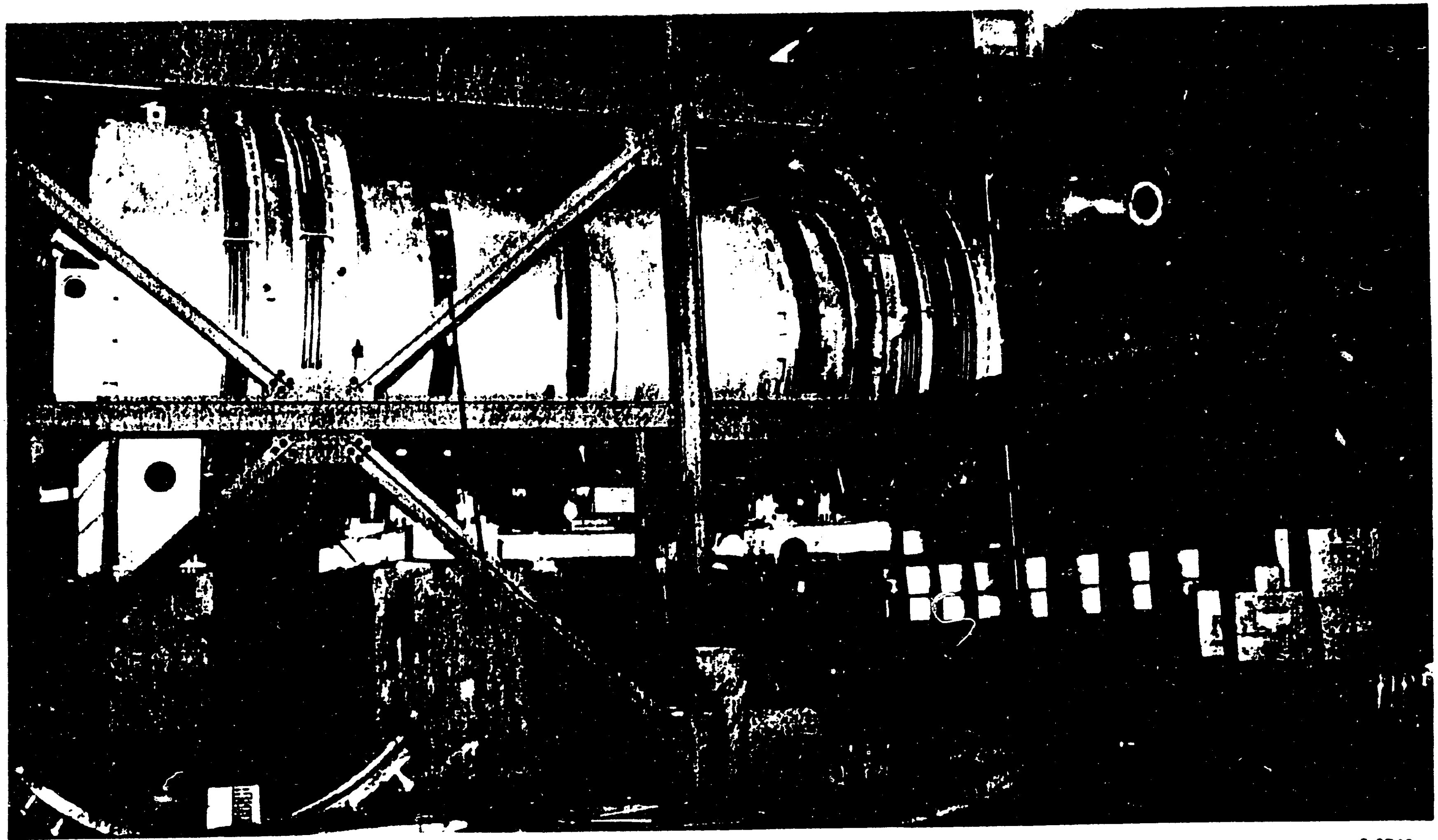


S4 10000

Low-Speed Shredder

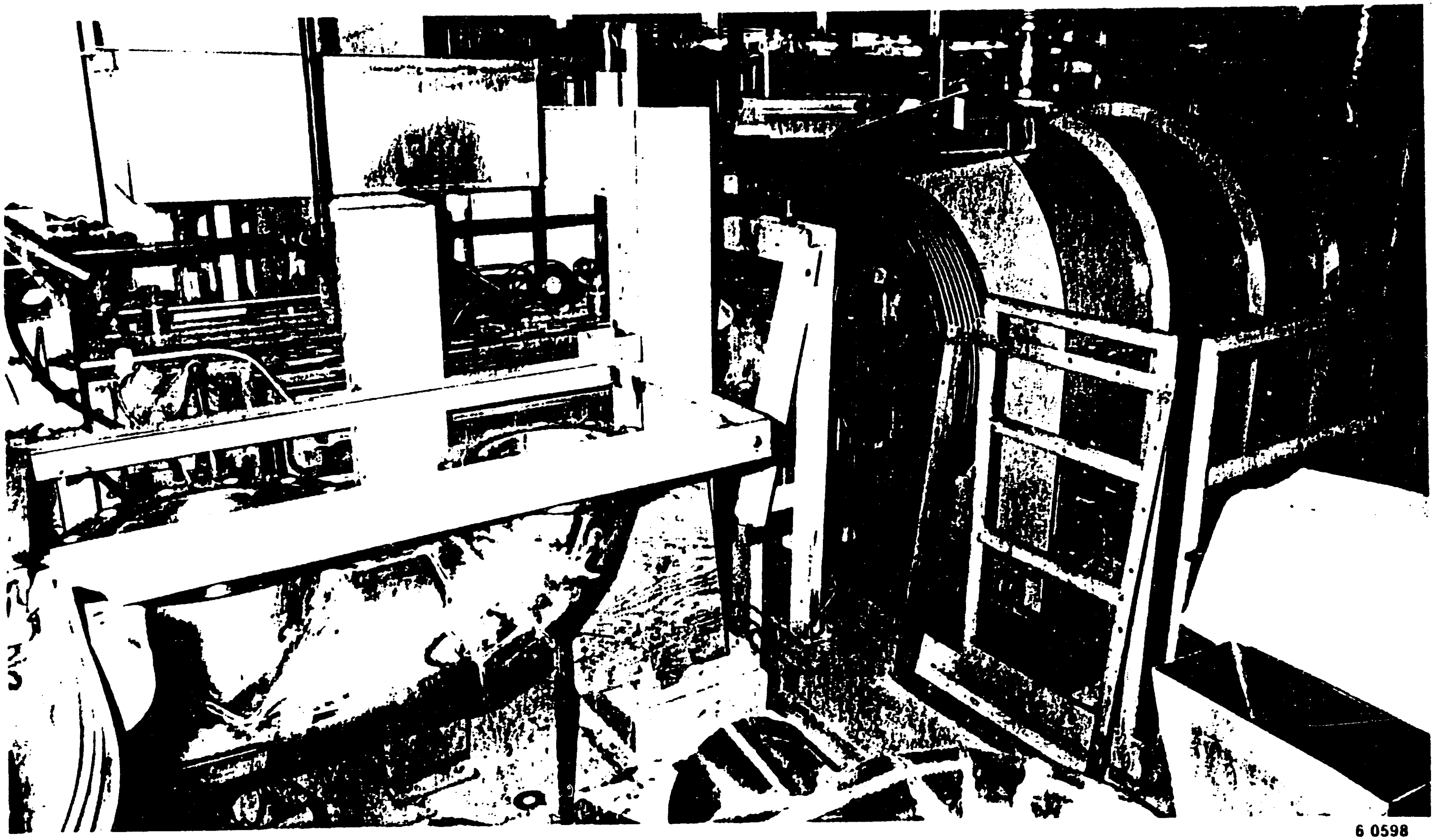
6 0596

Rotary Kiln Incinerator



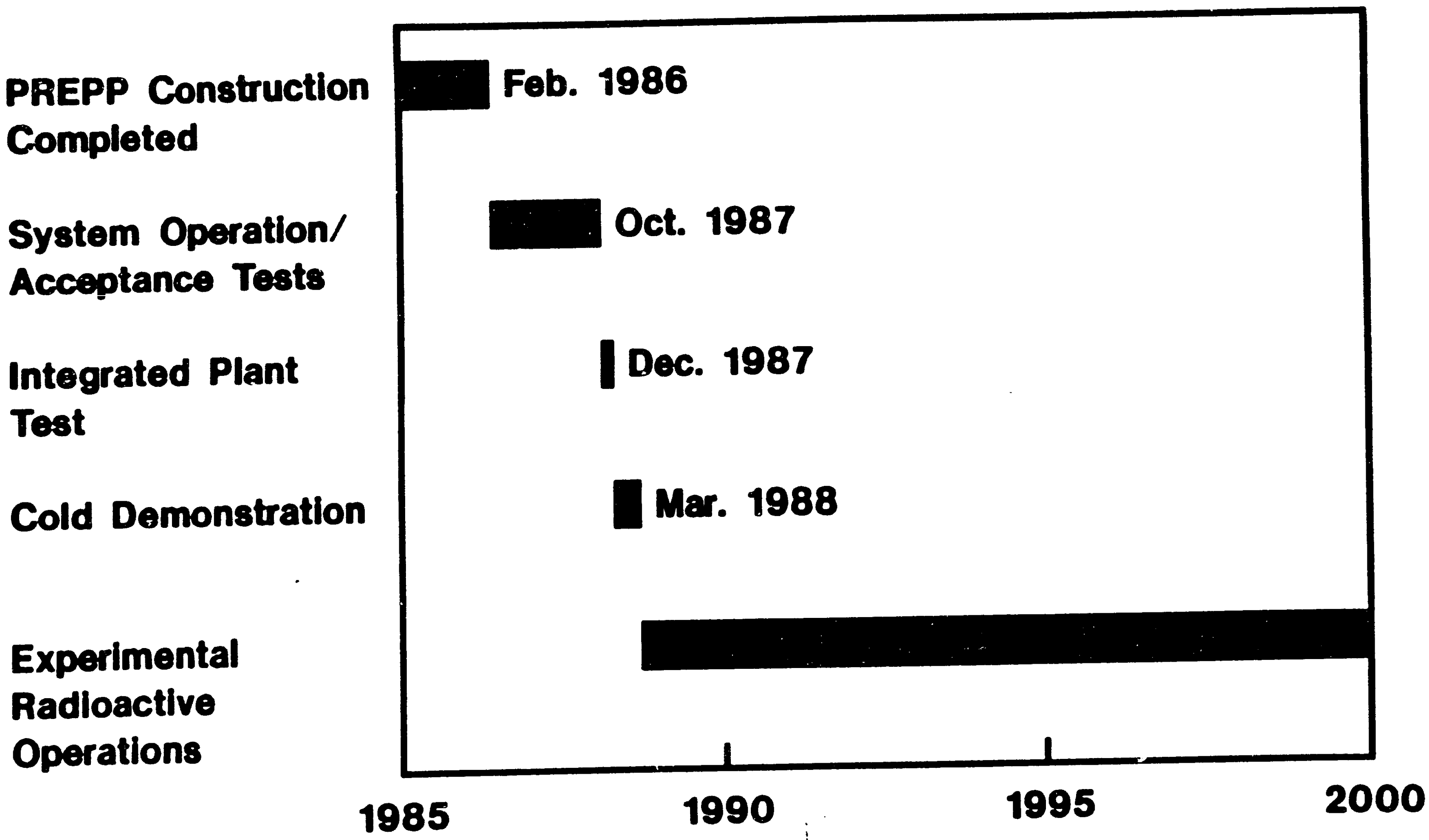
6 0740

Trommel



6 0598

PREPP Schedule

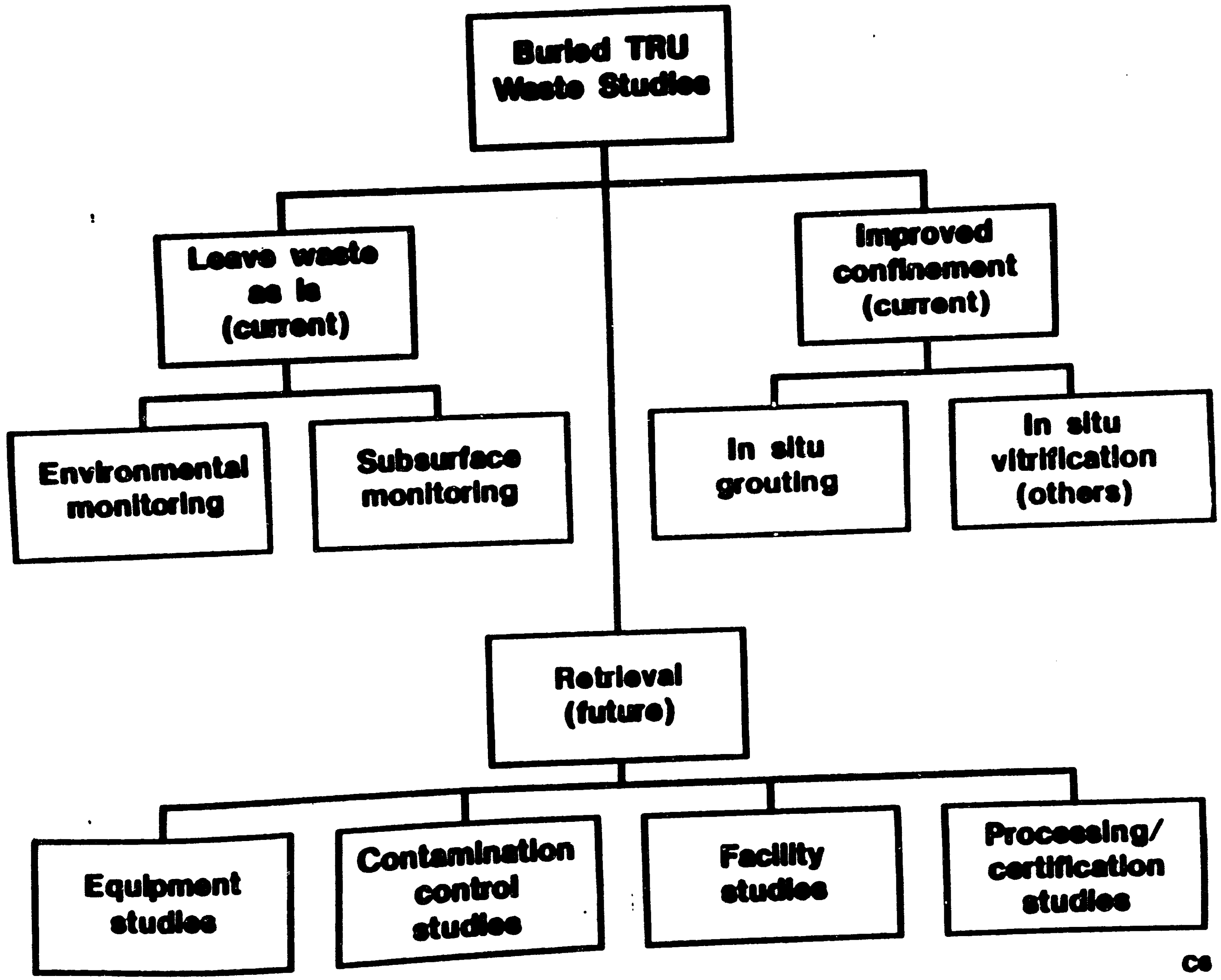


C6 1202

- Remote-handled and special-case TRU wastes will be processed and certified in SWEPP II/PREPP II for future disposal at WIPP.

- Management alternatives have been evaluated to determine processing and facility requirements.

CS 1144


Buried TRU Waste Studies
Leave waste as is (current)
Improved confinement (current)
Environmental monitoring
Subsurface monitoring
In situ grouting
In situ vitrification (others)
Retrieval (future)
Equipment studies
Contamination control studies
Facility studies
Processing/certification studies

CS 1146

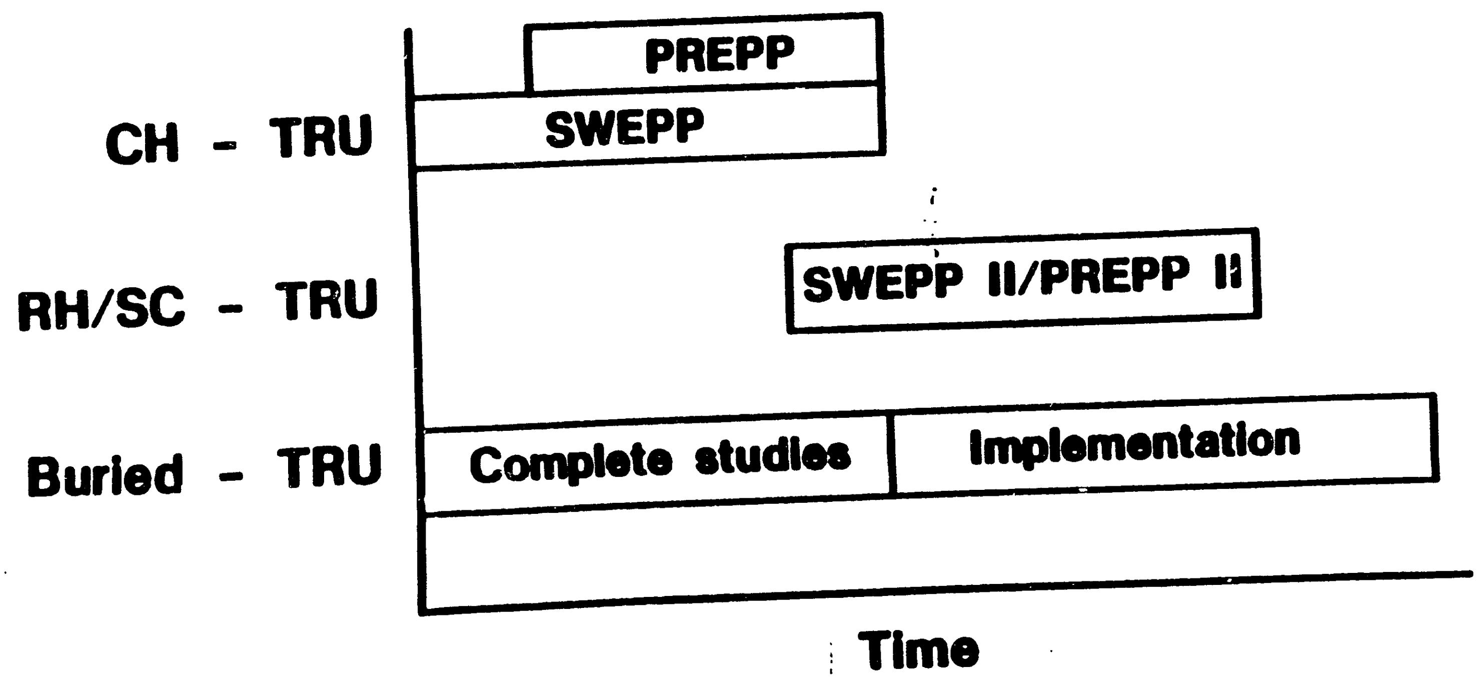
28'

Current studies involve evaluation of in situ grouting as an improved confinement technique.

- In situ grouting will use particulate and microfine particulate grouts to fill soil voids and encapsulate the waste containers.

CS 1146

Each segment of the INEL TRU Waste Program addresses safe management of transuranic wastes.



CS 1147

These facilities and studies are an integral part of the long-term strategy for managing INEL TRU wastes.

JOHN WARREN - LANL

TRU WASTE PROCESSING OVERVIEW

WIPP CRITERIA

WASTE FORM
- FREE LIQUIDS
- PARTICULATES
- PYROPHORICS/EXPLOSIVES
- PRESSURIZED CONTAINERS
- CHEMICAL WASTES

WASTE PACKAGE
- SIZE
- WEIGHT
- SPECIFICATIONS

RADIOACTIVITY
- FISSILE LIMITS
- DOSE
- TRU CONTENT

RECORDS/LABELING

Los Alamos TRU Wastes

Newly Generated - 500 m³/y

Stored - 7400 m³

Sources
- Pu Facility
- Analytical Chemistry
- Liquid Waste Processing
- Other
- D&D

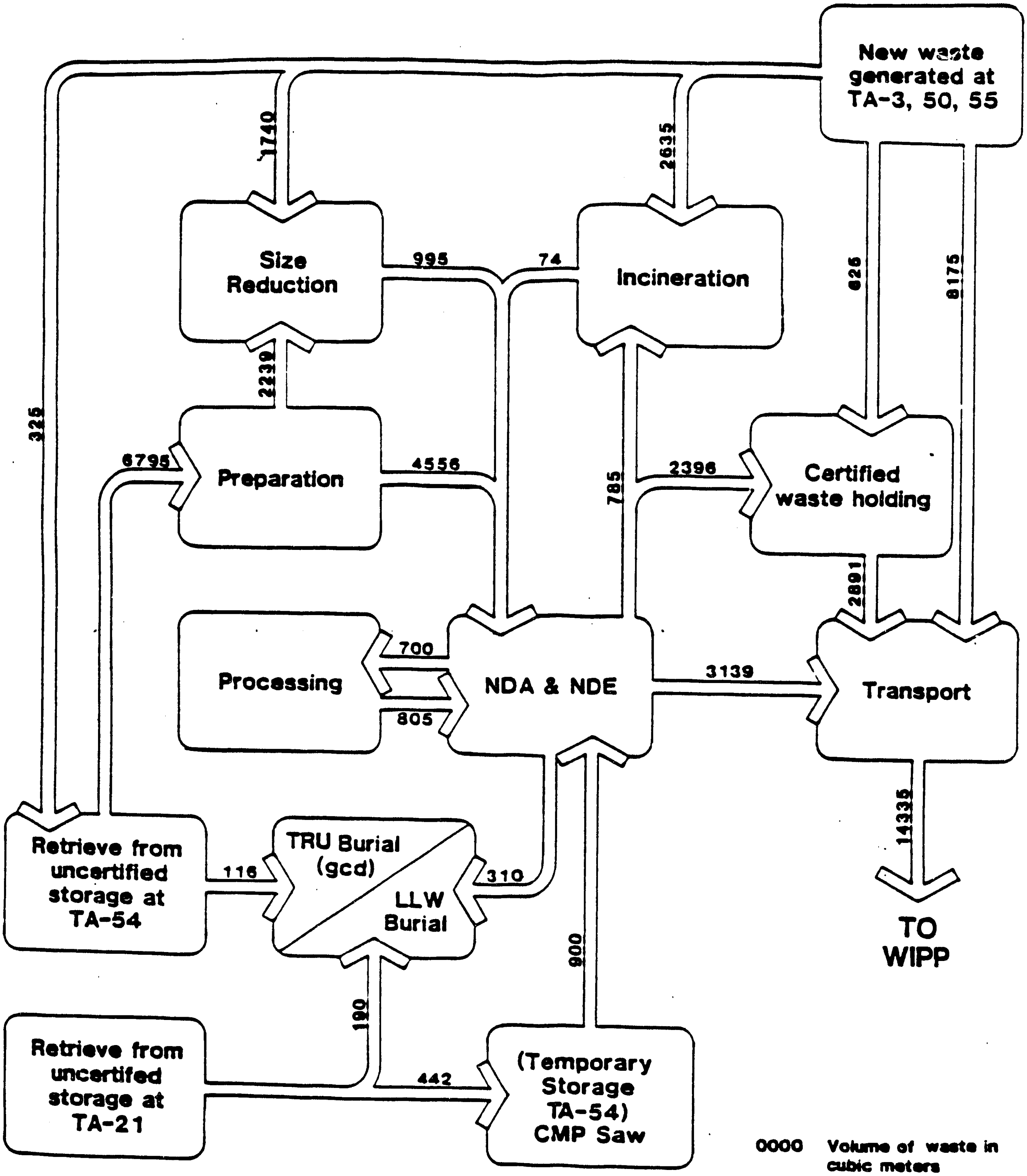
25-40 % NG is combustibles

TRU Work-Off Strategy for Stored Waste

* Size Reduction
* Incineration
* Direct Certification through Non-Destructive Techniques
* Cutting/Packaging of CMPs
* Immobilization

Facilities Required

* Size Reduction (Operational FY83)
* Controlled Air Incinerator (Newly Generated TRU Incineration FY86)
* TRU Waste Preparation
* NDE/A
* TRU Waste Processing
* Transportation



PROCESS PATH FOR NEWLY GENERATED AND TRU WASTE STORED DURING WORK-OFF PERIOD CY 86 TO CY 15

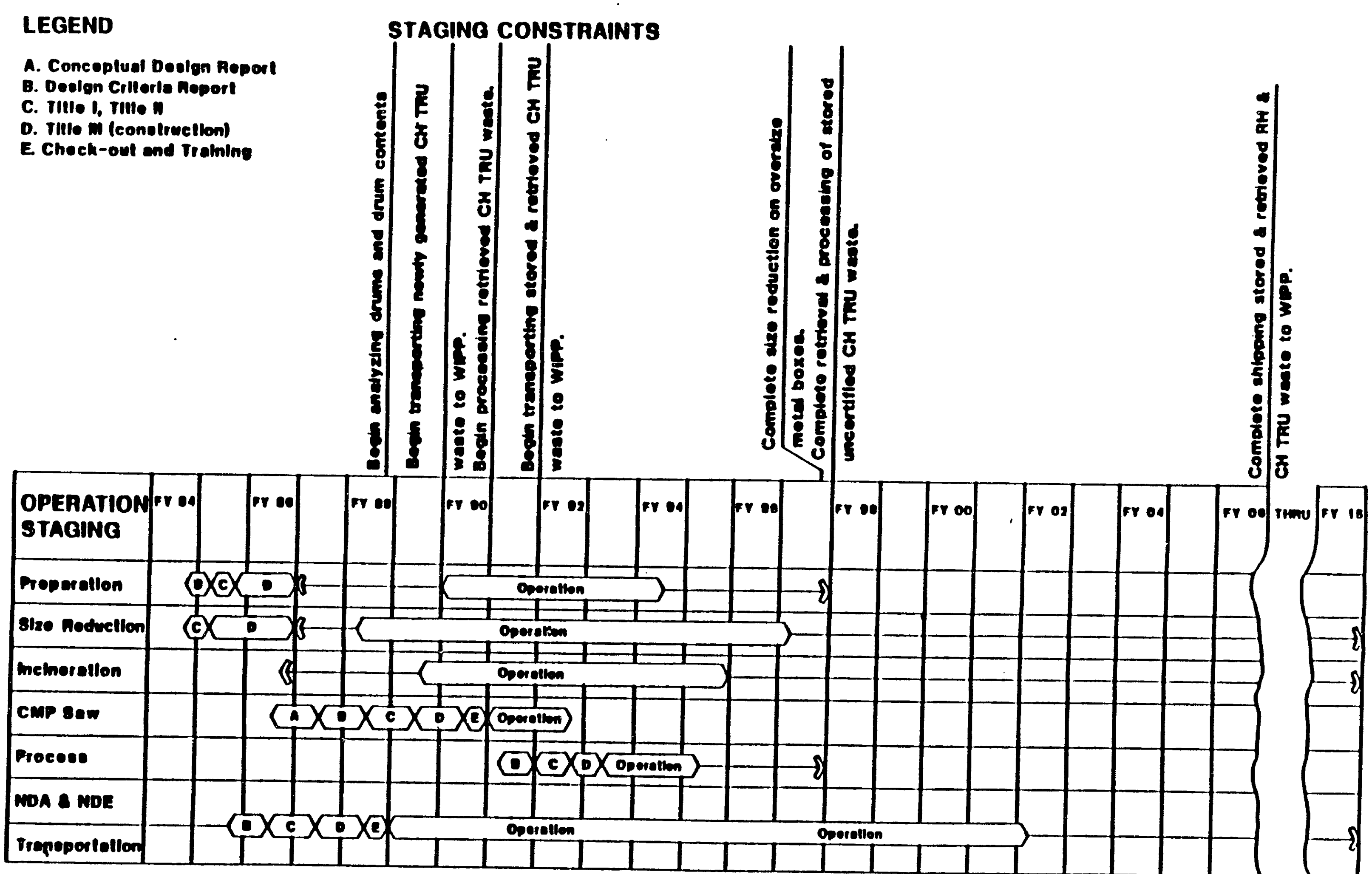
TRU WASTE INVENTORY WORK-OFF FACILITIES

Los Alamos Los Alamos National Laboratory Los Alamos, New Mexico 87545

Lab Job No.: 7641-0 Date: 6-15-85

Holmes & Narver, Albuquerque, NM

H&N Job No.: 1644.70 H&N Task No: 136

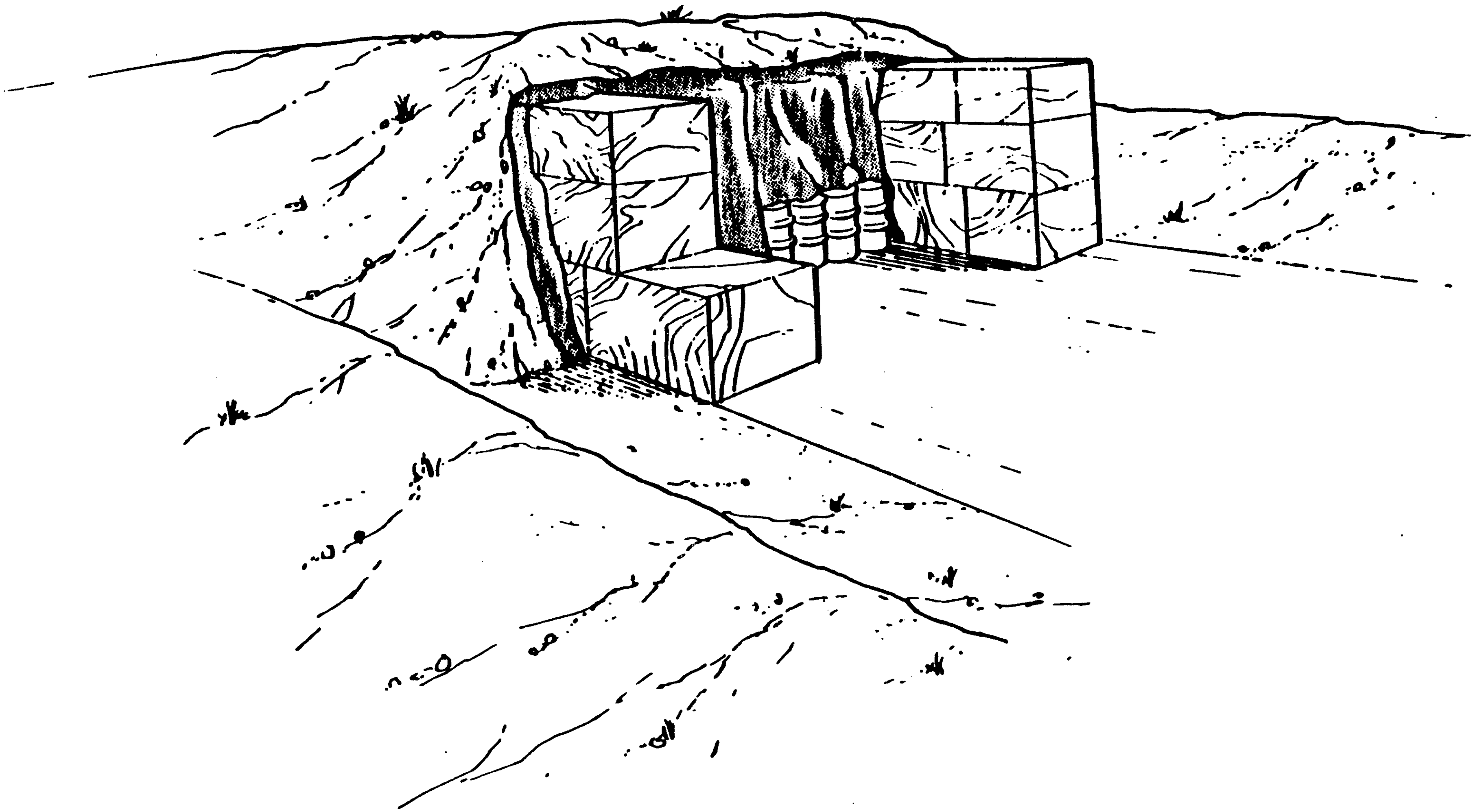


OPERATION STAGING
FACILITY STAGING
STRATEGY

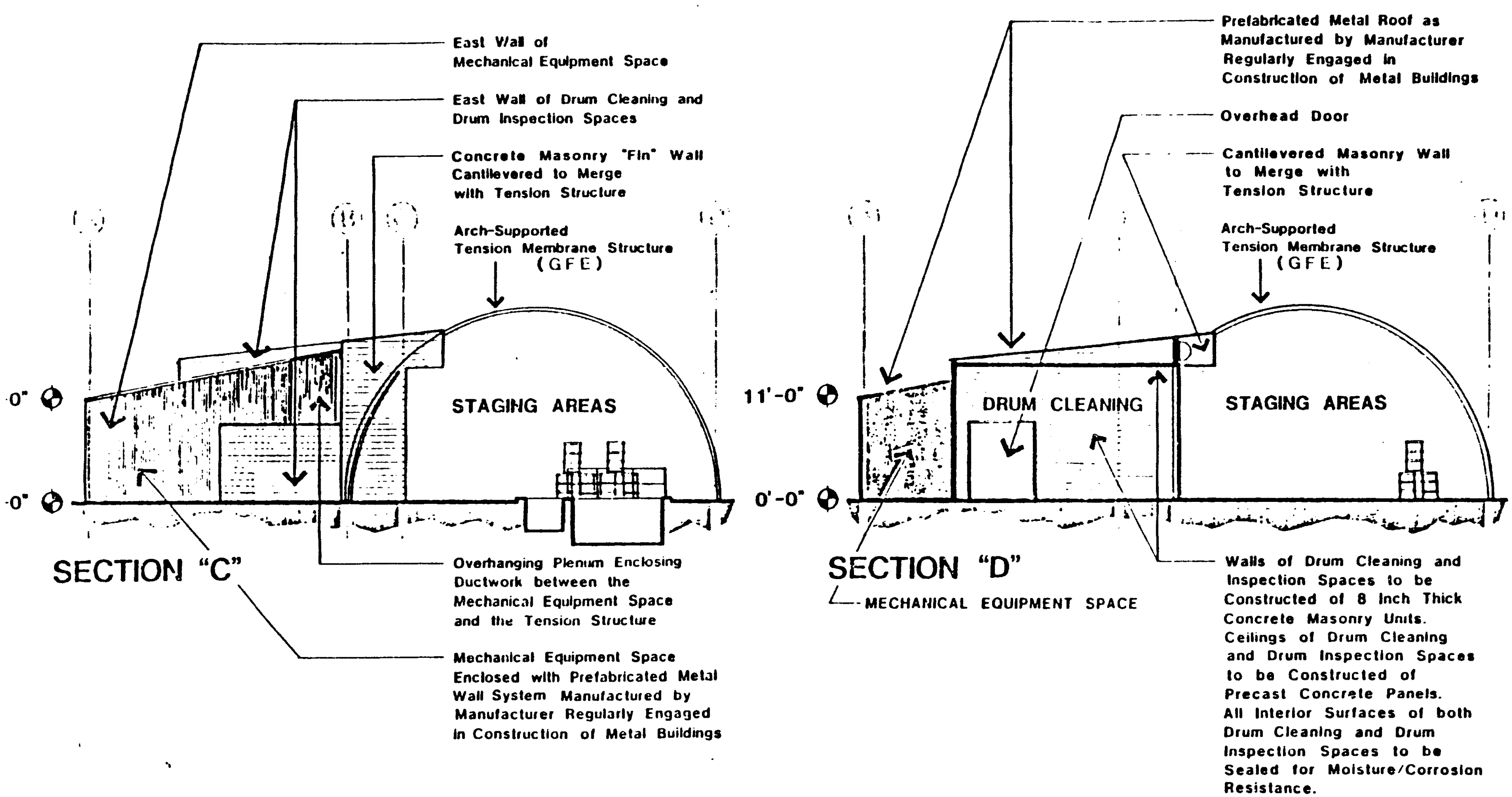
TRU WASTE INVENTORY
WORK-OFF FACILITIES

Los Alamos Los Alamos National Laboratory
Los Alamos New Mexico 87545

Holmes & Narver, Albuquerque, NM

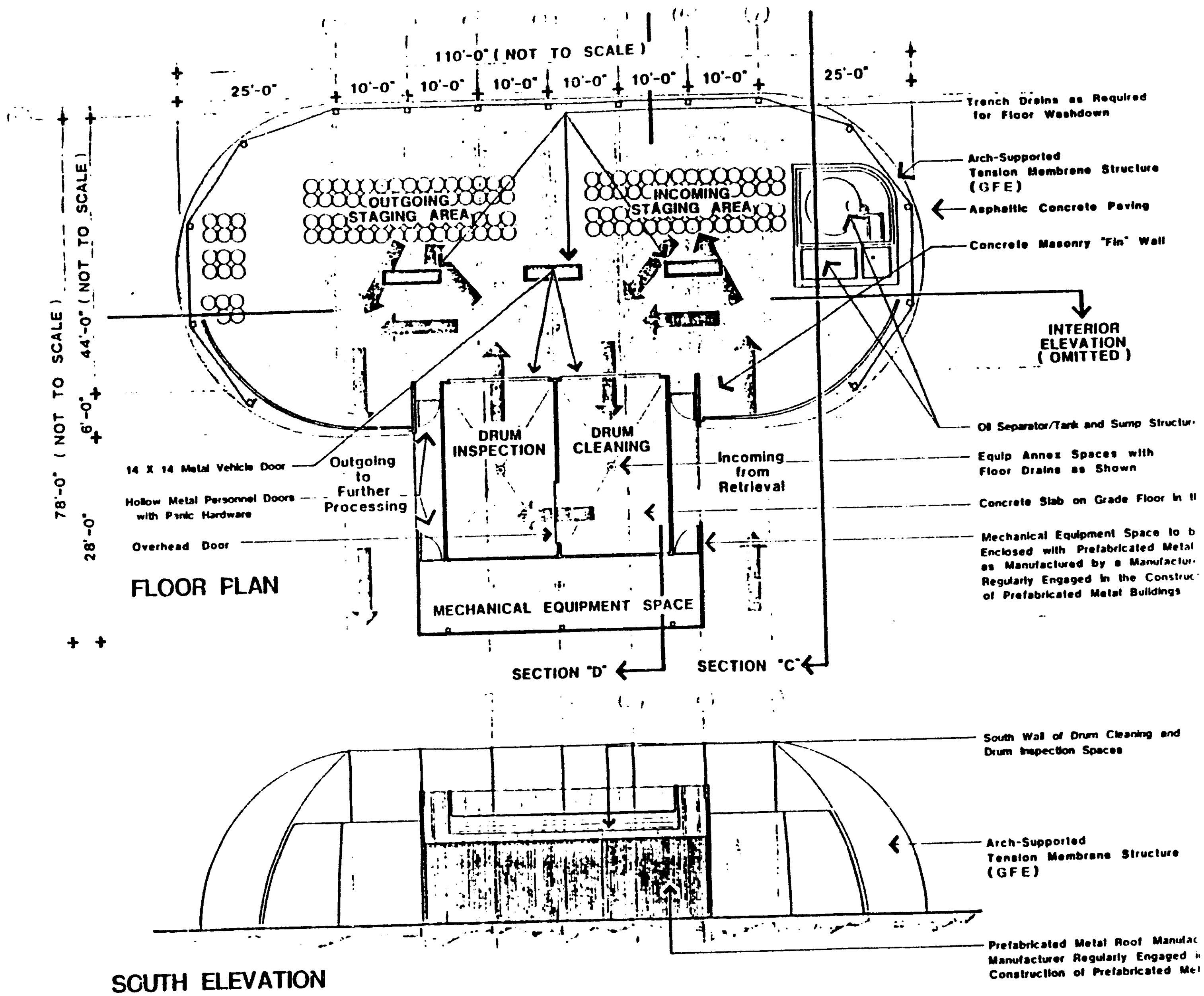


TRU Waste Storage Pad



TRU WASTE PREPARATION FACILITY

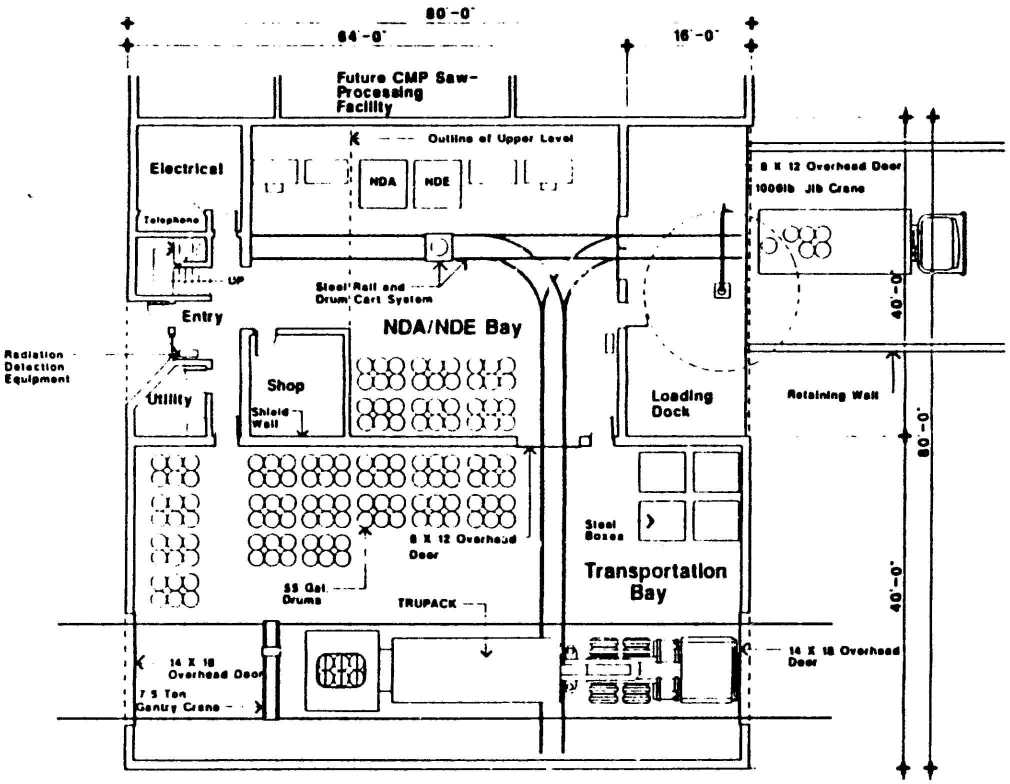
Los Alamos Los Alamos National Laboratory
Los Alamos, New Mexico 87545



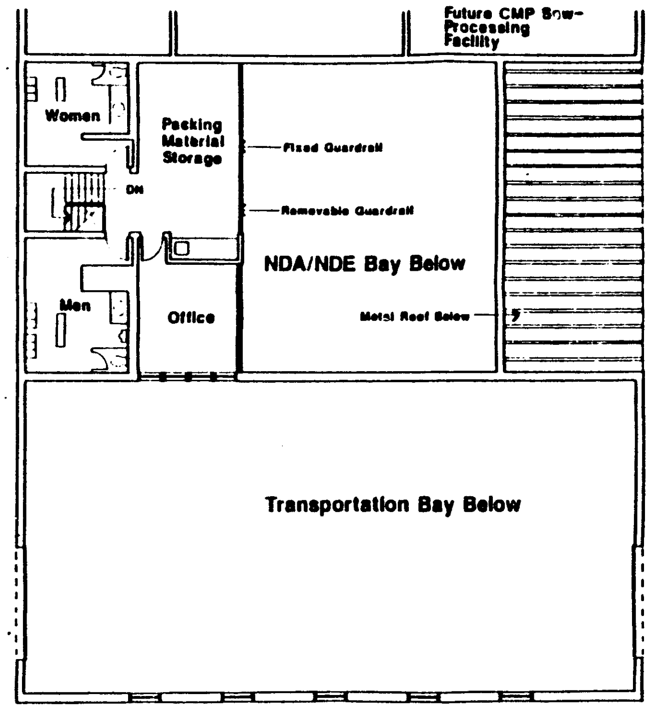
TRU WASTE PREPARATION FACILITY

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545



FIRST FLOOR



UPPER LEVEL

FLOOR PLANS

North

0 4 8 16 24 32
Feet

NOTES

Jib Crane and Steel Rail Drum Cart System are suggested to enhance waste container handling safety.

A Gantry Crane is suggested in lieu of a Bridge Crane to minimize initial construction costs.

Shield wall is provided to protect NDA & NDE equipment from possible radiation by materials stored in the Transportation Bay. 12" CMU is suggested.

This drawing is intended solely to illustrate basic design concepts and criteria.

TRU WASTE NDA / NDE-TRANSPORTATION FACILITY

Los Alamos Los Alamos National Laborat[ory]
Los Alamos, New Mexico 87[5..]

Applications of TRU Drum Assay Acquired for TRU Work-Off Program

Work-Off Waste

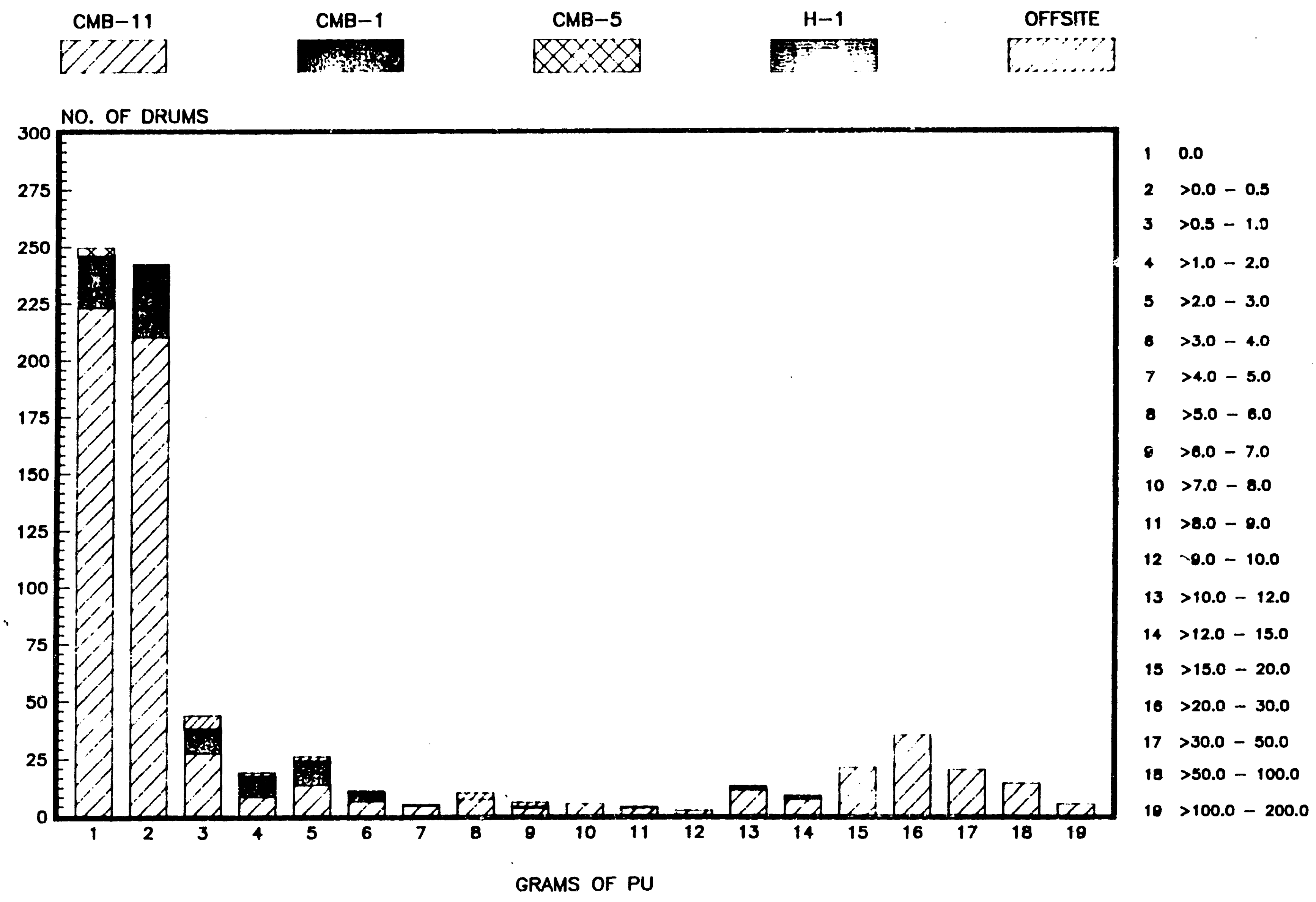
* Identify non-TRU portion
* Assure compliance with drum content limits
* Determine content for transport, Pu-equivalent, and thermal power

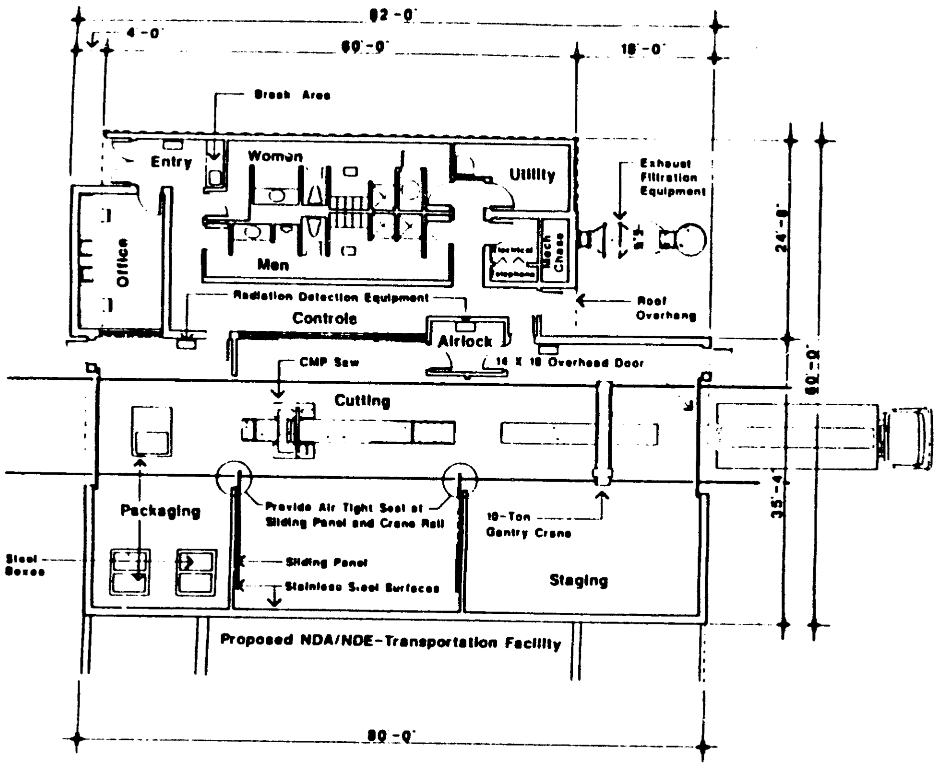
Newly Generated Waste

* Occasional verification - QA Sampling

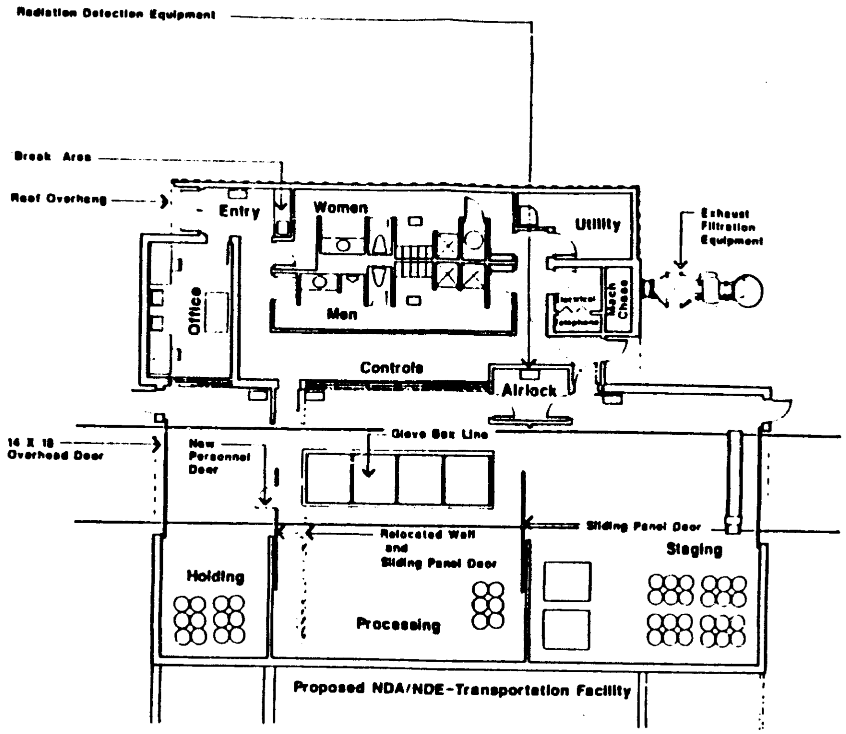
TRANSURANIC COMBUSTIBLE WASTE

STORED AT LOS ALAMOS IN CY81



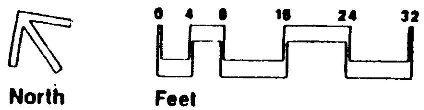


CMP SAW CUTTING CONFIGURATION



FUTURE PROCESSING CONFIGURATION

FLOOR PLANS



NOTES

A Gantry Crane is suggested in lieu of a Bridge Crane to minimize initial construction costs.

A complete air tight seal of the Cutting Room is required to control radiation contamination

This drawing is intended solely to illustrate basic design concepts and criteria.

TRU WASTE CMP SAW - PROCESSING FACILITY

Los Alamos
Los Alamos National Laboratory
Los Alamos New Mexico 87545

DAVID SWALE, BNFL SELLAFIELD

PROJECT PROCEDURE - THE PLANT OPERATORS VIEWPOINT

PRESENTATION TO US/UK WORKSHOP ON PCM PLANT DESIGN
OCTOBER 1986

PROJECT PROCEDURE - THE PLANT OPERATORS VIEWPOINT
by D J SWALE

1 The aim of this presentation is to give a brief outline of the procedure involved during the design and construction of a new PCM facility, within BNFL, from an operator's point of view. An attempt is made to describe both the formal and the informal liaison between the Design Office and the eventual plant operators. Detailed information on BNFL safety standards and principles is included, for interest.

2 Any large project is initiated by production of a Functional Specification, raised by the eventual plant operator (ie the customer) which contains:

Plant purpose/reason
Plant feed/throughput/wastes
Safety standards and principles, in relation to:
- i) protection of persons outside the site
- ii) protection of persons outside the plant
- iii) protection of plant personnel
- iv) protection of plant and inventory.

This Functional Specification and subsequent safety documents are considered by Site Nuclear Safety Committees.

3 The Safety standards and principles applied to new BNFL projects are summarised below (those marked '*' have been generated from statutory requirements. Others are BNFL standards which have been accepted by the Nuclear Installations Inspectorate):

a) <u>Normal Operating Conditions</u>

i) <u>External and Internal Radiation</u>:

- Plant Group average whole body dose $\not>$0.5 rem ($\not>$5mSv) per year effective dose equivalent
- maximum individual dose on a plant (external + internal) $\not>$1.5 rem ($\not>$15mSv) per year
- internal exposures negligible ($\not>$1% ALI average, with maximum of 10% ALI)
- * - all exposures must be reduced to ALARP
- if targets cannot be met, then a full justification of alternative targets must be made
- "greenfield" site conditions are to be assumed

- gamma plus neutron dose rate at normal operating positions $\ngtr$0.1 mrem/h ($\ngtr$1μSv/hr) or 200 mrem/a (2mSv/a) for the full working year

- dose to extremities $\ngtr$ 20 rem/a average (200mSv/a)
  $\ngtr$ 30 rem/a maximum (300mSv/a)
  but where reasonable, seek to reduce to $\ngtr$ 5 rem/a (50mSv/a)

* - dose to eye lens $\ngtr$ 15 rem/a (150mSv/a)

- routine requirement for wearing respiratory protection $\ngtr$0.5 hour per day or 2 hours per week (average), with a maximum of 1 hour per day or 5 hours per week

- routine wearing of ventilated suits to be avoided

- doserate at external building walls to be $\ngtr$0.1 mrem/h (1μSv/h) and $\ngtr$0.025 mrem/h (0.25μSv/h) at 20 metres.

ii) <u>Liquid Effluent Discharges</u>

- A liquid effluent discharge targetting system is in use for new plants.

- BNFL have undertaken to reduce discharges from the Sellafield Site to $\ngtr$20 Ci/a alpha (0.74TBq/a) and $\ngtr$8000 Ci/a beta (296TBq/a).

- Dose to the critical group $\ngtr$10% ICRP dose limit (ie 10% of 0.5 rem, and on the basis of the above activity targets, has been assessed as at most 5% ICRP dose limit which includes a contribution of 0.1% from WTC Phase 1).

iii) <u>Aerial Effluent Discharges</u>

- An aerial effluent discharge targetting system is in use for new plants.

- Committed effective dose to the critical group $\ngtr$10% ICRP dose limit (ie 10% of 0.5 rem/a) from the Sellafield Site.

b) <u>Potential Fault Conditions</u>

i) <u>General</u>

- Accident risk criteria have been developed aimed at reducing risk of death to a member of the general public and to members of the workforce to perceived acceptable levels. Faults which may lead to such risks include process faults, loss of services, external hazards, fire and explosion, theft, criticality.

The risk of death to a member of the general public from any single new plant (sum of all potential hazards) $\ngtr 10^{-7}$/a from accidental aerial discharges.This is generated from the <u>prime</u> standard of reducing the risk to the most exposed member of the public to $\ngtr 10^{-6}$/a from the Site as a whole (based on 100 plants and a 1 in 10 chance of wind direction).

Earthquakes and high winds are considered separately as they would affect many installations, unless the impact is assessed as a dose of less than 0.5 rem (5mSv) in one week following the event. A return event frequency of 10^{-4}/a is used for such events.

The frequency at which extra environmental monitoring is undertaken as a result of an acute release should be less than 10^{-2} events/a. (Low consequence but high P.R. "nuisance" events).

The risk of death to a member of the general public from any new installation (sum of all potential hazards) $\ngtr 10^{-8}$/a arising from all accidental discharges to marine pathways.

The risk of death for non-radiation workers $\ngtr 10^{-5}$/a from radiological incidents.

The risk of death from radiological accidents for radiation workers $\ngtr 10^{-5}$/a.

The summed frequency of internal events which could lead to a building evacuation $\ngtr 10^{-2}$/a.

The summed frequency of criticality incidents $\ngtr 10^{-5}$/yr. (This can be relaxed if specific dose criteria are not exceeded).

All areas where criticality doses could exceed 10 rems (100mSv) from a 10^{18} fission incident shall be covered by an automatic CID alarm system.

ii) <u>Seismic Events</u>

- A Design Base Earthquake (DBE) of 0.25g, horizontal acceleration is defined. (Return event frequency 10^{-4}/a).

- Where it can be shown that as a result of a DBE, the consequent dose uptake from a plant to the most critical member of the public would not exceed 0.5 rem (5mSv) in one week, assuming the loss of all containment, then that plant need not be seismically qualified.

4 The Design Office receiving the Functional Specification for a new plant (ie the Project Office) are also constrained by construction and materials standards aimed at making the plant easier to decontaminate and eventually decommission. Some of the more important Atomic Energy Code of Practices (AECP) are listed below:-

AECP 59	Unshielded gloveboxes
AECP 1050	Design Office Practice
AECP 1008	Welding Handbook
AECP 1054	Ventilation of Radioactive Areas
AECP 1062	Parjo Method of Leak Testing

5 The eventual Plant Manager and Maintenance Manager are usually nominated following acceptance of the Functional Specification. They continue to liaise with the Project Office throughout the project.

6 The Nuclear Installations Inspectorate (NII) of the Health and Safety Executive receive a copy of the Functional Specification, as advanced warning of a forthcoming project. They involve the Department of the Environment on waste management aspects of new plants.

7 A concept design flowsheet (plus alternatives) is produced and HAZOP 1 studied (simple HAZard and OPerability study) by a team including representatives from the Project Office, the Operators and Safety Specialists.

8 A Plant Specification (PS) and Preliminary Design Safety Assessment (PDSA) are produced, normally following approval of the Capital project. This is acknowledged by NII as the "the Specification" required by the Site Licence, and they issue a Notification of No Objection (NONO) to Construction to allow the project to proceed. Consideration is currently being given to replacement of these initial project documents by others containing more detailed safety assessment.

9 Detailed design and development work are carried out, during which the operator maintains close contact with the Project Office.

10 Construction and plant installation commence, followed by pre-handover testing when plant becomes available. This work is the responsibility of the Project Office.

11 Detailed Engineering Diagrams and Supporting Sequence and Interlock Diagrams are produced and are HAZOP 2 studied (more detailed study again by Project Office, Operators, other Design Offices and Safety Specialists). A Design Safety Report (DSR) is then produced which highlights those design safety features provided to comply with the safety standards and principles requested in the Functional Specification.

12 The Operator produces a Safety Commissioning Schedule (SCS) and detailed commissioning worksheets, which detail checks to be carried out during commissioning. The Operator also produces a draft Operational Safety Assessment (OSA) from which are derived Operating Limits and Conditions for commissioning. Nuclear Safety Operating Rules are also produced at this stage. NII issue a NONO to commissioning following receipt and consideration of the DSR and SCS. The Commissioning Manager is nominated from the Operator's staff (usually the eventual Plant Manager).

13 The project is generally handed over for commissioning purposes to the Operators (ie the Commissioning Manager) following satisfactory completion of the pre-handover testing.

14 Following commissioning, a Commissioning Report and a final Operational Safety Assessment (OSA), specifying operational safety features (Operating Rules) are produced. The OSA needs to be available prior to 'active' commissioning, but is finalised at this stage.

15 Following satisfactory commissioning and a Consent to Operate from NII, and the production of a Summary Safety Management Appraisal Document and Addendum, approved by the Director of Operations, the plant becomes operational.

D J Swale
Fuel Plants and Waste Management

6 October 1986

ROBERT THOMAS, UKAEA

FACILITY DESIGN CRITERIA

UKAEA PROJECT PROCEDURES (To supplement DJS's Design Criteria Presentation)

The details of the steps involved in the development of a UKAEA design project depend on a number of factors, including the size of the project and who the Customer is. For a medium-sized project (of the order of £1 M) for Dounreay, the steps are in essence as follows.

<u>Customer Specification</u>

The plant operators (the Customers) prepare the specification of functional requirements. Following receipt of the necessary financial and resource deployment authorisations, the Customer then prepares the Hazard Assessment document for the proposed plant, together with the Design Safety Principles document for which it forms the basis. These documents are both submitted to the appropriate Safety Working Party.

<u>Safety Working Party</u>

The SWP is an officially constituted body at Dounreay whose function is formally to advise the Director on safety matters. It is composed of site personnel, together with representatives from the UKAEA Safety and Reliability Directorate and the Engineering Directorate Design Office. The Chairman is an independent Assistant Director.

<u>Engineering Directorate Proposal</u>

The Client is the Engineering Directorate Design Office, who prepare the EDP for the project. This is the formal proposal for meeting the Customer's requirements, and includes a technical description, a cost estimate and a programme. It makes reference to the Hazard Assessment and the DSP documents, and shows how the issues of decontamination and decommissioning have been addressed in the design, together with handling and disposal of radioactive waste arisings, and any international safeguards issues. It demonstrates, by describing alternative approaches which have been considered, that the proposals represent the best investment, and it includes a description of how QA will be applied during the design.

Design

Following completion of the design, the Client produces the Design Safety Report which demonstrates how the DSPs have been implemented. This is submitted to the SWP.

Before active operation, criticality calculations are checked by an independent auditor.

Plant handover to the Customer is by formal Handover Certificates following completion of functional testing.

The Customer commissions the plant and then prepares the Operational Safety Document, again for submission to the SWP, and the Operating Manual.

Operation

Authorisation to operate the plant is given by the Director to a nominated member of the management by means of an Authority to Operate certificate, on the advice of the SWP.

UKAEA DESIGN CRITERIA (Source Material for a 10 Minute Presentation)

a. Radiological Criteria

The recommendations of ICRP 26 (1977) were incorporated in Euratom Directive L246. In order to ensure UK compliance with this Directive, the Ionising Radiation Regulations 1985 have been established and brought into force under the Radioactive Substances Act 1960.

i. Individual Exposures

Workers

The new regulations in respect of radiation workers are shown below in comparison with the standards they superseded. Note that the inclusion of an internal dose limit (the committed effective dose equivalent from that year's intake of radionuclides) in the 1985 IRRs is an innovation, and requires the dose integrated over 50 years to be ascribed to the year of intake.

Radiation Workers

DOSE CATEGORY	LIMIT
1985 IRRs	
Effective dose equivalent from external radiation plus the committed effective dose equivalent from that year's intake of radionuclides	50m Sv pa*
Effective dose equivalent to body extremities	500m Sv pa
Effective dose equivalent (external plus internal) to eye lens	150m Sv pa
Previous (now superseded)	
Whole body (external only)	30m Sv per quarter
Extremities	400m Sv per quarter and 750m Sv pa
Eye lens	80m Sv per quarter and 150m Sv pa

* At a recorded dose of 15m Sv, a management investigation is required into working practices in order to confirm that these are ensuring that exposures are ALARA.

Public

For members of the general public, the ICRP limit for whole body dose is 5m Sv pa, but the National Radiological Protection Board have advised that lifetime dose should not be allowed to exceed 70m Sv, and that the easiest way to ensure compliance is to restrict annual doses to not more than 1m Sv.

ii. Collective Doses

Workers

No targets are set, but collective doses are used as criteria for judging management effectiveness on operating plant.

Public

There is no statutory limit, but collective doses (UK, Europe and world, integrated to 500 years and infinity) are used in CBA/ALARA judgements on the provision of effluent treatment facilities. Criteria currently used in the UKAEA are:

COST OF AVOIDING THE DOSE DETRIMENT (£K/man Sv)	DECISION
< 3	Implement
3 - 100	Consider on a case by case basis
> 100	Do not implement

b. UKAEA (Northern Division) Radiological Protection Policy for Design

UKAEA (Northern Division) policy for the design of new plant is given below:

i. <u>Workers</u>

Target annual whole body dose for an individual worker (external plus committed internal)	≯ 15 m Sv (cf IRR management investigation level)
Target annual external exposure to body extremities	≯ 250 m Sv
Target annual external and internal exposure to eye lens	≯ 40 m Sv
Target annual whole body dose per individual worker <u>averaged over the plant work force</u>	≯ 10 m Sv

Note that the last criterion does not correspond to any regulatory requirement, but is of more use to designers than the individual worker limit. It is set at a level which allows a 50% margin for the most exposed worker.

In order to achieve these restrictive targets, design targets are set for external dose rates at working positions and for air contamination levels. These are given below.

Design target dose rate at normal operating positions	1μSv/h
Target average airborne contamination levels	≯ 5% DAC

Note that the 1μSv/h design target dose rate at normal operating positions corresponds to a 2m Sv exposure over a 2000h year. For design purposes, a wallpaper dose rate of 2.5μSv/h is assumed to comply with the criterion in most cases. This is a convenient approach for the designers. Higher dose rates are permitted in areas of low occupancy on a case by case basis. The Q factor for neutrons is currently 10, but because the ICRU are considering increasing this, UKAEA designers are required to consider the implications of a further factor of 5.

Static air monitors with alarms are installed, together with static air samplers for indication of longer term trends. In practice, 5% of the DAC is considered to be achieved if the installed static air samplers indicate an average of $\not> 0.5\%$ DAC (ie 0.04 DAC h in an 8h shift).

Plant air flows are designed to cope with resuspension, and surfaces and materials are specified to aid housekeeping. The aim is negligible surface contamination throughout all operating areas (ie $\not> 10^{-5}\ \mu Ci/cm^2\ \alpha$ and $\not> 10^{-4}\ \mu Ci/cm^2\ \beta$, and then only in isolated spots where these are not readily removable by normal means), in order to achieve the target air activity levels. Areas where these standards are applied are known at Dounreay as Contamination Control Zones (CCZ). These surface contamination levels are the DWLs. Measurements at Dounreay have shown that 0.5% of the surface contamination DWLs are regularly achieved, and theoretical and experimental work on floor resuspension at Harwell has indicated that floor contamination levels in normal operating areas at about 1% of the DWL give rise to airborne activity levels of about 1% of the DAC. There is confidence therefore that the target of 5% DAC is readily achievable for new plants.

The restriction of exposure is by engineered controls and design features such as shielding, containment, ventilation etc, so far as is reasonably practicable. The use of personal protective equipment is permitted in certain circumstances, but in general the design is such as to avoid the need for routine working in protective clothing. (In practice on the plant the operators wear respirators during certain posting operations, as a prudent operational precaution).

For radiological accidents, the risk target for workers is ALARP and $\not> 10^{-5}$ pa per worker risk of premature death (set at a small fraction (10%) of the routine radiological risk of premature death for an average worker).

Accident risk in this context excludes minor accidents which may cause radiation doses similar to those incurred during routine operation: these are catered for as part of normal operation.

ii. Public

The UKAEA target is ALARP, and $\not>$10% of the L246 limits (ie 10% of 5m Sv pa = 0.5m Sv pa) for the most exposed member of the public (ie a member of the defined critical group).

ALARP is a real target for designers. For EDRP, the dose target for critical groups of the public is 10% of the 1m Sv pa lifetime limit (or 20% of the UKAEA self-imposed limit of 0.5m Sv pa).

The risk of premature death from radiological accidents for an individual member of the general public should be ALARP, and for EDRP, noting that the plant will be one of only 2 major plants at the Dounreay Nuclear Power Development Establishment (the other being the Prototype Fast Reactor), an individual fatal accident risk target is set at not more than 10^{-7} pa (ie again 10% of the routine radiological risk for the critical groups, who receive $\not>$100 μSv pa).

In assessing risk of premature death a stochastic risk factor of $1.25 \times 10^{-2}\ Sv^{-1}$ is used.

c. Decommissioning

Designers are required to make provision for decommissioning in the design of plant. The objectives are to minimise both waste arisings and operator exposures during the decommissioning phase. This requires both attention to design detail and segregation of equipment to minimise contamination. Ventilation and maintenance equipment, for example, are generally housed in separate areas from the process plant, although in some cases equipment such as a power pack may be situated inside an active enclosure in preference to providing an additional through-wall drive. In general, good design for maintenance leads naturally to good design for decommissioning.

For EDRP, the current design basis requires that the option is retained to decommission to a green field state should this prove justified. Experience within the UKAEA at Dounreay and within BNFL at Sellafield has shown that there is considerable benefit in formulating a decommissioning strategy at the early design stage and building this strategy into the design as it proceeds. EDRP is designed with a fully integrated waste management system, and a design aim is that waste disposal during decommissioning should be via the routine operational waste routes. PCM arising during decommissioning of other parts of the plant will be transferred via the PCM handling facility to the encapsulation plant for immobilisation. The PCM facility (and the other solid waste facilities) will remain available until late in the decommissioning programme and will provide the route by which active solid wastes arising from decommissioning can be handled with minimum risk to the staff involved. Cell and area ventilation and all essential services will be fully maintained during these operations, and safety requirements will mirror those during extended shutdowns for maintenance during the plant operational lifetime.

d. External Hazards

General

In principle, external hazard risks are included in the overall risk targets but it is recognised that in practice the risks of the former cannot be quantified accurately because of uncertainties both in the definition of the external hazard and in the determination of the plant response. The general approach to external hazards for EDRP is to ensure that they make no more than a small additional contribution to the plant risk.

Seismic

Plant areas are screened by assuming complete loss of containment and assessing the risk (probability x consequences) in comparison to the plant risk targets. This identifies areas which require closer assessment in order to determine the possible need for mitigating design measures.

It is common practice in the UK to use a peak horizontal ground acceleration of 0.25g. This typically corresponds to an exceedance frequency of 10^{-4} pa. 0.25g is currently being used as a design figure for EDRP although since Dounreay is in an area of low seismicity relative to the rest of the UK the corresponding exceedance frequency approaches 10^{-5} pa.

There are no economic requirements for seismic protection on the plant: the criterion is that of safety only.

Others

The external hazard corresponding to the appropriate frequency of occurrence (usually 10^{-4} pa) is defined and used as a deterministic design basis. This is applied to plant selected on the basis of a risk assessment.

Again, the incentive is safety and not economics.

e. Ventilation

PCM gloveboxes are provided with a single stage of HEPA filtration on the inlet and on the extract. Inlet air is taken from the operating area, and the extract passes to a glovebox extract header which includes a global secondary HEPA filter en route to the main stack. All HEPA filters are provided with in-situ DOP test points. A vortex amplifier controller is provided on the extract side, designed to maintain a minimum inflow velocity of 1m/s through a maximum credible breach (a glove port or La Calhene port).

Within EDRP, the design intention is that all operating areas will be maintained to the CCZ standards of airborne contamination (ie 5% DAC). The operating areas are sub-divided into zones for which specified levels of ventilation, environmental monitoring and other design features are established in order that this requirement can be met. There are 3 zones, C1, C2 and C3, which define areas of progressively higher risk of airborne contamination. The operating area containing the PCM glovebox is classified C2 by definition: some leakage of contamination into the area could occur under fault conditions. C2 areas may be accessed directly from uncontrolled areas via a changeroom. Air change rates are set with regard to the need to permit alpha in air alarm monitors to discriminate between process material and natural background (materials of construction are selected to give a low radon/thoron background), although with the latest monitors it is found that the requirement to deal with resuspended activity dominates. Air change rates are therefore taken to be a nominal 5 ach as a basis for design, although rates as low as 3 ach are sometimes acceptable in practice. The aim is to provide sufficient air flow to deal with any resuspension of activity. C2 areas are fitted with alpha and beta in air instruments and gamma monitors, all of which provide alarm facilities.

The need for space extract filtration is determined by the potential threat to the environment that could result from the area under consideration. In general, the need to protect the operator ensures that there will be no hazard to the environment, but the criterion for EDRP is that if a potential release into the operating area could lead to a discharge exceeding a normal day's discharge, then filtration should be provided. As an example, for EDRP the maximum annual aerial discharge is calculated to lead to critical group exposures not exceeding 0.1m Sv over 250 operating days, or 0.4 Sv/d. This would correspond to a discharge of the order of 1 mg Pu.

f. Waste Minimisation

It is Government policy that the nuclear industry should conduct its business in such a way as to minimise arisings of active waste.

In respect of plant design, this has led to wide spread use of engineered posting systems (principally La Calhene at Dounreay, with development work on purged ports), and to the adoption of in-cave ventilation systems based on low volumetric flow rates.

SID HUNTER, UKMoD

FACILITY DESIGN CRITERIA

DESIGN CRITERIA

AWRE POLICY

- Release of radioactive materials to the environment as a result of Waste Management Operations shall be as low as is reasonably practicable
- Where a disposal route is governed by a formal agreement, the intent in using the route shall be to limit the release to less than the agreed level
- Reduction to a minimum of the quantity of waste arising and, more importantly, the amount of contaminant associated with it
- The Radiation exposure involved in waste handling treatment and disposal shall be kept as low as reasonably practicable
- The generation of waste for which there is no available treatment/disposal route shall be avoided
- Waste will be disposed of as soon as is reasonably practicable

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DESIGN CRITERIA

Health & Safety Executive

H.M. Nuclear Installations Inspectorate

SAFETY Assessment Principles
for Nuclear Chemical Plant

FUNDAMENTAL REQUIREMENTS & POLICY

BASIC PRINCIPLES

ENGINEERING PRINCIPLES

MANAGEMENT PRINCIPLES

Fundamental Principles

1. No person shall receive R/A dose in excess of the appropriate dose limit as a result of normal operation.

2. Doses to individuals shall be as low as reasonably practicable.

3. Having regard to 2. the collective dose to persons on and off the site, resulting from operation of the nuclear installation shall be kept as low as is reasonably practicable.

4. All reasonable steps shall be taken to prevent accidents.

5. All reasonable steps shall be taken to minimise the consequences of any accident.

DC2

BASIC PRINCIPLES

Radiological.

Principles for the evaluation of radiation exposures under normal operating conditions.

Principles for the evaluation of fault conditions and protection systems.

ENGINEERING PRINCIPLES

Response to faults/design/protection

R/A materials control

R/A materials movement

R/A waste and scrap control

Radiological protection practice

Protection systems

Essential resources

ENGINEERING PRINCIPLES (Contd.)

Plant containment and ventilation

Plant Operation

Analysis of faults, transients and abnormal conditions

Reliability analysis

External hazards

Layout

Installation checks and commissioning

Servicing

Decommissioning

MANAGEMENT PRINCIPLES

The Management of Safety

Quality Assurance

Design principles to aid the decommissioning of alpha radioactive facilities

- Minimise the overall quantity of equipment within radioactive containment
- Limit the quantity of equipment within any particular containment
- Design for ease of decontamination
- Design for dismantling and size reduction

TRANSLATION OF PRINCIPLES INTO PRACTICE

OWN EXPERIENCE

OPEN LITERATURE eg. DOE, MAFF

UK ADVISORY BODIES eg. NRPB

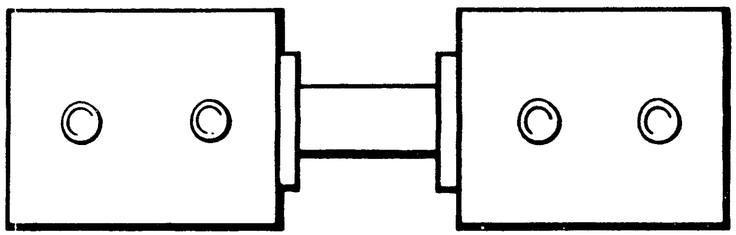
BNF.plc & UKAEA PRACTICE

USA CIVIL PRACTICE

USA OTHER PRACTICE

DESIGN FOR DECOMMISSIONING

- Design for ease of disconnection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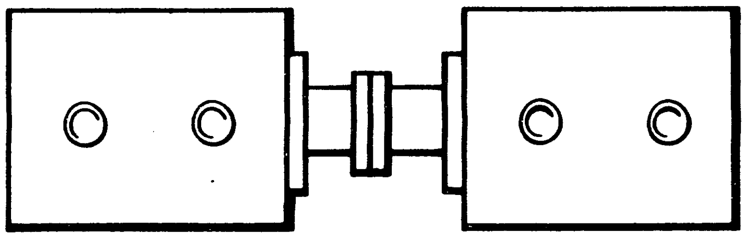
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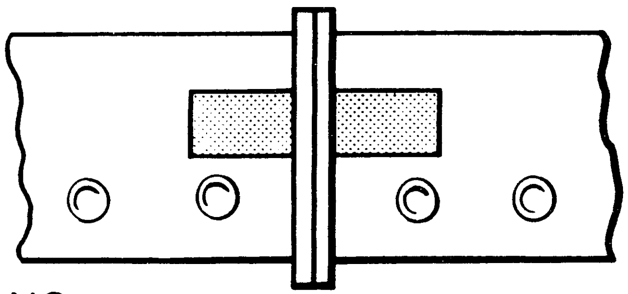
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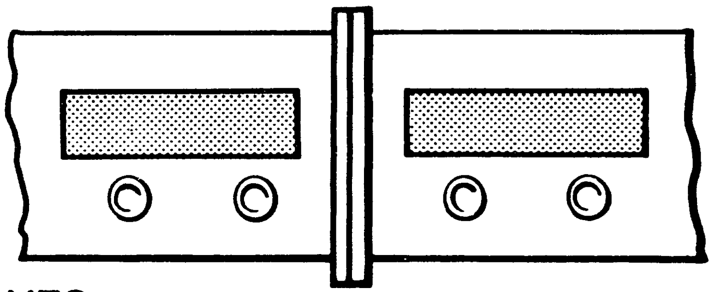

YES

STEVE MENTRUP, SRP

PROCESSING OF TRANSURANIC WASTE AT THE SAVANNAH RIVER PLANT

TRU WASTE FACILITY MISSION

TO SAFELY RETRIEVE AND PROCESS
TRU WASTE FOR DISPOSAL AT THE WIPP
MINIMIZING OCCUPATIONAL RADIATION
EXPOSURE AND ENVIRONMENTAL EFFECTS

WASTE HAZARDS

- RADIOLYTIC GAS GENERATION (EXPLOSION)
- RADIATION AND RADIOLOGIGAL ASPECTS
- CONTAINER CONDITIONS

INVESTIGATION AREAS

- EXPLOSION CONSEQUENCES
  - TO PUBLIC
  - ONSITE PERSONNEL
- CONTAINER EXPLOSION TESTS

RETRIEVAL DESIGN

- MINIMIZE HANDLING OUTSIDE OF TWF BUILDING
- REMOTE TECHNIQUES
- EXPLOSION PROTECTION
  - LIFTING CANISTER
  - TRANSPORT CASK
  - CAB DESIGNS

TWF BUILDING DESIGN CONSIDERATIONS

GENERAL

EXPLOSION

STRUCTURAL

RADIOLOGICAL

VENTILATION

CRITICALITY

MAINTENANCE

GENERAL

- FACILITY LOCATION
- SUPPORT SERVICES
  - UTILITIES
  - PERSONNEL
- DESIGN CAPACITY
- EXPANDABLE

EXPLOSION DESIGN

- REINFORCE STRUCTURAL
- REMOTE HANDLING
- CONTAIN / CONTROL AT SOURCE
- VENTILATION DAMPENING

STRUCTURAL DESIGN

- FACILTY LIFE
- SEISMIC / TORNADO
- EQUIPMENT REMOVAL
- DECONTAMABILITY
  - MATERIAL
  - SURFACE FINISH

RADIOLOGICAL DESIGN

- SHIELDING
- REMOTE WORK
- MINIMAL GLOVEPORT WORK
- FACILITY CLEANUP

VENTILATION DESIGN

- CASCADE AIR FLOWS
- AIRLOCKS
- HEPA LOCATIONS
- PRESSURE DIFFERENTIALS
- SAND FILTER

CRITICALITY DESIGN

- CONFIGURATION DESIGN
- ACCESSABLE COLLECTION AREAS
  - MONITORING
  - CLEANOUT
- LIMIT INVENTORY

PRESENTATIONS, VISUALS, AND HANDOUTS

TUESDAY, OCTOBER 28, 1986

APPLICATION OF DESIGN CRITERIA TO SMALL PLANTS

AND

APPLICATION OF DESIGN CRITERIA TO LARGE PLANTS

JOHN BUCKLE, BNFL

PURPOSE OF WTC - PHASE I

PURPOSE OF WTC - PHASE I

- To sort drummed PCM into:
  - Shreddable and non-shreddable categories
  - Hi & lo Plutonium content
- Volume reduce the shreddable category and prepare for subsequent processing.
- Pack both categories into drums for either storage, future treatment or disposal.

PLANT FEED

- Drums of material from current operations and backlog stores.
- Hepa filters.
- Contents of small bagless transfer containers.

DESIGN FOR NORMAL OPERATING CONDITIONS

OBJECT

- To design and build to limit the following:
  - Internal and external radiation to personnel.
  - Radiation exposure of the public.
  - Liquid and aerial effluent discharges.

DESIGN FOR NORMAL OPERATING CONDITIONS

SOLUTION

- Internal and external radiation to personnel and radiation exposure of the public.
  - Containment: Use of high quality gloveboxes located in process cells to provide primary and secondary containment.
  - Shielding: Use of shield materials to reduce radiation levels.
  - Remoteness: Minimise or prohibit routine operator/maintenance procedures in active areas.
- Liquid and aerial effluent discharges
  - Effluent management:

    LIQUID: Hold, sample and dispose/store

    AERIAL: Filter, sample and/or monitor and dispose/store.

DESIGN FOR POTENTIAL FAULT CONDITIONS

OBJECT

- To design and build to cope with the following fault conditions:
  - Loss of containment
  - Loss of services
  - Criticality
  - Fire/Explosion
  - Environmental conditions (Seismic events, wind, flood etc)
  - Theft
  - Hazardous operations

DESIGN FOR POTENTIAL FAULT CONDITIONS

SOLUTION

- Loss of containment:-
  Shut down plant
- Loss of services:-
  Provide back-up services
- Criticality:-
  Limit quantities of fissile material in the process line by assay of incoming and outgoing material and regular clean-up.
- Fire and explosion:-
  Venting of explosive gases, inert gas purging in high risk areas, controlled use of thermal cutting equipment and use of for example low smoke and fume (LSF) electrical cable.
- Environmental conditions:-
  Design of building to cope with recognised weather extremes.
- Theft:-
  Adopt stringent security and safeguard procedures.
- Hazardous operations:-
  Limit damage that could occur by guarding hard wired interlocks etc.

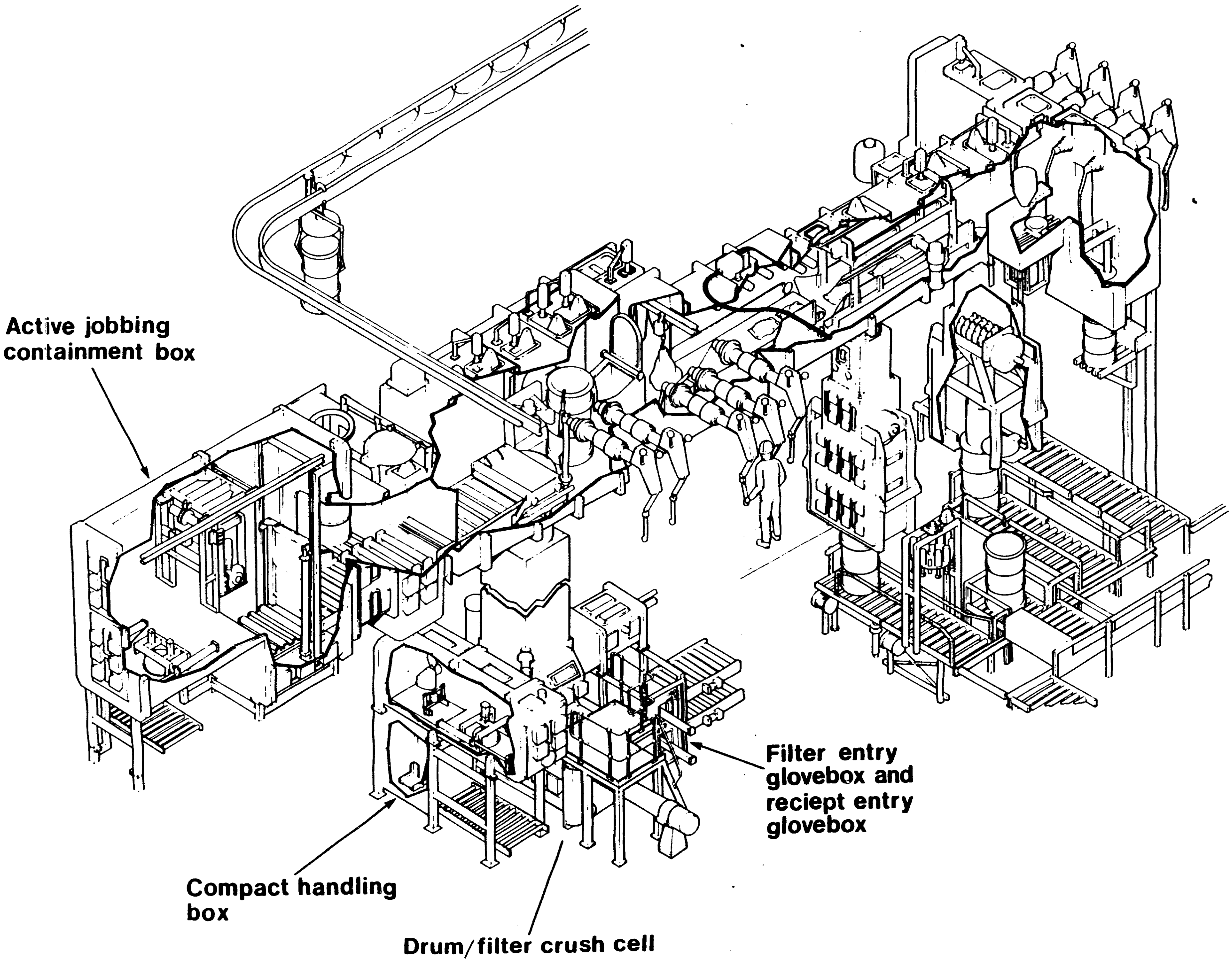
DESIGN FOR EASE OF OPERATION AND MAINTENANCE

- Simple equipment design: Modular construction, unit replacement etc.
- Close liaison throughout design and manufacture with operators and maintenance personnel
- Ergonomic design of control and maintenance faces
- Use of quality control procedures to control design and manufacture
- Extensive equipment/procedures testing
- Development of novel or new equipment
- Operator/Maintenance familiarisation with completed equipment

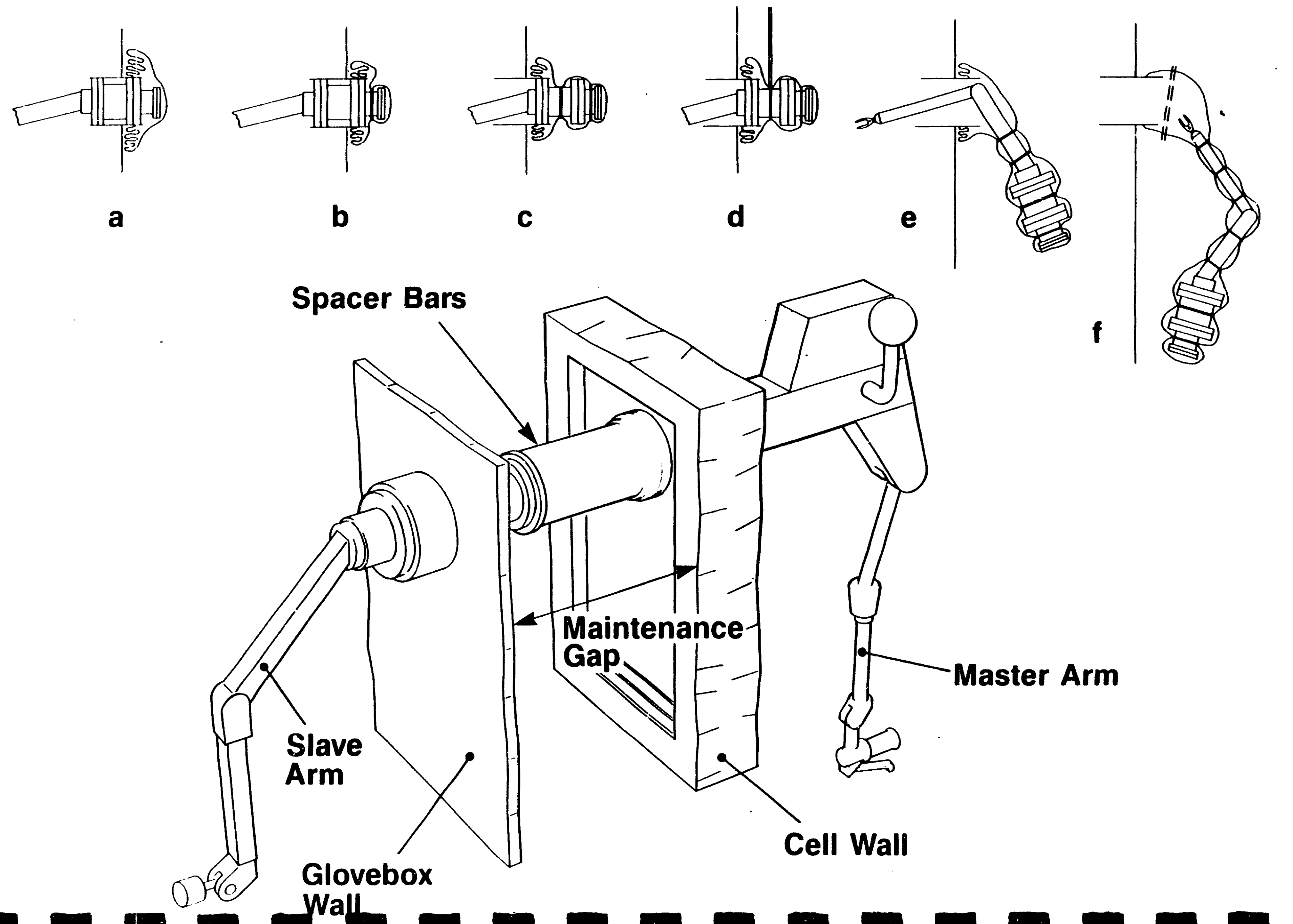
DESIGN FOR ULTIMATE DECONTAMINATION AND DECOMMISSIONING

- Modularise plant/equipment for ease of dismantling
- Include in building structure means to aid final dismantling, e.g. Lifting beams, access
- Minimise in-cell equipment
- Divorce services from active areas
- Pre-plan removal routes
- Identification of key services

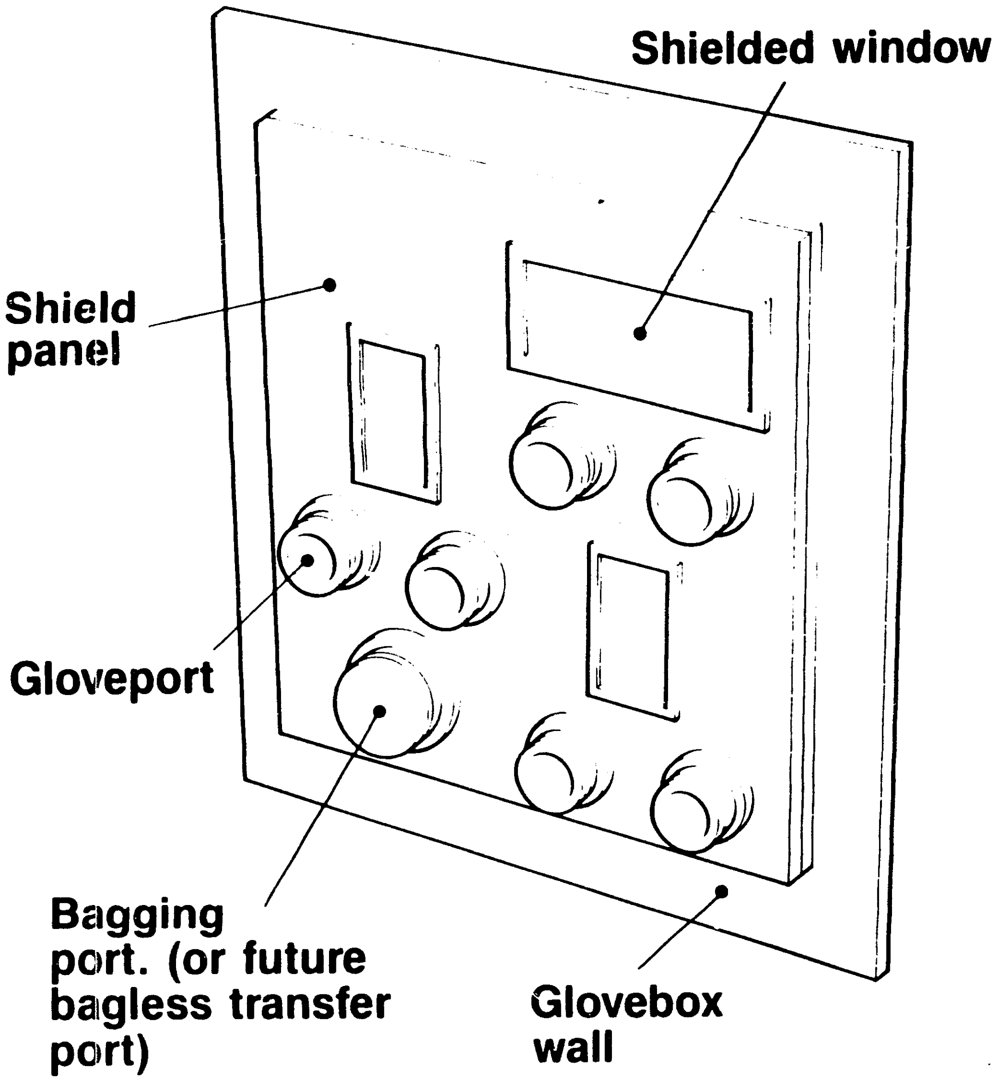
MAIN PROCESS LINE

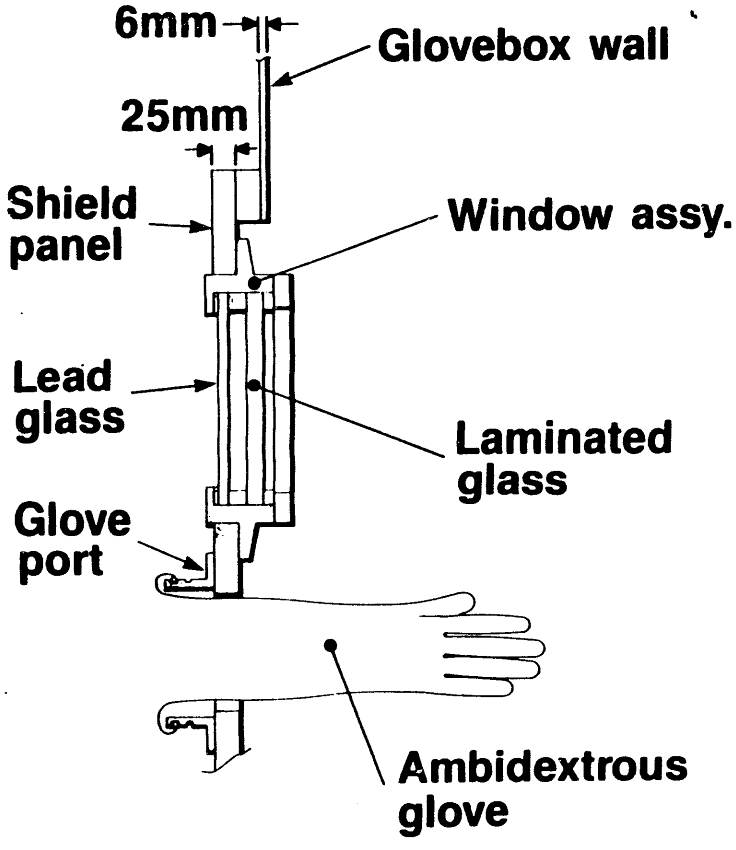


BAGGING OUT PROCEDURE FOR SLAVE ARM MSM IN SLAVE ARM CHANGE POSITION



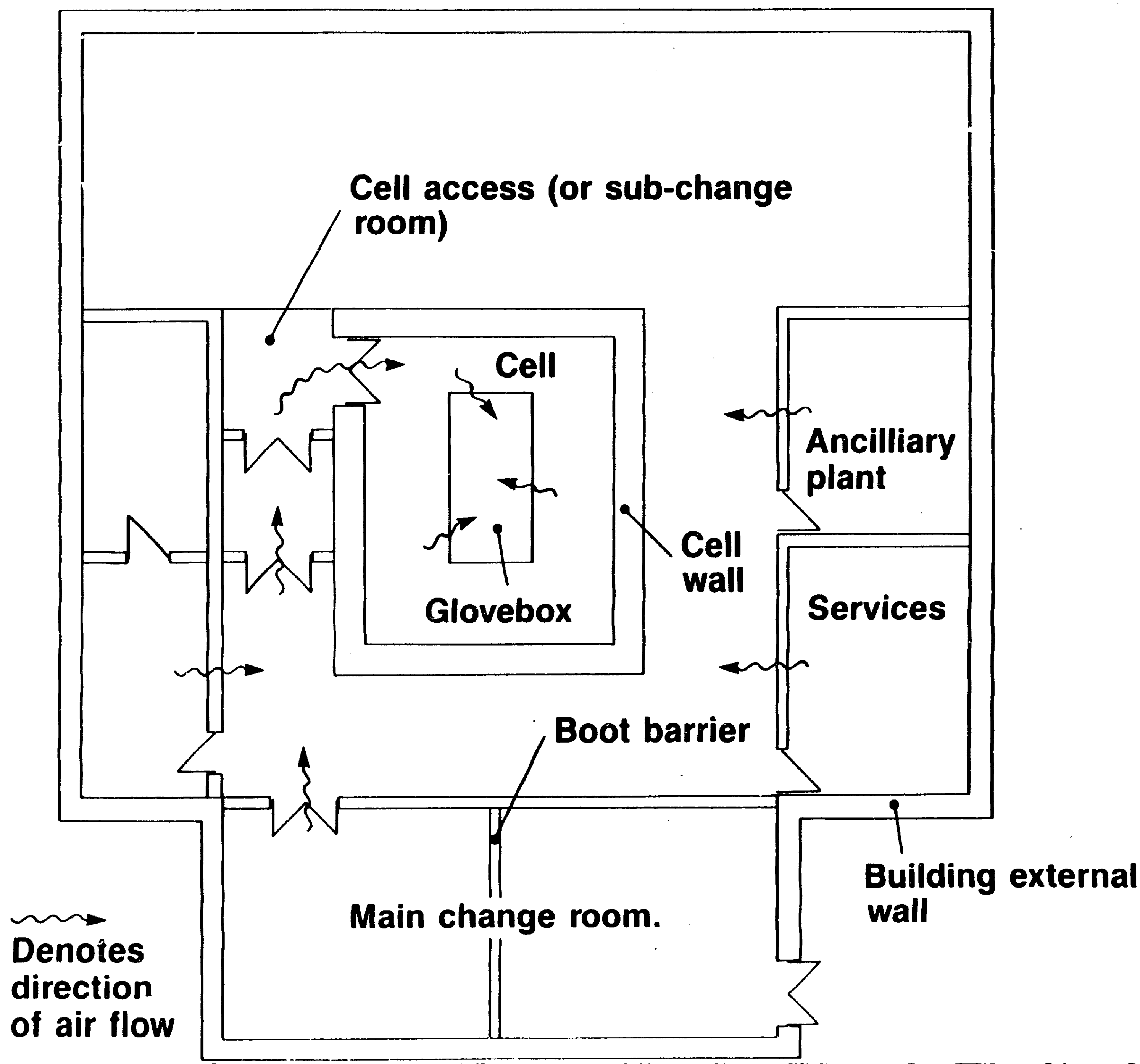
TYPICAL ARRANGEMENT OF GLOVEBOX MAINTENANCE WORKING FACE SHIELD PANEL



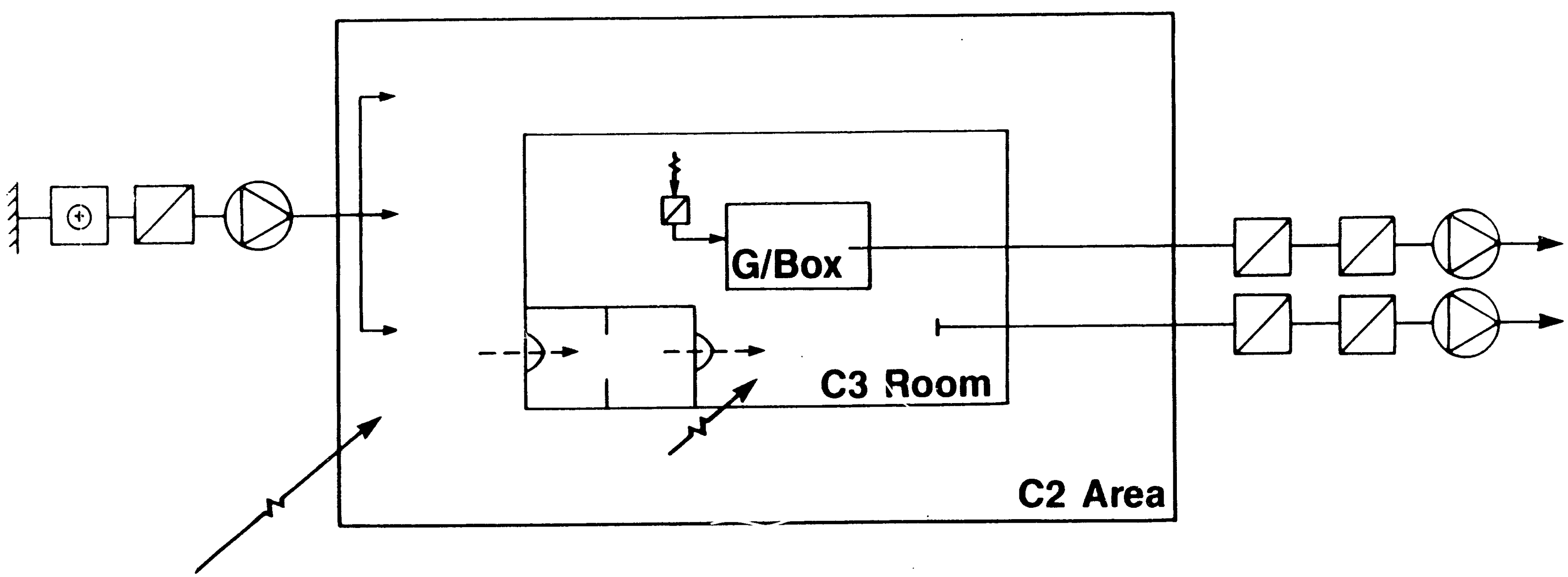


TYPICAL SECTION OF SHIELD PANEL

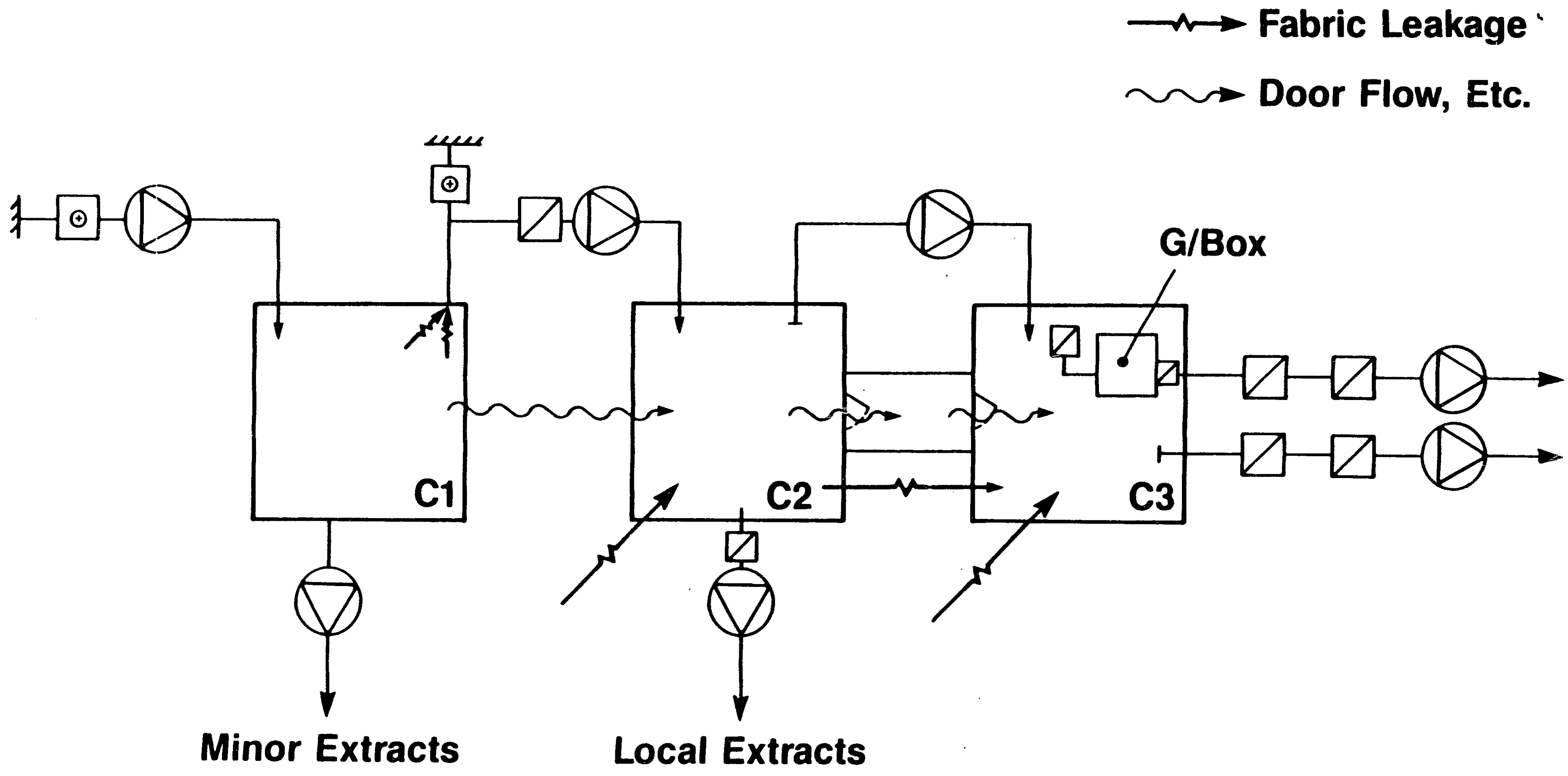
TYPICAL BUILDING LAYOUT SHOWING CELL ACCESS PRINCIPLES AND AIR FLOWS

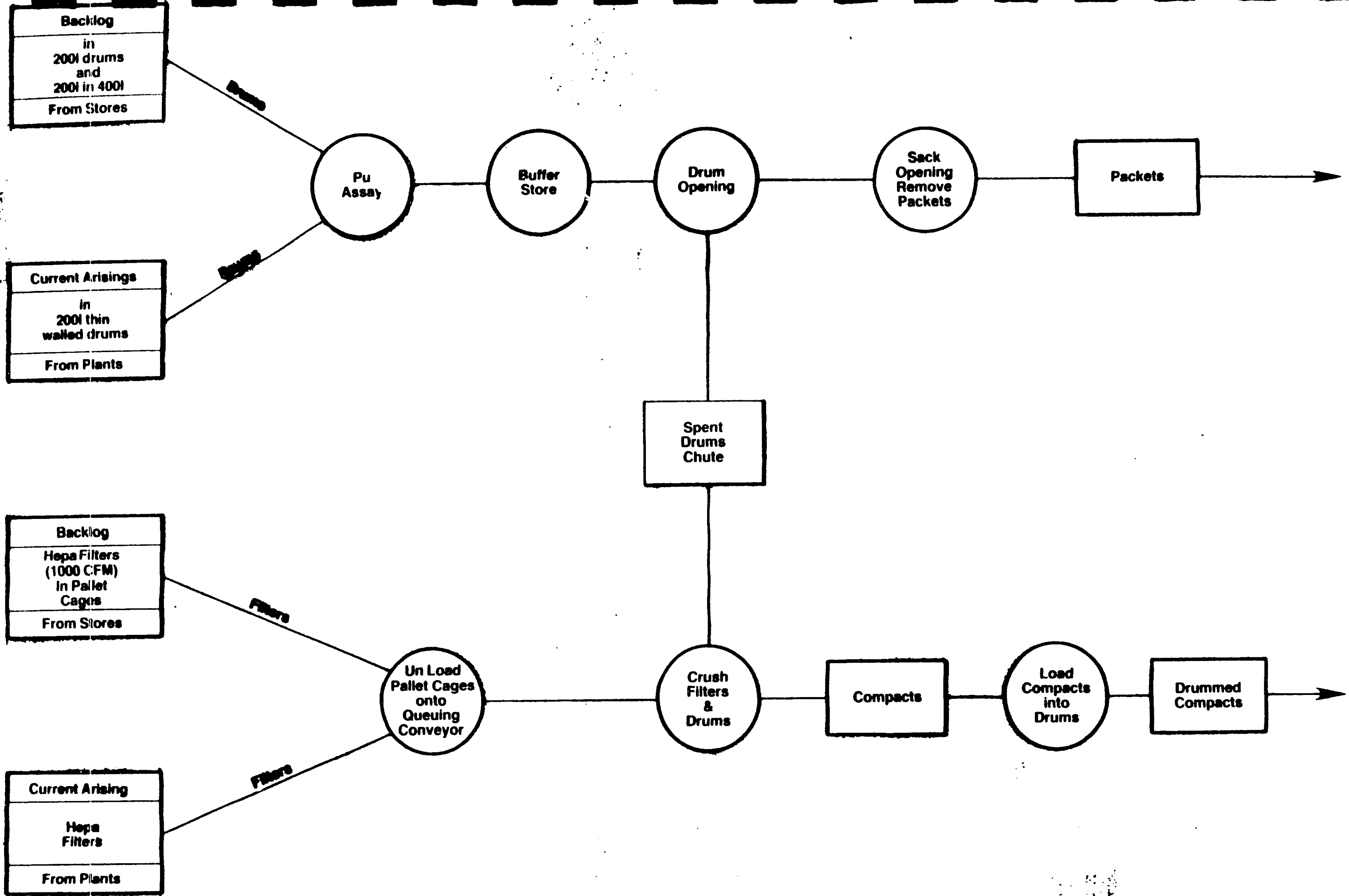


IDEAL VENTILATION CASCADE SYSTEM



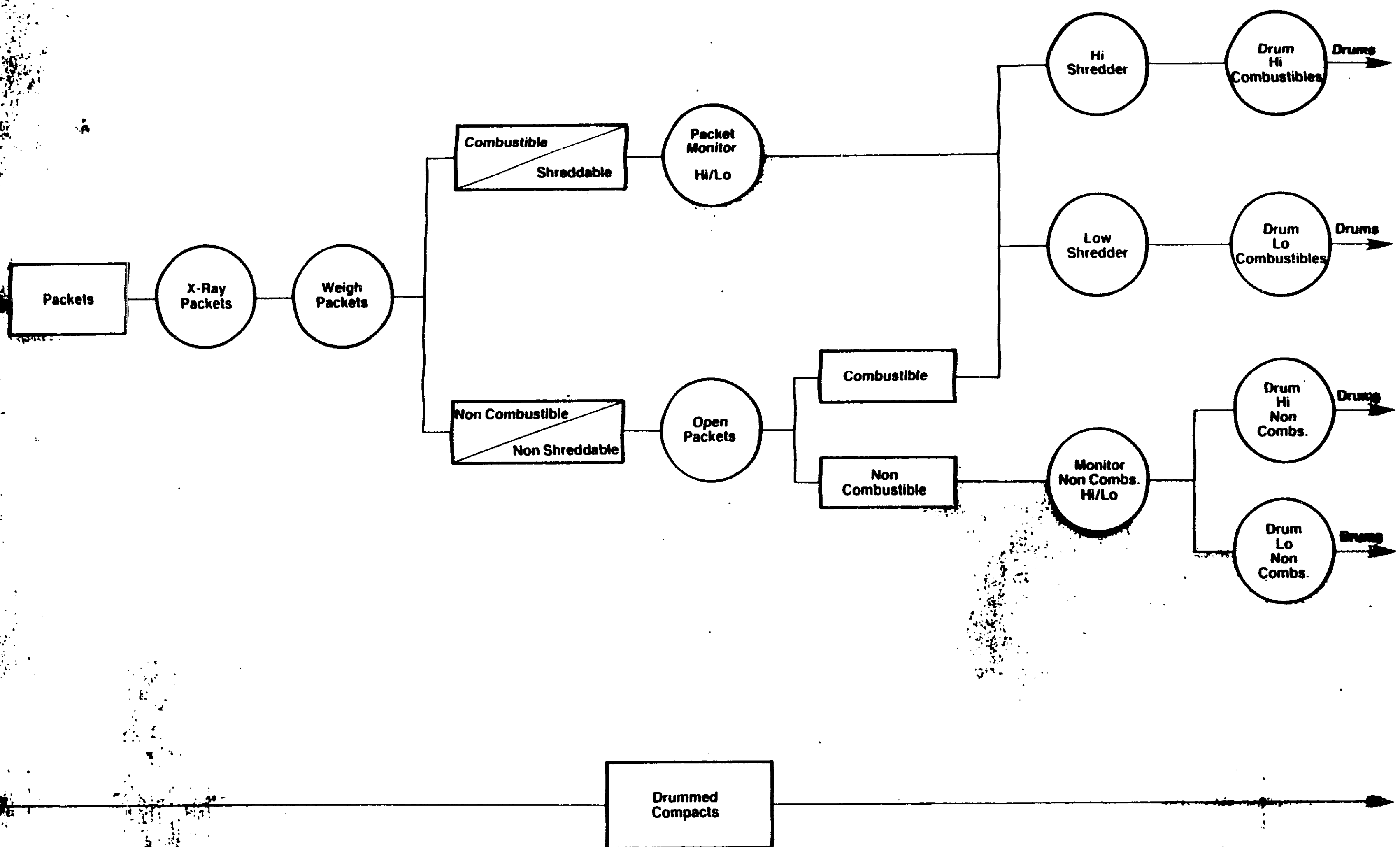
WTC - PHASE 1 VENTILATION CASCADE SYSTEM



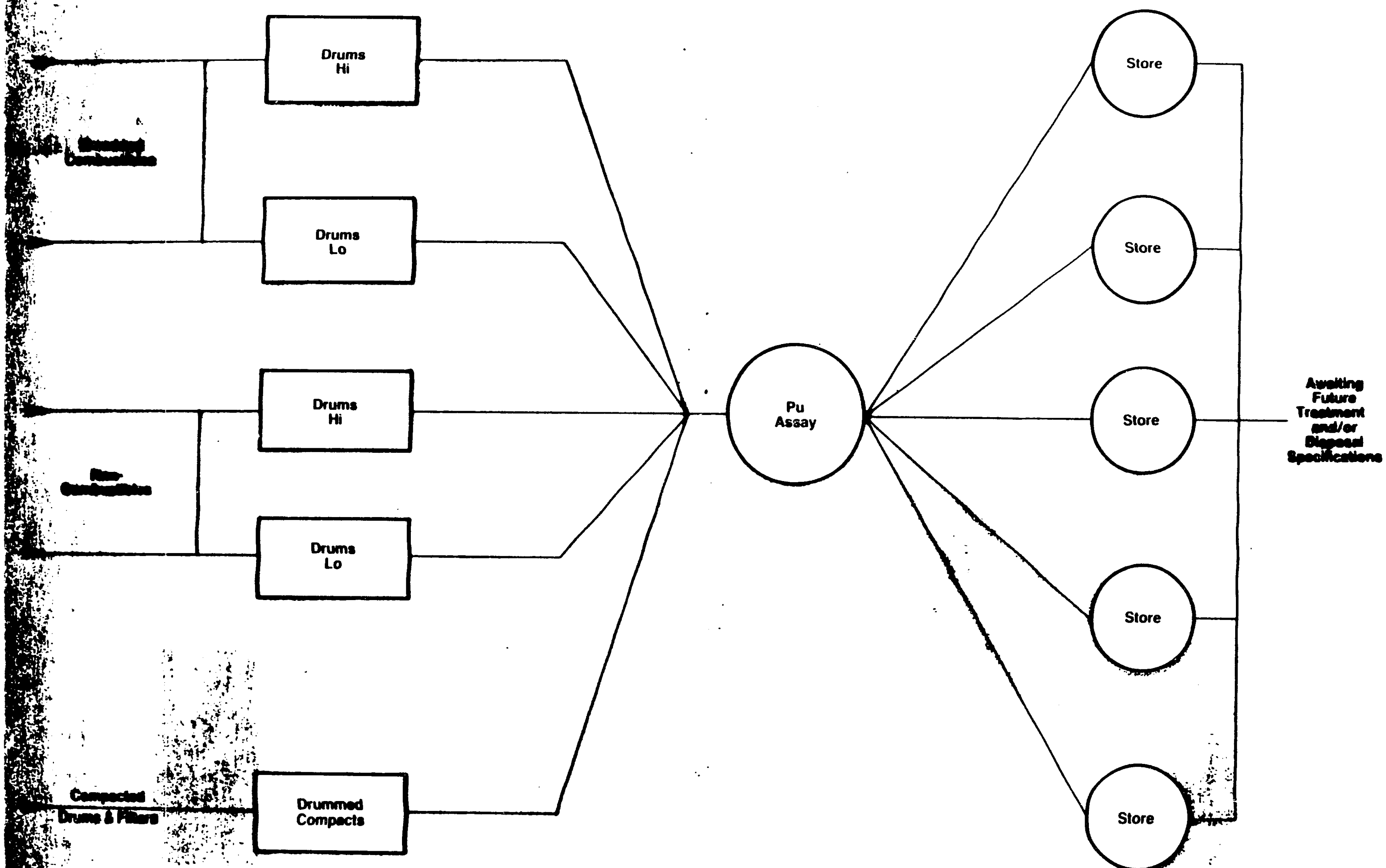


Simplified Flowsheet WTC Phase I

Sheet 1 of 3

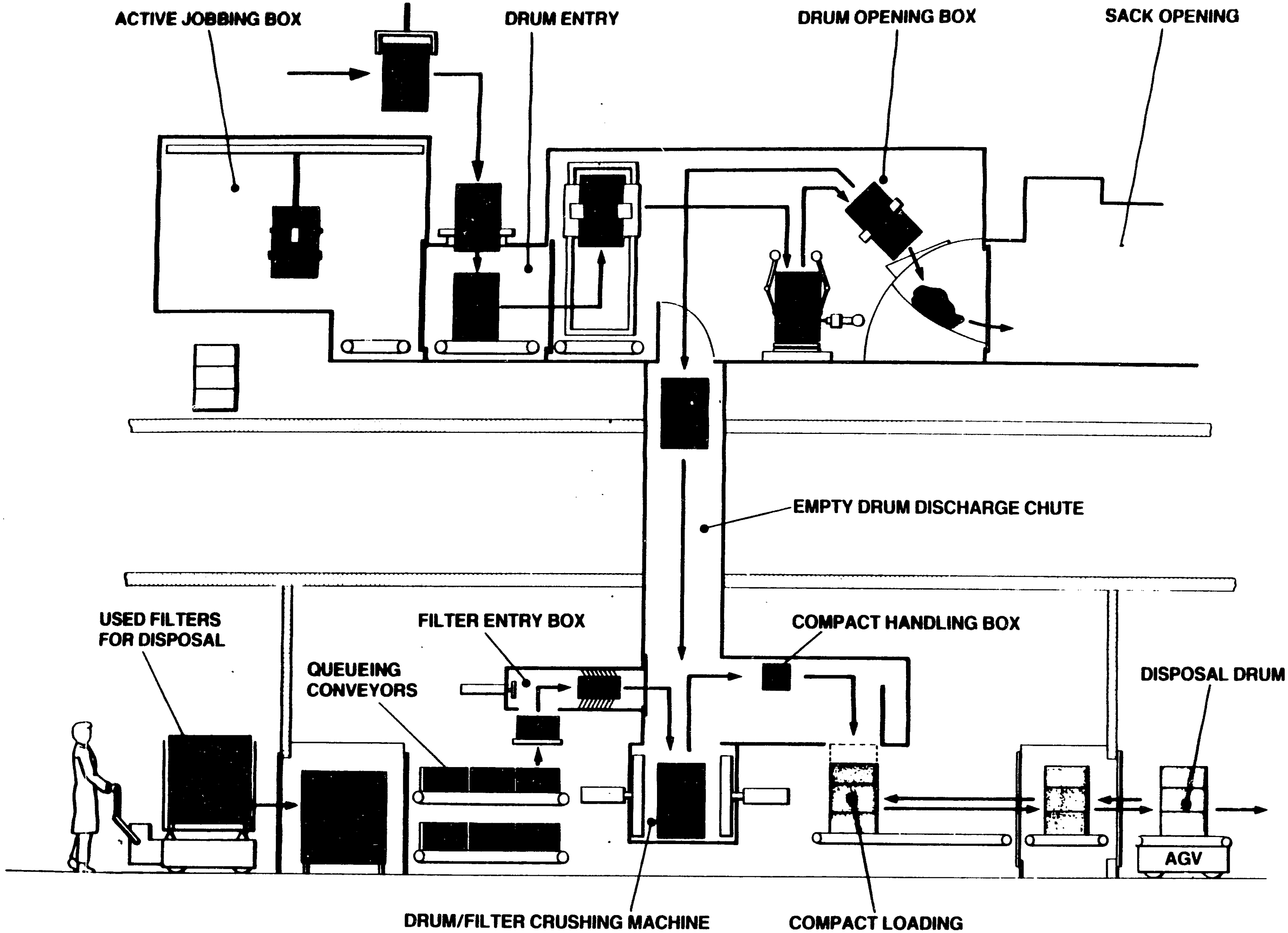

Packets
X-Ray Packets
Weigh Packets
Combustible
Shreddable
Non Combustible
Non Shreddable
Packet Monitor Hi/Lo
Open Packets
Combustible
Non Combustible
Hi Shredder
Low Shredder
Monitor Non Combs. Hi/Lo
Drum Hi Combustibles
Drum Lo Combustibles
Drum Hi Non Combs.
Drum Lo Non Combs.
Drums
Drums
Drums
Drums
Drummed Compacts

Sheet 2 of 3

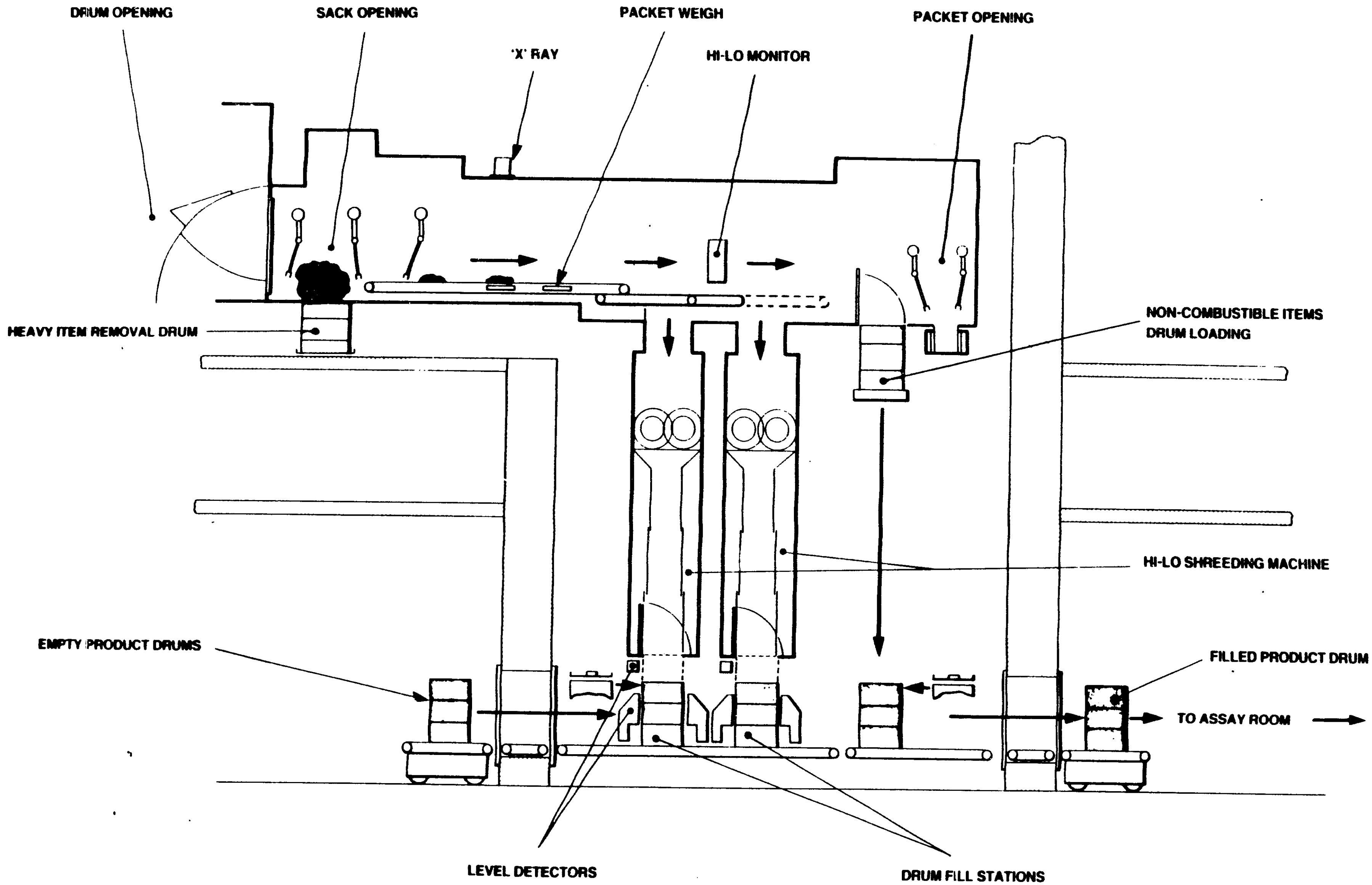


Drums
Hi
Drums
Lo
Drums
Hi
Drums
Lo
Compacted
Drums & Filters
Drummed
Compacts
Pu
Assay
Store
Store
Store
Store
Store
Awaiting
Future
Treatment
and/or
Specifications

Sheet 3 of 3

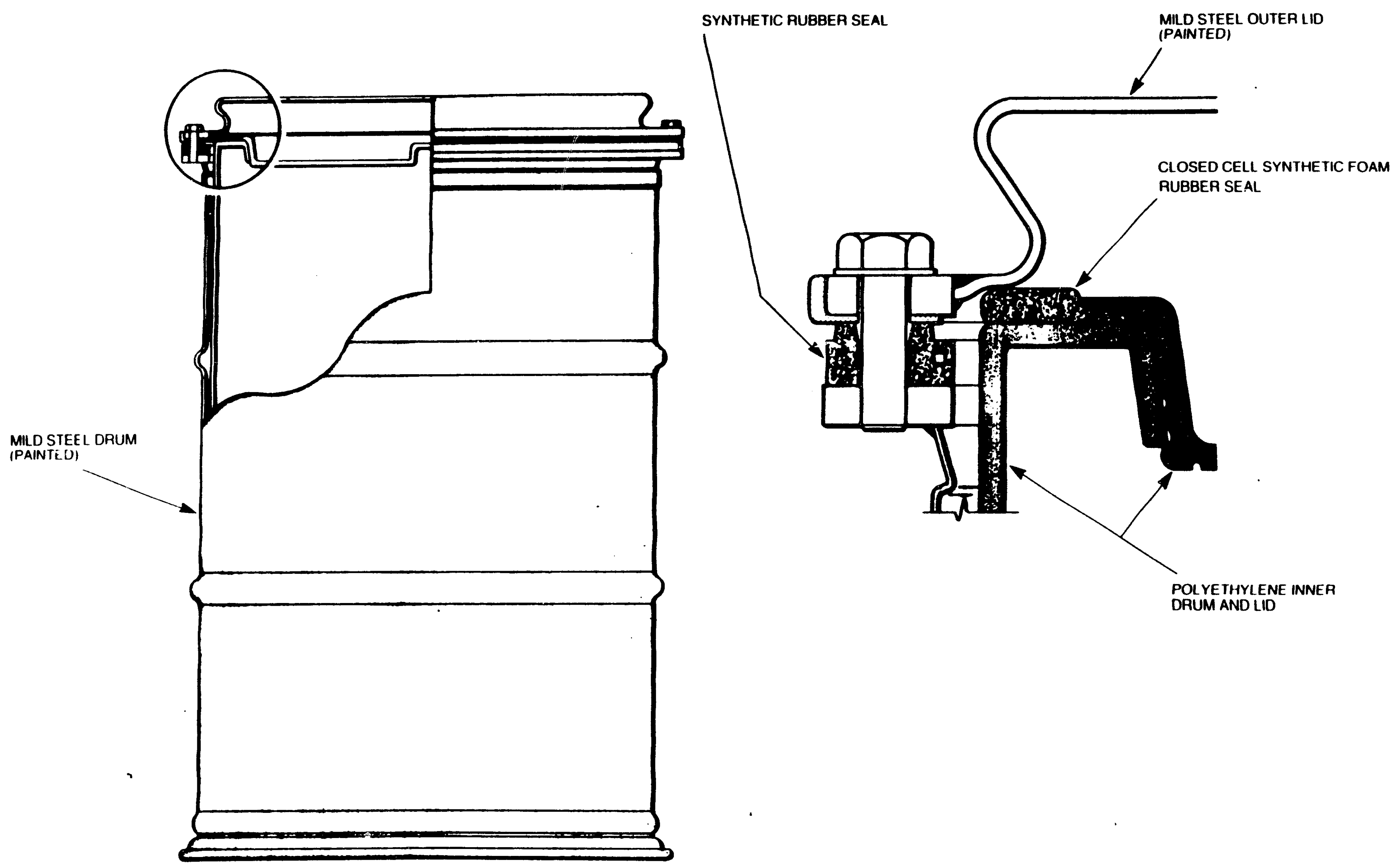


DIAGRAMMATIC LAYOUT OF PROCESS LINE SHEET 1 OF 2

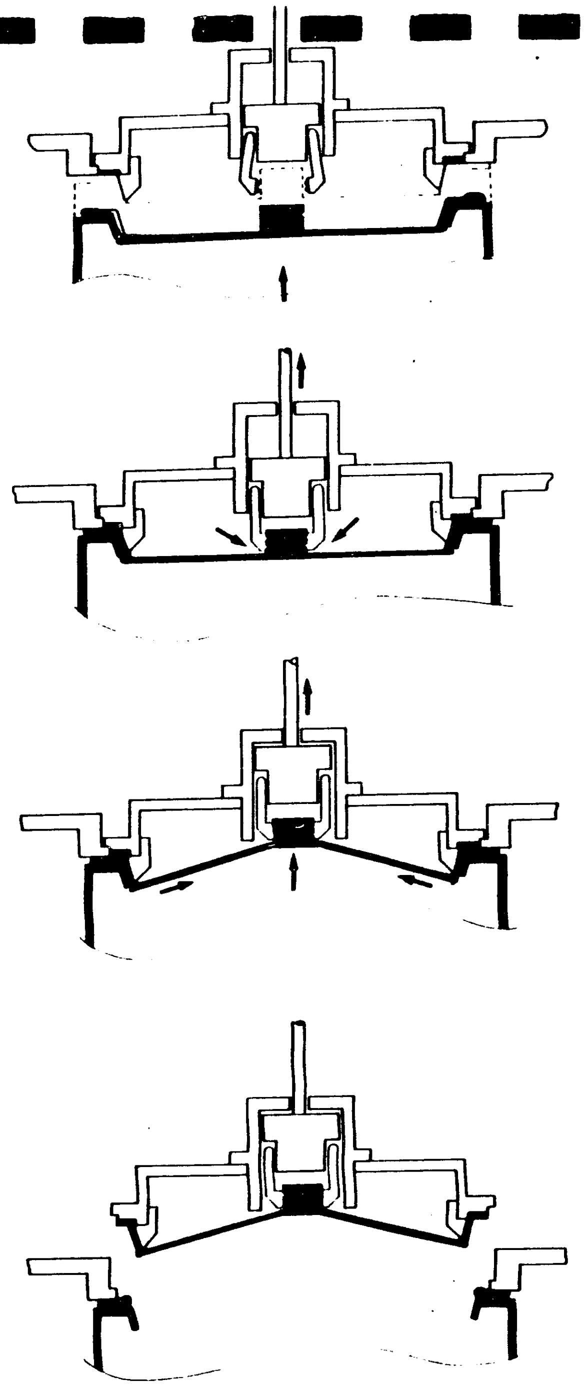


DIAGRAMMATIC LAYOUT OF PROCESS LINE

SHEET 2 OF 2



200 LITRE STORAGE DRUM



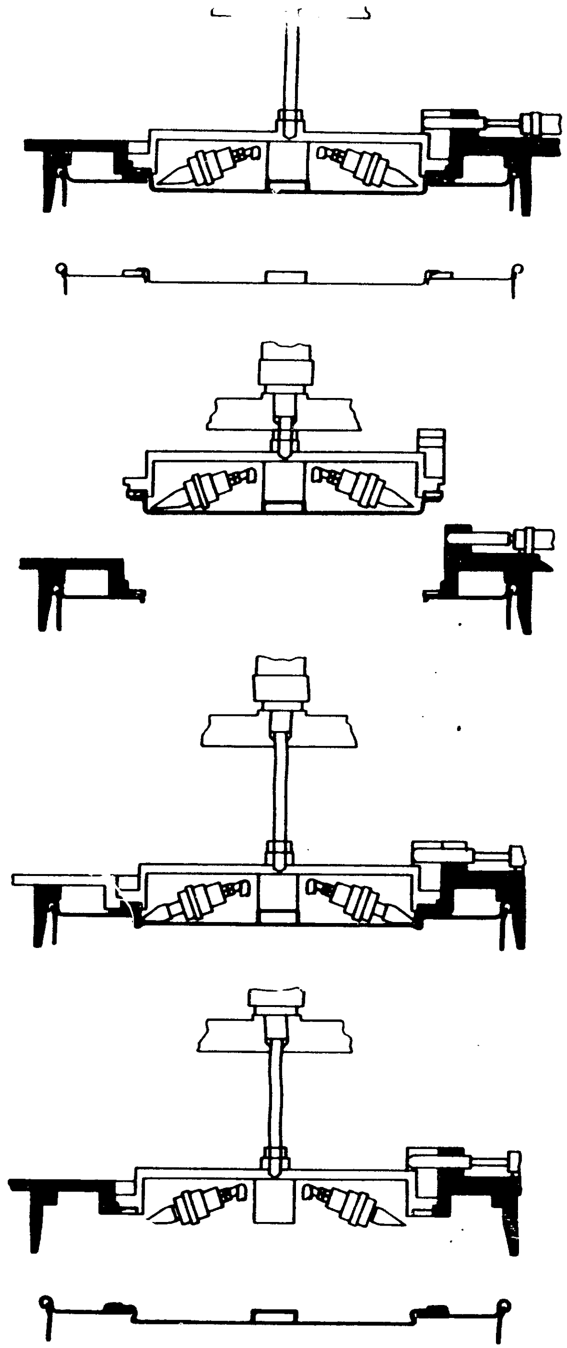
1. POSITION DRUM UNDER PORT AND RAISE DRUM INTO LID REMOVAL POSITION (DRUM SEAL COMPRESSED 50%)

2. RETRACT CYLINDER ALLOWING JAWS TO GRIP THE SPIGOT AND RETAIN THE LID TO THE PORT DOOR.

3. CONTINUE TO RETRACT LID INTO A POSITION WHERE IT DEFLECTS SUFFICIENTLY TO RELEASE FROM THE DRUM.

4. RETRACT FURTHER LIFTING THE PORT DOOR (WITH LID ATTACHED) CLEAR OF THE DRUM THE PORT ASSEMBLY CAN NOW BE MOVED CLEAR OF THE PORT.

SEQUENCE DIAGRAM FOR THE REMOVAL OF POLYETHYLENE INNER DRUM LID — BAGLESS TRANSFER TECHNIQUE



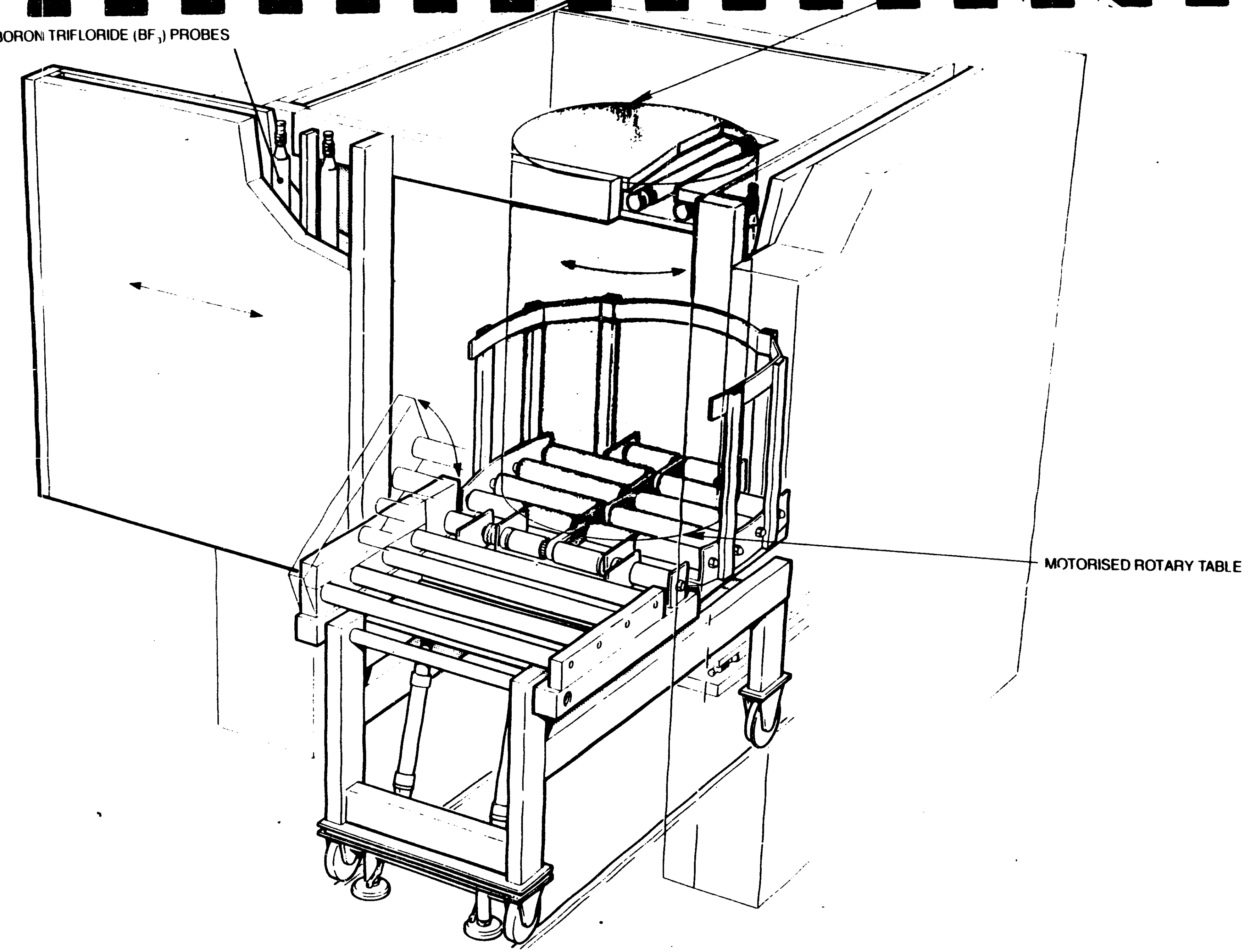
1 POSITION DRUM UNDER PORT AND RAISE INTO LID REMOVAL POSITION (DRUM SEAL COMPRESSED 50%)

2 RAISE PORT DOOR COMPLETE WITH LID, WHICH IS HELD IN PLACE BY MAGNETS (NOT SHOWN) THE DOOR ASSEMBLY CAN NOW BE MOVED CLEAR OF THE PORT

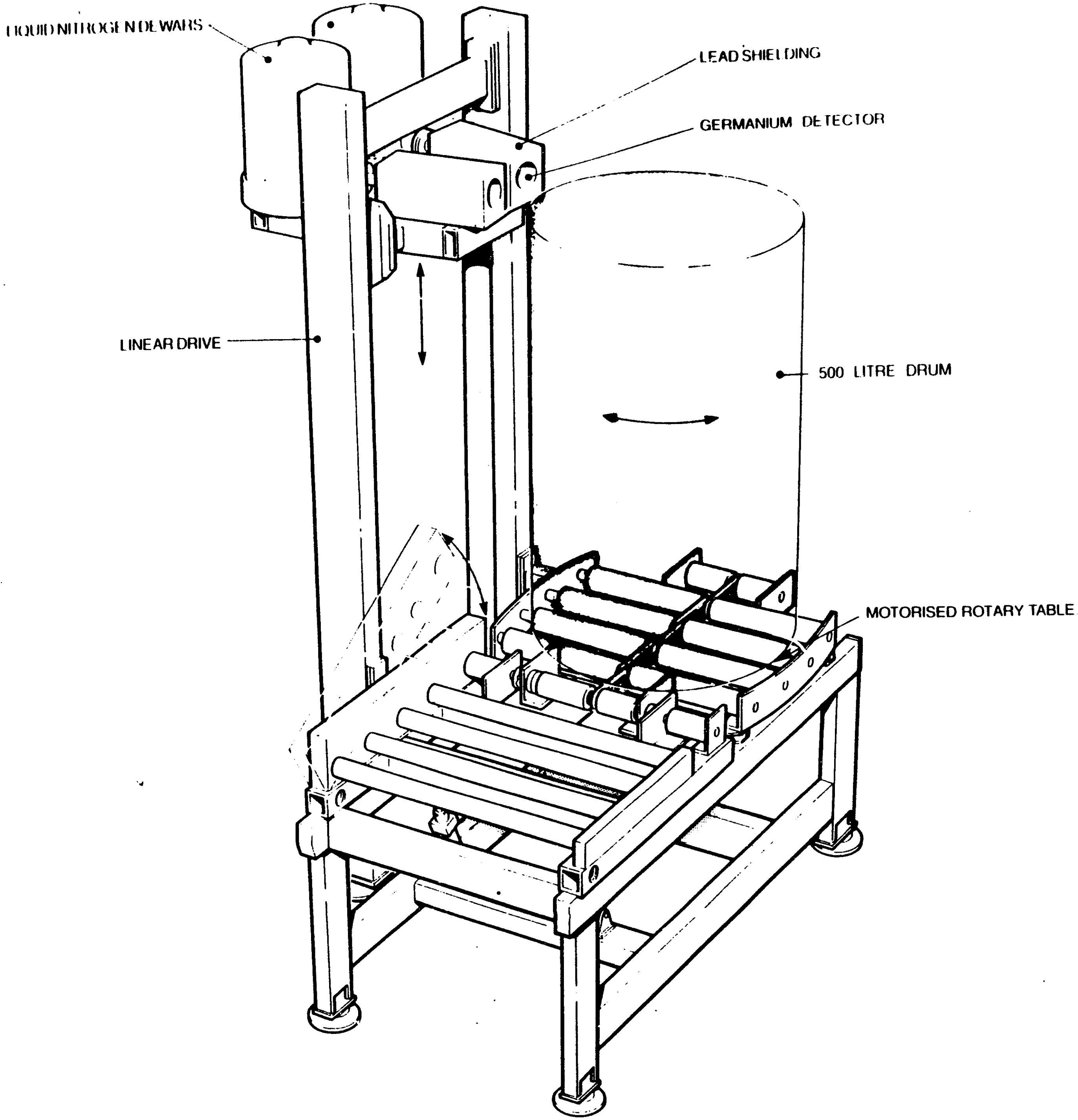
3 AFTER DRUM LOADING, REPLACE THE PORT DOOR AND LOCK THE LID INTO THE DRUM BY INDENTING

4 REMOVE DRUM FROM PORT

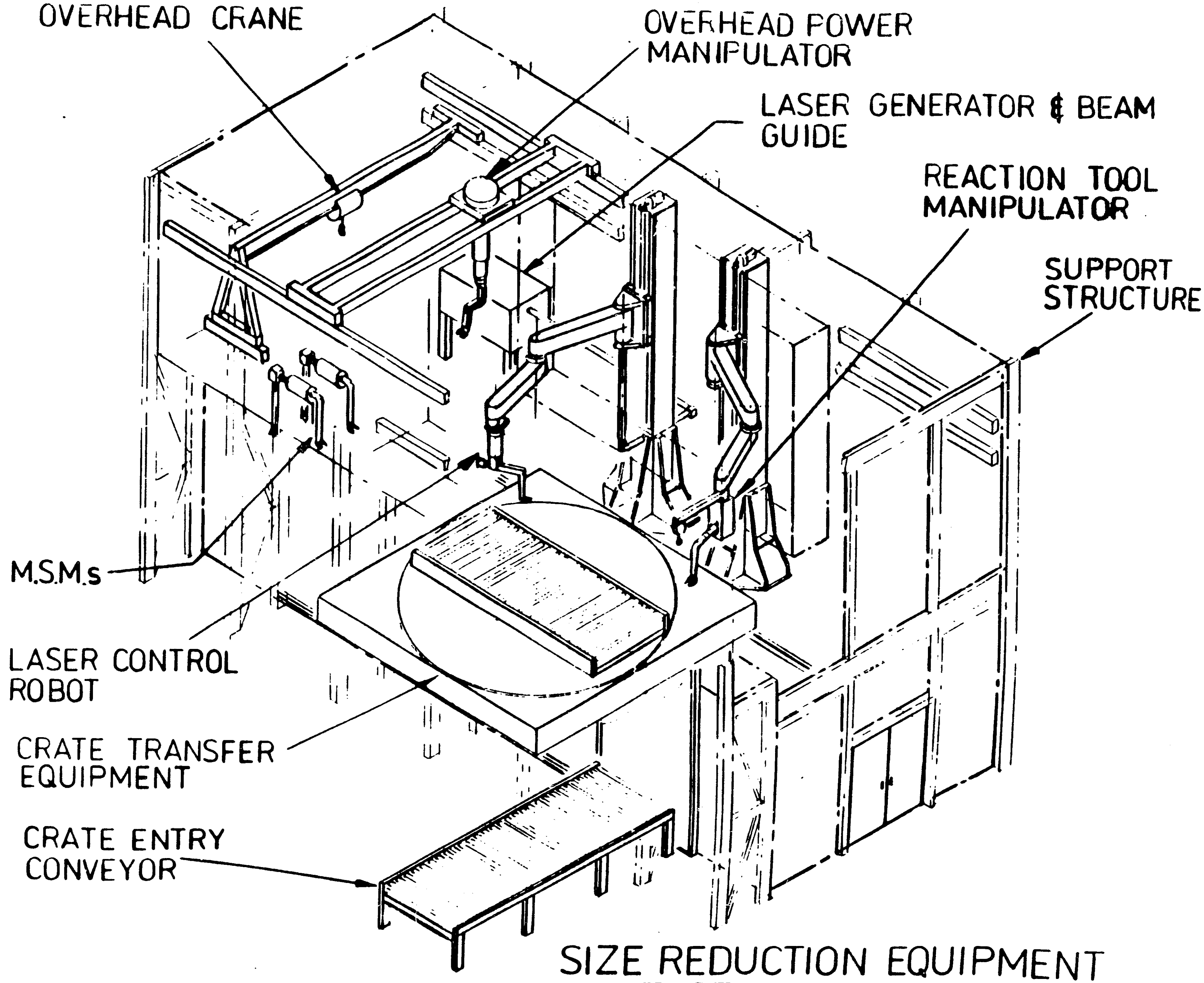
SEQUENCE DIAGRAM FOR LOADING AND SEALING THE ONE TRIP DISPOSAL DRUM — BAGLESS TRANSFER TECHNIQUE



NEUTRON COINCIDENCE MONITOR
(UP TO 500L DRUM CAPACITY)



GAMMA SCANNER
(ISOTOPIC DETECTION COMPOSITION)



SIZE REDUCTION EQUIPMENT TEST FACILITY

ROBERT THOMAS, UKAEA

UKAEA SMALL PLANTS

UKAEA SMALL PLANTS (Source Material for a 30 Minute Presentation)

a. Dounreay PCM Handling Facility

i. Description

PCM arises at Dounreay from Pu fuel reprocessing operations, analytical work and operations in the development laboratories.

The PCM is delivered in La Calhene containers which are assayed using a coincident passive neutron counter and a segmented gamma scanner. The waste is then posted into a sorting glovebox which has 2 operating faces: one shielded and one unshielded. The operator uses whichever is appropriate according to the radiation level from the packages on the bench top. The waste is sorted into combustible and incombustible compenents, which are loaded separately into one or other of a pair of 200 l polythene drums docked to the underside of the box. In practice, the waste is segregated at source into combustible and incombustible fractions, and since this works effectively the centralised sorting is mainly a verification stage. No size reduction is practised at present.

The polythene drums are jacked up underneath the glovebox by means of a drum pallet truck in the inspect room alongside and below the glovebox. Their lids are withdrawn into the glovebox having been sealed in a double-door arrangement to the bench hole cover plates which are handled by a swing-jib crane within the box (Slides 14, 15, 16). The crane travels on a runway beam and may be lowered to bench level for maintenance by means of counterbalanced runway beam extension. With safety in mind, slewing is by handwheel action outside the box, travel and hoist are by push-to-run control buttons and limited to 10 fpm and 6 fpm respectively.

A shroud collar is fitted to the drum port in order to minimise seal contamination during filling.

After the lid has been snapped into position, the polythene drum is withdrawn into the inspect room and loaded into a steel drum. This is then placed in an NDA monitor (Slides 4, 5, 6) and subsequently into a simple airlock from where it is picked up and drawn into the store by the drum handler (Slides 8, 9).

A repack room is provided, equipped in the same way as the inspect room, for use in repacking drums found to have deteriorated in storage. It has never been needed. Both of these rooms were designed as active areas for pressurised suit working but in practice are operated as CCZs.

NDA Systems

There are 2 NDA systems for assaying 270 mm (about 25 l) La Calhene containers.

The first NDA system is a BF_3 passive neutron counter for measuring fissile material, with a detection limit of about 3 mg Pu which for PFR Pu is about 12 m Ci /m^3. The counting period is 10 minutes, followed by a 10 minute background count.

The second is a segmented gamma scanner used for measuring the Pu 239 and U 235 content of light waste with a gamma transmission of over 10%. The limiting radiation level is about 0.35m Sv/h. The container is scanned in 22 segments with a one minute count at each segment. Allowing for the movements of the mechanical drive, this gives a total count period of about 30 minutes per container. The detection limit is about 10mg Pu. Combustible and incombustible wastes above the land burial levels are drummed (separately) in 200 l drums using the sorting glovebox. The 200 l drum is then assayed using a passive neutron counter giving a detection limit of 10 mg Pu (5m Ci /m^3 for PFR Pu) against a drum surface dose rate of 0.75m Sv/h. Again a 10 minute count period is used, followed by a 10 minute background count.

The assay data are recorded by computer, both within the waste management group and also by transfer to the consignor's computer for materials accountancy purposes.

Drum Fork Lift Truck

This is used in the Inspect Room for lifting and rotating drums. It is hand pushed, with a battery operated hydraulic hoisting motion, and hand-powered screw-operated fork closure and rotating motions.

b. EDRP PCM Handling Facility

Arisings of PCM in EDRP (noting that bagless transfer systems will be used) are estimated to be about 46m^3 pa combustible and 12m^3 pa incombustible. Taking a volume reduction factor of 2 for the combustible fraction on shredding, this corresponds to an annual arising to the PCM drum store of about 75 500 l drums. The principal sources in terms of volume will be the Pu conversion plant and the active laboratories. The Pu content is dominated by the former, estimated at 13 kg pa, with an estimated further 0.5 kg pa from the laboratories (Slide 104).

Criticality calculations for the drum store indicate a maximum allowable Pu content of about 250g per drum, which is little higher than the limit for a 200 l drum. With this limit, the 75 drums pa could accommodate the forecast Pu arisings if each were loaded to about 180g. However, consideration is being given to providing a dedicated store adjacent to the drum store for small PCM containers (say 20 l each) to be held in an engineered array. This would give the operators the flexibility, if required, to store items of particularly high Pu content (say of the order of 100g Pu per 20 l container) separately in order to assist in segregation and in maximising the number of low-Pu drums (ie up to 10 or 20g Pu per 500 l), and in avoiding filling any drums only part full for criticality reasons. In-line liquor filters and in-box ventilation filters from powder boxes have been identified from previous experience as items which may fall into this particularly high Pu category. An alternative approach being investigated is to seek a criticality limit relaxation for drums with a limited moderator content.

The handling facilities are based closely on the successful design of the existing Dounreay facilities. The principal differences are:

i. The size of drum. EDRP uses a 500 l drum, whereas at Dounreay at present a 200 l drum is used.

ii. Provision in EDRP for segregating combustible PCM into 2 categories depending on its Pu content (because of the higher Pu throughputs anticipated). Typically, 20 l containers containing less than 1 or 2 g of Pu will be categorised as 'low', and containers containing more than this and up to a few tens of grams of Pu will be categorised as 'high'.

iii. Provision, in the EDRP PCM treatment glovebox, of shredding equipment for soft material and of a filter crusher.

iv. Increased radiation protection for the operators in EDRP. This is necessitated by the higher Pu throughputs anticipated, and particularly by the PuO_2 dust content of the conversion plant PCM. For present design purposes, the gloveboxes are assumed conservatively to be provided with ¼ inch Pb shielding, and windows to a corresponding standard, although in due course the requirements for this will be reassessed, with due regard being paid to Pu quality, operator occupancy levels and so on. Simple hand tools will be provided in order to minimise finger doses during waste sorting, and PCM will be transported within the glovebox by an automatic conveyor system.

v. In EDRP, the PCM will be loaded to drum liners contained within the glovebox, and a drum will be docked to the box only during liner transfer operations, thus minimising the time for which the glovebox containment relies on the docking seal integrity.

vi. Provision in EDRP of a separate glovebox for filling LLW drums (200 l). Very little cross-contamination is experienced at Dounreay, but EDRP will deal with higher Pu levels on certain waste, and also PuO_2 powder contamination. The overall facility will be described with reference to Slides 105, 106.

The EDRP PCM handling operations will take place within a single large glovebox. The waste will be introduced via engineered posting ports (probably 270 mm purged ports: Dounreay have an inactive prototype) and will be sorted manually using gloves and simple hand tools into the following categories:

High combustible
Low combustible
Incombustible
Filters

Transport within the glovebox will be by a monorail hoist in order to minimise operator hand doses.

The waste will be loaded to the appropriate one of 4 500 l drum liners situated in wells in the base of the box. When a liner is full, a lid will be fitted and the liner will be lifted from its position using an in-box travelling hoist which will place it inside a 500 l drum which will have been docked to the underside of the box to receive it.

The box will be of stainless steel construction, with radiation protection provided by ½ inch lead and windows to suit. The ventilation arrangements will be similar to these of the existing Dounreay Waste Posting Facility.

The box will contain a shredder for soft material and a filter crusher.

PCM Shredder

AERE Harwell have had several years inactive and active experience with a Pulvermatic HS 800 shredder supplied by Metal Box plc.

The shredder consists of 2 parallel shafts, contra-rotating at speeds of 34 rpm and 17 rpm respectively. The shafts are fitted with alternate pairs of cutters and spacers which intermesh and shear the material drawn between them. The shredded material then falls through a grid beneath.

Inactive trials were carried out with PVC, polythene, hypalon, butyl rubber and paper tissues, using 25mm and 35mm grids and also a plough: this latter grid has teeth which project into the spaces between the cutters on one shaft and the spacers on the other, and is intended to prevent material wrapping around the spacers. Maximum feed rates were 4kg/min using the 35mm grid, 3kg/min using the

25mm grid, and much higher for the plough. The bulk density of the shredded material (for 20kg batches) was 216kg/m^3 for the 35mm grid, and 230kg/m^3 for the 25mm grid. Temperature rises in the feed due to shredding were up to 24°C.

The plough was found to be effective, but only with slot sizes larger than the holes in the standard grids. The penalty therefore was a less dense shredded product.

Shredding a HEPA filter led to thick clouds of dust being emitted from the shredder. A feed of 100% tissues likewise generated a major dust problem, as did a feed of 95% tissues with 5% PVC. It was established however that with a 100% tissue feed, the free cellulose dust concentration in the chute in the worst case was < 0.22 g/m^3, or 200 times lower than the published limit of concentration for deflagrations of cellulose dust.

Active experience has also been obtained in the Pressurised Suit Area at Harwell since June 1985. Throughput rates have been found to be lower than those measured inactively. A bolt-on feed pusher has been fitted to assist certain materials to catch on the blades.

Following this experience, it is currently proposed to install a similar but smaller unit in EDRP (Slide 102). This will be the PL42, and it will be installed, together with its direct-drive electric motor (the HS800 has a hydraulic drive), inside the PCM handling glovebox. A hydraulic drive may be reverted to if development work indicates that problems may be encountered with an electric drive.

Filter Crushing

Dounreay operate an in-cave HEPA filter crusher consisting of a press driven by air motors operating on a screw thread. No local containment is provided.

For EDRP, it is proposed to install a Martonair 14 ton impact bench press within the PCM handling glovebox. This is a pneumatic device which will be modified to give a slow operating stroke. During crushing, the filter will be enclosed by a polycarbonate guard, and the enclosure will be ventilated (Slide 101).

Ventilation

The operating area will be managed as a CCZ. The space extract will discharge to the main stack, and may or may not be provided with a single stage of HEPA filtration, depending on an assessment of hazard. (This is expected to indicate a requirement for the filters). All space air in EDRP is supplied from a central inlet plenum, and so no local space inlet filtration or conditioning is required.

The gloveboxes are both provided with a single stage of HEPA filtration on the inlet, and similar provision on the outlet. The outlet header includes a secondary HEPA filter, and the system is protected by a VXA. Inlet filters are situated outside the boxes, outlet filters on the inside.

Experience at Dounreay indicates that the drum store itself can be operated as a CCZ. However, because of the vented drums provision will be made for simple access control (change barrier) and airlock entry. The ventilation extract will be passed through a single stage of HEPA filtration locally before ducting to the main stack.

Currently no provision is being made for any inert gas blanketing, but the safety case for the PCM sorting glovebox will be reviewed in due course because of the shredding machine.

Local ventilation of the shredder and the filter crusher within the glovebox will be via a local filter element exhausting back into the box.

SID HUNTER, UKMoD

AWRE ALDERMASTON
SOLID WASTE TREATMENT PLANT

AWRE ALDERMASTON

Solid Waste Treatment Plant

A89.3

EQUIPMENT SHOULD BE: -

ROBUST

RELIABLE

SIMPLE

TRIED AND PROVEN

MAINTAINABLE

COMPATIBLE

CLEANABLE

DECONTAMINABLE

FIRST TIME CONTAINMENT

TESTABLE

UNBREAKABLE

VICE FREE

LOW FIRE RISK

NON FLAMMABLE

SPARK FREE

FAIL SAFE

DESIGNED WITH SAFETY IN MIND TO REDUCE RELIANCE ON THE WORKER OR ON ADMINISTRATIVE CONTROLS

DECOMMISSIONABLE

SW7

SOLID WASTE TREATMENT PLANT (SWTP)

FUNCTIONS:-

(1) COLLECTION OF 'CONTACT' WASTE IN DRUMS.

(2) DRUM MONITORING : PU, FISSILE CONTENT, WEIGHT.

(3) SEGREGATION OF WASTE CONTAMINATED WITH WEAPON-GRADE PU.

(4) DISPOSAL OF OTHER 'CONTACT' WASTE. SHREDDING ALL CELLULOSICS, PLASTICS, GLASS, LIGHT-GAUGE METAL, ETC.

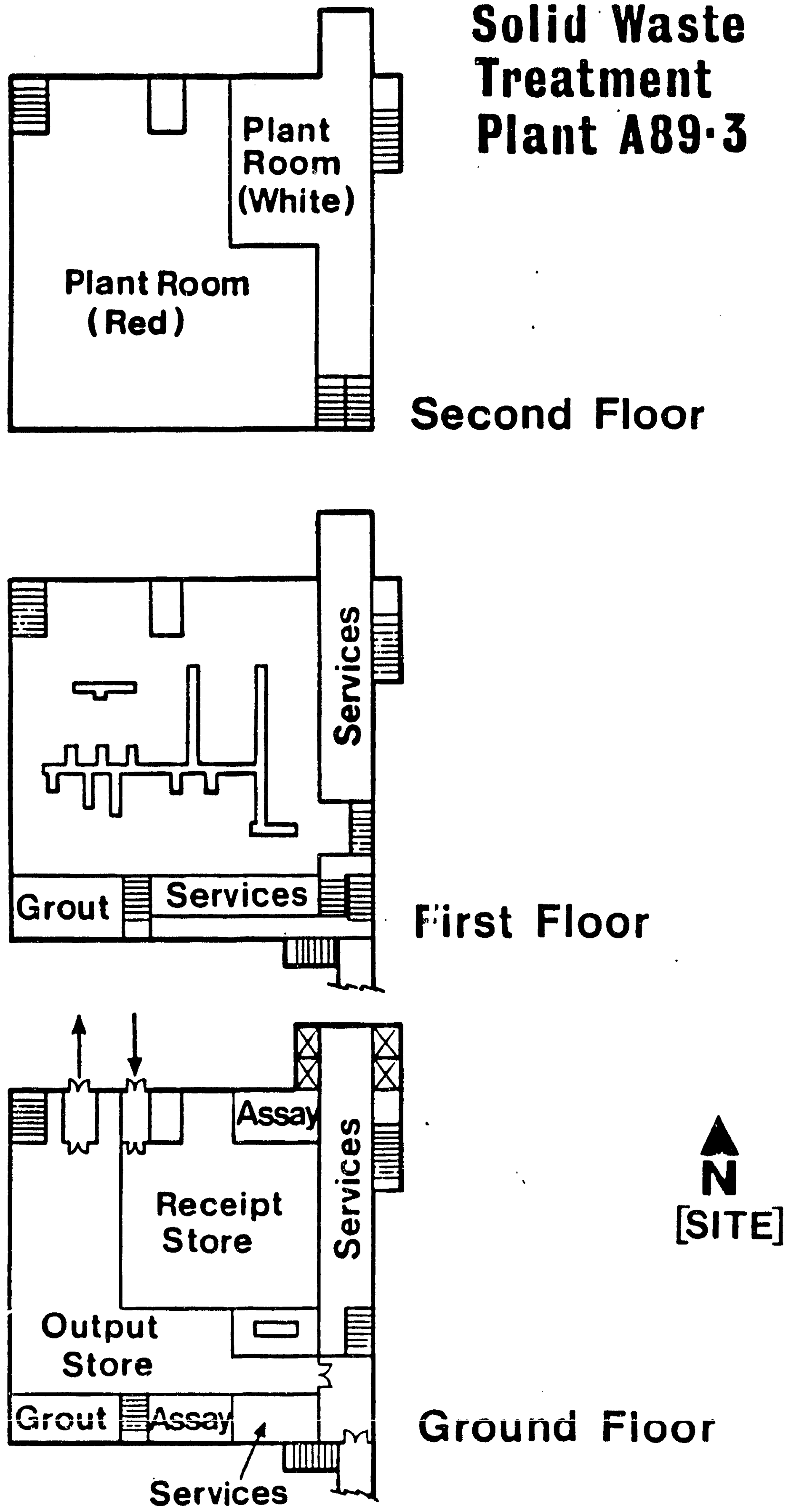
(5) PACKAGING SHREDDED WASTE AND NON-SHREDDABLES IN A FORM SUITABLE FOR SEA DISPOSAL.

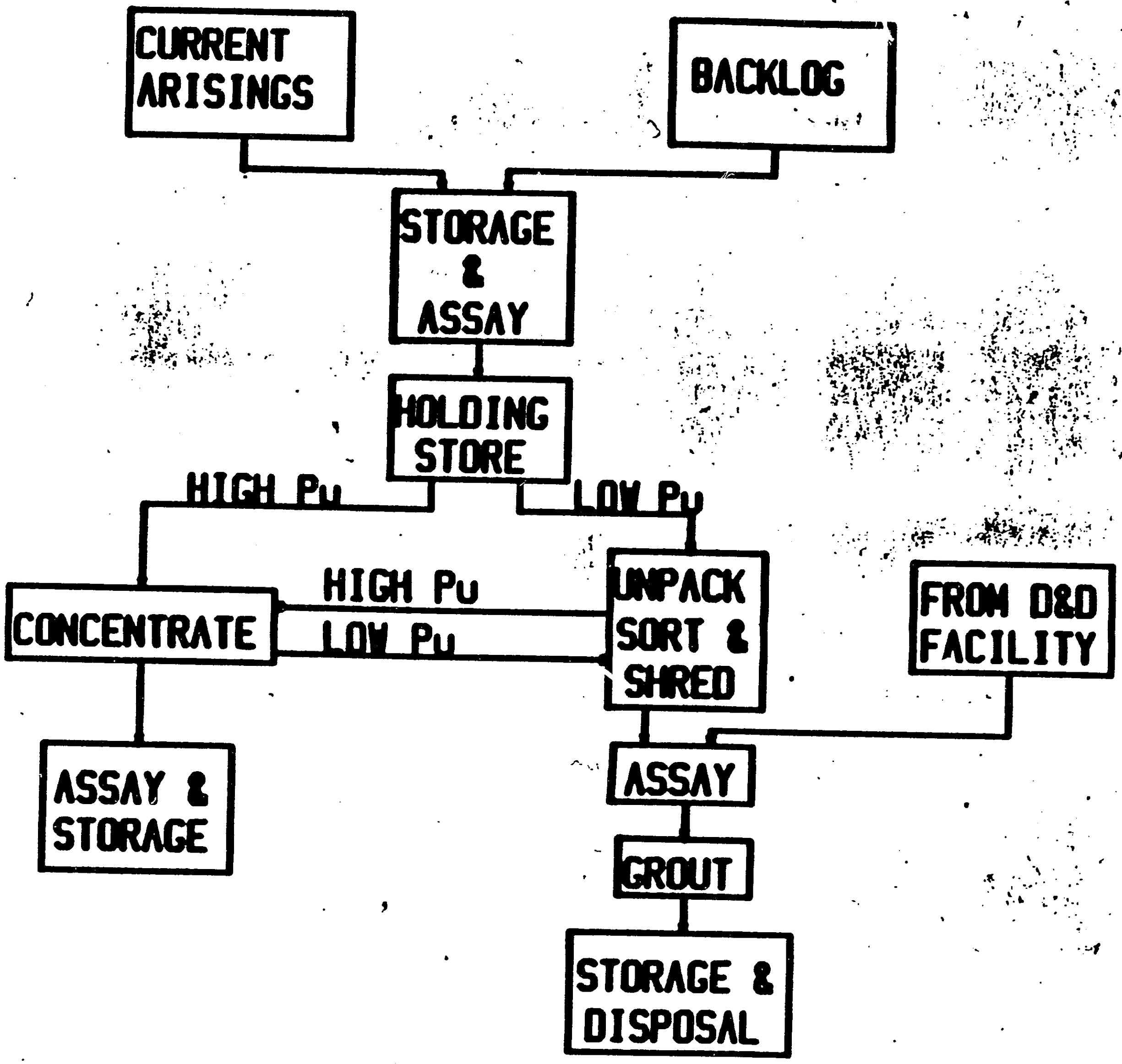
(6) CONCENTRATION TREATMENT OF WASTES RICH IN WEAPON GRADE PU BY WASHING, INCINERATION, ETC.

(7) TREATMENT OF NON-STANDARD R/A CONTAMINATED MATERIALS EG HG DISTILLATION, SOLVENT EVAPORATION, ETC.

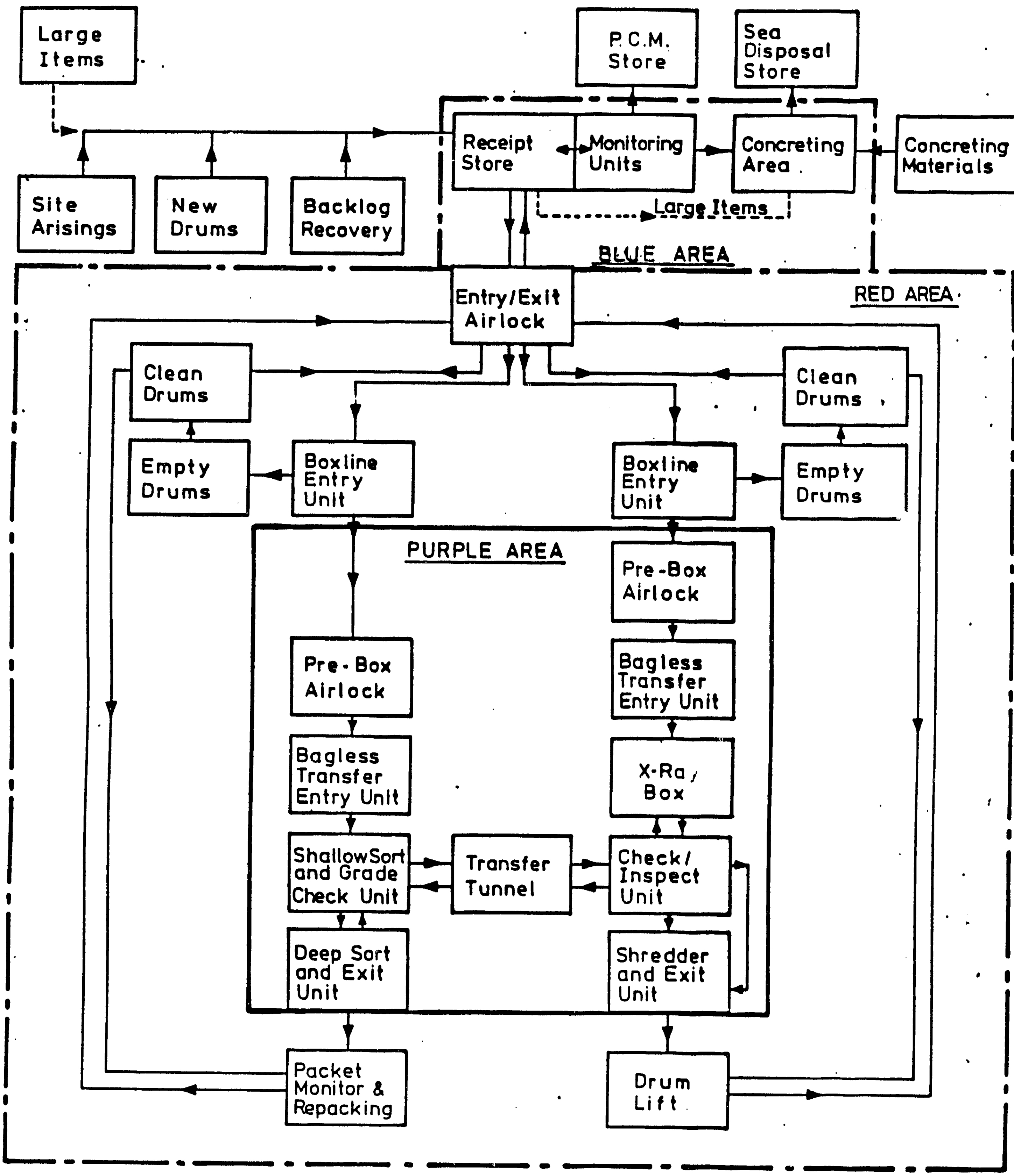
42m x 40m x 19m high £27m

Solid Waste Treatment Plant A89·3





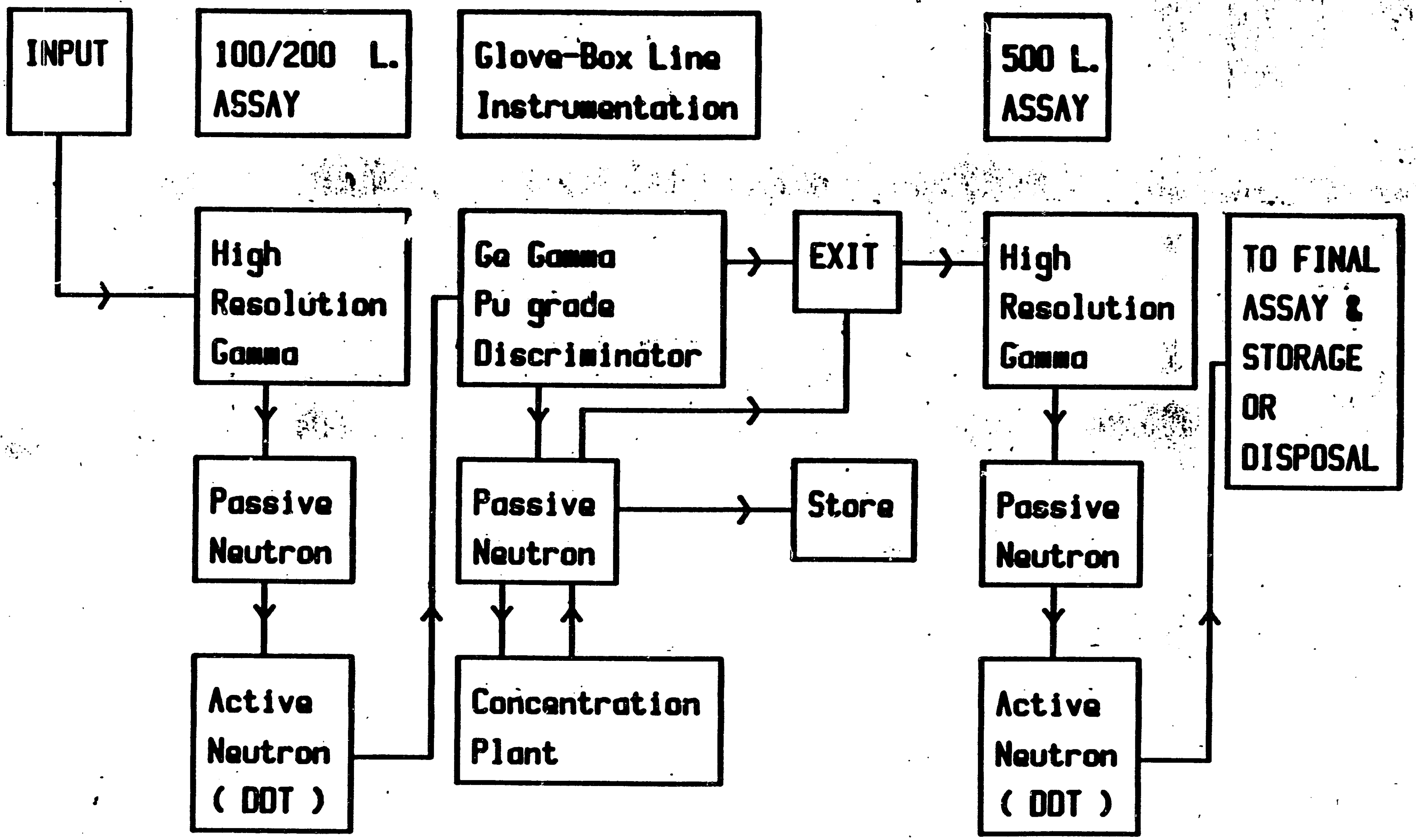
SWTP, A89. 3, SIMPLIFIED BLOCK FLOW DIAGRAM



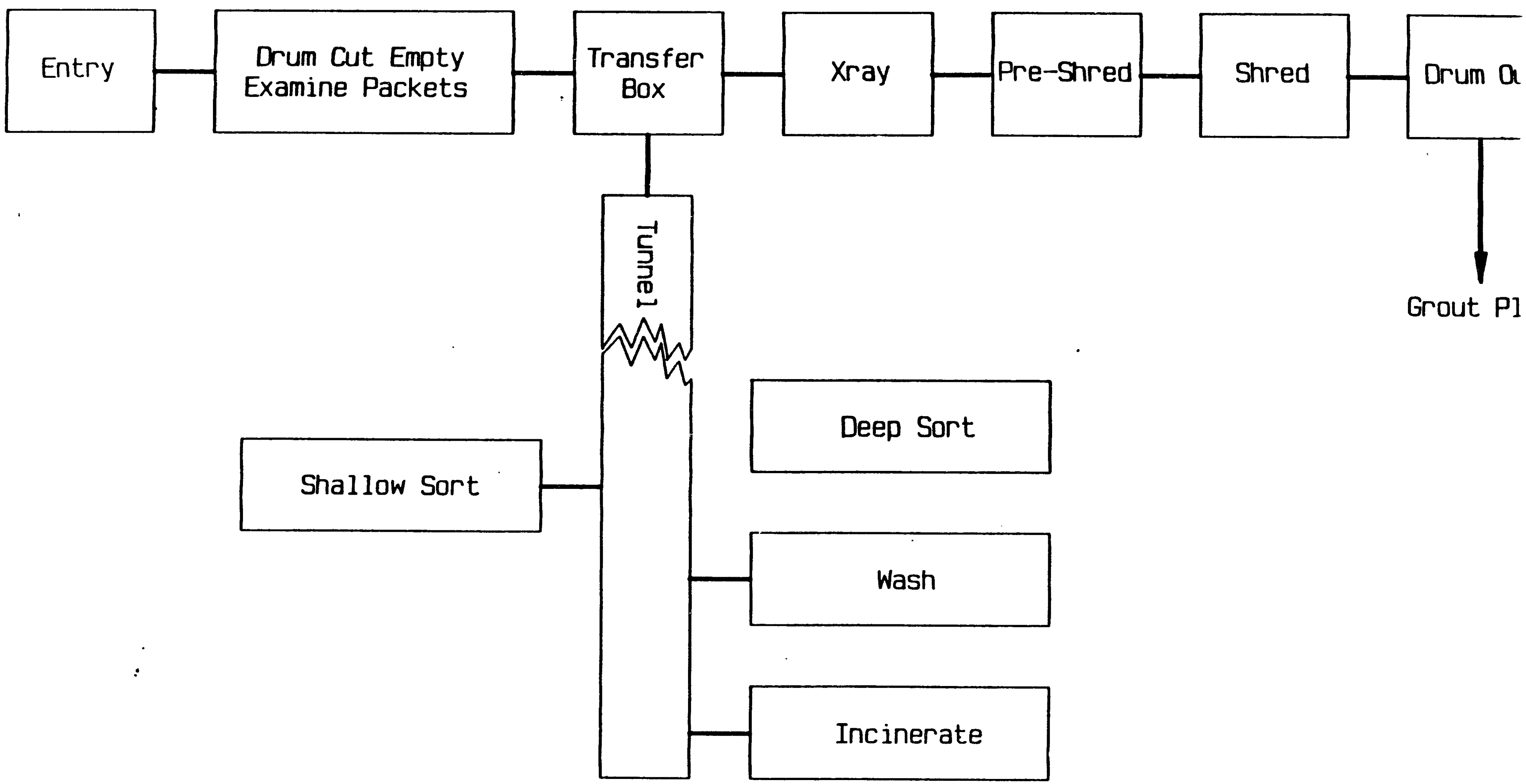
PROPOSED SOLID WASTE TREATMENT PLANT A89·3

6

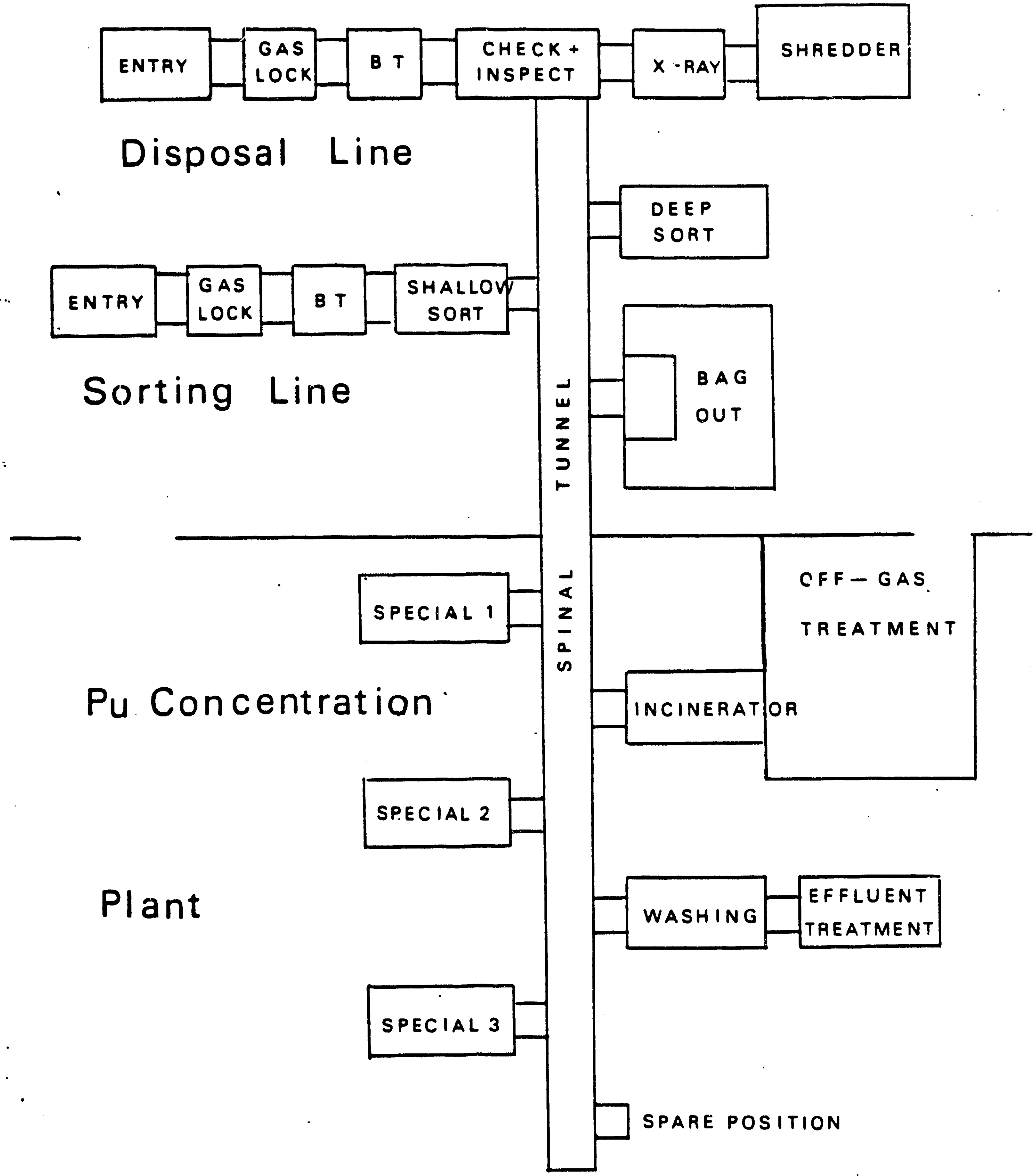
SOLID WASTE TREATMENT PLANT
ASSAY EQUIPMENT



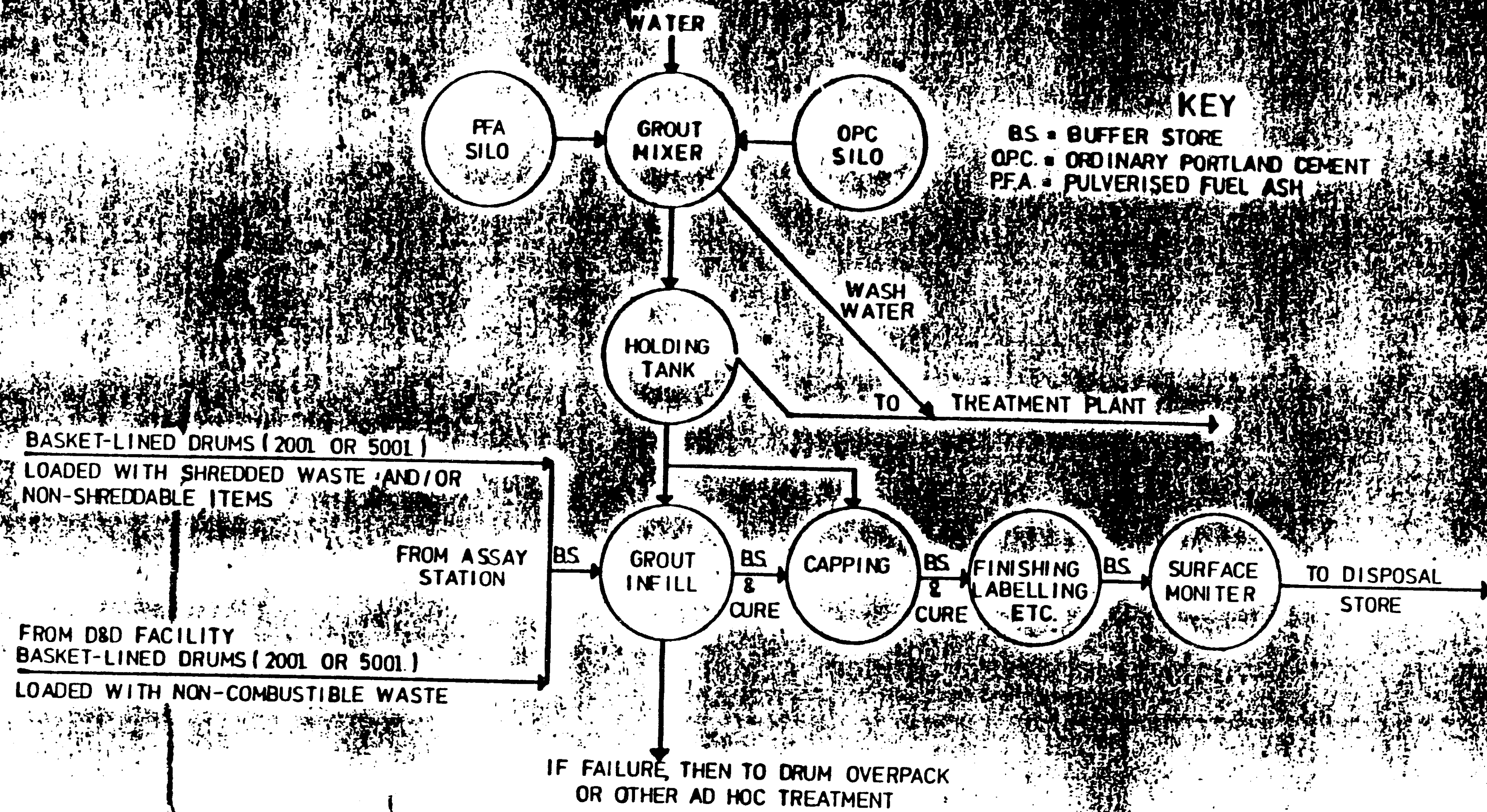
WASTE DISPOSAL BOXLINE



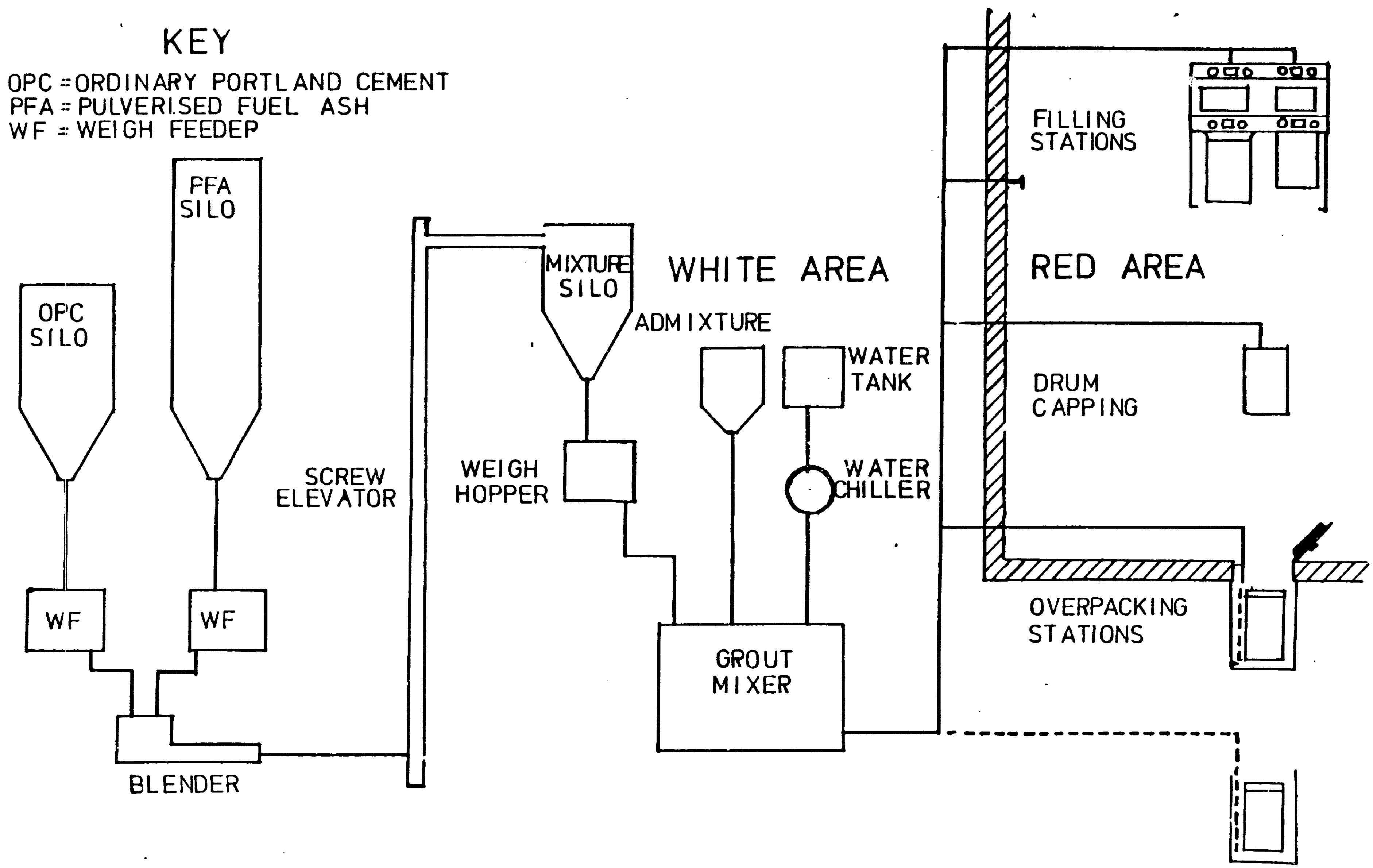
SW#A 7



SWTP Proposed Glovebox Arrangement



SWTP PROCESS FLOWSHEET
PART 3: PREPARATION OF VOID-FREE PACKAGES BY GROUT INFILTRATION



S.W.T.P.: GROUT PLANT FOR VOID-FREE PACKAGING

A2.

THE CONCENTRATION PLANT - PROCESSES

1. COMBUSTIBLE (CELLULOSIC) WASTE - INCINERATION
2. PLASTICS AND RUBBER - AQUEOUS WASHING
3. HARD WASTE - AD HOC PROCESSES - SUCH AS
   - VIBROCLEANING AND ULTRASONICS
   - AQUEOUS WASHING
   - SOLVENT WASHING
   - SURFACE ABRASION

THE PRODUCT FROM ALL THREE OF THE ABOVE ROUTES WILL BE THE SAME AN ASH PRODUCED DIRECTLY FROM (1) OR INDIRECTLY BY BURNING THE FILTERS USED FOR RECOVERY OF THE PARTICULATE MATERIALS SEPARATED IN (2) AND (3). THIS ASH IS CHEMICALLY INERT AND RELATIVELY HIGH IN PLUTONIUM CONTENT AND THUS PROVIDES A SAFE AND COMPACT FORM FOR STORAGE AND IS A SUITABLE FEED FOR A RECOVERY PROCESS.

9

SOLID WASTE TREATMENT PLANT (SWTP)

POSSIBLE FUTURE MODIFICATIONS

1. Larger capacity Disposal Drums
2. Rectangular Containers
3. Void-free packaging
4. Improved monitoring of waste

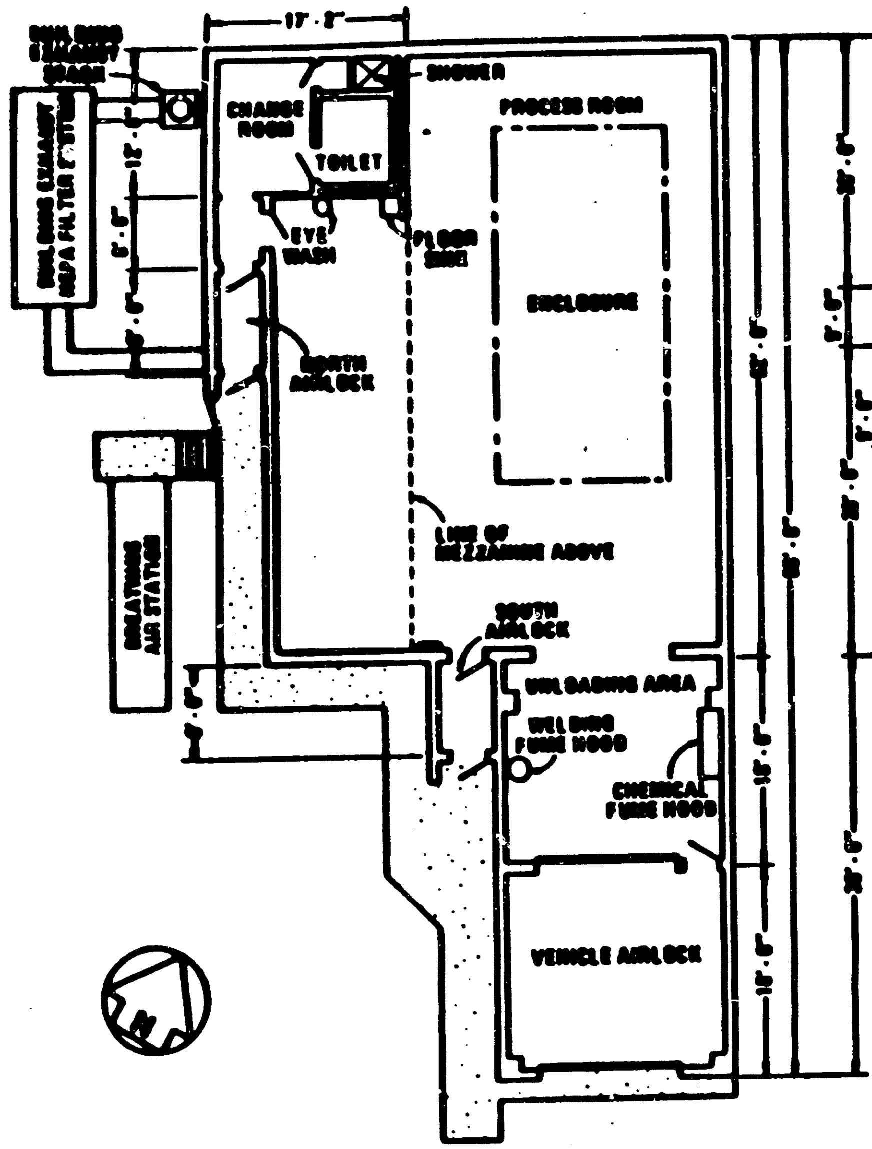
SOLID WASTE PLANT

MAJOR DEVELOPMENT ITEMS

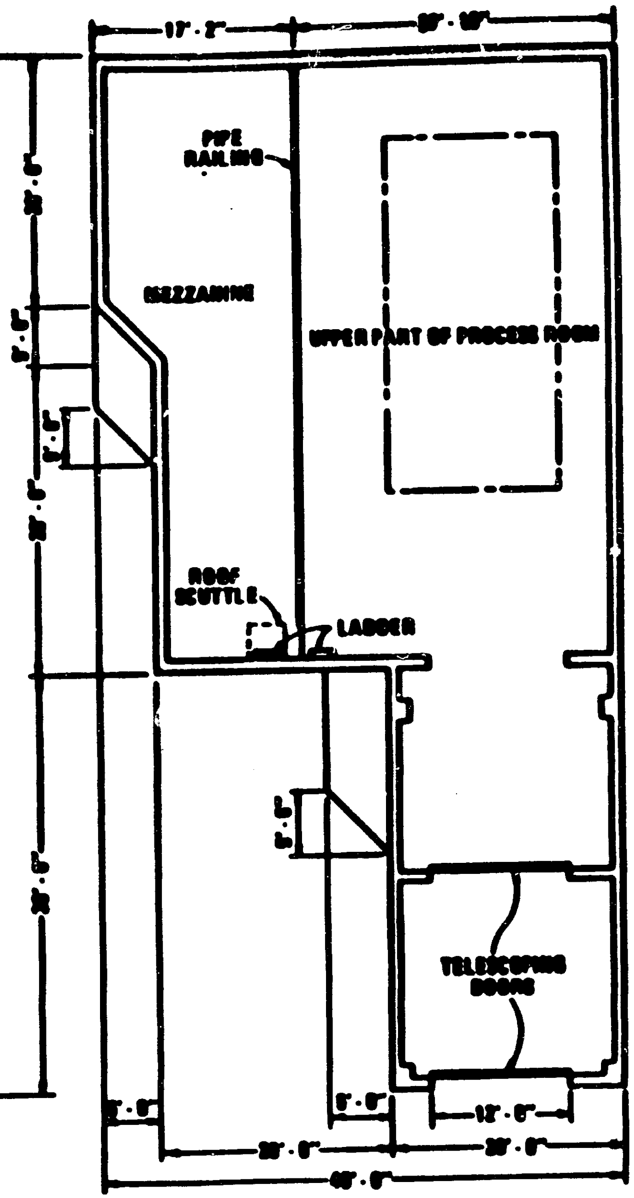
- X-RAY UNIT - BASED ON AIRPORT BAGGAGE SCANNER
- SHREDDER - HEAVY DUTY INDUSTRIAL UNIT DEVELOPED FOR FULL CONTAINMENT AND EASY MAINTENANCE
- HANDLING - THROUGHOUT LINE TO MINIMISE DOSE TO OPERATORS.
- INCINERATOR- BASED ON LANL LABORATORY UNIT.
- WASHER - BASED ON DOMESTIC MACHINE MODIFIED FOR FULL CONTAINMENT, EASE OF MAINTENANCE ETC.

JOHN HARPER, LANL

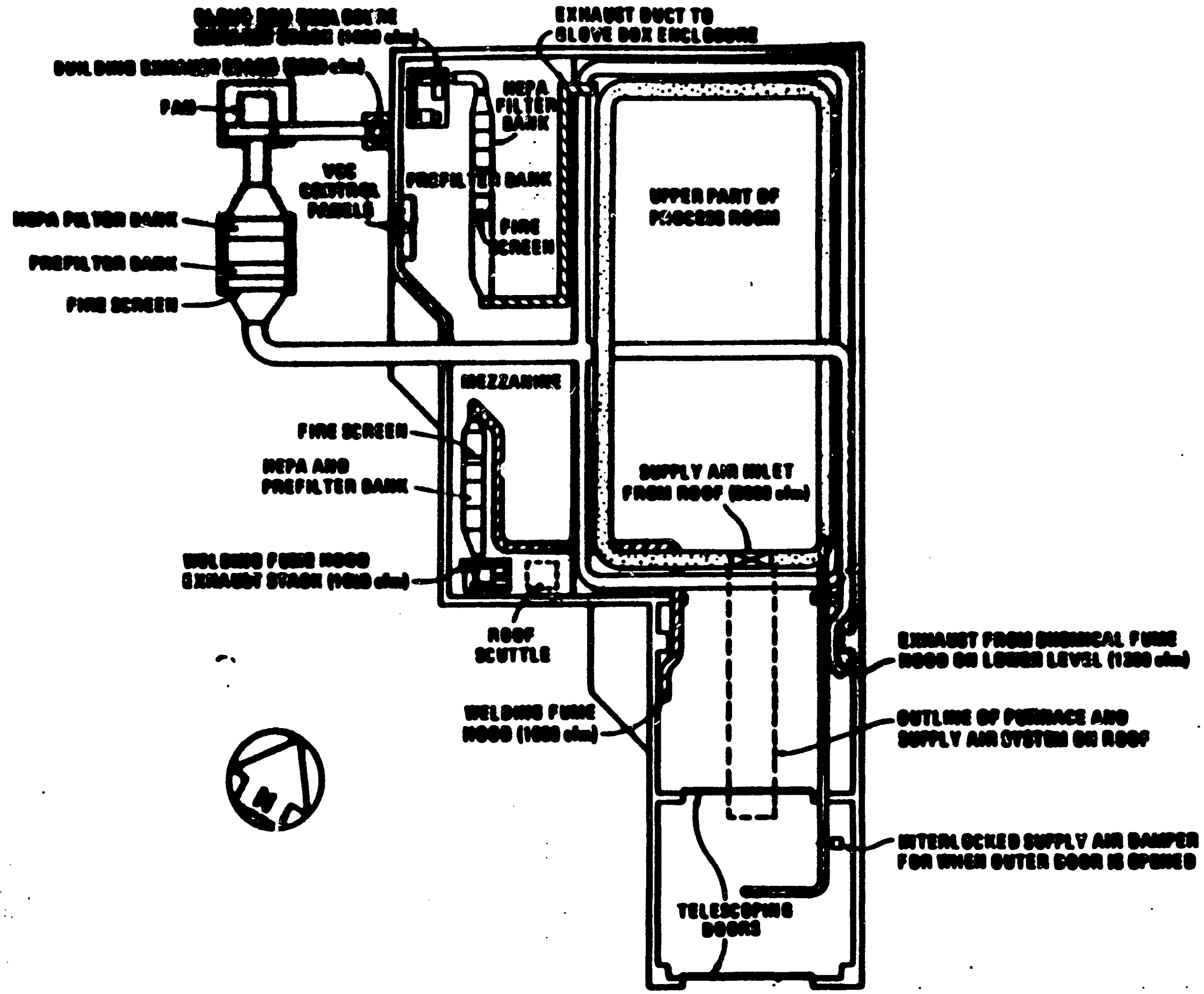
SIZE REDUCTION FACILITY



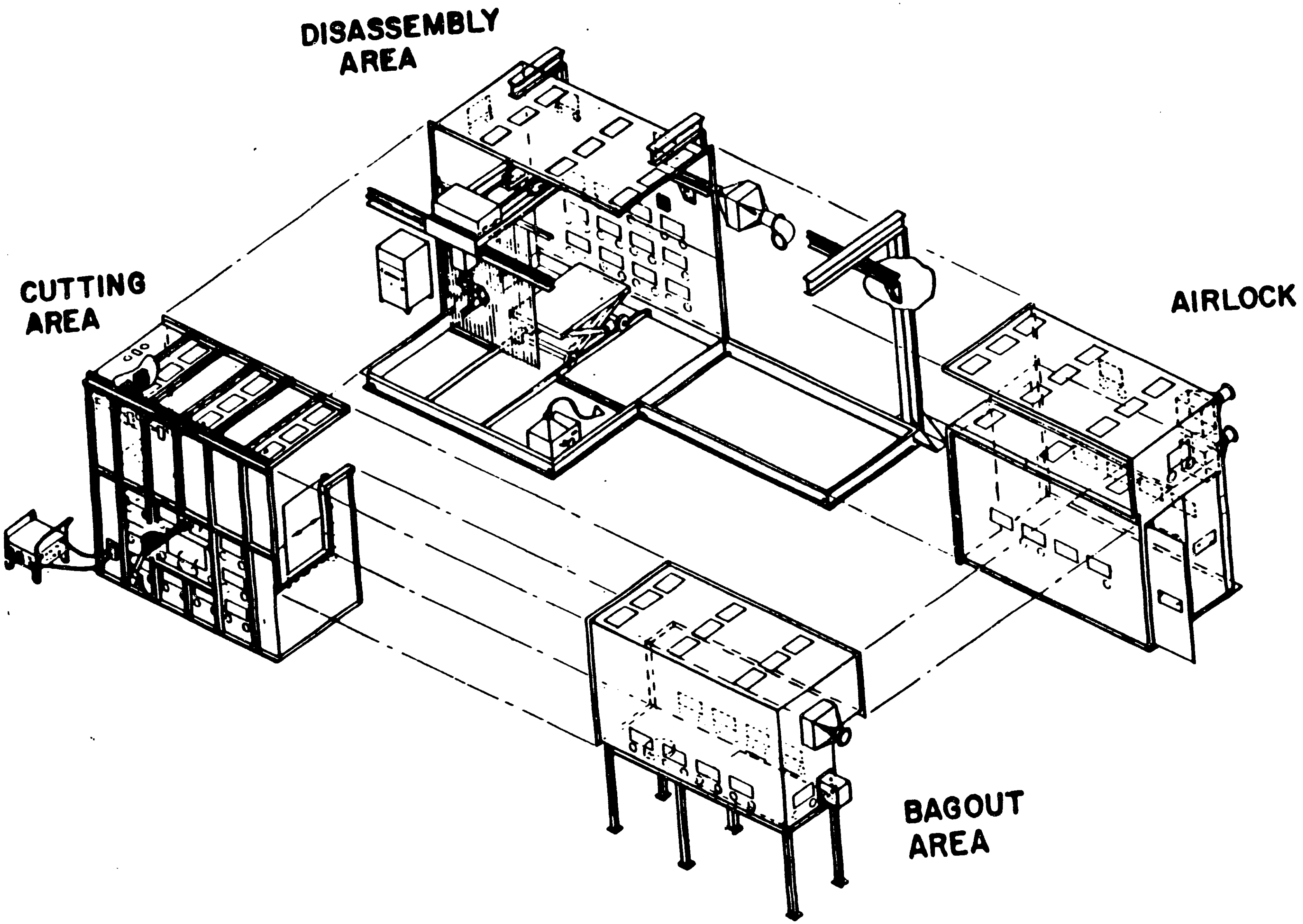
SIZE REDUCTION FACILITY



MEZZANINE LEVEL



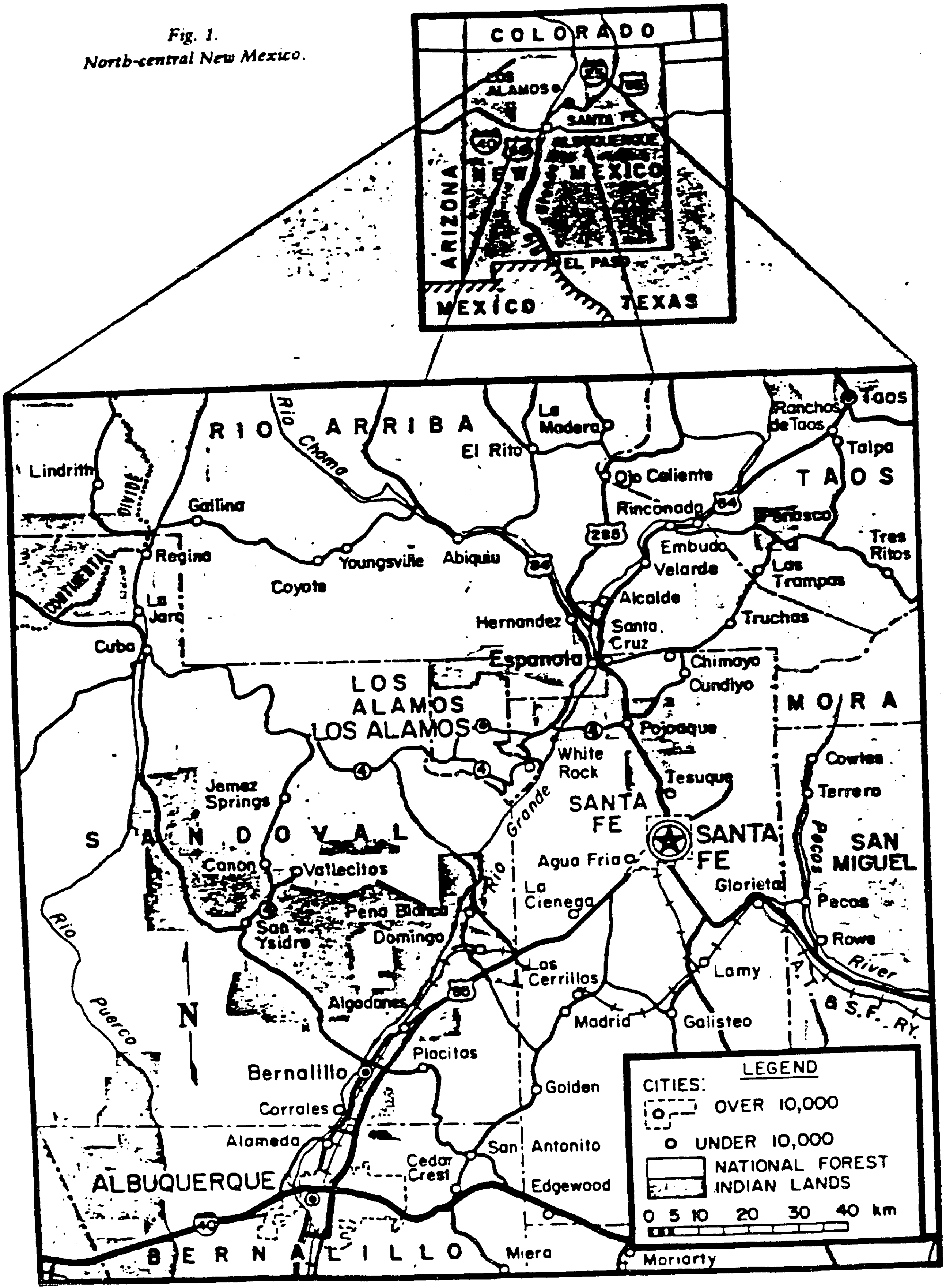
UPPER LEVEL VENTILATION PLAN

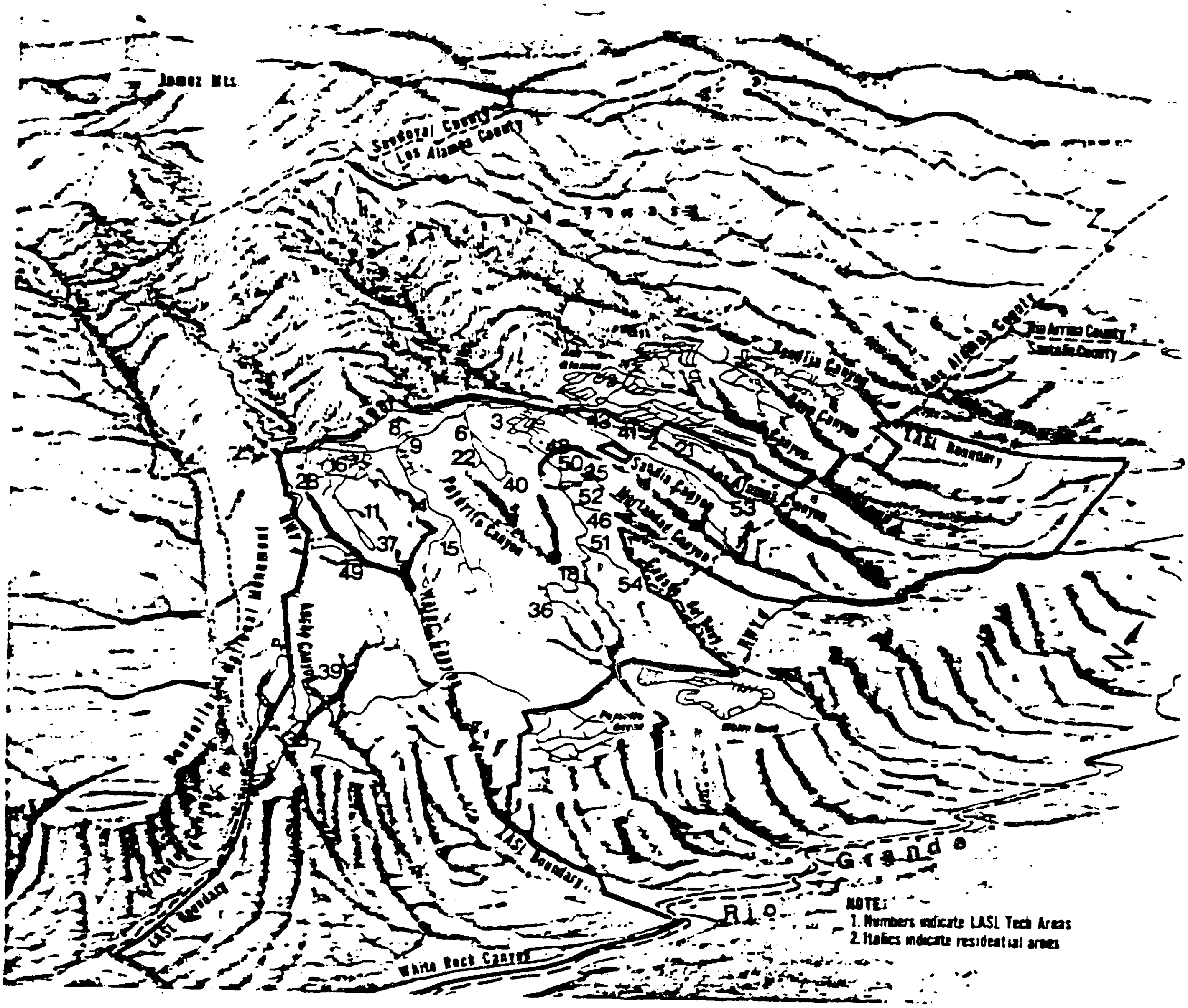

DISASSEMBLY AREA
CUTTING AREA
AIRLOCK
BAGOUT AREA

CHARLES WARNER, LANL

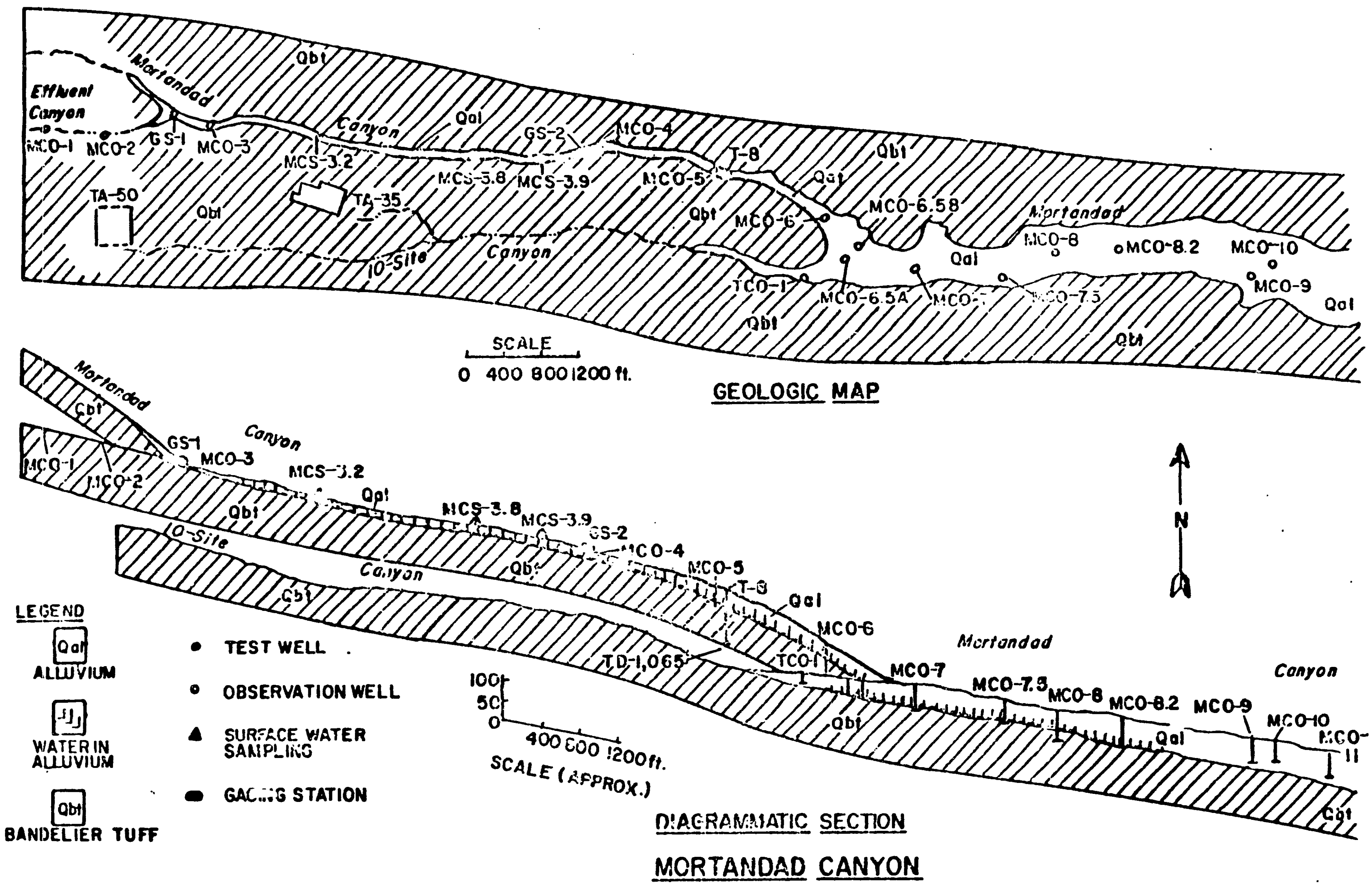
TRU INCINERATOR

Fig. 1.
North-central New Mexico.





Topography of the Los Alamos, N. M., area.



Effluent Canyon
Mortandad
Canyon
MCO-1
MCO-2
GS-1
MCO-3
MCS-3.2
MCS-3.8
MCS-3.9
GS-2
MCO-4
MCO-5
T-8
MCO-6
MCO-6.58
MCO-6.5A
TCO-1
MCO-8
MCO-8.2
MCO-10
MCO-9
MCO-7.5
TA-50
TA-35
10-Site
Qbt
Qal
SCALE
0 400 800 1200 ft.
GEOLOGIC MAP
N
MCO-7
MCO-11
TD-1,065
100
50
0
400 800 1200 ft.
SCALE (APPROX.)
LEGEND
Qal
ALLUVIUM
WATER IN ALLUVIUM
Qbt
BANDELIER TUFF
TEST WELL
OBSERVATION WELL
SURFACE WATER SAMPLING
GAGING STATION
DIAGRAMMATIC SECTION
MORTANDAD CANYON

FIG. 3.2.1-4

LOCATIONS OF DAYTIME POPULATION CONCENTRATIONS WITH RESPECT TO PROPOSED SITE FOR SOLID WASTE TDF, TA-50

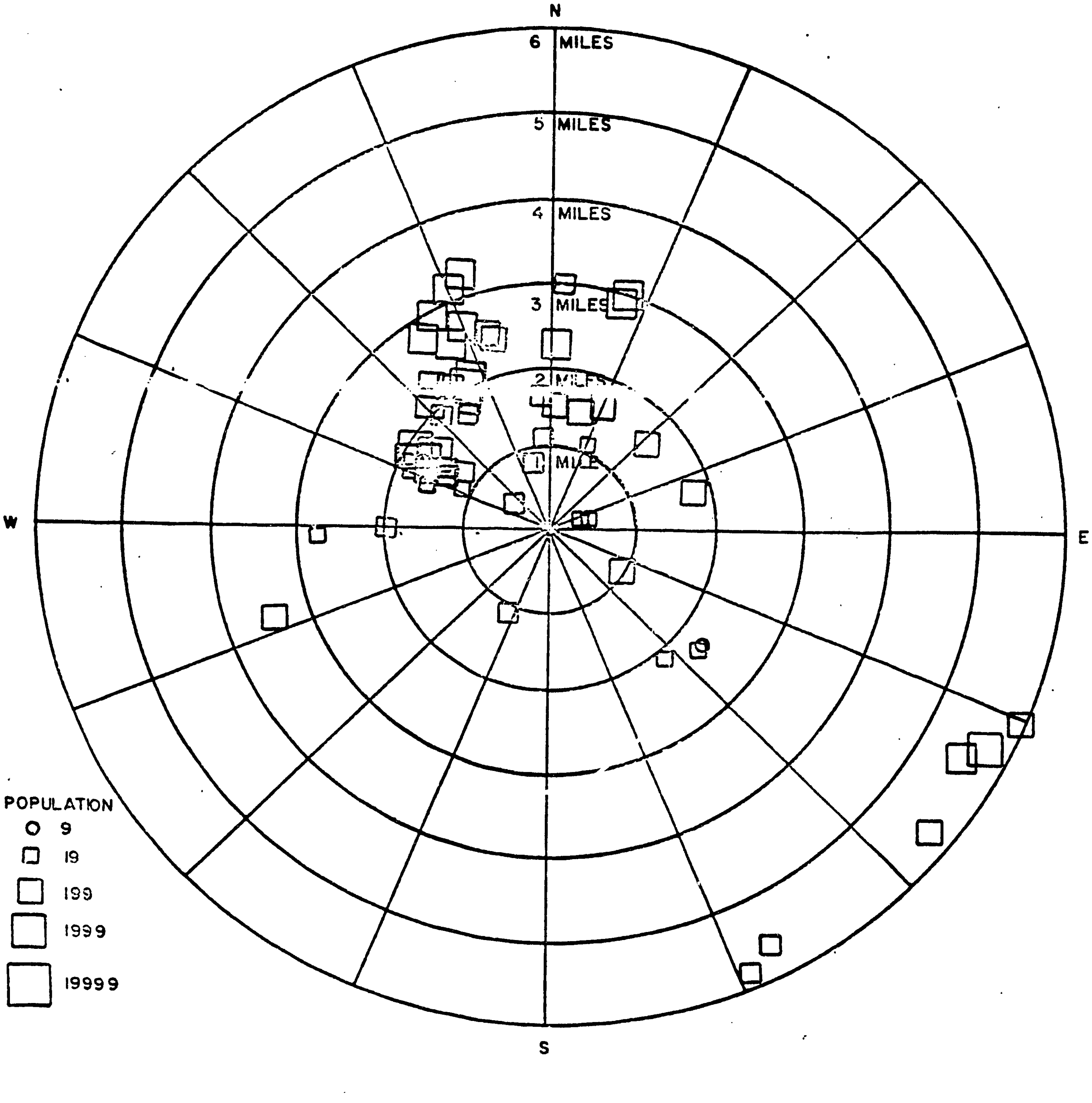


FIG. 3.1.2-1

LOCATIONS OF NIGHTIME POPULATION CONCENTRATIONS WITH RESPECT TO PROPOSED SITE FOR SOLID WASTE TDF, TA-50

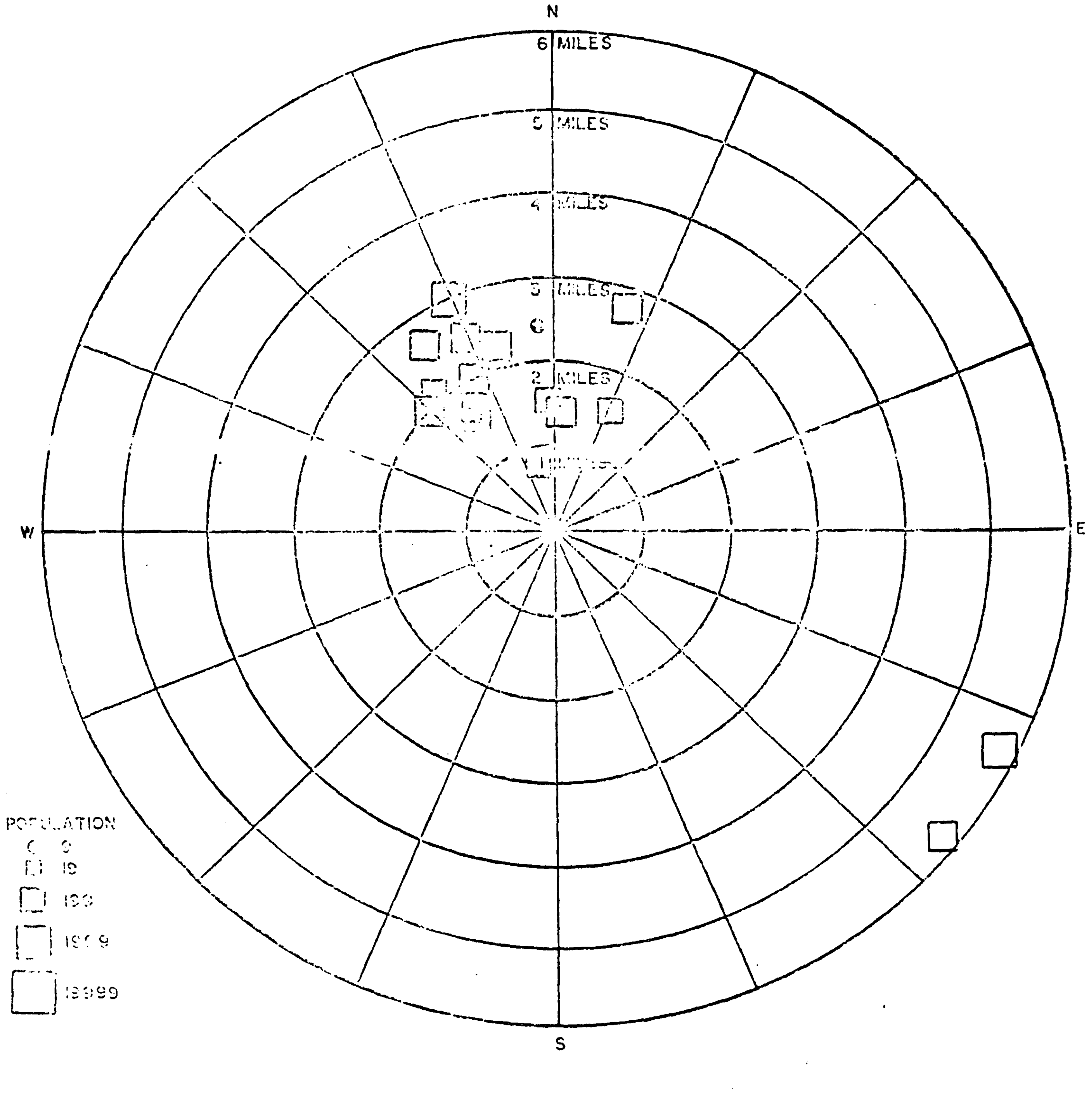
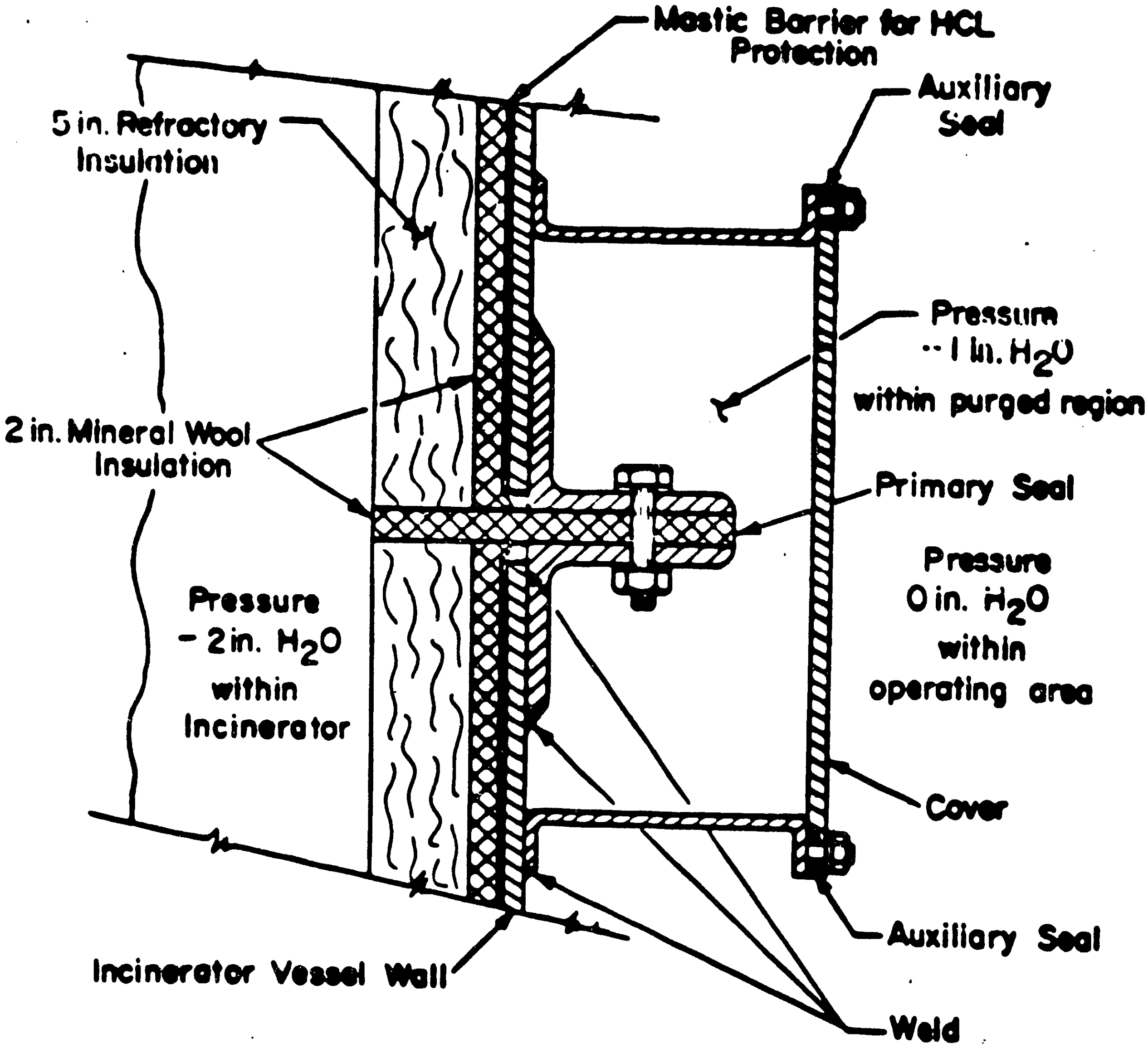


FIG. 3.1.2-2


Mastic Barrier for HCL Protection
Auxiliary Seal
5 in. Refractory Insulation
Pressure -1 in. H2O within purged region
2 in. Mineral Wool Insulation
Primary Seal
Pressure -2 in. H2O within Incinerator
Pressure 0 in. H2O within operating area
Cover
Auxiliary Seal
Incinerator Vessel Wall
Weld

WASTE MANAGEMENT TECHNICAL SUPPORT
FY 1986 ACTIVITIES

- RCRA Part B Incineration Permit
  - Obtain Test Burn Permit
  - Submit Test Burn Results
  - Obtain RCRA Operations Permit

- Hazardous Waste Disposal/HSE-7 Operations Support
  - Initiate Routine Disposal of Combustible Laboratory-generated Chemical Wastes

- PCB Disposal
  - Transfer/Incinerate TRU-contaminated PCBs from other DOE site(s)

- New Incinerator
  - Continue Planning/Concept
  - Initiate Procurement

- HE Disposal
  - Continue M-Division Support in Modification and Testing of Contained Combustion System

- Hazardous Waste Programs (HWPO) - ?????
  - Incinerator Documentation
  - Gas Cylinder Disposal
  - Transportable Incinerator

- General Operations Support
  - Planning Support
  - Alternate Zero Discharge Concept
  - Mixed Waste Incineration - ???

JOHN BUCKLE, BNFL

PURPOSE OF WTC - PHASE II

PURPOSE OF WTC - PHASE II

- To size reduce crated redundant plant and equipment
- To size reduce drummed waste not able to be processed by WTC - Phase I
- Sort waste into:
  - shreddable and non-shreddable categories and
  - Hi & Lo Pu content
- Volume reduce the shreddable category and prepare for subsequent processing
- Pack both categories into drums for either storage, future treatment or disposal

PLANT FEED

- Crates of material from decommissioning operations and backlog stores
- Drummed waste from WTC Phase - I which cannot be processed thro' that plant

DESIGN FOR NORMAL OPERATING CONDITIONS

OBJECT

- To design and build to limit the following:
  - Internal and external radiation to personnel.
  - Radiation exposure of the public.
  - Liquid and aerial effluent discharges.

DESIGN FOR NORMAL OPERATING CONDITIONS

SOLUTION

- Internal and external radiation to personnel and radiation exposure of the public.
  - Containment: Use of high quality gloveboxes located in process cells to provide primary and secondary containment.
  - Shielding: Use of shield materials to reduce radiation levels.
  - Remoteness: Minimise or prohibit routine operator/maintenance procedures in active areas.

- Liquid and aerial effluent discharges
  - Effluent management:

    LIQUID: Hold, sample and dispose/store

    AERIAL: Filter, sample and/or monitor and dispose/store.

DESIGN FOR POTENTIAL FAULT CONDITIONS

OBJECT

- To design and build to cope with the following fault conditions:
  - Loss of containment
  - Loss of services
  - Criticality
  - Fire/Explosion
  - Environmental conditions
    (Seismic events, wind, flood etc)
  - Theft
  - Hazardous operations

DESIGN FOR POTENTIAL FAULT CONDITIONS

SOLUTION

- Loss of containment:-
  Shut down plant
- Loss of services:-
  Provide back-up services
- Criticality:-
  Limit quantities of fissile material in the process line by assay of incoming and outgoing material and regular clean-up.
- Fire and explosion:-
  Venting of explosive gases, inert gas purging in high risk areas, controlled use of thermal cutting equipment and use of for example low smoke and fume (LSF) electrical cable.
- Environmental conditions:-
  Design of building to cope with recognised weather extremes.
- Theft:-
  Adopt stringent security and safeguard procedures.
- Hazardous operations:-
  Limit damage that could occur by guarding hard wired interlocks etc.

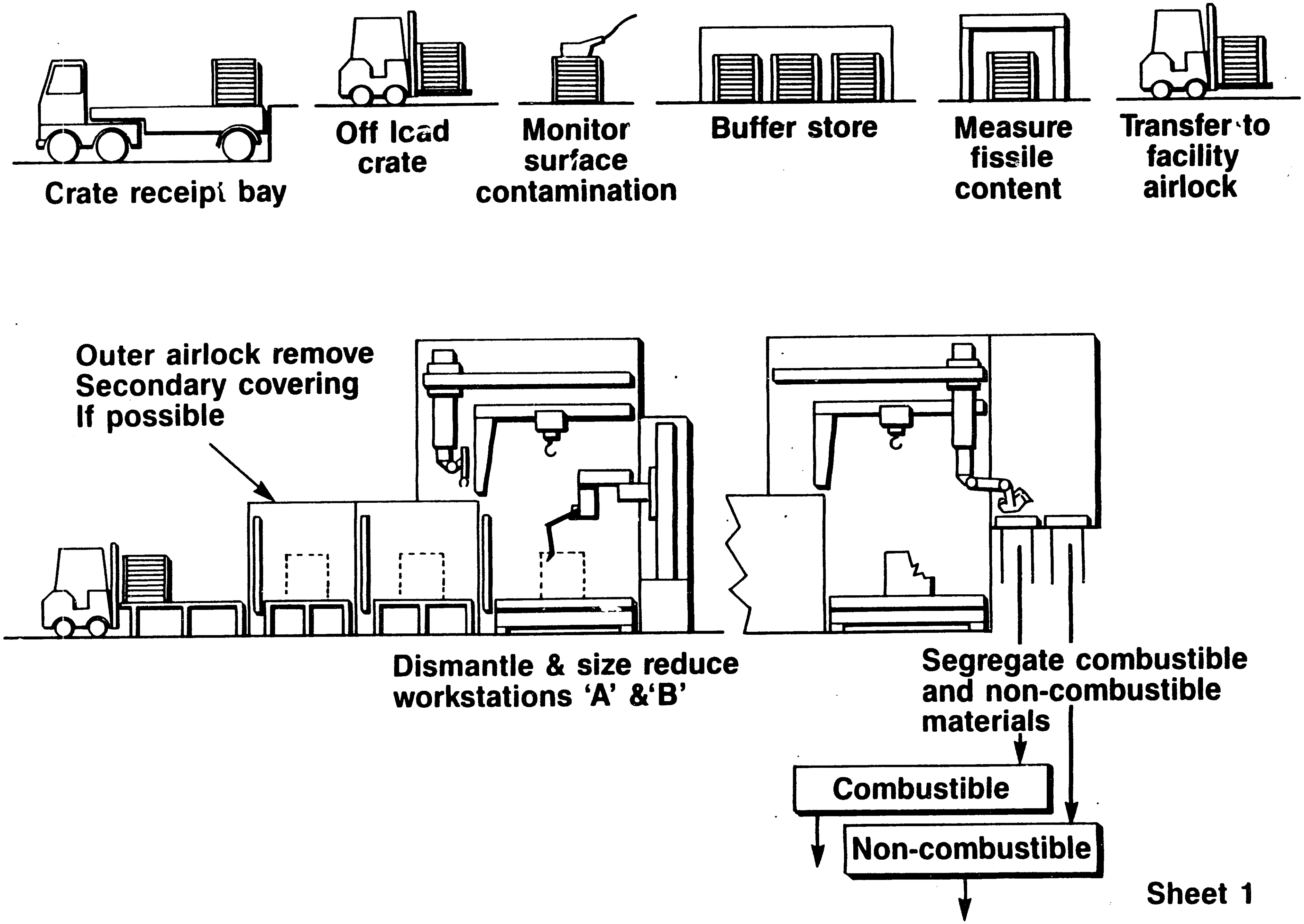
DESIGN FOR EASE OF OPERATION AND MAINTENANCE

- Simple equipment design: Modular construction, unit replacement etc.
- Close liaison throughout design and manufacture with operators and maintenance personnel
- Ergonomic design of control and maintenance faces
- Use of quality control procedures to control design and manufacture
- Extensive equipment/procedures testing
- Development of novel or new equipment
- Operator/Maintenance familiarisation with completed equipment

DESIGN FOR ULTIMATE DECONTAMINATION AND DECOMMISSIONING

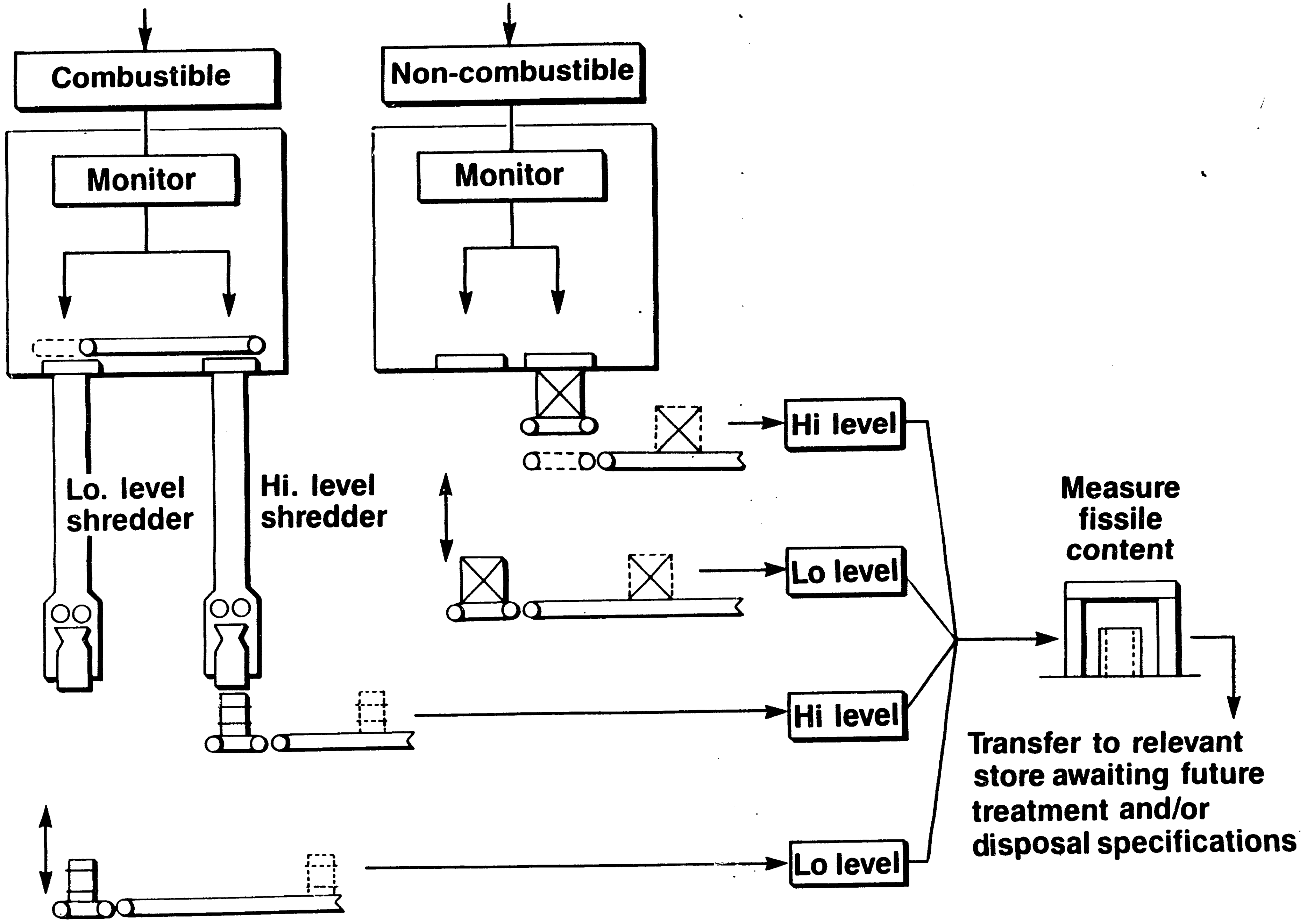
- Modularise plant/equipment for ease of dismantling
- Include in building structure means to aid final dismantling, e.g. Lifting beams, access
- Minimise in-cell equipment
- Divorce services from active areas
- Pre-plan removal routes
- Identification of key services

ENGINEERING FLOW DIAGRAM
SIZE REDUCTION OF CRATED WASTE



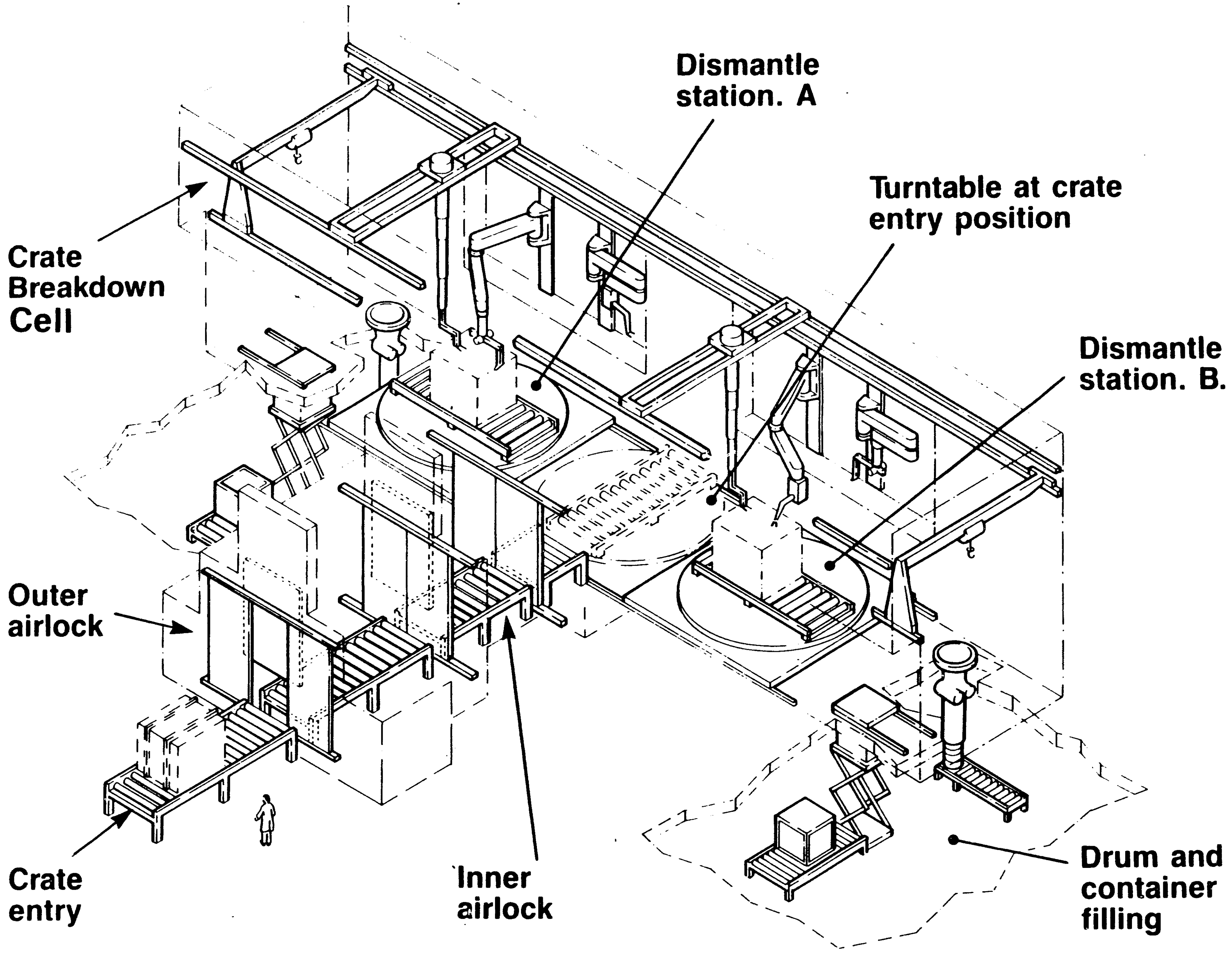
Sheet 1

ENGINEERING FLOW DIAGRAM
SIZE REDUCTION OF CRATED WASTE

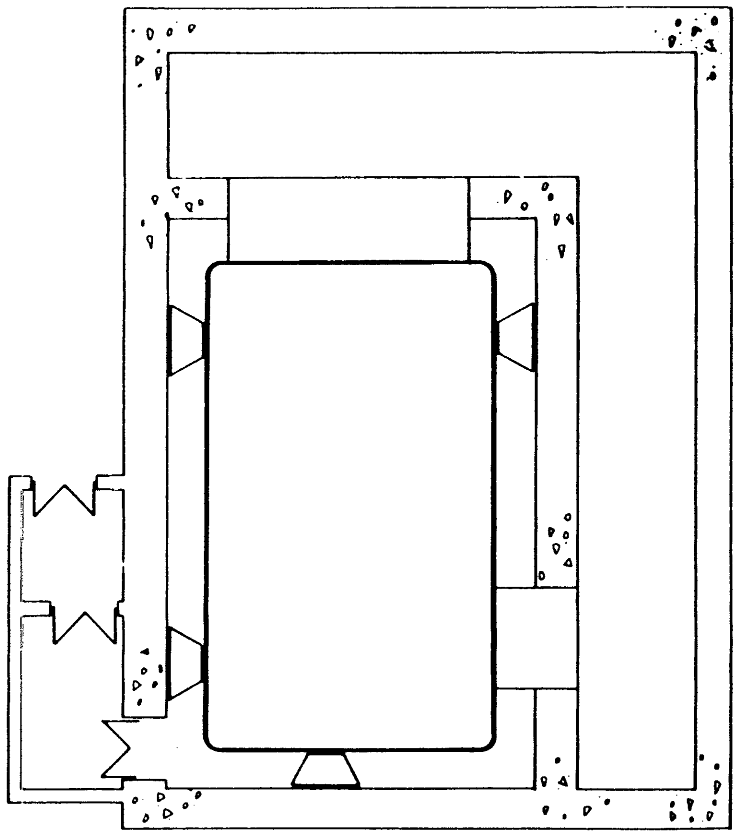


Sheet 2

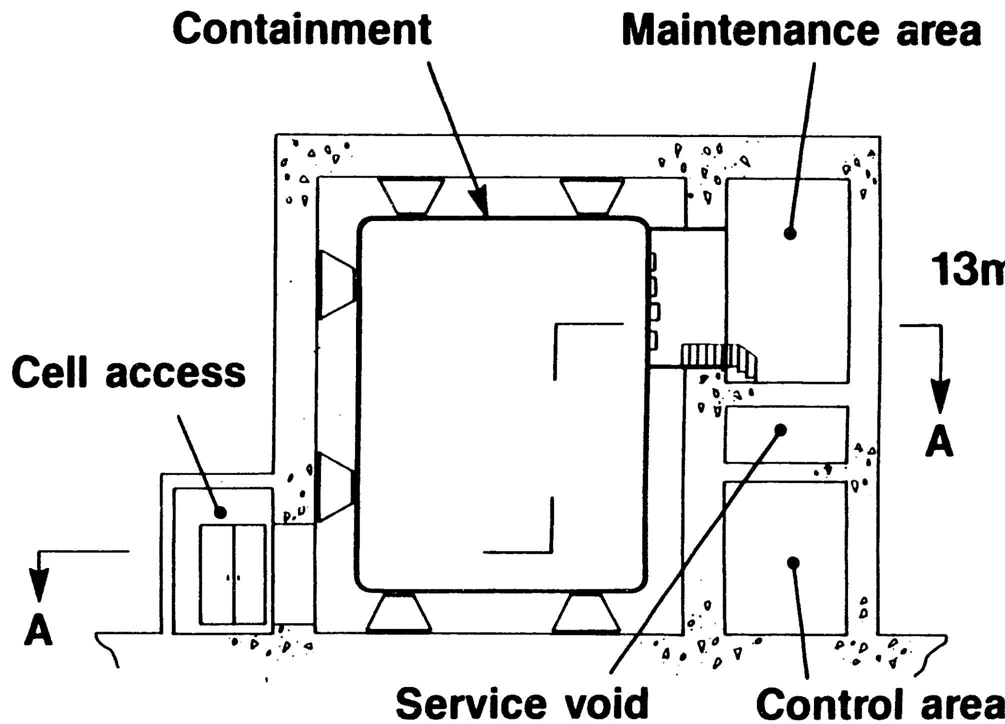
CONCEPTUAL CRATE BREAKDOWN FACILITY



PROPOSED WTC - PHASE II CELL CONSTRUCTION



SECTION A-A



ELEVATION THRO' CELL

SID HUNTER, UKMoD

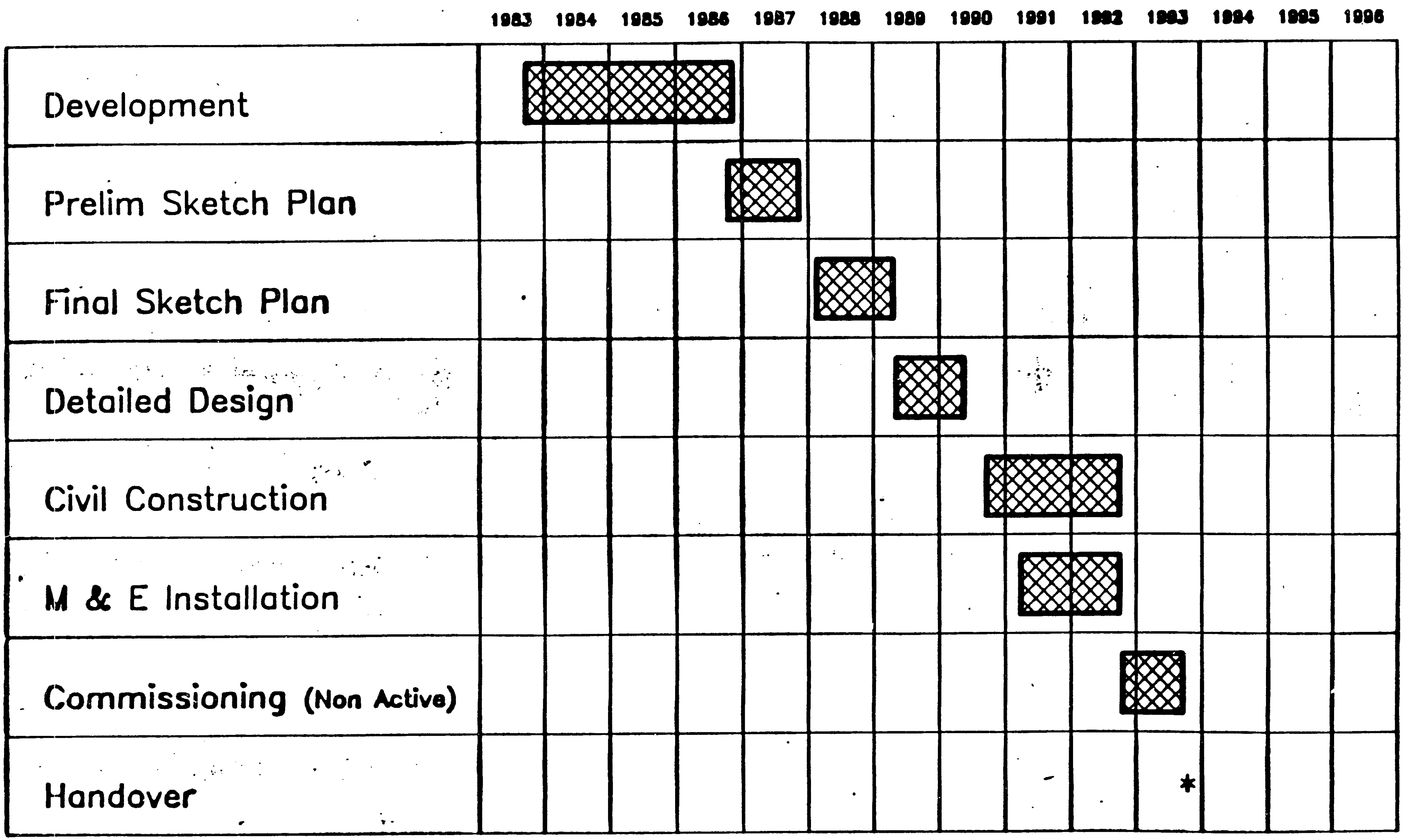
AWRE A89.4
DECOMMISSIONING WASTE TREATMENT PLANT

A.W.R.E

A89.4

DECOMMISSIONING WASTE TREATMENT PLANT
(DWTP)

DECOMMISSIONING WASTE TREATMENT PLANT PROGRAMME



A89.4 FACILITY – DESIGN REQUIREMENTS

- To Process Contaminated Materials to a Form Suitable for Disposal by an Authorised Route.

  Product Material to be in a Form Suitable For Further Processing Should Alternative Disposal Routes be Adopted.

- Radiation Dose to Workforce to be as Low as Reasonably Practicable and Below 1 REM/year for Individuals

- To Size Reduce Materials Until They Can be Packed Into Currently Available Disposal Containers.

- To Decontaminate / Clean to the Extent Practicable.

- Throughput Equivalent to Two Standard Gloveboxes [4'x4'x8'] and Associated Equipment per Week.

- Maximum Size of Feed Items Equivalent to an A1.1 Extn Glovebox [15'x12'x6' external].

- Maximum Weight of Feed Item – 10 Tonne.

DESIGN PRINCIPLES

REMOTE OPERATION

DESIGN FOR EASE OF MAINTENANCE/
CLEANING/
INSPECTION

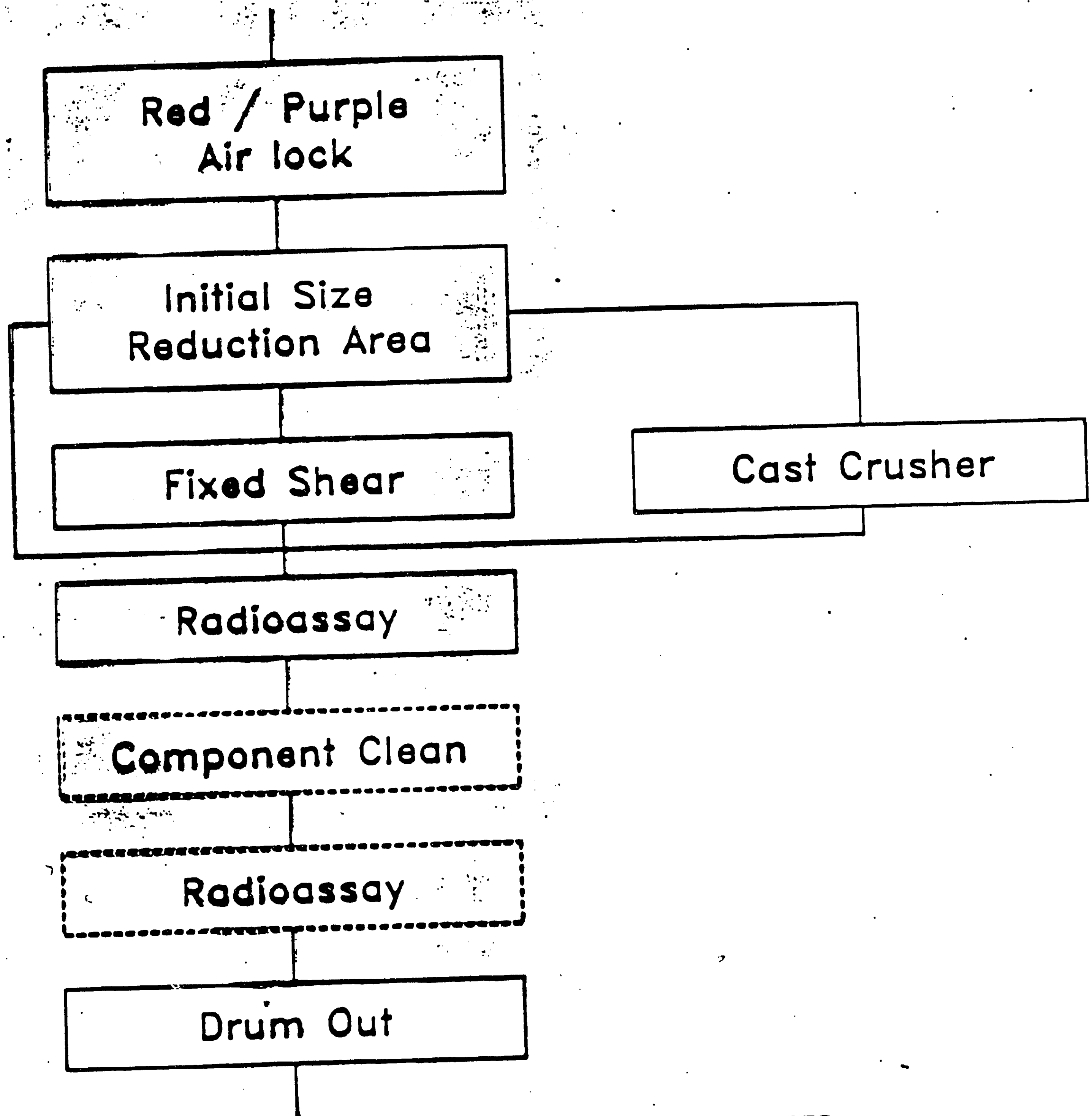
SINGLE S/S PURPLE CELL WALL

NO BASEMENT MULTIPLE BARRIER

COLD CUTTING

NON AQUEOUS CLEANING
if necessary for facility
No Drains in Purple cell

DECOMMISSIONING WASTE TREATMENT PLANT PROCESS FLOWSHEET



SERVICES

1. Facility Clean
2. Viewing & Lighting
3. Overhead Handling
4. Man Entry/Exit

DECOMMISSIONING WASTE TREATMENT PLANT

Feed materials from decommissioning operations

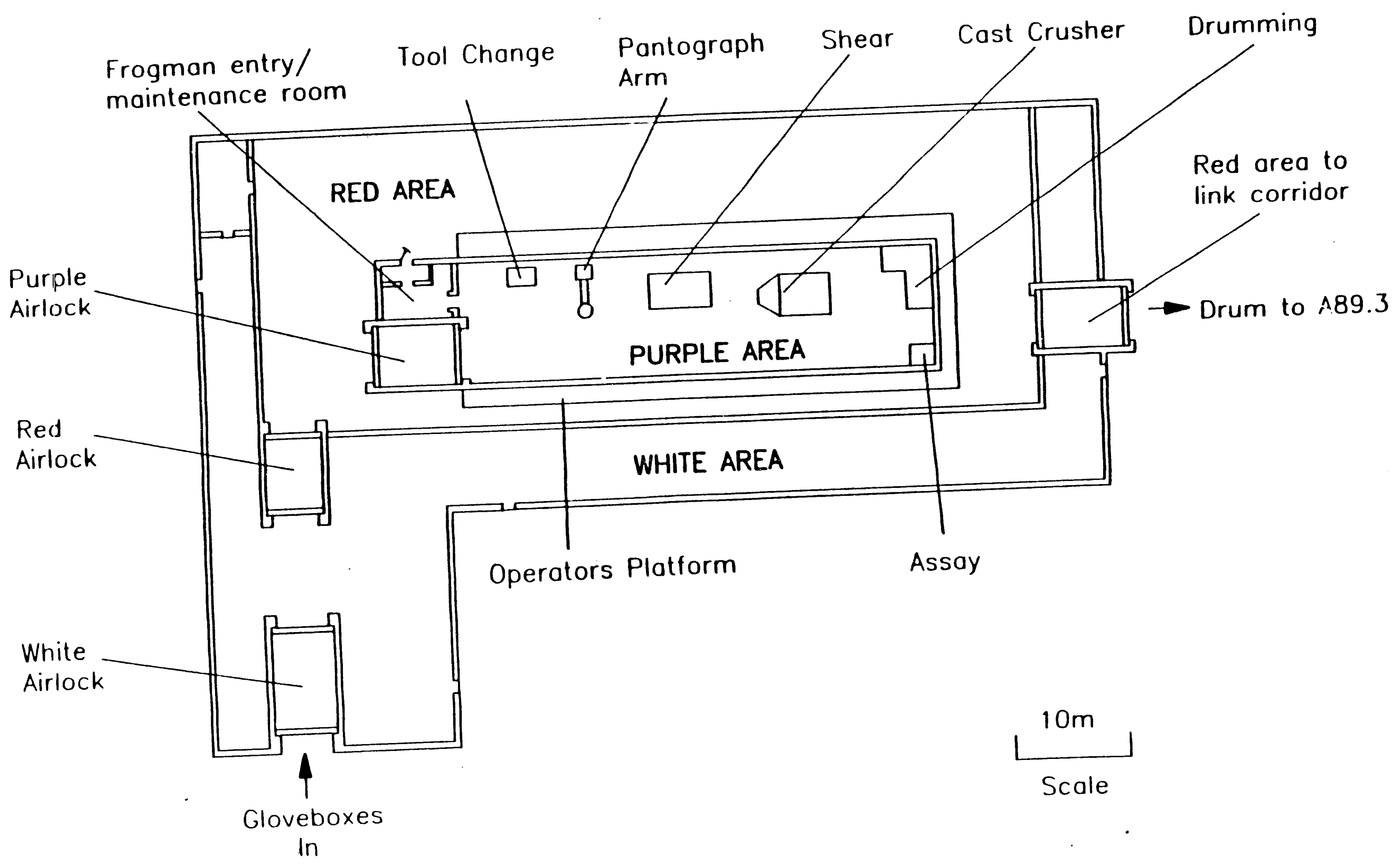
- Glove boxes and contents
- Materials ex 'Frog Areas'
- Active Air Filters
- Drummed materials
- Contaminated ductwork and pipework

Input to the facility

- By shuttle vehicle
- By crate transporter
- By drum transporter

DECOMMISSIONING WASTE TREATMENT PLANT (A89.4)

PROPOSED FACILITY LAYOUT



A89.4

MAINTENANCE PHILOSOPHY

- In–Situ (Pressurised Suit)
- Modular Replacement & Direct Disposal
- Remote Maintenance Using Manipulators
- Maintenance in a Special Glovebox

A89.4 DEVELOPMENT PROGRAMME

- Cold Mock Up – Equipment Trials
- Shear – Portable and Fixed
- Bandsaw / Cast Crusher
- Plasma Arc
- Portable Tools
- Air Pad Transporter
- Pantograph Arm Manipulator
- Remote Handling – Integrated Study
- Component Cleaning
- Facility Cleaning
- Radioassay
- Viewing Aids

DECOMMISSIONING WASTE TREATMENT PLANT CLEANING PHILOSOPHY

Facility Cleaning

- Dry methods – Vacuum cleaning
- Wet methods – Freon cleaning

Component Cleaning

- Depends on disposal route options
- Development of Freon systems

A89.4

DECONTAMINATION & DISPOSAL FACILITY

RADIO ASSAY SYSTEM PHILOSOPHY

1) Criticality Control

2) Fissile Material Accountancy

3) Grade Discrimination

4) Disposal Route Acceptance

5) Cleaning Process Control

DECONTAMINATION & DISPOSAL FACILITY

RADIO ASSAY TECHNIQUES

1) INPUT ASSAY
   TLD
   Active Crate Monitor (?)

2) IN PROCESS ASSAY
   Differential Neutron Dieaway
   Segmented Gamma Spectrometry

3) RECOVERED FISSILE RESIDUE ASSAY
   Differential Neutron Dieaway
   Passive Neutron Coincidence
   Segmented Gamma Spectrometry

4) DISPOSAL ASSAY
   Differential Neutron Dieaway
   Total Neutron Count
   Passive Neutron Coincidence

DECONTAMINATION AND DISPOSAL FACILITY

PROBLEMS WITH RADIOASSAY

1. Presence of Uranium 235

2. Variable Matrix
   random packing of chopped metals, plastics etc.

3. Variable Disposition
   single lump of material in, for example, a machine tool
   or evenly spread contamination

BRENT DAUGHERTY, DuPont - SRP

PROCESSING OF TRANSURANIC WASTE AT THE SAVANNAH RIVER PLANT

DP-MS-86-48

PROCESSING OF TRANSURANIC WASTE AT THE SAVANNAH RIVER PLANT

by

B. A. Daugherty, L. M. Gruber, and S. J. Mentrup

E. I. du Pont de Nemours and Company
Savannah River Laboratory
Aiken, South Carolina 29808

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and for publication in the proceedings

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B. A. Daugherty, L. M. Gruber, and S. J. Mentrup

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ABSTRACT

Transuranic wastes at the Savannah River Plant (SRP) have been retrievably stored on concrete pads since early 1972. This waste is stored primarily in 55-gallon drums and large carbon steel boxes. Higher activity drums are placed in concrete culverts. In support of a National Program to consolidate and permanently dispose of this waste, a major project is planned at SRP to retrieve and process this waste. This project, the TRU Waste Facility (TWF), will provide equipment and processes to retrieve TRU waste from 20-year retrievable storage and prepare it for permanent disposal at the Waste Isolation Pilot Plant (WIPP) geological repository in New Mexico. This project is an integral part of the SRP Long Range TRU Waste Management Program to reduce the amount of TRU waste stored at SRP. The TWF is designed to process 15,000 cubic feet of retrieved waste and 6,200 cubic feet of newly generated waste each year of operation. This facility is designed to minimize direct personnel contact with the waste using state-of-the-art remotely operated equipment.

INTRODUCTION

The Department of Energy (DOE) has instituted a national program to isolate defense TRU waste in a deep geological repository, the Waste Isolation Pilot Plant (WIPP), in Carlsbad, New Mexico. Currently, the highly toxic and long half-life TRU waste at the Savannah River Plant (SRP) is stored on above-grade storage pads in 55-gallon drums, carbon steel boxes, and concrete culverts. To support this national program, facilities are necessary for processing TRU waste in preparation for shipment to the WIPP and for safely transporting this waste to the WIPP.

The proposed Transuranic Waste Facility (TWF) will process TRU waste retrieved from storage as well as newly generated waste that does not meet the WIPP Waste Acceptance Criteria (WAC). After processing, this waste will be able to be certified for WIPP disposal. The TWF will initially process primarily Pu-239 contaminated waste because interstate transportation issues concerning Pu-238 are not yet resolved. Substantial quantities of Pu-238 contaminated waste, stored primarily in concrete culverts, will be processed in the TWF with the addition of future processing facilities. Therefore, the initial facility design will be based on the future requirements for handling Pu-238 contaminated waste.

BACKGROUND

TRU waste has been generated at SRP since plant startup in early 1953. From 1953 through 1964, TRU waste was disposed of nonretrievably in shallow land burial trenches. Beginning in 1965, TRU waste was stored both nonretrievably and retrievably. Packages containing less than 0.1 Ci of TRU isotopes were disposed of nonretrievably in shallow land burial trenches. Waste packages containing greater than 0.1 Ci per package were placed in retrievable concrete containers or encapsulated in concrete monoliths in shallow land burial trenches.

Since 1974, all TRU waste suspected of containing greater than 10 nCi/g of TRU contaminants has been stored retrievably on aboveground concrete pads under a soil mound. Solid waste contaminated with 10 nCi/g to 0.5 Ci per container is stored in 55-gallon galvanized steel drums with 90-mil polyethylene liners. Solid waste contaminated with greater than 0.5 Ci per container is also stored in 55-gallon galvanized steel drums with 90-mil liners. These drums are also enclosed in concrete culverts. The concrete culverts are seven feet in diameter and seven feet high with six-inch-thick walls and can contain up to fourteen 55-gallon drums. Bulky TRU waste is placed in carbon steel, polyethylene or concrete boxes, which can be as large as 12' wide x 18' long x 7' high.

The drums, filled concrete culverts, and boxes are stored on a one-foot-thick concrete pad. When the pads are full, three feet of soil is mounded over the containers, a moisture barrier is placed on top of the soil, and an additional foot of soil is placed on top of the moisture barrier. Shallow rooted grasses are then planted on the mound for erosion control.

GENERAL DESIGN BASIS

The primary mission of the TRU Waste Facility is to safely retrieve and process stored waste for disposal at WIPP, while minimizing occupational radiation exposure and environmental effects.

The design life of the TWF will be 30 years. The TWF design will meet the General Design Criteria of DOE Order 6430.1 for new DOE facilities and DOE Manual 5480.1A, Chapter XI, "Standards for Radiation Protection". Plutonium processing facility standards for fire resistance and protection, ventilation and radiation protection will apply to the design.

Because process inventory will be controlled so that exposures to offsite and near-in personnel resulting from a design basis accident will not exceed plant exposure limits, the building loading design criteria for seismic and tornado activity for plutonium processing facilities have not been applied.

Radiation doses to personnel will be kept "as low as reasonably achievable" (ALARA). To accomplish this, working dose rates have been limited to 0.5 mrem/hr for areas of constant occupancy and 5 mrem/hr for areas occupied less than ten percent of the time. Facility design will address shielding requirements for personnel protection based on future operational needs for handling Pu-238 isotopes. Shielding equivalents for process cell windows and walls will be provided based on the building layout scheme so that exposure to operating personnel will not exceed 1.0 rem/yr to the whole body, 15 rem/yr to forearms, or 30 rem/yr to the hands as prescribed in DOE Order 5480.1.

All regulated area and radiation zone floors, walls, and ceilings will be smooth and free of obstructions, and coated with a material designed for ease of decontamination. All cranes and monorails will be epoxy coated for ease of decontamination and corrosion resistance. Regulated areas outside the process areas and airlocks will have suspended, removable panel ceilings with piping, ductwork, cable trays, and conduit located above the ceiling.

Process and personnel airlocks will be provided between areas of differing contamination potential. Two airlocks in series will be provided between regulated access areas and process cells. The main process cell and all process airlocks will be stainless steel lined.

All floors are to be sloped toward collection sumps that can be pumped into drums for waste removal. A waste collection system shall be provided for the liquid waste from the laboratory area and the personnel decontamination facilities.

The equipment installed in the radiation zones has been specifically designed for remote operation and maintenance. Where possible, equipment motors have been installed outside of contaminated cell areas to reduce exposure during maintenance. All radiation zone lighting will also be accessed from outside the process areas for ease of changing the lamps without breaking containment seals.

Several areas of the TWF will be designed to withstand forces generated by a hydrogen gas explosion within a waste drum. Hydrogen gas is a product of radiolysis that can occur in the sealed waste drums. To identify specific areas of risk and to determine measures to eliminate personnel exposure to these risks, a study was conducted in which several drums containing a mixture of hydrogen in air were detonated. These tests provided a technical basis for the design of areas where there will be a potential for drum explosions.

The building ventilation system design will meet the requirements of DOE 5480.1A Chapter 1, 8.a.(1) (h); ERDA 76-21, Nuclear Air Cleaning Handbook. Facility design will provide safeguards to prevent uptakes and ventilation system reversals that could cause contamination of clean areas.

Process building air and all glovebox air effluents are to be exhausted through DOP-testable HEPA filters. In-cell HEPA filters will also be provided in areas of high contamination potential as an added protection. This type of ventilation ensures that the population at SRP and in the surrounding communities will be protected in the unlikely event of a process upset. For the purpose of maintaining facility nuclear safety limits for plutonium inventory, all process area regulated ductwork will be accessible for HP fissile material monitoring and cleaning.

The pressure differential throughout the entire facility will be maintained negative with respect to the outside environment. Building pressure differentials will provide air flow from clean areas through regulated areas, to radiation zones and finally to the air cleaning system and the exhaust stack.

An automatic fire detection and alarm system is to be provided in all building areas, including the glovebox enclosures. Local process equipment fire suppression systems will be provided where necessary. A Halon system will be required in process areas.

PROCESS DESCRIPTION

General

The TWF process will handle approximately 15,000 cubic feet of retrieved waste and 6200 cubic feet of newly generated waste each year of operation.

The primary wasteforms received at the TWF will be 55-gallon drums and carbon steel boxes. Stored waste drums contain a mixture of combustible and noncombustible waste. The carbon steel boxes contain large, bulky waste wrapped in plastic and packed into plywood boxes. Equipment capacities and enlarged areas to process culverts will be included in the design of the TWF. However, until Pu-238 processing facilities are added, the culverts will be handled only on a demonstration basis. Waste processing through the TWF is shown in Figure 1.

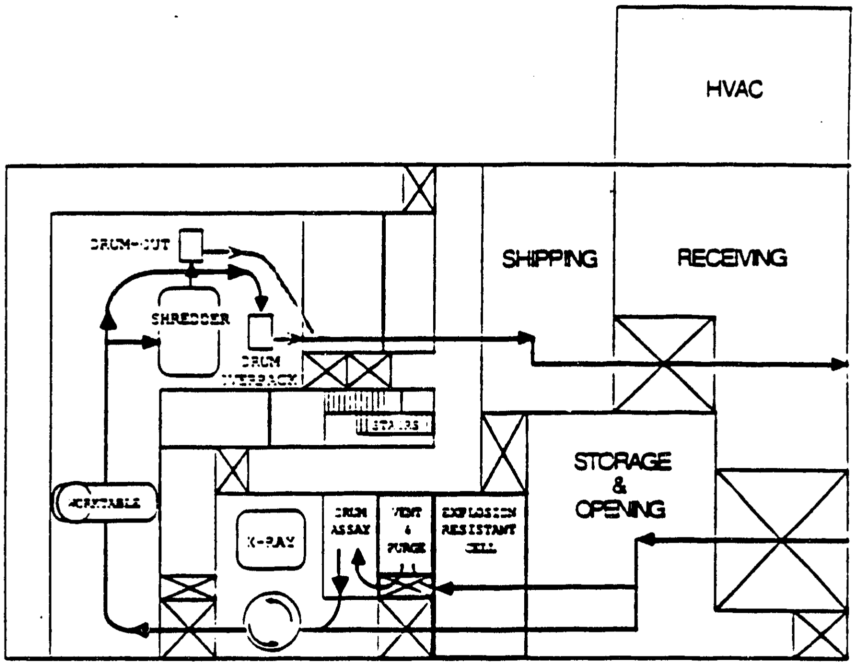

FIGURE 1. TWF Process Flow

Waste Retrieval Operations

To retrieve TRU waste, the four-foot soil cover over the stored waste will be removed by earthmoving equipment to within approximately six inches of the waste containers. The remaining soil will be removed with a remotely operated, HEPA-filtered soil vacuum truck. Due to the potential for drum explosions due to radiolytically generated hydrogen, 55-gallon drums will be removed from storage using a specially designed and shielded lifting canister. This canister will fit over the drum to protect personnel in the event of an explosion and control any contamination released. Drums will be placed from the lifting device into an explosion resistant cask for transportation to the TWF. Larger containers will be lifted from the pads and placed directly on a low-boy trailer for shipment to the TWF building. All equipment used in the retrieval operation will be radiation and explosion shielded.

Storage and Opening Area

Waste containers will be received into the TWF through an airlock into the Storage and Opening Area. Stored waste drums contain a mixture of combustible and noncombustible wasteforms. The carbon steel boxes contain large, bulky waste wrapped in plastic and packed into plywood boxes. Steel boxes will be opened in the high bay area and the plywood boxes will be removed to be processed through the facility. The shielded drum transportation cask and and the culverts will be placed directly into an adjacent explosion resistant room. In this area the culverts will be opened remotely using a system of wedges to break the grout seal at the culvert lid.

Using an overhead crane, drums will be removed individually from the shipping containers and placed in a cell where the drums can be vented, purged with an inert gas, and fitted with a carbon composite filter vent before being introduced into the Verification Area. These vents allow gases to diffuse, preventing the buildup of radiolytically generated hydrogen in waste drums while they are awaiting processing.

Verification Area

In the Verification Area both drums and boxes will be assayed using neutron interrogation to determine the waste container curie content for inventory control and record purposes. Each waste container will then be x-rayed to identify any objects that must be removed to allow the package to meet the WIPP Waste Acceptance Criteria.

Waste Processing Cell

After x-ray, containers pass through an airlock into the Waste Preparation Area. Design of the airlock will incorporate balloon seals to prevent potential backflow of contamination into the Verification Area. In this cell contaminated equipment will be removed from its plywood box. The equipment can then be placed on an electric worktable and size reduced using a heavy-duty, electromechanical manipulator (telerobot) in conjunction with master-slave manipulators, as illustrated in Figure 2. The worktable has been custom designed for use with the telerobot. It has the capability to hold large, bulky objects, weighing up to 3600 pounds, in place in any position while it is being operated upon by the robot. The worktable has also been designed to facilitate remote maintenance by the telerobot.

The telerobot is capable of holding several tools, including a plasma arc torch, for size reduction of large equipment contained within the plywood boxes. The telerobot will also be utilized to remove any objects identified in the x-ray process as unacceptable for WIPP disposal.

Drums and other equipment can then be placed in a low-speed, high-torque shredder or directly in a drum overpack for removal from the Waste Processing Cell. Waste from the highly contaminated cell is removed using Drath and Schrader bagless transfer systems. The Drath and Schrader system allows waste to be removed from a radiation zone without the use of traditional bagout operations.

Using this system the waste is placed directly in a 55-gallon drum and removed from the contaminated area. A unique set of seals prevents the top of the drum lid and the exterior surface of the drum from exposure to the contaminated environment. Although this technology is new to the United States, D&S systems have been used extensively in Germany.

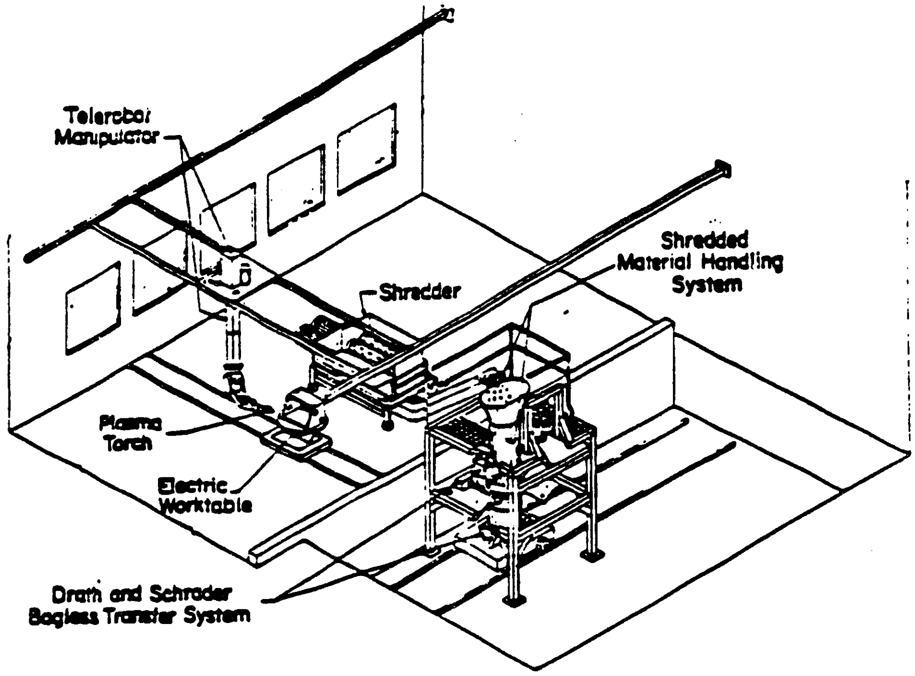

FIGURE 2. Waste Preparation Cell

The Waste Processing Cell will also contain a glovebox for changing tool tips and for other operations that must be performed manually. An in-cell vacuum cleaning system will be provided in this cell to remove dust and contamination. Operations in this cell will be completely remote and can be viewed from the telerobot operating console corridor through lead shielded windows. A closed circuit television system will provide localized viewing of individual equipment operations. All cameras will be fitted with cerium stabilized lenses to prevent radiation damage and will be accessible to the telerobot for in-cell maintenance.

Shipping and Receiving Area

Drums of processed waste removed from the waste preparation cell using the bagless transfer system are transported to the shipping area where they are prepared for shipment to the Waste Certification Facility (WCF) for classification as low-level waste, as WIPP intended waste, or as noncertifiable waste.

Regulated Maintenance Facilities

Regulated maintenance facilities include a regulated maintenance shop and a master-slave manipulator repair glovebox. The regulated maintenance shop will be located on the second floor of the TWF between the Storage and Opening Area and the Waste Processing Cell. Maintenance access to the overhead cranes and monorails in these areas will be incorporated into the facility design through the use of service decks accessed from this regulated maintenance shop. Lead shielded windows will be provided in the shop to view repair operations in the Waste Processing Cell.

The master-slave manipulator repair glovebox will be located adjacent to the Waste Preparation Cell for easy access from the cell area using the telerobot. This glovebox provides 360 degree access for repair of the contaminated "slave" end of the manipulator.

CONCLUSION

With the construction of the TWF in 1991, interim storage of Pu-239 contaminated waste can be ended at SRP by the year 2000. If the TWF is expanded to process Pu-238, the end of interim storage of all TRU waste can be realized by 2010. The placement of TRU waste in a deep geological repository will provide a single disposal site for the long-lived TRU isotopes now stored at the Savannah River Plant.

ACKNOWLEDGMENT

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DAVE CHARLESWORTH, DuPont - SRP

OVERVIEW - INCINERATION AT SRP

INCINERATION AT SRP

Overview

D. L. Charlesworth

October 28, 1986

Agenda

Overview - Incineration Technology

Beta-Gamma Incinerator

Hazardous Waste Incinerator

Pu-238 Waste Incinerator

Recovery Incinerator

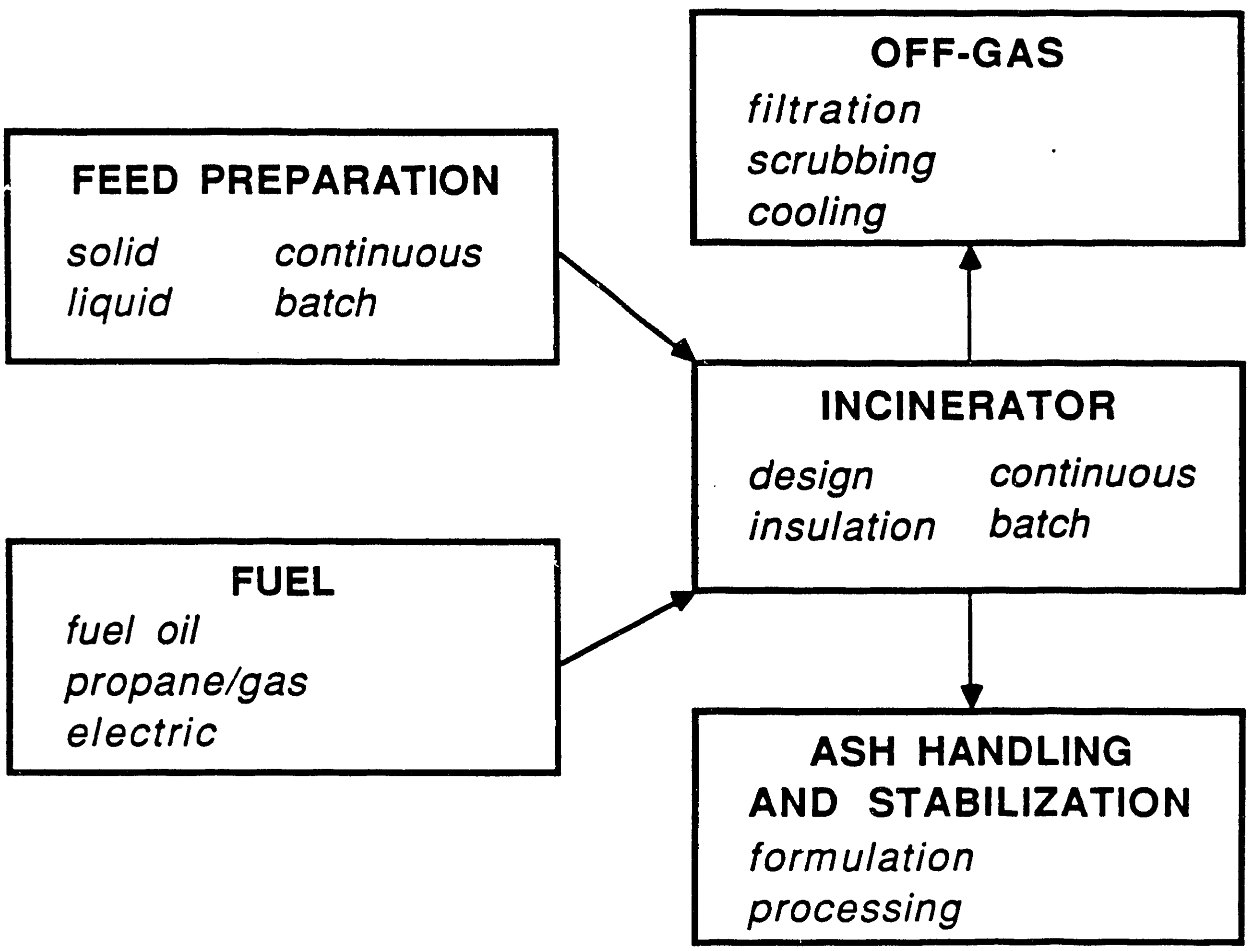
SAVANNAH RIVER LABORATORY
Solid/TRU Waste Technology Group

Mission: Develop processes and equipment to permanently dispose of low-level, hazardous, mixed, and TRU waste.

WASTE FORM	PROCESSING METHODS and TECHNOLOGIES	FINAL DISPOSITION
RCRA Hazardous Waste	Volume Reduction - shredding - incineration - compaction	destruction / RCRA approved landfill
"Mixed" Waste	Immobilization Remote Operation	destruction / RCRA approved landfill
Low-level Waste	- Telerobot - bagless transfer Decontamination	Burial
TRU Waste	- robotic applications - physical and chemical	WIPP
High-level Waste	Vitrification Immobilization	glass/repository saltstone

INCINERATION: TECHNICAL ISSUES

GENERIC	RADIOACTIVE
attainment	containment
material handling	remote operation
process control	process control
materials of construction	criticality
kinetics and mass transfer	
feed characterization	



BETA-GAMMA INCINERATOR

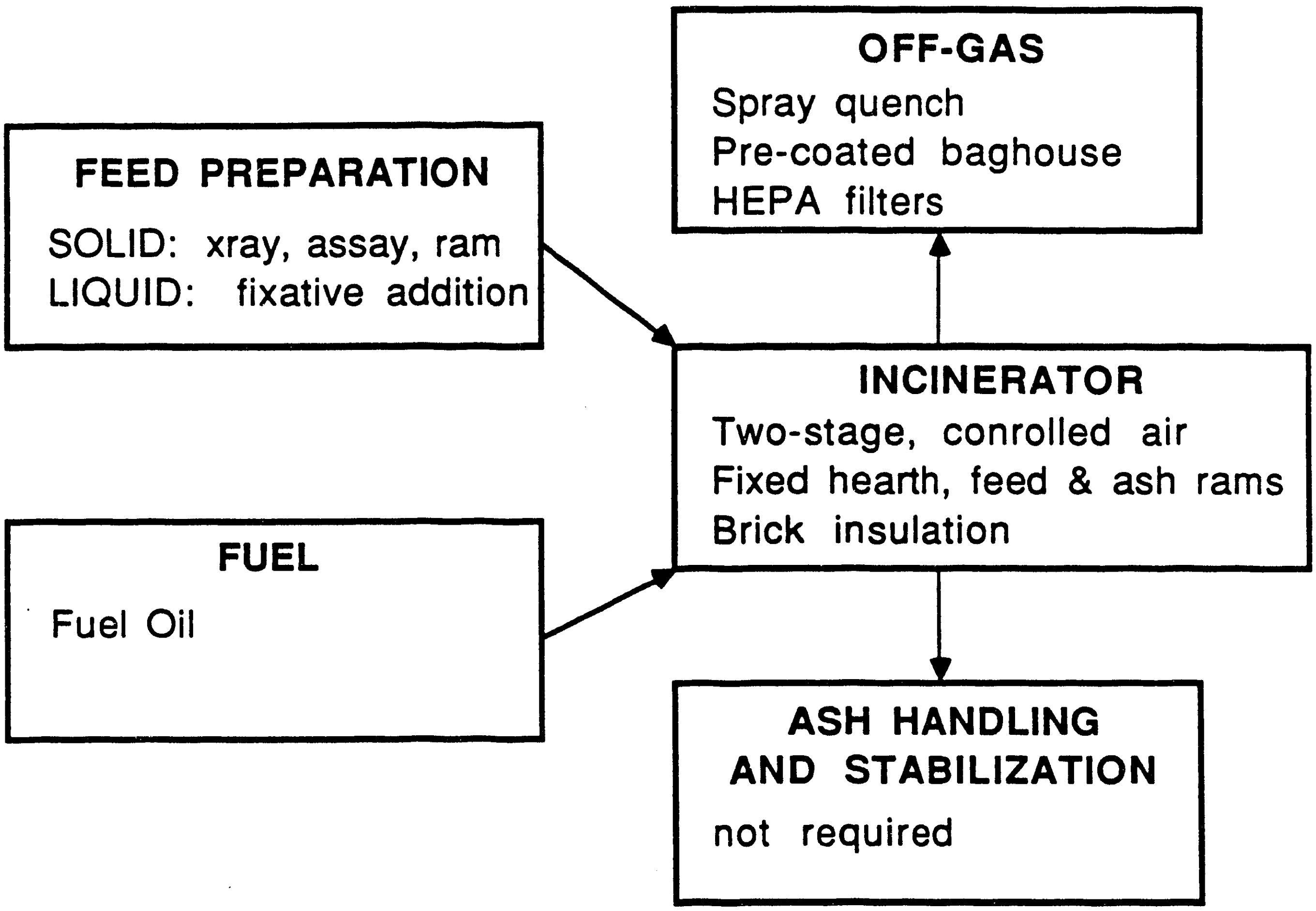
Program Goals

- Burn 130,000 Gallons of Spent Purex Solvent
  - 18% Tributyl Phosphate in Kerosene

- Burn 168,000 Cubic Feet/Year Low-Level Waste
  - 22% Cellulose
  - 63% PVC
  - 10% Polyethylene
  - 5% Rubber

BETA GAMMA INCINERATOR FLOWSHEET

Capacity: nominal 400 pph solids; 40 gpm liquids



BETA-GAMMA INCINERATOR

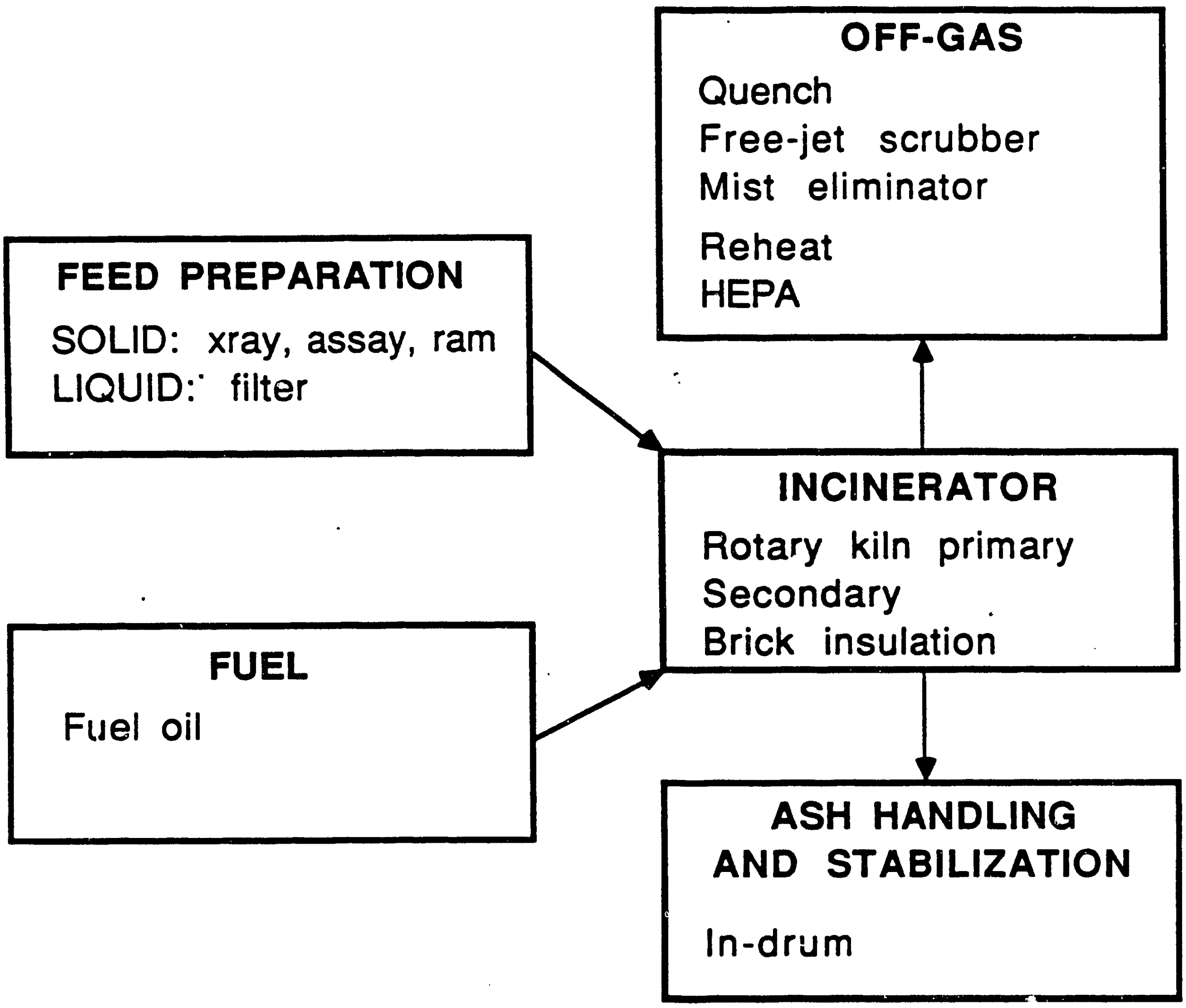
Program Goals	Status
• Burn 130,000 Gallons of Spent Purex Solvent - 18% Tributyl Phosphate in Kerosene	Almost Complete 4500 Hours
• Burn 168,000 Cubic Feet/Year Low-Level Waste - 22% Cellulose - 63% PVC - 10% Polyethylene - 5% Rubber	19,000 Cubic Feet Complete 750 Hours

HAZARDOUS WASTE INCINERATOR

Program Goals

- Burn 500,000 Cubic Feet/Year Low-Level Waste
- Burn 10,000 Cubic Feet/Year Mixed Solid Waste
- Burn 50,000 Gallons/Year Mixed Liquid Waste
- Burn Inventory of Mixed and Hazardous Waste
- Startup in 1991

PLANNED HAZARDOUS/LOW-LEVEL COMBINED INCINERATION FACILITY FLOW SHEET

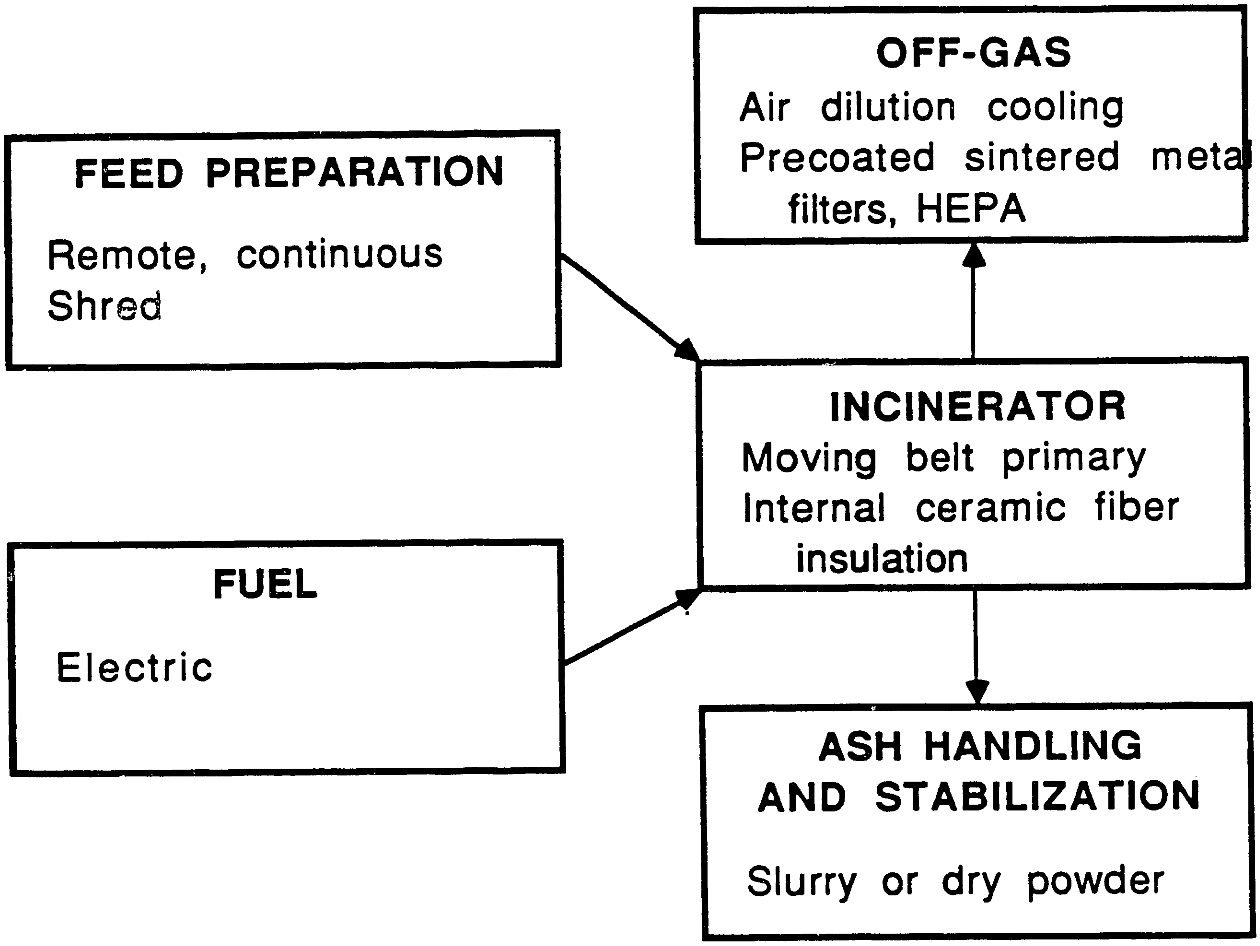


HAZARDOUS WASTE INCINERATION STATUS

- Rotary Kiln/Off-Gas Test Program in Progress
- Design Studies in Progress
- Project Authorization 7/87
- Startup 1991

Pu238 WASTE INCINERATOR FLOW SHEET

CAPACITY: nominal 20 pph



Pu-238 INCINERATION PROCESS DEVELOPMENT

Design Features

- Electrically heated, two-stage, controlled air incinerator
- Remote feed preparation; no manual handling or sorting
- Dry off-gas filtration system
- Ash compatible with Pu recovery

Results to Date

- 400 hours operation
- Achieved 90% utility during 75 - hour run
- Belt life - major technical concern
- Technical issues:
  - remote operability
  - vacuum control
  - feed prep system
  - ash burnout

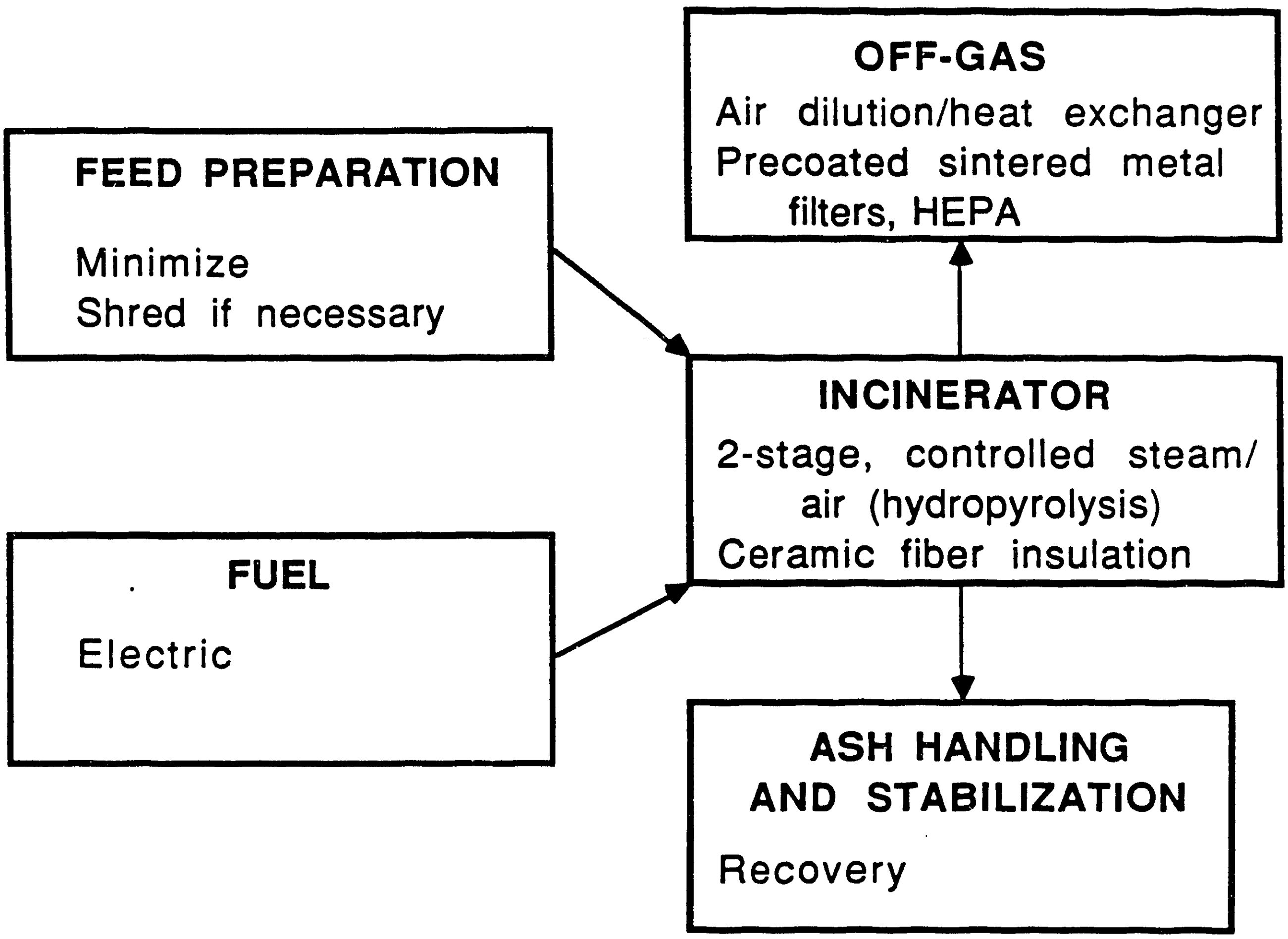
Pu RECOVERY INCINERATOR
CONCEPT AND CONSTRAINTS

1. Improve Pu-Line Yield by Incinerating Waste Known to Contain Pu
   - Hydropyrolysis to Produce Low-Fired Ash
   - 80/20 Rule Applies to Activity/Volume
   - Potential Problem for Waste Handling Eliminated
   - Process Material that Cannot Go to WIPP

2. Incinerator Must Be Simple - Easy to Operate and Maintain.
   - Physical Size - Must Fit in Glove Box
   - Minimal Handling/Sorting of Waste
   - Nominal 5-Gallon Waste Cut
   - Minimize Off-Gas and Secondary Treatment
   - Criticality May Constrain Physical Dimensions

Pu RECOVERY INCINERATOR FLOW SHEET

CAPACITY: 1 5-gallon waste cut/2-4 hours
(nominal 1000 ft3/year)



Pu RECOVERY INCINERATOR STATUS

- Feasibility Study Complete
- Lab Scouting Tests in Progress
  - Hydropyrolysis
  - Off-Gas Generation
- Fy 1987 Project - Startup 1991
- Plans for Prototype Being Developed

STATUS OF INCINERATION PROGRAMS AT SRP

Waste Form	Complete	In Progress	Planned
RCRA Hazardous Waste; Mixed Waste	*conceptual design*	*off-gas and incinerator testing*	*design and construction of consolidated incineration facility*
Mixed Waste; Low-Level Radioactive Waste	*Phase I: full-scale lab demo*	*Phase II: plant rad demo*	*design and construction of consolidated incineration facility*
TRU Waste Pu238	*small-scale and pilot testing*	*pilot demo*	*Pu recovery?*
Pu Recovery	*feasibility study*	*scoping studies*	*radioactive lab tests*

JOHN STEWART, DuPont - SRP

Pu INCINERATOR

DP-MS-86-71

DEMONSTRATION OF A REMOTELY OPERATED TRU WASTE SIZE-REDUCTION AND MATERIAL HANDLING PROCESS

by

John A. Stewart, III, Thomas F. Schuler and Clyde R. Ward

E. I. du Pont de Nemours and Company
Savannah River Laboratory
Aiken, South Carolina 29808

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ABSTRACT

Noncombustible Pu-238 and Pu-239 waste is generated as a result of normal operation and decommissioning activity at the Savannah River Plant and is being retrievably stored at the site. As part of the long-term plan to process the stored waste and current waste for permanent disposal, a remote size-reduction and material handling process is being tested at Savannah River Laboratory to provide design support for the plant TRU Waste Facility scheduled to be completed in 1993. The process consists of a large, low-speed shredder and material handling system, a remote worktable, a bagless transfer system, and a robotically controlled manipulator, or Telerobot. Initial testing of the shredder and material handling system and a cycle test of the bagless transfer system were completed. Initial Telerobot run-in and system evaluation was completed. User software was evaluated and modified to support complete menu-driven operation. Telerobot prototype size-reduction tooling was designed and successfully tested. Complete nonradioactive testing of the equipment is scheduled to be completed in 1987.

BACKGROUND

Pu-238 and Pu-239 are produced at the Savannah River Plant (SRP) for use in thermoelectric generators for the space program and for use in the national defense program. Noncombustible plutonium waste is generated as a result of production, laboratory work, and decommissioning activities and is being retrievably stored at SRP. To effectively process and dispose of this waste, the plant proposes to build a Transuranic Waste Facility in the late 1980's. Figure 1 is a schematic of the SRP TRU Waste Management Plan.

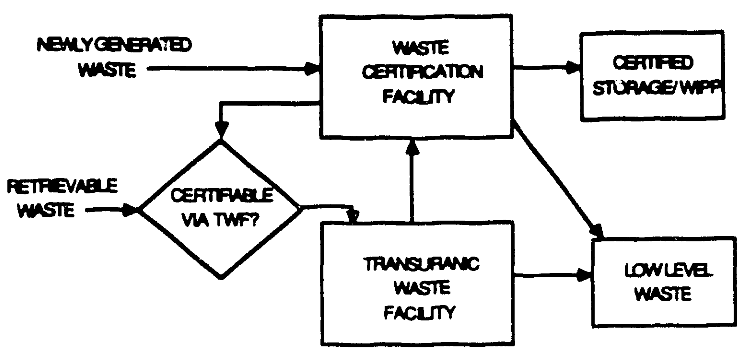


FIGURE 1. Savannah River Plant TRU Waste Management Plan

The Transuranic Waste Facility will process retrieved drums, concrete culverts containing drums, and large steel boxes containing transuranic waste for permanent disposal.

PROCESS

The Components Test Facility (Figure 2) will demonstrate remote size-reduction and material handling techniques to be used in processing plutonium-contaminated, noncombustible items such as gloveboxes, piping, valves, small process vessels, etc. Feed materials are prepared using a robotically controlled manipulator in conjunction with an electric worktable. Once prepared, the items are placed on the shredder loading door and raised into the shredder. Shredded material drops onto a conveyer and is carried into a drum hopper. A level-sensing device shuts down the conveyer and shredder when the drum hopper is full, and the contents drop into a bagless transfer system for removal.

The robotically controlled manipulator, or Telerobot, utilizes a variety of specially adapted hand tools to prepare items for shredding. Items too large to fit into the shredder are partially size-reduced with a plasma torch and placed in the shredder. The plasma torch is also used to size-reduce objects with material thicknesses greater than 1/4" or other unshreddables such as process vessels.

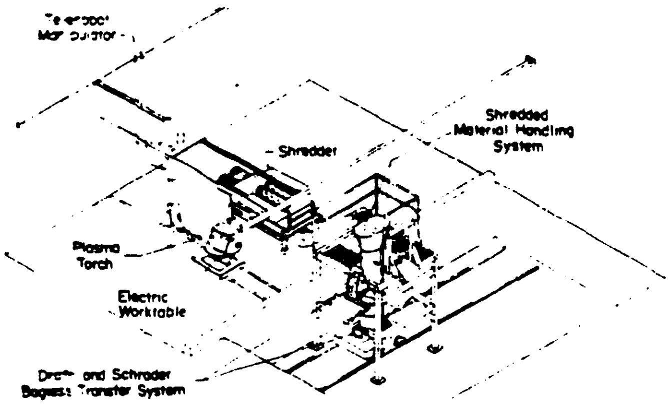


FIGURE 2. Size-Reduction and Material Handling Demonstration Facility

The Telerobot combines a gantry mounted industrial robot with nuclear hot cell manipulator technology. Capacity is 300 lb at the manipulator hand and 3000 lb at a hook beneath the shoulder pivot point. The support structure has a 20' span, 72' length, and is 20' high. A central computer is used to contro all executive control functions, and a trajectory processor controls all linear interpolated movements. The Telerobot is controlled by a single operator sitting behind a special wrap-around control station, which also contains the controls for all other equipment used in the demonstration. The Telerobot operates in either manual, semi-auto., or preprogrammed modes. Two 3-axis potentiometer joysticks are used for calculated rate control of the bridge axes and the axes of the manipulator arm in the manual and semi-auto mode operation. Removal of the arm is performed via a completely remote, three step process (push up, rotate, let down) with an arm removal attachment on the remote worktable.

The remote worktable is capable of precisely clamping, lifting, tilting, rotating, and moving back and forth objects weighing up to 3800 lb. These motions are used by the operator during feed preparation for remote positioning of materials during plasma torch and hand tool operations.

The shredder is a Shred-Pax Model AZ-160, a low-speed, 160 HP, electrically driven unit. The shredder hopper is completely enclosed during operation to avoid kickback of material and to reduce noise levels. Hopper inner wall construction includes a steel-backed rubber (with the steel facing in) to absorb the high impact forces of large, heavy items bouncing around during shredding. The shredder is able to accept items with external dimensions up to 3' x 4' x 5.5' and gross weights up to 1000 lb.

The material handling system includes a hopper that measures, by volume, exactly one drum of shredded material using a time-delayed light sensor. The light sensor automatically shuts down the shredding process when the hopper is full and a clamshell at the bottom of the hopper opens, allowing the shredded material to fall into a bagless transfer drum below. The hopper is then tilted upward, allowing the bagless transfer machine to reposition the false lid onto the drum. Finally, the drum is removed from the facility and a new drum is put in position.

The bagless transfer system is a converted German Drath and Schrader unit. This is the device used to remotely remove contaminated waste with less personnel exposure through remote rather than hands-on contact. This system will eliminate the potential release of contamination by replacing the bagout technique currently used to remove TRU waste from contaminated environments, especially when removing sharp-edged shredded metals. The system was chosen because it had already been proven reliable in over 10 years of operation in Europe. Improvements have been made to the unit in order to meet U.S. and Du Pont standards.

TELEROBOT TESTING

The Telerobot was initially erected on a 20' x 20' x 20' gantry prior to completion of the full-scale Components Test Facility (Figure 3). The smaller runway allowed the robot's functional checkout in a smaller, controlled atmosphere.

A maximum straight lift load limit of 2000 lb was established to prevent system overload. Larger moving loads produced a pendulum swing that overloaded the robot's emergency limits. A 300 lb perpendicular lift load capacity (with the arm straight out) was also established. Repeatability was lab tested at 0.040" at GCA's robotic laboratory. This value will be retested at the full-scale facility.

Initial trajectory, host, and basic programming software was successfully tested to evaluate the robot's overall operating capability. The basic operating program system was modified to increase user-friendly options. The basic frame was modified to shift operator attention from the computer console to the control console. Menu driven program access allows the operator to log-on and then operate any necessary robot function or automatic program with the console control buttons. This not only increases operator effectiveness but also reduces the chance for accidental program changes and system modifications.

FIGURE 3. Telerobot Mounted on Small Frame

Prototype size-reduction and maintenance tooling was developed and tested. A complete remote tool-change system was designed to adapt specialized tools to the present manual tool-change system. By combining electrical and mechanical locking in one operation, tool-change and overall processing time is greatly reduced.

Standard electrical industrial tools were purchased and modified to reduce costs and system downtimes. By choosing standard heavy-duty tools, a broken tool can be changed out, replaced with a new tool, and then thrown away. Specialized tools are available, but are costly and inconvenient for remote radioactive service.

A Milwaukee 1/2" drill and electric scissors shear were successfully modified and tested. Additional tools will include a circular saw, chop saw, impact wrench, and reciprocating saw. A remote tool-change table was designed to safely store each tool and indicate its presence on the table to the operator.

The wrist assembly is currently being modified to accommodate a modified Erickson tool-change system.

SHREDDER TESTING

A series of four tests of the large shredder and material handling system has been completed (Figure 4). Feed materials included both scrap and fabricated stainless and carbon steel boxes. These tests have shown that the system can consistently shred a 3' x 4' x 5'1/4" enclosed stainless steel box in less than two hours with a two-by-two blade configuration installed in the shredder. The shredded material handling system, which conveys the shredded metal to a holdup hopper, has experienced no material handling problems. Approximately 475 lb of shredded metal fits into each drum without additional shaking or compaction. Volume reductions averaging 10:1 have been achieved using box configurations similar to gloveboxes.

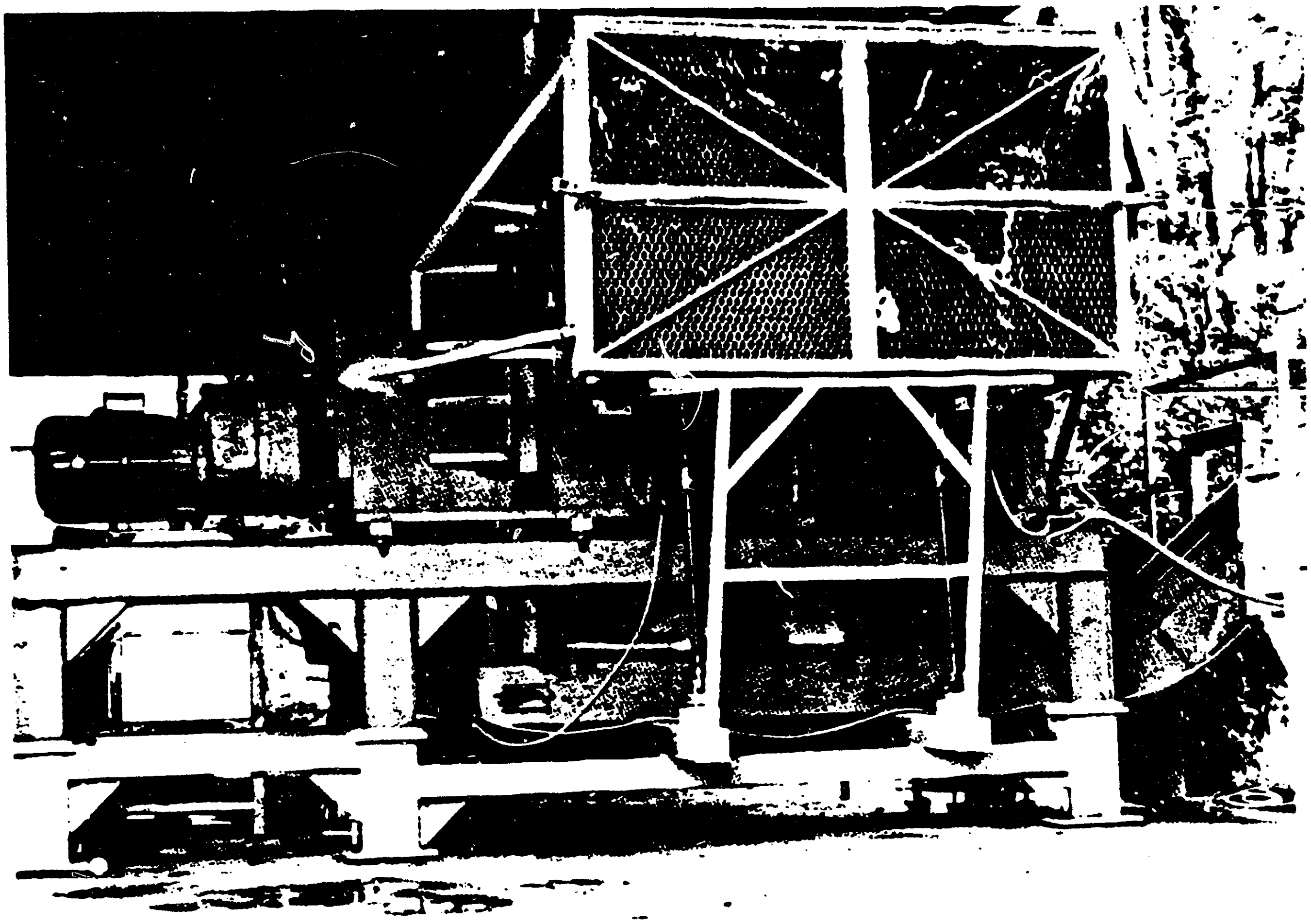


FIGURE 4. Shredder and Material Handling System

Additional testing of the shredder and material handling system will be done in conjunction with the Telerobot and electric worktable in the Components Test Facility.

In the initial testing, scrap materials were used as the feed material (see Table 1). In the first of the initial tests, a scrap stove was used. The stove, which was fabricated of very thin (1/16") carbon steel, was shredded too quickly and produced unacceptably long (14") pieces. The feed rate was also too rapid for the material handling system, which was designed for a slow, steady feed from the shredder. A variable, reversing timer was installed that controlled both problems. The timer was set to allow control of the amount of time that the shredder blades would rotate in the forward direction, at which point they would reverse. In the second of initial tests, a similar stove was used and the reversing timer was set for 5 seconds. Feed rate was more controlled and piece size was reduced to acceptable levels. In the third test, a scrap refrigerator was shredded with similar results.

TABLE 1 - Test Results Shredding of Scrap Materials

Test #1	
Size:	42" high by 24" wide by 40" high (scrap stove)
Material:	1/16" carbon steel with fiberglass insulation
Shredding Time:	2 minutes
Final Volume:	2 (3/4 full) lined, 55-gallon drums
Piece Size:	2" wide by 14" long
Test #2	
Size:	42" high by 24" wide by 40" high (scrap stove)
Material:	1/16" carbon steel with fiberglass insulation
Shredding Time:	5 minutes
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	2" wide by 9" long
Test #3	
Size:	66" high by 33" by 26" (scrap refrigerator)
Material:	1/16" carbon steel with fiberglass insulation
Shredding Time:	15 minutes
Final Volume:	2 (3/4 full) lined, 55-gallon drums
Piece Size:	2" wide by 9" long
Test #4	
Size:	80" by 50" by 34" (scrap air-handling duct)
Material:	1/8" stainless steel
Shredding Time:	1 hr 50 minutes
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	2" wide by 5" long
Test #5	
Size:	80" by 50" by 34" (scrap air-handling duct)
Material:	1/8" stainless steel
Shredding Time:	2 hrs 15 minutes
Final Volume:	1 - 55-gallon drum
Piece Size:	2" wide by 5" long

In tests #4 and #5, the scrap materials closely resembled gloveboxes typically found in TRU waste. Both items were constructed of 1/8"-thick stainless steel, fabrication was both bolted and welded, corner and side bracing was found on the interior, and they were enclosed on five of six sides. In both cases, the items shredding times were within acceptable levels (2 hrs), piece size was very good (5" long), volume reductions of 10:1 were achieved, and material flowed smoothly through the material handling system. Before and after shots of test #6 are shown in Figures 5 and 6, respectively.

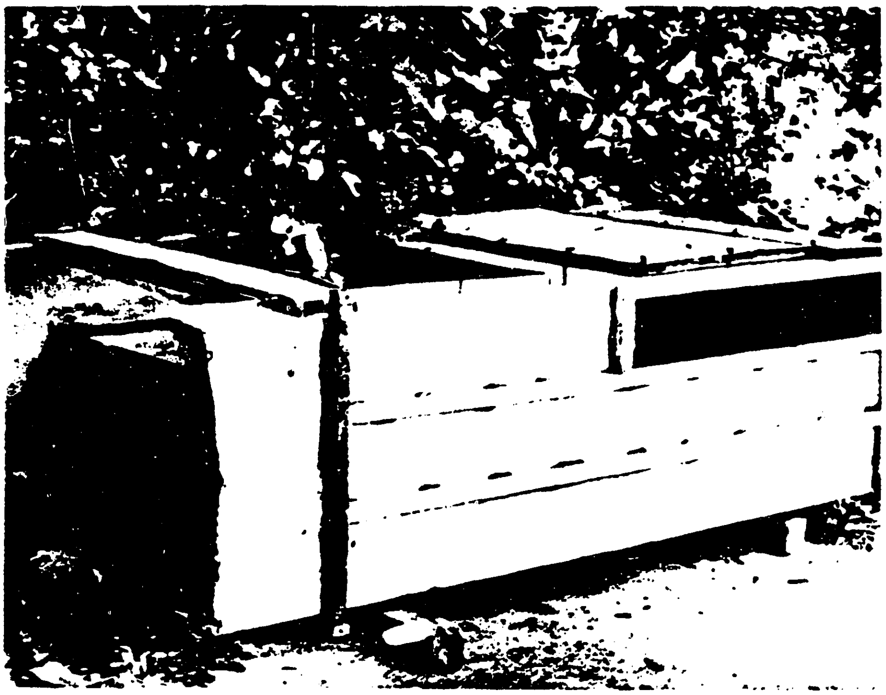


FIGURE 5. Stainless Steel Air-Handling Duct Used in Test #5

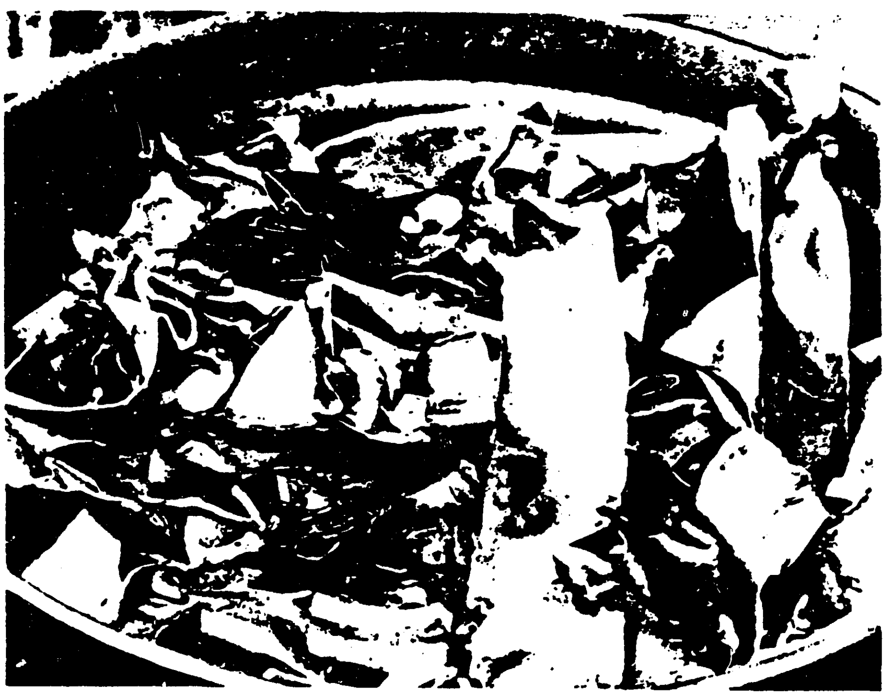


FIGURE 6. Shredded Material From Test #5

In the second stage of testing (Table 2), a series of enclosed rectangular boxes fabricated out of 1/8" and 1/4" carbon and stainless steel plates were used for feed material. These large boxes were used to test the ability of the shredder to grab onto large rectangular shapes without appendages and to further assess the ability to shred 1/8" and 1/4" steel.

TABLE 2 - Test Results Fabricated Steel Boxes

Test #6	
Size:	3' x 4' x 4'
Material:	1/8" carbon steel
Shredding Time:	2 hrs 15 minutes
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	2" x 6"

Test #7	
Size:	3' x 4' x 5' (reinforced)
Material:	1/8" carbon steel
Shredding Time:	3 hrs 10 minutes
Final Volume:	1 1/3 (3/4 full) lined, 55-gallon drum
Piece Size:	2" x 6"

Test #8	
Size:	3' x 4' x 5'
Material:	1/4" carbon steel
Shredding Time:	1 hr 10 minutes (Time spent trying to grab box, then discontinued and used for Test #4)
Piece Size:	2" x 5"

Test #9	
Size:	3' x 4' x 5' with a 2' x 3' window and 2 - 7" dia. holes cut in 1 side
Material:	1/4" carbon steel
Shredding Time:	2 hrs 30 minutes (Discontinued after half of box had been shredded due to slow shredding speed)
Piece Size:	2" x 5"

Test #10	
Size:	3' x 4' x 4'
Material:	1/8" stainless steel
Shredding Time:	5 hours
Final Volume:	1 (3/4 full) lined, 55-gallon drum (shown in Figure 7)
Piece Size:	2" x 5"

Test #11	
Size:	3' x 4' x 5'
Material:	1/8" stainless steel
Shredding Time:	5 hrs 40 minutes
Final Volume:	1 1/4 (3/4 full) lined, 55-gallon drum
Piece Size:	2" x 5"

Test #12	
Size:	1/4 of a 3' x 4' x 5' box (1.5' x 2' x 2.5')
Material:	1/4" stainless steel
Shredding Time:	35 minutes (for 10% completion)
Problems:	Slow shredding
Piece Size:	2" x 5"

In test #6, a 3' x 4' x 4' 1/8"-thick carbon steel box was used. Although some difficulty was experienced in getting the shredder to take the initial bites out of the box, shredding became rather smooth after this. Total shredding time was 2 hours 15 minutes. In test #7, a 3' x 4' x 5' 1/8"-thick carbon steel box with reinforcing bracing (welded between the interior walls) was used. The internal bracing simulated piping internal to gloveboxes that would tend to limit the ability of the shredder to crush and fold the box. Results of this test were similar, with about a 50% increase in shredding time due to the internal bracing. In tests #8 and #9, the same 1/4"-thick carbon steel box was used. After over 3-1/2 hours of shredding, 85% of the box remained. It had become apparent that the shredder was unable to handle 1/4"-thick material.

In tests #10, #11, and #12, 1/8" and 1/4" stainless steel boxes were used. Although the piece size and volume reduction were very good (1/8" material), with 85% of the material less than 5" long, the shredder jammed frequently. The shredder was unable to shred 1/4" material. Unjamming of the shredder was performed remotely by pulsing the motors in the reverse direction until the steel that jammed in between the blades was backed out.

The following problems were seen in the first two tests and were later corrected by changing the blade configuration from a one-by-one to a two-by-two:

- The shredder was unable to shred 1/4"-thick material
- Shredding times were slow
- Jamming was frequent
- The shredder motors were overworked

In the two-by-two configuration, two blades are stacked next to one another rather than singly, resulting in a cut twice as wide. Because only half as many cuts are made across the shredder, twice as much power is delivered to each cut. This results in much faster shredding speeds and the ability to cut thicker materials. The main drawback is larger piece size, which can be controlled by the reversing timer.

After installation of the two-by-two blade configuration, several tests (Table 3) were made using fabricated steel boxes similar to those used in the second set of tests. Results were dramatically improved. The initial test (#13) shred the 85% complete 1/4" carbon steel box used in tests #8 and #9 in 1 hour and 45 minutes. The box had previously been only 15% completed in 3-1/2 hours with the one-by-one blade configuration. In test #14, a 2.5' x 3' x 6' 1/4" stainless steel box section was shredded in 1-1/2 hours with no problems. Tests #15 and #16 shred 3' x 4' x 5' 1/8" stainless steel boxes in just over an hour each. Due to the poor shape of the feed hopper after these series of tests had been completed (damage occurring from boxes slamming into thin hopper walls and loading door), further testing was suspended until a new, stronger hopper could be made.

TABLE 3 - Test Results Two-By-Two Blade Configuration Fabricated Steel Boxes

Test #13	
Size:	3' x 4' x 5' with a 2' x 3' window and 2 - 7" dia. holes cut in 1 side
Material:	1/4" carbon steel
Shredding Time:	1 hr 45 minutes
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	4" x 6"

Test #14	
Size:	2 1/2' x 3' x 4' x 6'
Material:	1/4" stainless steel
Shredding Time:	1-1/2 hrs
Final Volume:	1-1/3 (3/4 full) lined, 55-gallon drum
Piece Size:	4" x 6"

Test #1[illegible]

Size:	3' x 4' x 5'
Material:	1/8" stainless steel
Shredding Time:	1 hr 10 minutes
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	4" x 8"

Test #1[illegible]

Size:	3' x 4' x 5'
Material:	1/8" stainless steel
Shredding Time:	1 hr
Final Volume:	1 (3/4 full) lined, 55-gallon drum
Piece Size:	4" x 8"

Sound levels were measured and found to be as high as 116 decibels. This was corrected by a total redesign of hopper, loading door, and some additions between the hopper and conveyor. The new design used the same concept but is much stronger, completely enclosed, and lined with 1-1/2" of Armaplate^{tm} (Goodyear), a steel-backed rubber plate. This was used to absorb the energy of the items as they bounced into the walls. The new hopper design is complete and will be installed when the shredder is reinstalled in the integrated demonstration.

BAGLESS TRANSFER SYSTEM TESTING

Cycle testing of the Drath and Schrader Bagless Transfer System was performed. The system proved highly reliable and durable.

A plexiglas cover was installed to obtain a seal during leak testing. Leak testing was scheduled before and after cycle testing under 2" H_2O positive pressure. After the first leak test proved successful, a 24-volt control system, to permit continuous cycling, was designed and installed. Cycle testing was scheduled to run for 2000 cycles. However, because the cycle testing served as a reliability test, the number of cycles run was determined by the successes or failures in the unit. Minor problems with limit switches occurred erratically. Therefore, to accumulate large numbers of successive runs, the number of cycles was increased twofold. A total of 4142 cycles were completed. Results are shown in Table 4.

TABLE 4 - Bagless Transfer System Cycle Test

Date '85	Cycles Complete	Notes
10/07	281	Drum gasket fell into drum. No mechanical problems
10/08	398	Gripper limit switch not working, on/off switch broken
10/09	413	Troubleshot limit switch for gripper and repositioned until in working order, on/off switch replaced, impression switch not working-need internal access for repair, drum replaced
10/14	648	Impression limit switch repositioned until working (435 cycles)
10/15	858	Lock limit switch not working, repositioned until working (750 cycles)
10/21	1757	Circuit tripped, but no mechanical problems occurred
10/28	2707	Repaired gasket. No mechanical problems
10/29	2756	Gripper limit switch not working, E & I unavailable for repair
10/30	2829	Gripper limit switch repositioned by E & I until working
11/04	2951	Lock switch not activated - adjusted screw controlling position until running
11/08	3787	Air pressure low, but no mechanical problems

No mechanical problems signifies that a system problem interferred with cycling, but that no mechanical problems were involved.

The minor problems caused by faulty limit switches occurred during cycling in the gripper, lock, and impression stages. Also, because of vibration, screws became loose in various locations in the unit causing system interlocks to be activated. Once lock washers were added on test screws and the limit switches were repositioned, the unit proved reliable for notable periods of 1169 and 1768 cycles. A leak test using DOP smoke was conducted after completion of cycle testing. Results verified that the unit maintained a good seal with no leaks.

FUTURE TESTING PROGRAM

The intended goals of future testing will be to determine the performance of the integrated process to handle a large variety of noncombustible waste including piping, valves, gloveboxes, and discarded process equipment. The performance of each individual component will be assessed for reliability and maintainability. The following is the projected schedule for testing:

Integrated demonstration	
Building constructed	Complete
Equipment installed	Complete
Startup	10/86
Demonstration and testing	11/86-12/87

CONCLUSION

Based on tests performed on the shredder, material handling system, and bagless transfer system, the proposed process appears to be an acceptable, reliable means of processing large, noncombustible waste items. Design of the SRP Transuranic Waste Facility will incorporate this process upon successful completion of the integrated demonstration in 1987.

PRESENTATIONS, VISUALS, AND HANDOUTS

WEDNESDAY, OCTOBER 29, 1986

APPLICATION OF DESIGN CRITERIA TO LARGE PLANTS
(Continued)

AND

APPLICATION OF DESIGN CRITERIA TO STORAGE FACILITIES

DON KUDERA, EG&G INEL

SWEPP DESIGN CRITERIA

SWEPP Design Criteria

D.E. Kudera, EG&G Idaho
T.L. Clements, EG&G Idaho

EG&G Idaho, Inc.

6 3492

Facility Descriptions

The major facilities associated with the SWEPP process are:

- The Production Drum Venting System
- The SWEPP Examination Facilities
- The Certified and Segregated Waste Storage (C&S) Building

6 3483

Production Drum Venting System

A facility to remotely puncture and install filters in 30, 55, and 83 gallon drums. The purpose is to allow H_2 generated by radiolysis to escape.

Significant design features are:

- The building encloses a silo in which the filter installation is performed
- The roof of the silo is designed to raise up to 12 inches to mitigate effects of design basis explosion (drum of 30% H_2, 15% O_2)
- Building operated at negative pressure, exhausted through HEPA filters
- Conveyors and punch/filter insertion machine are remotely operated.

6 3485

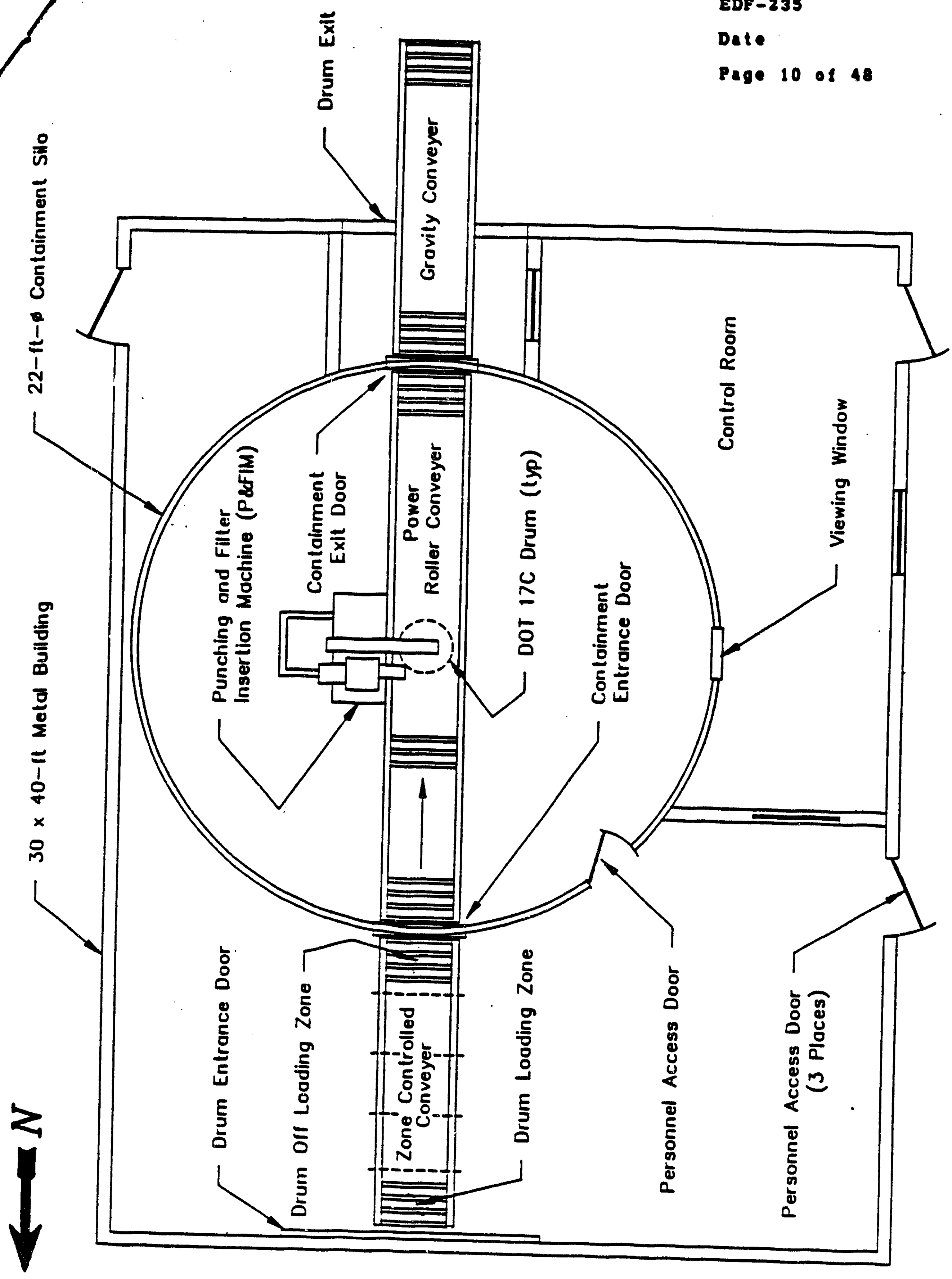


Figure 1-2. Drum Venting Building (DVB) Plan View

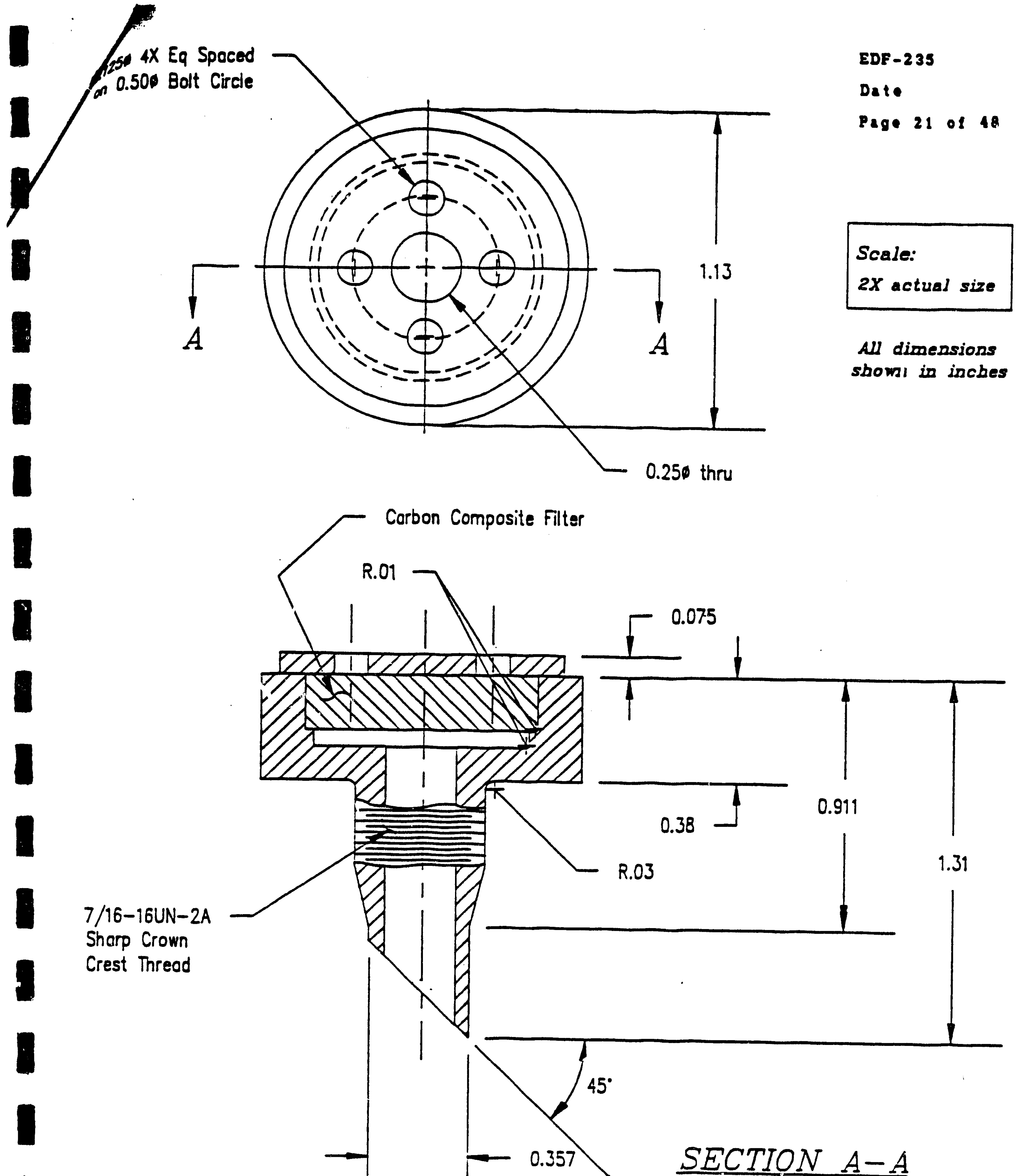


Figure 1-7. Punching and Filter Insertion Machine (P&FIM) Filter Assembly

SWEPP Examination Facility

The SWEPP Building is a 60 x 160 pre-engineered metal building and houses the examination and data recording systems. It also provides office space and rest areas.

The major pieces of equipment are:

- The real-time raidography (RTR) unit
- The neutron assay system
- The container integrity system
- The computers and data recording equipment to support these systems

6 3487

C&S Building

The C&S building is a large (150′ x 550′) air support building. Salient features are:

- Interior of building is pressurized to approximately 1-1/2 inches of water. Pressure is maintained by two fans (one running continuously). Each fan is capable of providing over 16,000 cfm
- Fabric is anchored to the concrete footing using structural channels and rubber gaskets
- Loads from fabric are transferred to cables which are anchored to the footings and pass over the top of the building
- A heater system is provided to melt snow or ice accumulations, thereby preventing building collapse.

Design Criteria

The design criteria for the SWEPP facilities can be divided into the following areas:

- Architectural, Structural, and Utility Requirements
- Safety Requirements
- Environmental Compliance
- Quality Control

6 3475

Architectural, Structural, and Utility Requirements

Common industrial standards were applied to the design and construction of buildings and structures. Some of these are:

- Uniform Building Code (UBC). Some specific criteria are:
  - Seismic zone 2
  - Wind loads up to 20 psf (equivalent to about 90 mph)
  - Snow loads up to 30 psf
  - No "design basis" tornado or volcano
- National Electric Code
- Institute of Electrical & Electronic Engineers (IEEE) Standards
  - IEEE-141 Electrical Power Distribution for Industrial Plants

6 3476

Safety

A Safety Analysis of the SWEPP facilities was performed in accordance with DOE Order 5480.1A. The analysis was performed to assess the safety aspects of SWEPP to assure that the SWEPP facility can accomplish its mission while maintaining the risk to the health and safety of operating personnel and the general public as low as reasonably achievable.

This analysis addressed industrial safety concerns as well as radiological safety.

The Operational Safety Requirements (OSR) which were developed for the SWEPP facilities assure that the safety envelope defined by the Safety Analysis will be maintained.

The OSR establish the safety limits, operating limits, surveillance requirements, and administrative controls necessary to operate SWEPP in a safe, reasonable manner.

6 3477

Environmental Compliance

An Environmental Evaluation has been performed for the SWEPP facilities. Based on this evaluation, there will be no significant release of radioactive material or effluents.

Any liquids other than radiologically clean water from eating or sanitary services will drain to an area where it is contained until it is sampled to assure it is radiologically clean. After these samples are analyzed, the liquid will be released to the Lost River drainage system.

Quality Control

A Quality Program Plan has been specifically written for the SWEPP activities. This Plan meets the requirements of:

- 10 CFR 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
- ANSI/ASME NQA-1, Quality Assurance Program for Nuclear Power Plant
- DOE-ID 5700.6 "Quality Assurance"

Basis for Design

The waste to be examined:

- Is packaged in metal drums, 4 ft x 5 ft x 6 ft metal bins, or 4 ft x 4 ft x 7 ft wooden, fiberglass reinforced polyester (FRP) coated boxes
- Is contact-handled (CH), i.e., less than 200 mR/hr on contact
- Has loose surface contamination levels less than 1000 dpm/dm^2 beta-gamma or 100 dpm/dm^2 of alpha

Radiation Safety

Personnel exposures are limited to 500 mrem/yr, and no more than 200 mrem per any week. Furthermore, ALARA principles are applied in all areas.

Direct exposure hazards are controlled by:

- Surveying waste containers to assure they have readings less than 200 mR/hr on contact
- Shielding equipment so that radiation fields, during operation, are generally less than 1 mR/hr.
- Workers wear self-reading dosimeters. TLD badges, and, is some areas, self-enunciating or digital dosimeters.
- Alpha CAMs, beta-gamma CAMs, and RAMs are required in the SWEPP Building
- Alpha and beta-gamma CAMs are required in C&S and retrieval areas

6 3491

Industrial Safety

The governing standards are established by the Occupational Safety and Health Administration (OSHA).

Additional regulations are provided by DOE Orders and Standards, the company Safety Manual, the DOE Hoisting and Rigging Manual, etc.

Industrial Safety

Major areas of concern in the area of Industrial Safety are:

- Industrial operations involving material handling
  - All equipment is load tested and inspected
  - Manual transport is administratively controlled through procedures and training
  - Floor loading, load limits, and stack heights are posted

- Electrical operations
  - Facility design and use is in accordance with national codes and standards (NEC, IEEE, NEMA, NFPA)

- Fire protection
  - SWEPP Building has:
    Wet pipe fire protection sprinkler system
    Automatic and Manual fire alarms
  - C&S Building does not have automatic fire suppression
    Three fire hose connections through building sidewall will be used.

Radiological Safety

The radiological safety aspects can be divided into:

- Radiation
- Contamination
- Criticality

The requirements for the radiological safety program are established by DOE and company Safety Manuals

Criticality Control

Containers are limited to the following fissile amounts per container

- 200 g per DOT 17C or 17H 55 gallon drum
- 0.177 g/ℓ, or 350 g total per DOE 7A wooden box
- 60 g per DOT M-III bin
- 100 g per DOT 17H 30 gallon drum

Calculations were performed, assuming these limits and an infinite array of drums, using the Monte Carlo computer code KENO.

The results of these calculations indicate that a criticality with this material is not credible.

6 3489

Contamination Control

In addition to CAMs, all containers are smear sampled to assure that loose contamination does not exceed 50 pCi/100 cm^2 of alpha or 450 pCi/100 cm^2 of beta-gamma contamination

Containers will not be deliberately opened in the SWEPP areas. In case of an accidental breach of a container, decontamination and recovery procedures (wipe down and mop up) will be performed by trained personnel.

The SWEPP facilities have been painted with epoxy based paints to aid decontamination efforts. No other decontamination facilities are included in the SWEPP facilities.

CHUCK CARGO, EG&G - IDAHO

PREPP FACILITY

NO VISUAL PRESENTATIONS

ROBERT THOMAS, UKAEA

PCM STORAGE FACILITY

UKAEA NORTHERN DIVISION STORES (Source Material for a 30 Minute Presentation)

a. <u>Dounreay PCM Store</u> (Operating since September 1980)

i. <u>Description</u>

The waste is stored in 200 l inner polythene drums, ¼ inch thick and sealed with a snap-on polythene lid containing a sintered filter plug. The polythene drum is contained in an outer galvanised steel drum (20 year design life) having a clamped lid. This outer drum has a number of 3-6 mm diameter holes to allow radiolytic gases to escape (Slide 17).

The drums are stacked axis vertical, 6 deep (limited by the strength of the bottom drum) between concrete pillars which prevent toppling (Slides 10, 11). Drum movements are effected fully remotely using TV monitoring from a control room (Slide 7) by an in-store drum handling crane. This is a 4 wheeled bridge spanning the width and travelling the length of the store, with a cross-travel crab carrying a drum grapple hoist and a TV camera hoist and lighting unit (Slide 12). All motors are electrically powered and controlled, and incorporate a hand-wind facility for maintenance. Crane coarse positioning is by means of a grid pattern on the walls for long travel and on the bridge for cross-travel. These are viewed by TV cameras. For fine positioning, the operator views a disc mounted on the top of a concrete column, again using a crane-mounted TV camera. The disc (which also carries the grid reference number) is smaller than the flat top to the column, and is mounted about an inch above it. The operator adjusts the crane position until the disc appears centralised above the column top. Interlocks and limit switches prevent crane collision with the structure, and hoist operations are prevented unless the machine is correctly aligned on a grid intersection. Auto switches prevent further lowering in slack rope conditions and cut-outs operate in the event of overload. The drum hoist has overspeed protection. In the event of a power failure, the grapple remains locked closed.

The drum is contained within guide tubes at all times to eliminate swinging, the 3 guide tubes telescoping down to connect to the tops of the

3 store columns defining each drum stack. The telescopic guide tubes are lifted and lowered by the raising and lowering of the grapple. A TV camera observes the grapple action and can also inspect the drums at any level in the stack. The drum hoist senses the weight of the drum, and this is displayed to the operator.

Crane maintenance is carried out within the store in a crane maintenance area.

The store construction (Slide 1) consists of 13½ inch double skin concrete brick walls designed to give external wallpaper dose rates of not more than 5 Sv/h. The roof is of concrete slabs. There are no windows. The inside faces of the walls are painted to minimise air ingress, as the building is operated at a depression. The floor has a granolithic finish with 3 coats of silicone-based floor hardening treatment to reduce dust formation. It is not completely impervious, but the risk of spillage is low and the store is a low occupancy zone. (Zero occupancy apart from crane maintenance etc). The store has recently been clad externally with Al sheet to prevent rainwater ingress.

Information on the contents of the drums (Pu content, weight, nature of waste) and their positions is held on a computer database. This is backed up by a disc board. A log book relates each drum back to the La Calhene consignments which fed it (Slide 2).

ii. Ventilation

The store has a once-through fresh air ventilation system (about 2 ach), induced by fans at the base of an external 17m stack. There is a single stage of HEPA filtration on the inlet and on the extract. Pu in air monitors are fitted before and after the extract filters, which trigger the main extract damper. A manual override is provided. All the filters are consigned to LLW after monitoring. The inlet air is heated to prevent condensation on the drum store walls.

iii. Hazard Assessment

Fire

The waste is double contained (polythene inner drum, steel outer drum) so that the oxygen supply is very limited. In addition there is no means of initiating combustion in the store.

Nevertheless, fire detection systems (heat and smoke detectors) are installed, together with a foam firefighting system. This latter requires a physical connection to be made outside the building and is able to fill a storage bay with foam in less than 30 minutes.

Criticality

The criticality clearance limit is set at 67g Pu/drum, based on calculations of drum base surface density which assumed optimally water-moderated Pu with the drums surrounded by foam. 67g is chosen as 2/3 of 100g, which has been shown to be safe.

Nevertheless, criticality detectors and alarms are provided. These have operated reliably, with no false alarms being generated.

Drum Rupture

The Pu is not very mobile, and the maximum possible release in the event of 4 drums of waste, each loaded to 67g Pu, being ruptured simultaneously, has been assessed as 1.3×10^{-7} Ci (assuming a HEPA filter efficiency of 99.9%). This is less than half the authorised daily discharge limit for the facility (set at 0.1% of the Derived Limit).

Flood

Flooding is assessed as very unlikely. There is no mechanism for flooding the store.

DUNCAN NIELSON, UKAEA

HARWELL STORAGE FACILITY

DRAFT - COMMERCIAL IN CONFIDENCE

US/UK EXCHANGE MEETING - DESIGN PRINCIPLES FOR TRU FACILITIES

NEW PCM WASTE STORE AT HARWELL

Synopsis

The ~~paper~~ presentation describes in principle the design, construction and proposed mode of operation of a new store for plutonium contaminated material. It is anticipated that material will have to be held in the store for a period of at least 15 years. Most of the material will be held in 200 litre mild steel drums, but provision will be made for storing larger items. The drums are to be stacked in a warehouse racking system served by a manually operated aisle crane. In this way it will be possible to inspect them in situ and by retrieval, and also to withdraw them for redrumming if necessary.

The capacity of the store will be about 2000 drums and the fissile material inventory will be about 25 kg plutonium.

The building will not be continuously manned.

Particular attention is given to safety aspects, and the principal hazards considered are:-

(i) Fire - this risk is considered to be very low, as although much of the waste is combustible, it will be contained in metal drums with no free access of air

(ii) Criticality - the maximum Pu^{239} (or fissile equivalent) content of a drum will be 100 g. All drums will have been measured by passive neutron counting before storage, and a preliminary criticality assessment indicates a very low risk.

(iii) Radiation - the γ and n radiation associated with PCM is low, and coupled with the low occupancy of the building should result in low doses to operators. There is provision to use shielding within drums in special cases, and to provide extra shielding for operators if necessary.

(iv) Contamination - a low risk, as the waste will be contained in sealed drums or packages. The store will be ventilated to cope with any leakage that may arise, particularly in accident situations.

(v) Toxicity - there will be no toxic materials handled in the building other than radioactive waste.

(vi) Mechanical hazards - these will be the general industrial hazards associated with lifting and moving equipment, such as conveyors, forklift trucks, and an aisle crane, and all operators will be adequately trained in the correct use of such equipment.

It is considered that the proposed design of the facility will enable PCM to be stored in a safe and secure manner, and this view has so far been endorsed by the relevant safety officers and committee at Harwell. The detailed design is still subject to consideration.

US-UK EXCHANGE MEETING - DESIGN PRINCIPLES FOR TRU FACILITIES

NEW PCM WASTE STORE AT HARWELL

1. INTRODUCTION

Alpha-active waste arises at Harwell from laboratory studies using plutonium or other actinide elements. The waste is predominantly soft, combustible materials, particularly plastics as these are used in bagging operations, but also includes items of equipment from glove-boxes. Such waste is segregated into two broad categories for treatment and disposal:

Low level waste, containing < 740 MBq m^{-3} (< 20 mCi m^{-3}) total α which can include < 74 MBq m^{-3} (2 mCi m^{-3}) transuranic α, which is packaged and sent to Drigg.

Intermediate level waste above this limit and averaging a few Ci m^{-3}, which has hitherto been processed for sea-disposal.

This intermediate category of α waste is known as Plutonium Contaminated Material (PCM) waste and the arisings are around 50 m^3 $year^{-1}$. In fact about 30% of the volume comes to Harwell through the National Disposal Scheme (NDS) and will generally contain other α emitters such as U, Th, Ra and Am.

Sea disposal has now ceased, at least temporarily (because of political rather than technical considerations) and it is not clear if, when, or under what conditions it may be resumed. The alternative method of disposal for this category of waste is probably to a deep land repository: but that is not likely to be available for a decade at least. Hence it is necessary for the waste to be stored at Harwell. In view of the uncertainty over the ultimate disposal route, and particularly the lack of definition of a form of waste suitable for land disposal, the UK Dept of the Environment (who have responsibility for authorising any final disposal of radioactive waste) would prefer to leave open the options on the final package form and hence that the waste should be stored in an unconsolidated state. Processing of the waste for sea disposal has involved sorting, some shredding (to comply with disposal regulations) and compaction into 200ℓ drums, which are then surrounded by a concrete jacket. More recently, the authorities have expressed preference for a "monolithic" design in which the soft waste would be shredded completely and grouted with concrete along with the hard waste. It is probable that a similar process would apply to wastes intended for land disposal, provided that it is acceptable to dispose of organic materials themselves. However, it is possible that the organics may need to be incinerated or otherwise chemically destroyed before land burial, and this is one reason for preserving the options.

Hence the current strategy at Harwell for the treatment of this intermediate level PCM waste will be to sort it, shred the soft component completely, and then to pack in drums for storage. Items too large and hard for shredding will be packed directly into storage drums.

At present such waste is being accumulated in the buffer stores intended for sea disposal wastes, but on the medium term a new store is needed, both to provide extra accommodation and to ensure conditions more suitable for the longer term storage which now seems to be inevitable.

This paper describes the proposed new store with reference to the design criteria being considered by the Exchange Meeting.

2. CUSTOMERS' REQUIREMENTS FOR STORE

2.1 Waste to be stored

It is intended that before reaching the store, the Harwell and NDS waste will have been processed through the treatment plant in the Pressurised Suit Area. In this plant the waste will be inspected for large hard items, or bottles of liquid which will be segregated. Packets of soft waste free of such items are then shredded and the shredded product placed in drums around hard items. (Any liquids are removed from the processing train and dealt with separately).

Hence the material to be contained is essentially dry inert solids, contained in 200ℓ drums (since that is a convenient size for handling). The arisings of shredded waste from the processing area are predicted to be some 35 m^3 $year^{-1}$, as compared with the 50 m^3 $year^{-1}$ of raw waste, since there is some volume reduction on shredding and repacking. In addition there may be some 5 m^3 $year^{-1}$ of items too large for drumming, such as glove-boxes. Because this store will be the best area available for PCM storage, it is also envisaged that raw PCM arisings may be held there on an interim basis for up to a year, in the event of delays in processing through the PSA. (This waste normally arises in 50 or 100ℓ drums from the consigners, and would be over-drummed in 200ℓ drums).

The fissile material content is expected to be less than an average 15 g Pu/drum [18.5 GBq (~ 0.5 Ci α)] on the basis of previous arisings and the associated radiation to be < 100 μSv hr^{-1} (10 mRem h^{-1}) at the drum surface. The radiation category of waste of course has to be compatible with unshielded transport since this is the route by which the waste reaches B462.

The store will be limited on criticality grounds (see later) to drum contents of 100 g Pu per drum, but given the expected average, very few drums should actually reach this level. Where an 'average' drum is needed for safety calculations, it will be assumed to contain 20 g Pu or the equivalent in fissile or contamination hazard.

The larger packages would typically comprise glove boxes, with a maximum declared loading of 100 g Pu, double-wrapped and sealed in PVC sheet (or possibly crated items).

The assumed lifetime of drums in the store is up to 15 years. This figure is chosen as one which should be relatively easy to attain, and also because within that timescale it is likely that an immobilisation method will be agreed so that it will be possible to withdraw the older drums and process them ready for final disposal. (In this state they may be rather more bulky but will also require a less sophisticated store because the final package is designed to retain activity over hundreds of years).

The store is required to receive at least 10 years arisings of waste, so that with a margin for unexpected arisings it is being designed to receive 2000 × 200ℓ nominal drums and 50 m^3 of larger waste in packages.

Thus, overall the store should accommodate 2000 × 200ℓ drums, plus 50 m^3 of larger waste.

2.2 Radioactive Inventory

The store will contain up to 25 kg Pu (considered as high burn-up Pu) or the equivalent fissile value of U. In addition to that Pu and accompanying or ingrowing activity, it may also contain up to TBq (Ci) Am, up to TBq (Ci) of Ra, and TBq (Ci) of other α emitters (e.g. Th, Po).

3. GENERAL DESIGN CRITERIA

This section outlines the general principles adopted, whose implementation is described in some more detail later in the paper.

At an early stage a view was taken that it would not be feasible to guarantee (e.g. to a safety committee) the integrity of a drum and of its seal for the required lifetime, partly because of lack of direct experience of the exact storage conditions over a long period of time. Thus it was decided to design the store so as to be able to detect the whereabouts of any drum that leaked and to allow rapid retrieval of each drum individually, either for routine inspection, or for repacking if necessary. On the same principle, drums were to be stacked in such a way as to maximise the possibility for in situ inspection. Hence the first objective was:

(i) To store plutonium contaminated material (PCM) and other α-active waste, mostly contained in 200 litre drums, for at least 15 years, in a safe and retrievable manner and readily available for inspection.

The other objectives relate to the limitation of external radiation doses and of ingested activity, viz:

(ii) To keep radiation doses to building operators and others as low as reasonably practicable, and always below statutory limits.

(iii) To ensure that appreciable release of radioactivity can occur only as the result of an accident and the consequences of such a release will be environmentally acceptable.

In quantitative terms objective (ii) was defined as:

> The design dose-rate at the exterior surface of the building and in the change and control rooms will be < 5 μSv hr^{-1} (0.5 mRem h^{-1}). This will include allowance for the effect of any (small) neutron flux coming from the building.

There is predicted to be no significant **routine** discharge of radioactive effluent from the building (see below) and the implementation of objective (iii) depends on ensuring that state of affairs, and also on assessing the size and probability of any release which might occur under conceivable accident conditions. The data for such accidents is compared with a standard graph (the "Farmer" curve, adjusted for the conditions of this plant) which defines the maximum acceptable release as a function of predicted frequency of such a release. The detail of this is considered below in section 7.

The more detailed application of principles presupposes an understanding of the proposed design and is dealt with in section 6.

4. DESCRIPTION OF FACILITY

4.1 Construction

This building as designed is a reinforced concrete framed structure, with a shallow pitch concrete roof. Walls are clad externally with cavity brick/block walling and walls and the roof shall be insulated. The approximate dimensions are 46 m long, 19 m wide, and 10 m high, giving a storage capacity of some 2000 drums and about 50 m^3 of larger objects which cannot easily be reduced in size for storage in drums. The design will provide for future extension should this become necessary.

The store will be constructed to provide a minimum of 1 hour's fire resistance to the external envelope, and the best standard of containment achievable by conventional building practice. To this end penetrations of the outer fabric for services, airlocks and emergency exits are kept to a minimum. There are no windows or rooflights.

4.2 Layout

The store will be divided into two areas - storage and service. The storage area will be a Controlled Area and personnel access will be over a shoe barrier via the Service Area: the Service Area is accessible from outside via a personnel or vehicle airlock.

The main part of the store consists of a drum storage area, sub-divided by longitudinal walls into six bays to provide for ventilation monitoring, fire detection and fire fighting. The drums will be stored in this area singly on metal pallets using a warehouse racking system fastened to the support walls. Each rack will hold a single row of drums and there will be five racks in vertical array. An **aisle crane** will be used to place drums in the racks. The service areas are grouped at one end of the building and consist of a vehicle airlock, change room, office, plant room, and a storage area for large items of waste. Figures 1 and 2 show the proposed layout. The floor will be coated with a hard-wearing impervious finish, probably epoxy resin, and walls and ceilings will be sealed, probably with gloss paint, to resist contamination.

4.3 Ventilation

The store atmosphere is to be extracted by a single fan, and drawn through a HEPA filter system before discharge to atmosphere. The capacity of the fan permits one air change per hour within the storage areas and five changes per hour in the change room. Inlet air is drawn into the building through coarse filters and steam heated to ~ 15°C before passing into the store. This will maintain the store temperature above dewpoint and prevent condensation corrosion of the storage drums.

Ventilation air will leave the storage area by roof-mounted longitudinal ducts running down the centre of each storage bay. Separate ducts provide extract for the service area.

It is intended to maintain a depression within the building under normal operating conditions. However, the hazard assessment will show that with no depression, the building containment will be adequate to prevent a site hazard release in the event of a primary containment failure, e.g. drum rupture. The vehicle and personnel airlocks will be designed to maintain the depression when entries are made into the building.

4.4 Instrumentation

Alpha-in-air samplers are to be fitted to the extract ducts to detect airborne activity, and a trolley mounted alpha-in-air monitor will be provided in the vicinity of the vehicle airlock and in the cab of the aisle crane. Operators working within the building will be supplied with personal air monitors.

The change-room will be provided with a hand and clothing monitor for personal monitoring, and the vehicle air lock will be supplied with instruments for monitoring vehicles.

Smoke detectors will be fitted to the extract ducts to give warning of combustion within the building. There will be a separate detector for each bay, and pipes will be installed to allow fire-fighting foam to be supplied to any particular bay from outside the building. A sump will be provided in each bay to collect condensed foam.

A display panel will be supplied in the control room which will indicate the condition of the alpha-in-air monitors, smoke detectors and ventilation system. An indication of an alarm condition on the display panel, will be led to the central emergency station for the site, which is manned 24 hours a day.

Emergency lighting will be provided in the building.

4.5 Change room

The change room is provided with washing, shower, and sanitation facilities. Change room drains will feed to the active delay tanks in the B462 complex. Two sets of self-air breathing apparatus will be provided in case full suit entry is required into the storage areas, and operating staff will be trained in their use.

4.6 Waste Packaging

Shredded PCM and small objects which cannot be shredded will be placed in large reinforced polythene sacks, closed by a twist tie, contained in 200 litre epoxy resin coated mild steel drums. The drums will have a full aperture lid fitted with a rubber seal and fastened by a ring clamp.

Large items, such as glove-boxes, large filters and pieces of equipment, will be double wrapped and sealed in PVC or polythene sheet. It is envisaged that possible loose contamination on such items will be immobilised using a fixative.

It is foreseen that it may be necessary occasionally to store untreated waste in the as-received condition in the store on a short term basis, perhaps because of operational difficulties in the sorting and shredding areas. Arisings on site are liable to be contained in either 50, 100, or 200 litre drums, and the smaller drums would be overpacked in 200 litre drums in order to provide a standard unit for the palleting and storage rack system. It is not intended that interim storage of such material would be for a period longer than one year, i.e. in accord with previous practice.

5. OPERATION OF FACILITY

The main function of the facility is the long term storage of PCM pending provision of a final disposal route. The route favoured at present involves immobilising the waste by grouting with cement before disposal, and to this end all soft waste will be shredded and drummed before long term storage.

5.1 Drummed waste

The waste will be sorted, shredded, and drummed in a pressurised suit area and before despatch to the store the drums will be monitored for radiation and contamination. A check on the fissile material content will be carried out by passive neutron counting, combined with segmented gamma scanning. Each drum will be given an identity number, and this, together with details of the contents, will be clearly stencilled on the side of the drum. In addition, the identity number will be stamped on a brass tag which will be securely wired to the clamping bolt. All details will be recorded in the Records Office before despatch. The normal operation of the pressurised suit areas will involve campaigns of waste sorting and shredding, and this will result in a batch of perhaps ten to twenty drums being prepared for storage. However, upon occasions it may be necessary to transfer single drums to the store. Under routine operating conditions it is envisaged that a squad of four men will work in the store for one half-day per week.

Drums will be transported to the store on a trailer or by forklift truck and will be mounted on their individual pallets before transfer. The vehicle will be taken into the vehicle airlock where the outer door will be closed before the inner door is opened. It is intended to provide interlocks to ensure that both doors cannot be open at the same time, and working instructions will emphasise this.

Emplacement in the store racking system will be by a manually driven aisle crane, capacity 600 kg. The crane will travel on a floor mounted rail running longitudinally down each storage bay, and transfer of the crane from one bay to another will be by a transfer car which also operates on a fixed rail running transversely across the ends of the bays.

It is intended to fill one bay before moving to another, but operational requirements may entail segregation of drums which will preclude this.

Once the transit vehicle is through the airlock each drum on its pallet will be off-loaded, by means of an electrical forklift truck, to a transfer station which will present the drum for pick-up by the aisle crane. The crane will then place the drum in a pre-designated position. Although the crane will be manually controlled to a given storage position, final emplacement will be governed by limit switches so that correct alignment is achieved and the possibility of operator error reduced.

During crane operations another worker will man the control room and keep in audio contact with the crane driver.

Because of the relatively modest levels of activity expected, it is planned as above to operate a manned store in the first instance. However, the aisle crane is capable of conversion if required to remote operation using a combination of direct viewing from the control room and closed circuit television. This conversion will be carried out if the early experience with the store indicates it would be appropriate.

5.2 Undrummed Waste

The packages will be inspected for integrity, assessed for fissile material content, and monitored for external contamination before transfer to the store. The transfer trailer will be taken through the building vehicle airlock and into the area allocated for undrummed items, where the items will be unloaded and stored, probably in a rack system.

5.3 Record keeping

All details of the drum location, contents, radiation and so on, will be logged in the control room, probably on a computer, but also some visual display, such as discs on a peg board, is being considered. A comprehensive record of all fissile material entered into the store is considered particularly important, both from the viewpoint of criticality control and also fissile material accounting. Detailed records of personal radiation doses received by the workforce are maintained as a routine practice.

5.4 Criticality control

Controls are subject to consideration by the Harwell Criticality Committee, which has still to give a judgement for this case. A preliminary assessment shows little risk of a critical configuration occurring within the store under any circumstances and it is not proposed to install a Criticality Incident Detection and Alarm system (partly because of the disruption produced by false alarms). Nevertheless, strict managerial control will be exercised over the emplacement and location of fissile material within the building.

5.5 Inspection of stored items

Although all items put into the store (drums and packages) will be subjected to a visual inspection and a swab check for contamination before emplacement, it is intended to carry out an annual inspection of a few per cent of the stored items to monitor for deterioration of packaging. Such items will be brought to an inspection area situated in front of the storage bays and examined for package deterioration and escape of contamination. Remedial action up to full repackaging will be taken if required. An in-situ visual inspection of stored items will be made on a routine basis.

6. IMPLEMENTATION OF SAFETY PRINCIPLES

6.1 Radiation

Existing experience leads us to expect a dose at the surface of a drum of $<$ 100 μSv (10 mRem) h^{-1}) due to (low energy) gamma emissions accompanying the decay of Pu and Am. An initial estimate of this would produce $<$ 50 μSv (5 mRem) h^{-1} in the aisles. To this must be added the equivalent dose from neutron emission (direct plus α,n reactions); which is predicted to give a dose equivalent of $<$ 30 μSv (3 mRem) h^{-1} in the storage area.

The initial level of radiation, including equivalent for neutrons, to an exposed operator in the aisle of the drum stack, is thus predicted at $<$ 80 μSv (8 mRem) h^{-1} which is compatible with normal operational controls (limited time of the operation ~ 4 h per week; rotation of staff duties) to restrict routine annual doses to operators to less than 15 mSv (1.5 Rem). Drums containing higher activity α-waste (e.g. Am sources) will be fitted with internal shielding as necessary.

Both neutron and gamma fluxes will increase during the store life of drums due to ingrowth of ^{241}Am. The extent of increase is strongly dependent on the age of the Pu (after reprocessing), which is not known in advance, but will be approximately determined by assay. [It is of course also dependent on the original Pu composition, but that is standardised at ~ 20% ^{241}Pu]. Assuming the Pu is at least 3 years old before receipt at the store, the doses over a 12 year store life would increase ×3 for γ emission and ×1.2 for neutron flux. Dose levels of γ will be monitored regularly with portable instruments. The neutron emission levels will be checked directly by passive neutron counter before the waste enters the store. Given the low energy of the γ emission (0.06 MeV and below) it is considered that doses to operators can be held at an acceptable level thereafter by the use of local shielding either of the most active drums or of the operating cab of the crane, where this is indicated as necessary by Health Physics measurements.

The construction of the building will ensure that external dose rates are limited to < 5 μSv (0.5 mRem) h^{-1}. The extent of any neutron emission is to be considered further.

6.2 Contamination

6.2.1 Surface contamination

All items entering the store will be swabbed and monitored to ensure surfaces are clean to regulatory levels (< 0.4 α Bq/cm^2).

6.2.2 Containment

The primary containment of the shredded waste is the drum, inside which the waste is enclosed in a heavy gauge polythene bag. The lid of the drum is closed using a full aperture clamping ring and the joint is then taped.

Drums have been stored in this manner for a number of years at AERE and other sites and no airborne contamination emanating from the drums has been evident. Routine inspection of drums will ensure that the integrity of the containment is maintained.

The store atmosphere will be maintained at a temperature above dew point to prevent condensation leading to external corrosion of the drums. Internal corrosion has not been shown to cause rapid degradation of drums. Inspection should identify corrosion problems before failure occurs. Drums will be internally and externally coated with epoxy resin.

Items in the store room will be double wrapped and are not expected to cause any contamination risk.

The building is designed as a good containment building. The containment will be penetrated for airlocks, service connections and emergency exits only. There should be negligible airborne contamination present under normal running conditions.

Respiratory protection will be available in the building for emergency use and also in the crane cab.

6.3 Ventilation

Air change rates of 1 per hour in the store volume and 5 per hour in the change room will be provided. The installed ventilation plant will consist of single fans and motors on the plenum input and extract, and a single bank of safe change HEPA filters.

No automatic change-over to duplicate components will be provided as the plant is not required to control discharges under normal working conditions. In the event of plant failure, store operations will be stopped until faults are rectified.

The ventilation plant will serve the following purposes:-

(i) filter out contamination if present;

(ii) reduce radon/thoron daughter product levels within the building such that reasonable alarm levels can be set for α-in-air monitors;

(iii) to circulate air in the store volume and aid heat distribution.

(iv) to remove the small amounts of H_2 caused by radiolysis of PCM.

The air flow pattern will be from clean to potentially less clean areas. Air will be extracted from the individual bays. The ducts will come together after the filters and the air will be exhausted at roof height. Analysis has shown no benefit in providing a stack of reasonable height in terms of radiological protection [6].

6.4 Monitors

Alpha-in-air samplers will be placed in the filter room which will sample air from the manifold. By installing samplers in the filter room, daily filter paper changing will not necessitate entry to storage area.

BNFL info

The DAC for Am and Pu is 8×10^{-2} Bq m^{-3} [4]. Experience in an unventilated store indicated average levels of contamination (after correction for radon) of 4×10^{-3} Bq (0.11 pCi) m^{-3} for drum contents averaging 86 Pu g/drum. This indicates both a considerable factor of safety in this case, and the sensitivity which can be achieved in air measurements.

If radium is stored, the concentration of radon will be limited inter alia by the ventilation provisions, but will be the subject of futher consideration.

The storage area will be divided into bays and these can be individually monitored. In the case of a fire or leak of contamination some indication of the locality of the release should be given.

Portable instruments and personnel air samplers will be worn by operators when working in the store and monitors will be placed in the change room and vehicle airlocks for personnel and vehicle monitoring before leaving building.

Smoke detectors may be of ionisation chamber type, as beam type detectors may be affected by motion of crane.

Detectors may also be placed in filter room, although analysis of the reliability of the sampling method has to be made before it is decided if this is sensible. Alternatively, detectors could be placed among the racks and be removed for servicing.

6.5 Decontamination

Work of this nature will require the use of respirators or pressurised suits, which may be the 'self-air' variety due to the dimensions of the store.

The surface finishes and building internal structure are designed to aid decontamination.

6.6 Criticality

6.6.1 Administration

Each drum will be assayed to determine its loading and Pu composition, before entering the building. Records of the drum content and storage allocation will be kept in the store control room and a duplicate set will be held elsewhere.

Each drum will be clearly marked for identification.

6.6.2 Criticality Control

Criticality incidents will be obviated by ensuring that drum loadings are less than 100 g Pu^{239} or equivalent fissile material.

An initial assessment of the storage array has shown that criticality incidents will not be feasible under any accident conditions. For this reason a criticality detection system will not be installed.

(The small store room has not yet been assessed.)

6.7 Fire and Explosion

6.7.1 Fire containment

The building is designed to withstand a one-hour fire.

The site senior fire officer has approved the building design in its present form.

6.7.2 Fire risk

The building and all installed equipment will incorporate reasonably practicable measures to prevent both a risk of ignition and an outbreak of fire occurring.

For raw PCM arisings, waste consignors are governed by site regulations. Local dispatch forms must indicate the presence or absence of waste presenting a special hazard. On this basis a decision can be made on the routing of waste. No potentially explosive materials will be held in the store. Combustible materials will be present inside the drums but with no free access of air. Small quantities of flammable gases will be generated by radiolysis but these will be insufficient to reach the limits of flammability (section 7.2.3).

During normal running conditions the only conceivable sources of ignition are the lighting installations and the electrical equipment associated with the crane and ventilation plant.

The installation will incorporate an isolating switch so that electrical supplies to the storage area can be isolated when no staff are in the store. The electrical installations will be designed to conform to IEE regulations and best standards in trade. As such, they will not present a significant ignition or fire risk.

6.7.3 Fire development

Fire development is determined by the availability and ignitability of combustible materials in the facility.

In the store, all PCM will be contained in drums or wrapped in PVC and held in the store room. The PVC wrappings and glove boxes will present a small fire load but there will be no source of ignition in this room except for lighting units and the electric forklift vehicle. Unexpected sources of ignition are allowed for in the Hazard Analysis.

Sources of ignition during maintenance, repairs, etc are still to be examined.

BNFL Drum fire tests carried out by BNF plc have shown that fires are not easily sustained in drums and that no pressurisation in surrounding drums is detectable.

It is assumed that there is a low probability of fire **development** occurring because of the inhibited scope for propagation and because the early presence of smoke will cause an early response from smoke detectors.

6.7.4 Fire Detection

Smoke detectors of ionisation chamber type may be used in the drum storage area as crane operation could interfere with beam type detectors.

A suitable number of detectors may be installed at appropriate positions throughout the building to ensure a high reliability of detection.

An automatic alarm system will be installed together with manually-operated alarms.

6.7.5 Fire fighting

Automatic fire fighting systems will not be installed as false alarms would result in extensive cleaning up operations.

Due to the low risk of outbreak and spread of fire, the site senior fire officer believes that all fires can be extinguished with hand held appliances. However, pipes for carrying water or foam may be installed in the drum storage area if necessary.

6.8 General Industrial Hazards

6.8.1 Building Standards

All work is designed in accordance with the Building Regulations 1976 and codes of practice therein.

6.8.2 Safety in Active Areas

The general safety of equipment within the store will be reviewed as part of the Authority To Operate. The provisions of appropriate safety codes and regulations will be observed.

6.8.3 Aisle Crane

Design standards for the installed handling equipment are set by: British Standards for passenger lifts and overhead travelling cranes; European FEM codes for high bay warehouse equipment.

Salient design safety features are:

(i) Safety gates enclose each aisle. They are interlocked with main power supply. Overrides are available for maintenance purposes.

(ii) Slowdown and ultimate limit switches control motion at the end of horizontal and vertical travel.

(iii) The hydraulic fork motion is interlocked to allow movement only when crane is stationary.

Position checking devices ensure correct alignment of pallet before delivery to crane and rack location.

(In automatic mode, vacancy of location is checked).

Torque limiters and cut-outs prevent fork movement if travel is obstructed.

(iv) A ladder or safety harness, allowing controlled descent from the cab, is installed for operator escape.

6.9 Loss of electrical supplies

In the event of a failure of the electrical supply, there is adequate storage capacity in electrical batteries to operate emergency lighting and safety instrumentation for up to 48 hours - considerably in excess of the length of any failure so far experienced. The aisle crane is equipped to "fail safe" and to allow the escape of an operator, irrespective of where the crane is placed at the time of failure. No standby power is provided for the ventilating fan because the store is considered to be safe under normal conditions without ventilation, provided no operations (which might give rise to accidental releases) are carried out until the power is restored. Steps to be taken in the event of power failure will be fully described in the operating instructions.

6.10 Accidental Releases

The possibilities of activity release due to an accident viz, fire, explosion or impact, have been considered in some detail (see Appendix 1) and the results are shown in Figure   which relates the probability of various accidents to the consequence in terms of equivalent Pu release.

[If 6.10 or equivalent is inserted, section 7 will become Appendix 1.]

7. OUTLINE HAZARD ANALYSIS

7.1 Introduction

The main possible hazards of the store are those due to its fissile and radioactive content: these in turn are largely associated with possible accidents due to fire or impact of the items stored due e.g. to a fall. Routine discharges were considered in the previous section.

7.2 Fire

7.2.1 Large Packages

The possibility of a fire in a store containing large packages such as dry boxes has previously been considered in relation to an earlier storage area. It might be initiated due to an electrical fault or malfunction of a vehicle, but that was considered to be remote. It was further concluded that even if a fire were initiated locally, its propagation would be restricted. That is, a building fire is highly unlikely because the only combustible materials in the store are inside packages or drums, whereas the most probable source of fire is installed electrical equipment which is remote from the packages.

7.2.2 Drums

The possibility of a fire starting in a drum has been considered. A fire could commence only given a source of ignition and a source of oxygen or oxidising matter in the waste. Since the combustible part of the drummed waste comes in the first place from working areas which have to avoid fires and since most of it will already have been processed by shredding, there is considered to be a very low probability of a drum spontaneously igniting and continuing to burn. Existing experience (of no such fires) would support a probability of the order $< 3 \times 10^{-5}$/drum for unprocessed drums with a further factor of 10^{-1} for processing (which is particularly likely to destroy possible sources of ignition). For ~ 200 new drums/year of processed waste this gives an average frequency of $< 6 \times 10^{-4}$ year^{-1} for a fire starting in a drum. Tests at BNF plc [3] have shown that even if a fire is deliberately started (with a blowtorch) and deliberately maintained (by allowing a through flow of air) in one drum in a stack, the fire does not spread, although material in adjacent drums is affected by the heat. For unprocessed drums the frequency limit is higher, viz. $< 6 \times 10^{-3}$ year^{-1}, but the consequences can be reduced by over-drumming.

7.2.3 Radiolysis gas

BNF Hemingway [2], in experiments which are still continuing, has measured a G value of ~ 0.7 mols H_2/100 eV energy for "new" waste, falling to about 0.4 after 100 days. (The fall is attributed to the limited range of α damage appreciably depleting the available hydrogen near each particle of PuO_2). Over longer times the value drops to 0.2. Taking a value of 0.4 to represent the early life of the waste gives a hydrogen production rate of 2.4 mls/Ci day. At that rate is would take some 34 days for the hydrogen concentration in the drum to reach the lower limit of flammability for the "worst case" drum containing some 10 Ci. Given the high diffusion rate of hydrogen, there is considered to be no chance of retaining it in the drum over this period of time (nor indeed is there any apparent reason why it should ignite if it were retained - c.f. flammable concentrations of petrol in a car petrol tank). Once the hydrogen has leaked into the store space it will be removed by the ventilation flow (or by natural turbulence and diffusion in the absence of ventilation) at a rate which ensures a very low concentration.

(Note: this flow of gas from drums is $\ll$ the flow induced by natural temperature changes in an unheated store. There is thus no concern that it may carry off harmful quantities of very fine particulates, since that is not observed in existing (unheated) stores.)

7.3 Impact and General

The nature of the handling operations is such as to pose limited and acceptable possibilities of harm to the operators from, e.g. falling loads. The work-force involved has extensive experience of handling drums and larger items. The implications for radioactive release of possible accidents are considered under section 7.6. A similar position obtains in the case of fire; where the physical risk to operators appears very small.

7.4 Deterioration of primary containment

During the store life it is possible that the drum seals will deteriorate due to radiolysis, and the drums themselves may corrode. The principle of the storage method is that such deterioration will be detected and rectified as necessary by repacking waste from faulty drums. (Similar drums in store at BNF plc have not shown appreciable activity release over 6 years or longer). However, the detection process may take some time. Assuming pessimistically that a level as high as 1 DAC went undetected for a month, it would result in the deposition of some 4.6×10^5 Bq (~ 12 µCi) Pu on the filters.

7.5 Release of contamination accompanying an accident

7.5.1 Fire

In the event of a drum fire, the release from a single (processed) drum is taken to be 10^{-4} of the Pu involved. This allows for the containment by the drum. Hence for the average design drum load of 10 g Pu, and from section 7.2.2, the frequency is $< 6 \times 10^{-4}$ year^{-1} for a release of 1 mg Pu. If the fire continued long enough to affect other drums severely enough to allow release from them, more Pu could arrive in the store space, but there is a reduced probability, because a longer fire involves failure of the fire-fighting arrangements. The BNF plc analysis (based on their fire experiments) shows that the worst combination of frequency and quantity released occurs for a single drum. This combination lies well below the acceptable "Farmer" curve on the frequency consequence diagram (i.e. by a factor of 16) without allowing for filtration or building containment.

For unprocessed waste the frequency limit for a fire is higher at $< 6 \times 10^{-3}$ year^{-1} but the release would be less by an average factor of 5, say, because of the smaller volume of waste and the secondary drum.

By comparison with the above, it follows that even very pessimistic assumptions about the possibility of fire in the box store (where sources of ignition are even less likely since we are not dealing with a mixed waste) should not give rise to an unacceptable combination of frequency and external release.

Considering contamination within the store, the release by a fire will generally be carried upwards by heat towards the ventilators, thus restricting the concentration at the floor.

If a relatively violent fire started, or if it were near to the operator, he would receive direct warning (noise, light) and would immediately take protective measures. On the other hand, if the fire were slow (smouldering) and/or remote from an operator, it is expected that the release would be correspondingly slow (BNF indicate that 10^{-4} release as above takes about 30 minutes and that is from a relatively rapid fire) and would be detected by the smoke or α-in-air monitors before an acutely dangerous concentration had penetrated through the body of the store.

7.5.2 Mechanical damage to drum

Earlier safety cases have assumed 1 in 50,000 movements of a forklift truck could result in an accident. Assume this rose to 1 in 10,000 with other handling equipment. Expected drum handling at an input of 200 per year, say 500 per year, to allow for inspections, replacings, etc.

Frequency of a drum being dropped = $500 \times 10^{-4} = 5 \times 10^{-2}$ p.a.

Probability of lid coming off to release contents = 0.1. The internal bag will give some (incomplete) resistance to further release. Assume that in 10% of cases the bag would burst open completely, to release all contents, but in the other 90% it would retain them, but allow a puff of aerosol to escape equal to 10% of that from the complete burst. The first case is clearly the worst, it gives:

overall probability {complete release of contents}

$$= 5 \times 10^{-2} \times 0.1 \times 0.1$$
$$= 5 \times 10^{-4} \text{ p.a.}$$

Release to suspension in air of α contents (in suspension after impact) = 10^{-5} say, allowing for some bouncing before opening. (Reference 5, p27, suggests a release of 10^{-6} from a dropped drum). This is for the average drum at 10 g loading. Hence release = 10^{-4} g Pu.

If we assume that the DF through a HEPA filter is only 1000, this would lead to an external release of 10^{-7} g Pu, at a probability of 5×10^{-4} p.a. (plus 10^{-8} g Pu at 45×10^{-4} p.a.) which is well within acceptable limits.

To estimate the danger to a worker in the store, data is available on the activity levels in air produced during processing by shredding of this waste (clearly an operation which would disperse activity much more effectively). The maximum levels measured in the containment around the shredder were 5×10^4 Bq m^{-3} (1.4×10^{-6} Ci m^{-3}). Assume that dispersion due to mechanical damage gave instantaneously as much as 10% of this level, viz. 5×10^3 Bq m^{-3} locally within the store. Assuming the operator could leave the area, or don a respirator in 15 seconds following the mechanical impact, he would have received 0.26 of one ALI. This is considered to be acceptable for the frequency quoted.

7.5.3 Mechanical damage to large package

The frequency of this was previously estimated on the basis of existing statistics at < 5×10^{-3} per box (< 5×10^{-2} p.a. for 10 boxes) but with a larger factor of release at 10^{-4} of the material in the box. This would give rise to a maximum external release of 2.5×10^{-6} g Pu, again assuming a filter DF of 1000. The maximum concentrations generated inside the store are within the same limits as discussed in the section above and are still regarded as acceptable. However, in view of the relatively high probability (once in 20 years) which is all that existing statistics can sustain, consideration will be given to means for fixing the activity in these boxes to further reduce the likely consequences of an accident.

7.6 Damage to filters

In the very unlikely event of fire or explosion in the store causing damage to filters and release of the contained burden, it is estimated along the lines of 7.5 that the release of Pu could amount to $\sim 2 \times 10^{-4}$ g.

The outline analysis shows that the system is likely to be satisfactory on a frequency/consequence basis, even in the absence of filtration. In practice, some filtration would be available except in the case of fan breakdown which is predicted to be $< 1\%$ of time. During that time, or during filter changes, no operations would be carried out; hence the probability of accidents would be further reduced.

7.7 Catastrophic Accidents

An aircraft crash, at an assumed probability of 1.2×10^{-7} p.a. (ref. SRD R8), with associated fire, would cause release of a fraction of the total inventory of up to 1.4×10^{8} MBq (3700 Ci) α activity. To keep this within the frequency/consequence boundaries recommended for high burn-up Pu within the B462 area, it is necessary to assume a release factor of no more than about 2.5×10^{-3}.

7.8 Seismic Disturbances

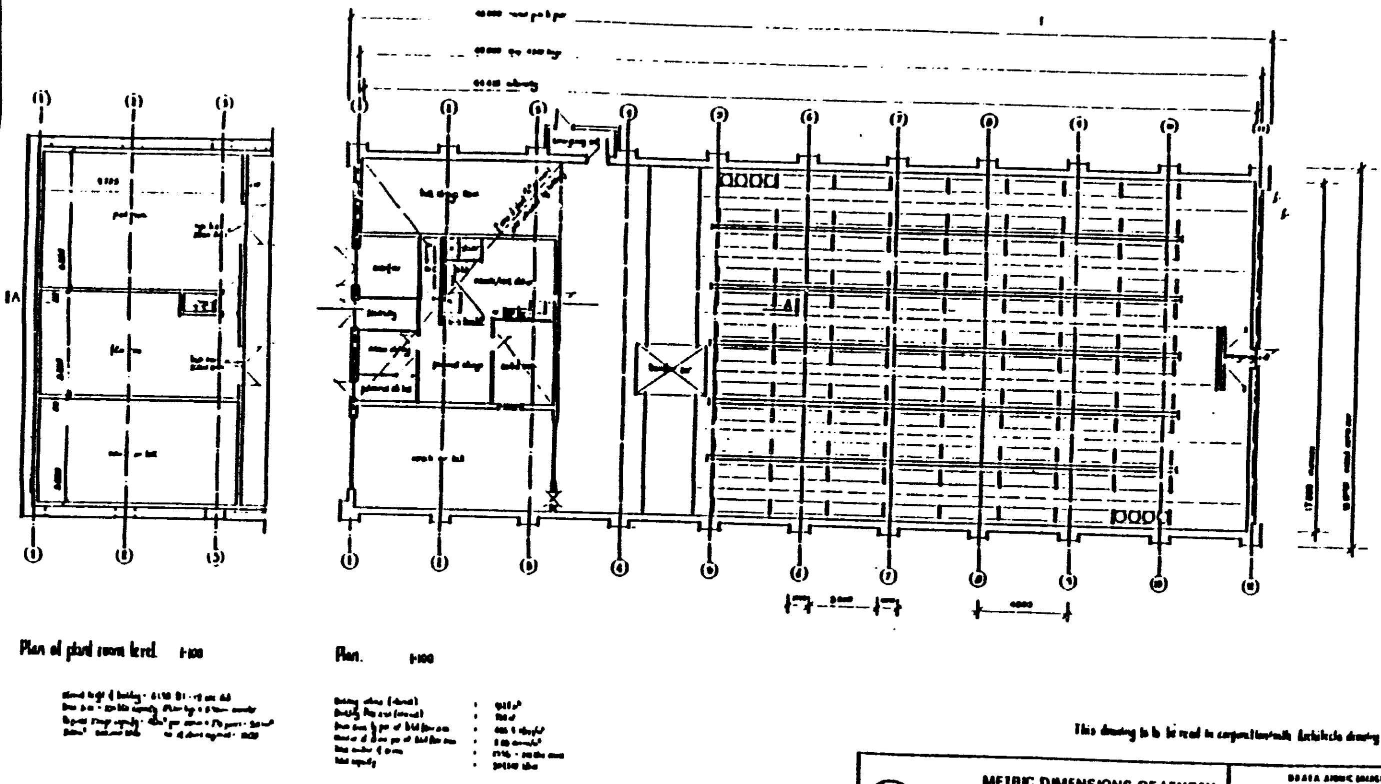
7.9 Frequency Consequence Diagram

Figure 4 shows the diagram and the limiting line for B462, as previously used, with points plotted for fire or rupture of primary containment. In the case of fire, it is assumed that the ventilation system is switched off but the building retains 90% of the primary release.

[MAIN POINTS TO CLEAR ARE:

(1) References to BNF fire tests and other experience.

(2) What can/shall be said about seismic disturbances.]



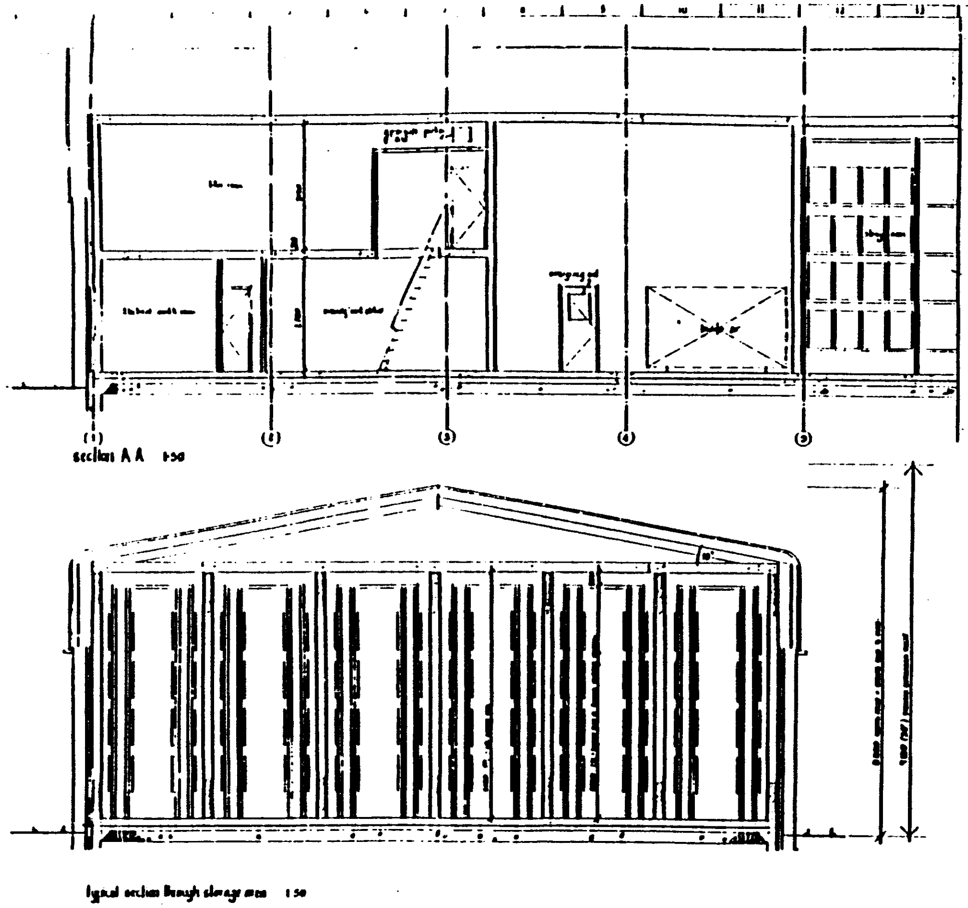
This drawing is to be read in conjunction with Architects drawing no. NW/A/462 23/15.

METRIC DIMENSIONS OF LENGTH
where no symbols are given
whole numbers are millimetres
decimalised expressions are metres

Building 462 E5 - Proposed PCM Store.
Scheme drawing - scheme 5.
Plan layout

NW/A/462 23/14

FIGURE 2



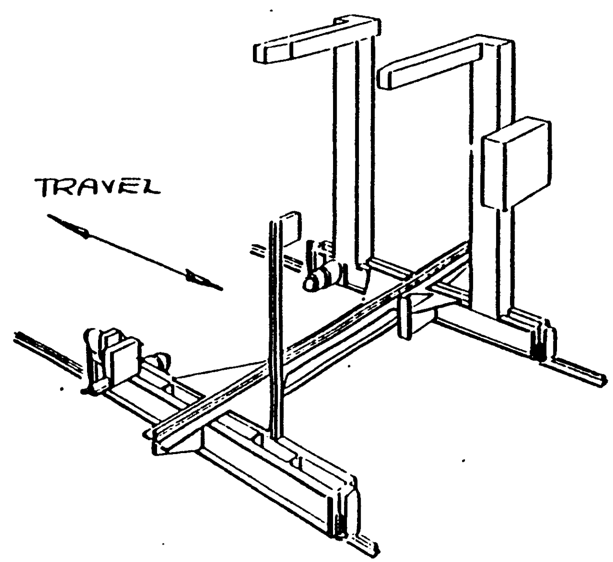
This drawing to be read in conjunction with Architects drawing no. NRI/A/462 23/14

METRIC DIMENSIONS OF LENGTH
where no symbols are given
whole numbers are millimetres
decimalised expressions are metres

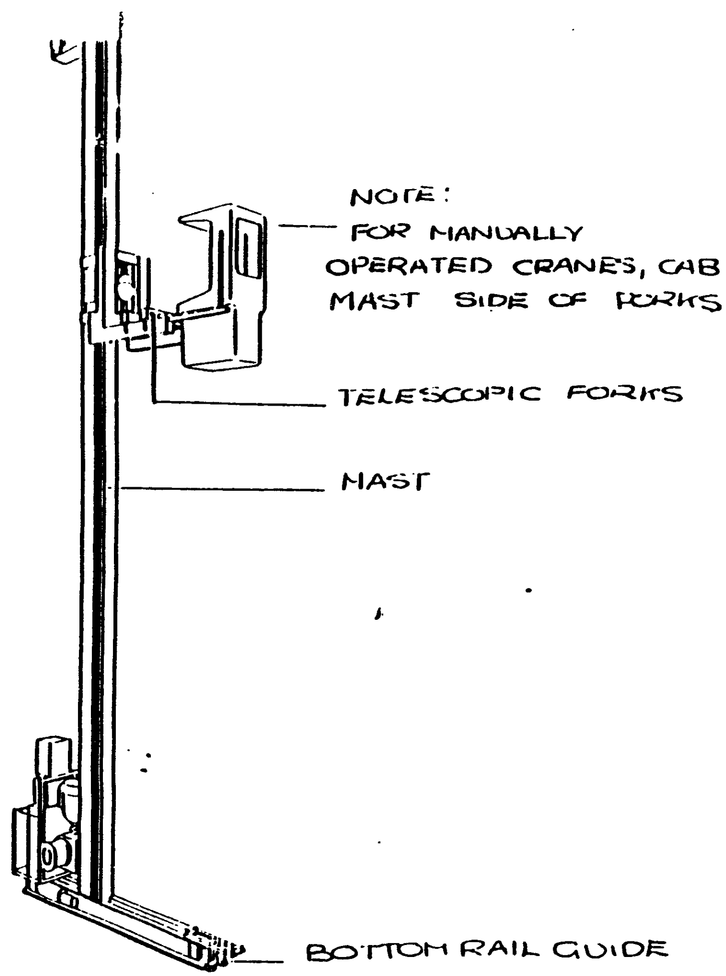
Building 462 E5 - Proposed PCM store
scheme drawing - scheme 5
typical sections

NRI/A/462 23/15

FIGURE 3



TYPICAL TRANSFER CAR



TYPICAL AISLE CRANE

Figure 5

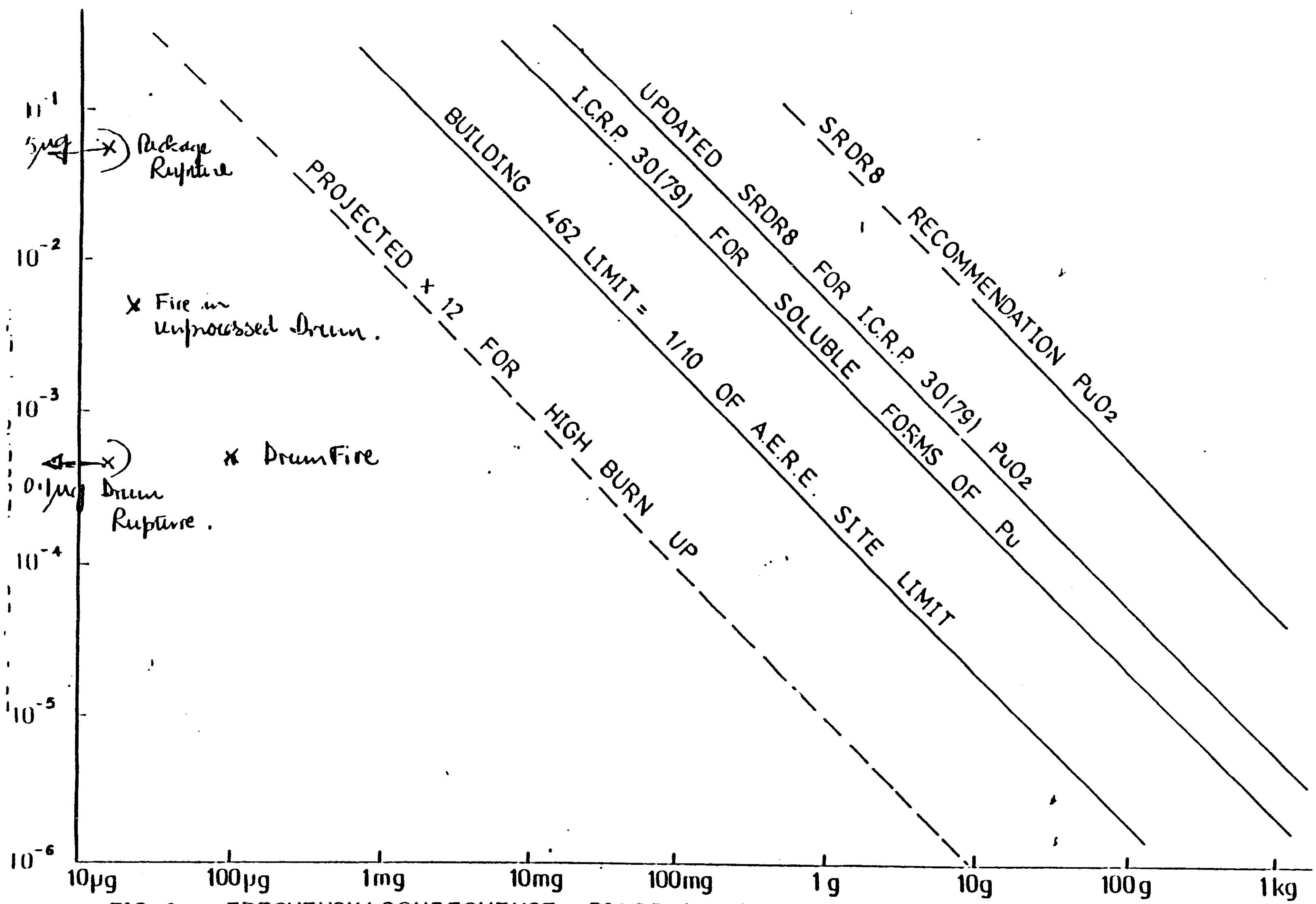


FIG. 4 FREQUENCY / CONSEQUENCE DIAGRAM (PLUTONIUM)

JERRY CRITCHLEY, BNFL

DESIGN FOR NORMAL OPERATING CONDITIONS

OBJECT

- To design and build to limit the following:
  - Internal and external radiation to personnel.
  - Radiation exposure of the public.
  - Liquid and aerial effluent discharges.

DESIGN FOR POTENTIAL FAULT CONDITIONS

OBJECT

- To design and build to cope with the following fault conditions:
    - Loss of containment
    - Loss of services
    - Criticality
    - Fire/Explosion
    - Environmental conditions
      (Seismic events, wind, flood etc)
    - Theft
    - Hazardous operations

FACTORS INFLUENCING FACILITY DESIGN

- Costs
- Operational philosophy
- Maintenance philosophy
- Decommissioning philosophy
- Safety factors

SAFETY ASPECTS

Normal operating conditions

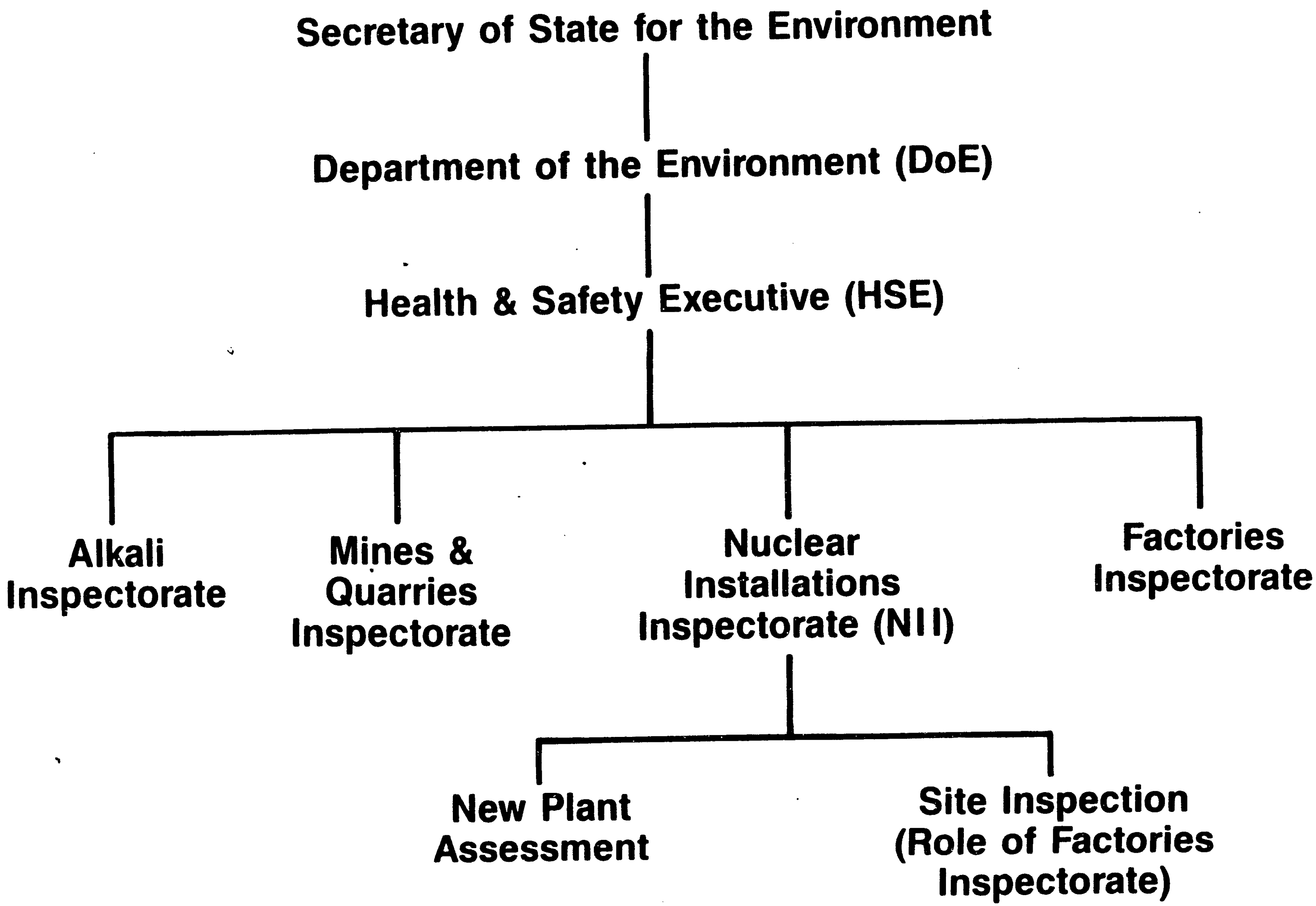
- Need to limit

- External radiation to personnel
- Internal radiation to personnel
- Radiation exposure to the general public

SAFETY ASPECTS

Abnormal conditions

- Loss of containment
- Loss of services
- Criticality
- Fire and explosion
- Extreme environmental conditions
- Failure of cranes, lifting and mechanical handling equipment


Secretary of State for the Environment
Department of the Environment (DoE)
Health & Safety Executive (HSE)
Alkali Inspectorate
Mines & Quarries Inspectorate
Nuclear Installations Inspectorate (NII)
Factories Inspectorate
New Plant Assessment
Site Inspection (Role of Factories Inspectorate)

BNFL PLANTS CURRENTLY IN DESIGN, CONSTRUCTION OR PLANNED FOR THE FUTURE

WTC Phase I	Sorting, shredding and concreting plant for drummed PCM due to commence operation in 1988.
WTC Phase II	Size reduction plant for crated redundant PCM plant and equipment to commence design 1986/7 for operation in 1994.
Engineered Store	For drummed PCM arisings from WTC Phase I and operating plants to commence design 1986/7 for completion in 1991.

UKAEA PLANTS CURRENTLY IN USE, DESIGN, CONSTRUCTION OR PLANNED FOR THE FUTURE

Dounreay PCM Facility	Sorting, handling, drumming and storage of PCM from reprocessing operations. In operation since Sept 1980.
EDRP PCM Facility	Sorting, handling volume reduction and storage of PCM from reprocessing and Pu oxide conversion operations. Due to commence operation in about 1996.
Harwell PCM Store	For the storage of shredded and sorted PCM in a non-concreted form. Due for completion late 1988.

MOD PLANTS CURRENTLY IN USE, DESIGN CONSTRUCTION OR PLANNED FOR THE FUTURE

Solid Waste Treatment Plant	Sorting, shredding and concreting plant for drummed PCM, planned for handover in 1990. Will have small capability for Pu recovery.
Decommissioning (Size Reduction) Facility	Size Reduction Plant for crated redundant PCM plant & equipment scheduled for operation in the mid 1990's.

PURPOSE OF ENGINEERED DRUM STORE

- To receive and store drums of PCM waste
- To allow drum inspection and ultimate removal for further processing or disposal

DRUM STORE FEED

- Drummed waste from WTC Phase I
- Containerised waste from WTC Phase II and Phase III

DESIGN FOR NORMAL OPERATING CONDITIONS

SOLUTION

- Internal and external radiation to personnel and radiation exposure of the public.
  - Containment: Use of high quality drums located in store vault to provide primary and secondary containment.
    Incorporation of ventilation system
  - Shielding: Use of shield materials to reduce radiation levels.
  - Remoteness: Minimise or prohibit routine operator/maintenance procedures in active areas. Use CCTV viewing
- Liquid and Aerial effluent discharges
  - Effluent management:
    LIQUID: Hold, sample and dispose/store
    AERIAL: Filter, sample and/or monitor and discharge

DESIGN FOR POTENTIAL FAULT CONDITIONS

SOLUTION

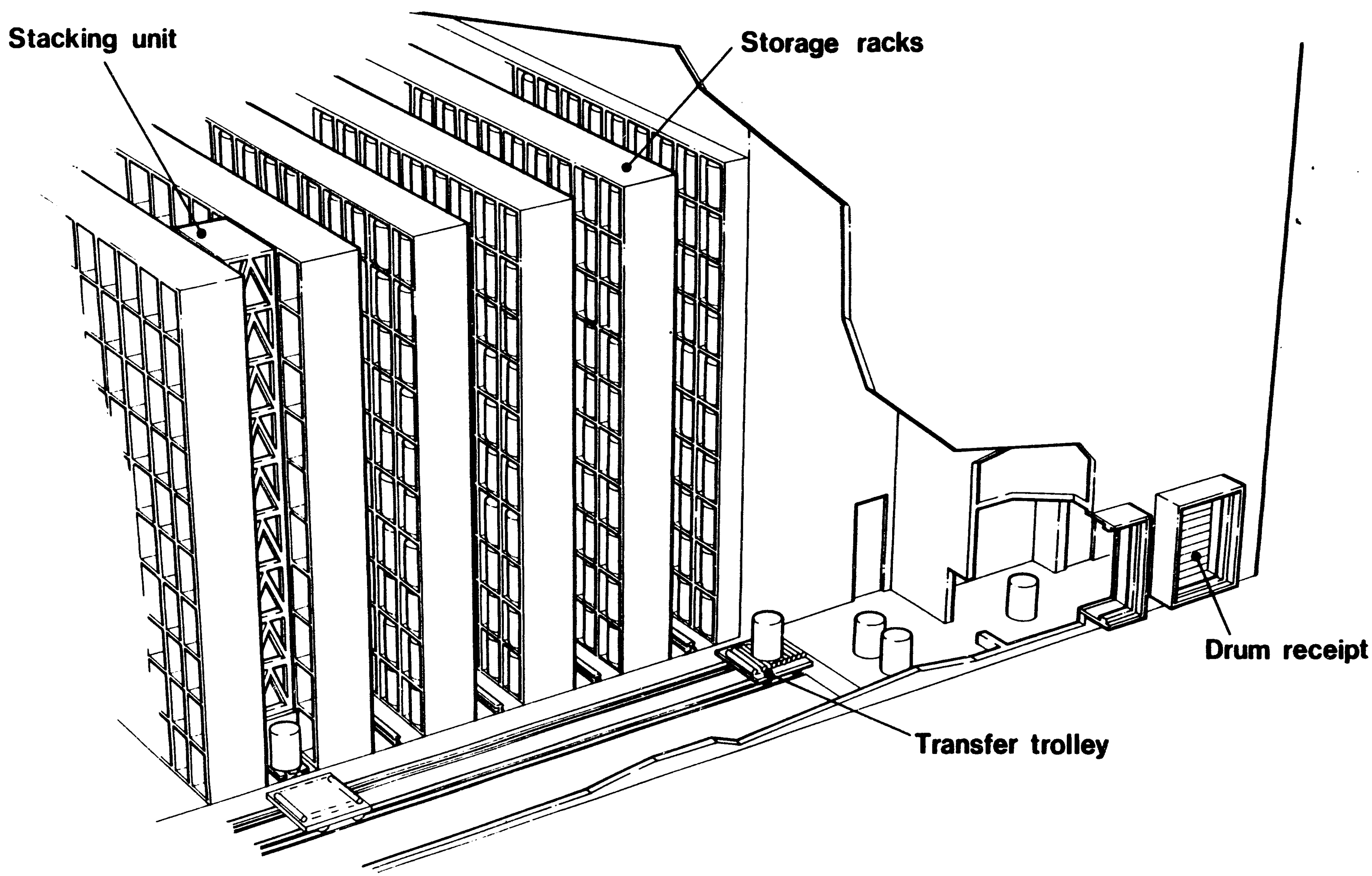
- Loss of containment :-
  Continued use of ventilation and overdrum storage container
- Loss of services:-
  Provide back-up services
- Criticality:-
  Limit quantities of fissile material in the drums as received
- Fire and explosion:-
  Venting of explosive gases. Use of for example low smoke and fume (LSF) electrical cable. Use of non-combustibe materials in building construction
- Environmental conditions:-
  Design of building to cope with recognised weather extremes
- Theft:-
  Adopt stringent security and safegaurd procedures
- Hazardous operations:-
  Limit damage that could occur by guarding, hard wired interlocks etc.

DESIGN FOR EASE OF OPERATION AND MAINTENANCE

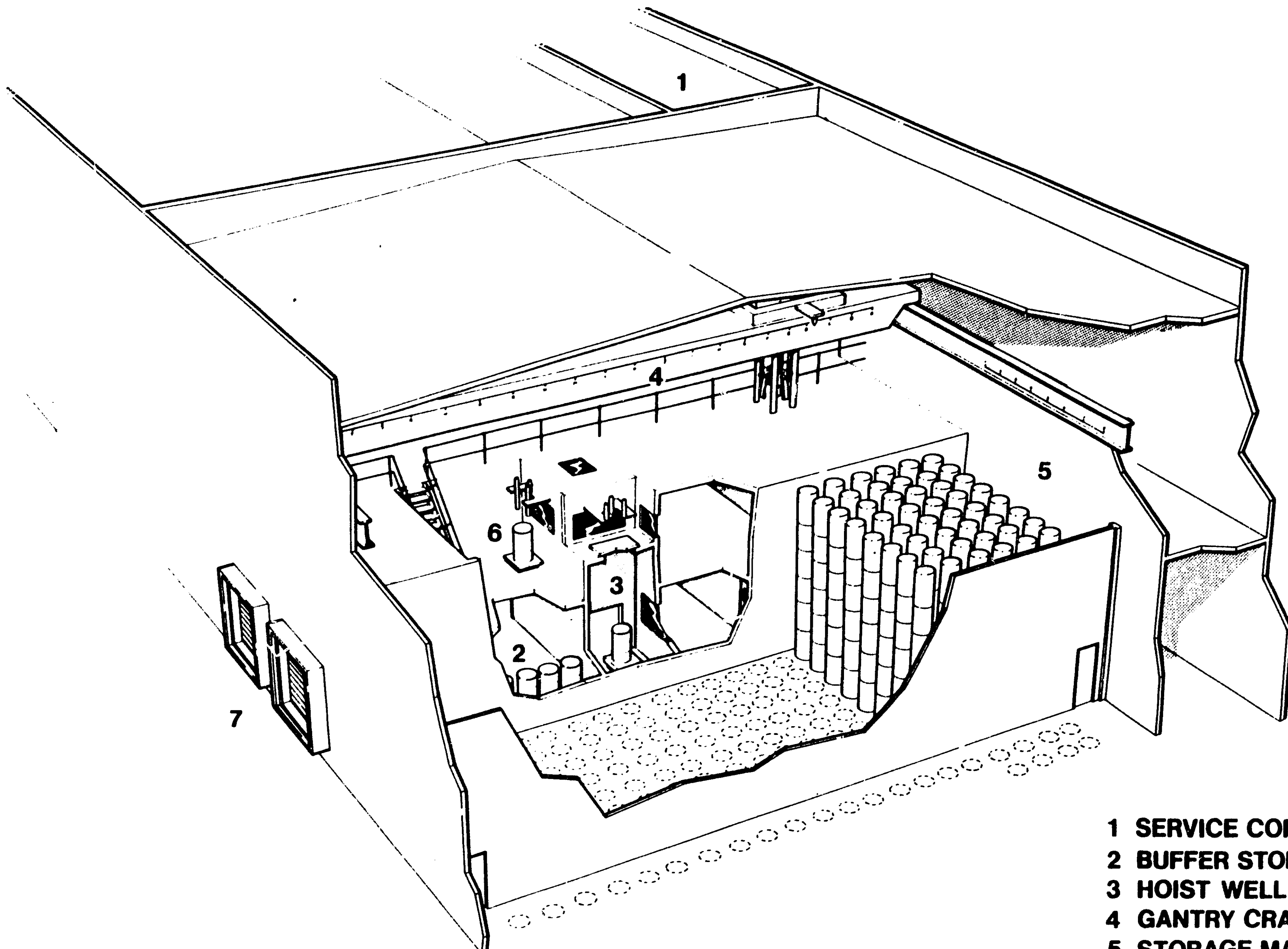
- Simple equipment design: Modular construction, unit replacement etc.
- Close liaison throughout design and manufacture with operators and maintenance personnel
- Ergonomic design of control and maintenance faces
- Use of quality control procedures to control design and manufacture
- Extensive equipment/procedures testing
- Development of novel or new equipment
- Operator/Maintenance familiarisation with completed equipment

DESIGN FOR ULTIMATE DECONTAMINATION AND DECOMMISSIONING

- Modularise plant/equipment for ease of dismantling
- Include in building structure means to aid final dismantling, e.g. Lifting beams, access
- Minimise in-cell equipment
- Divorce services from active areas
- Pre-plan removal routes
- Identification of key services



ENGINEERED DRUM STORE - PCM COMPLEX SELLAFIELD



1 SERVICE CORRIDOR
2 BUFFER STORE
3 HOIST WELL
4 GANTRY CRANE
5 STORAGE MATRIX
6 DRUM INSPECTION
7 TRANSPORT VEHICLE DOCKING

NARROW AISLE STACKING SYSTEM ENGINEERED DRUM STORE

END

DATE FILMED

11 / 22 / 91