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# Preliminary Feasibility Assessment for Several Specific MRS Design Alternatives with the Potential for Early Deployment

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February 1990

(Revision 1) November 1990

Work Performed under Contract

DE-AC01-87-RW00060


Prepared by

**Roy F. Weston, Inc.**

for

**U.S. Department of Energy**

**Office of Radioactive Waste Management**


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## FOREWORD

This document presents the results of WESTON'S preliminary assessment of the feasibility of several alternative fuel-transfer and storage concepts that have the potential for early spent-fuel acceptance at an MRS facility. The feasibility study is part of a series of studies being conducted by the U.S. Department of Energy (DOE) in an effort to establish the MRS design configuration. It was focused on fuel-transfer technologies for the first phase of the MRS facility and provides a preliminary examination in terms of design status and maturity, schedule, cost, and licensability. Thus, it covered only a limited portion of MRS design, and it did not examine the systemwide implications of the concepts evaluated. Furthermore, this document does not represent the DOE policy on MRS design and development, nor is it intended to convey any design decisions.

Revision 1 of this document provides an update of specific cost data relating to a single design concept, namely the Modular Vault Dry Storage (MVDS) being developed by Foster Wheeler Energy Systems. This revised vendor data information is contained in the new Appendix D.

# EXECUTIVE SUMMARY

## Purpose

This document presents the results of a preliminary assessment of the feasibility of several alternative fuel-transfer and storage concepts that have the potential for early spent-fuel acceptance at an MRS facility. This assessment was initiated by the DOE MRS Management Team in its memorandum dated December 20, 1989 (see Attachment 1).

The preliminary assessment focused on technologies for the direct transfer of spent fuel from shipping casks to the concrete storage casks that could be used for field storage at an MRS facility. Direct-transfer technologies are needed because the phase 1 MRS facility that would be developed for early spent-fuel acceptance would not have the spent-fuel-handling facilities that will be part of the full-capacity MRS facility developed in phase 2. In addition to direct-transfer technologies, the assessment included three concepts that encompass both transfer and storage. Two of these are modular storage systems that are currently in use or proposed for use in the United States; the third is FUELSTOR, a European design that has just been introduced for applications in the United States. Altogether, 13 different concepts were evaluated. The assessment did not include the feasibility of using dual-purpose transportable storage to allow early spent-fuel acceptance at an MRS facility; the use of these casks remains an alternative that will be considered.

## Approach

The facility designs that were examined were limited to concepts that provided the capability to transfer spent fuel from transport casks directly to MRS field storage concrete casks. This mode was considered to be the most feasible alternate to the transportable storage casks concept for an early deployment MRS phased facility. The spent fuel transfer designs reviewed were based on (a) the technical references provided in Attachment 1, (b) two other design concepts that are being deployed and marketed in the U.S. for at-reactor spent fuel transfer and storage, and (c) overseas operational facilities that provide spent fuel transfer capabilities. The reference data has been used directly without detailed verification or modifications. The total number of design configurations examined was limited to the following -

- Modular Vault Dry Storage (MVDS), two configurations
- Dry transfer, vertical, shuttle
- Dry transfer, vertical, turntable
- Dry transfer, vertical, igloo

- Dry transfer, vertical, below grade, prefabricated hot cell
- Dry transfer, vertical, fuel transfer mechanism (FTM)
- Wet transfer, vertical, (FTM)
- Dry transfer, horizontal to vertical
- Dry transfer, vertical, permanent facility
- Dry transfer, vertical, below grade, (FTM)
- Dry transfer, horizontal, mobile hot cell
- Dry transfer using NUHOMS canisters

For an initial evaluation of the identified design concepts, a general assessment was made against criteria of -

- Design maturity
- Operational experience
- Capability to meet MRS functional requirements
- Potential for minimum construction durations
- NRC licensability

Assessment

The spent fuel transfer concepts were reviewed for areas of common characteristics of their fuel transfer mode, and were placed in 5 basic categories as follows -

- Category (A) Dry transfer by use of a shielded fuel transfer mechanism or device. (See Figure 5 for a typical example.)
- Category (B) Dry transfer by use of a permanent or prefabricated hot cell facility. (See Figure 7 for a typical example.)
- Category (C) Dry transfer in dry shielded canisters. (See Figure 15 for a typical example.)
- Category (D) Wet transfer in pool. (See Figure 9 for a typical example.)
- Category (E) Modular concrete dry transfer and storage. (See Figure 2 for a typical example.)

Each category was evaluated to determine if it contained a fuel transfer concept that, based on the initial review, was worthy of more detailed assessment. From this procedure, the following concepts were eliminated - Category (A) (shielded transfer mechanism) due to its lack of design maturity and Category (C) (dry shielded transfer) due to the lack of an existing method of transporting a canister to an MRS facility. Concepts from Category (B) (prefabricated hot cell), Category (D) (wet transfer), and Category (E) (MVDS, Foster Wheeler - GEC design) were selected for further detailed analysis in the areas of specific design information, NRC licensability, facility schedules, and cost estimates.

## Results

<u>Design, Operational Experience, and Licensing Experience</u> - For the three configurations selected as being the most feasible for early MRS deployment, the results of the additional analysis in the categories of design maturity, operating experience, and NRC licensing experience are summarized in Diagram 1.

Diagram 1

Design Configurations
Level of Confidence Comparison

| | MVDS (Type 1) | Prefabricated Hot Cell (Type 5) | Wet Pool Transfer (Type 7) |
|---|---|---|---|
| Design Maturity | Medium (1) | Low (2) | High (3) |
| Operating Experience | Medium (1) | None | High (3) |
| NRC Licensing Experience | Medium (4) | None | High (5) |

Notes:

(1) Based on design origins derived from a single overseas facility storing gas cooled reactor fuel.

(2) Based on the lack of a complete conceptual design.

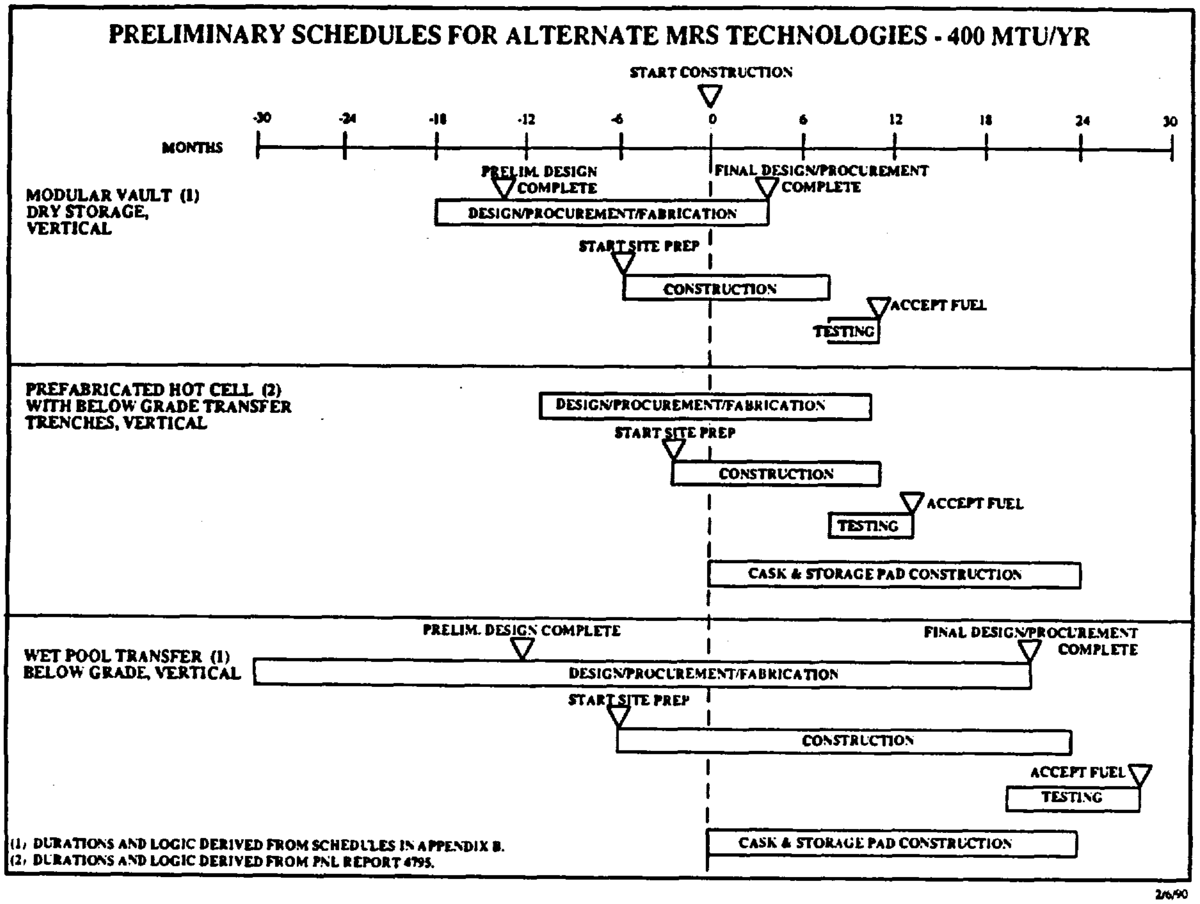
(3) Based on fully proven facilities at 112 nuclear power reactors and one Independent Spent Fuel Storage Installation (ISFSI) in the US.

(4) Based on approved generic topical report. This will become "High" upon issuance by NRC of safety evaluation report (SER) following submission of license application by Public Service of Colorado for the Fort St. Vrain facility.

(5) Based on 112 nuclear power plants licensed under 10 CFR Part 50 and one away from reactor ISFSI licensed under 10 CFR Part 72. (However, no license has been issued for a separate site, stand alone ISFSI which is analogous to a potential MRS facility.)

**Schedule Assessment** - The schedule assessment comparison for the selected options is summarized in Diagram 2 based on the referenced data.

DIAGRAM 2

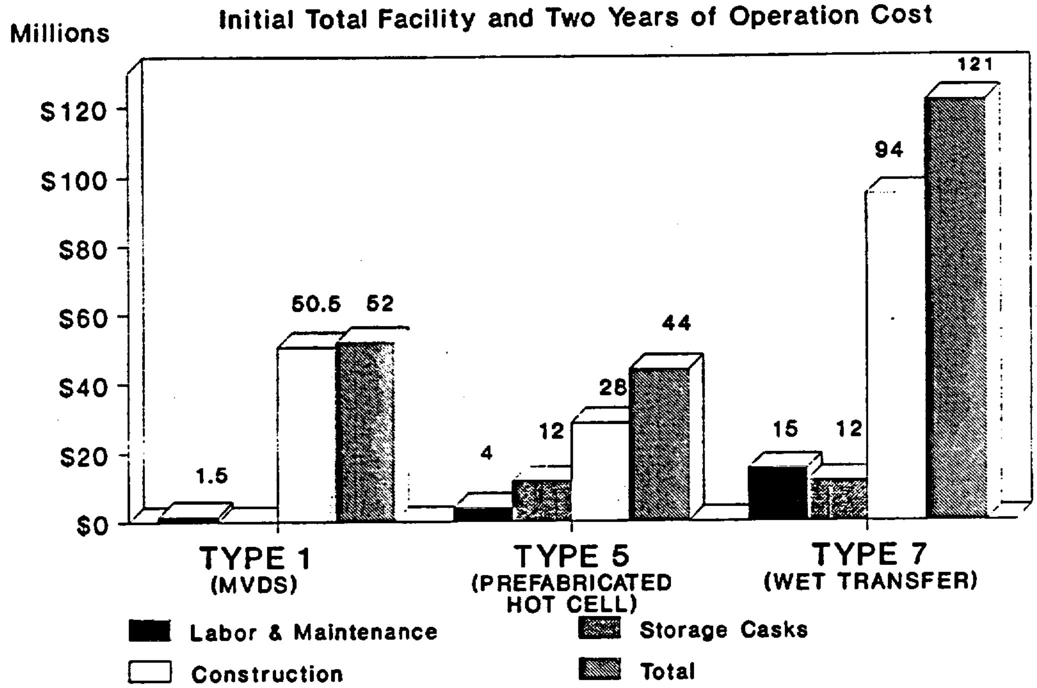



**Cost Assessment** - The cost estimates presented are preliminary in nature and should not be considered to represent a rigorous, grounds-up cost estimate. The cost information data inputs have been included in an appendix to the report and every effort has been made to present cost estimates on a comparable basis. It is emphasized, however, that due to the lack of detailed cost data available for each of the options under review, the cost estimates should not be misinterpreted as representing a true one-to-one comparison of these technologies.

Diagram 3 is a graphic comparison of the costs as a function of storage for the MVDS, trench, and wet transfer concepts. The graph is the initial total facility costs and 2 years of operations costs for a 400 MTHM/yr throughput with a total storage of 800 MTHM. There are no decommissioning costs shown on Diagram 3. It is important to note that Types 5 and 7 have initial capital costs allocated to the required cask manufacturing facility for start of operations. Diagram 3 illustrates that the MVDS and Prefabricated Hot Cell concepts have comparable costs for the first 2 years of operations at 800 MTHM storage. The comparable cost for the Wet Transfer concept is significantly higher due to the capital costs for constructing the wet transfer pool. The operating costs for Wet Transfer are also significantly higher than the other two concepts.

DIAGRAM 3.

Initial Total Facility and Two Years of Operation Cost




(400 MTHM/year throughput, 800 MTHM storage, no decommissioning)
Preliminary estimates only based on unverified input data contained in Appendix B and D.

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DIAGRAMS



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# I. INTRODUCTION

## Purpose

This document presents the results of a preliminary assessment of the feasibility of several alternative fuel-transfer and storage concepts that have the potential for early spent-fuel acceptance at an MRS facility. This assessment was initiated by the DOE MRS Management Team in its memorandum dated December 20, 1989 (see Attachment 1).

The preliminary assessment focused on technologies for the direct transfer of spent fuel from shipping casks to the concrete storage casks that could be used for field storage at an MRS facility. Direct-transfer technologies are needed because the phase 1 MRS facility that would be developed for early spent-fuel acceptance would not have the spent-fuel-handling facilities that will be part of the full-capacity MRS facility developed in phase 2. In addition to direct-transfer technologies, the assessment included three concepts that encompass both transfer and storage. Two of these are modular storage systems that are currently in use or proposed for use in the United States; the third is FUELSTOR, a European design that has just been introduced for applications in the United States. Altogether, 13 different concepts were evaluated. The assessment did not include the feasibility of using dual-purpose transportable storage to allow early spent-fuel acceptance at an MRS facility; the use of these casks remains an alternative that will be considered.

## Scope

The scope of the assessment was limited to an evaluation of data included in several technical reports and, in some cases, information supplied by vendors.

The referenced DOE memorandum identified four specific technical documents for the preliminary feasibility assessment:

1. A report on the modular-vault-storage system proposed by Foster Wheeler for dry storage at the site of the Fort St. Vrain high-temperature gas-cooled reactor.

2. A report prepared by the Electric Power Research Institute (EPRI) on fuel-transfger systems. EPRI NP-6425

3. A report prepared by the Pacific Northwest Laboratory (PNL) on dry intercask transfer. PNL-4795

4. A report prepared by the NUS Corporation on dry-transfer casks. NUS TTC-0736

In addition, 2 other concepts have been examined based on directions received from DOE. NUHOMS, a modular storage system that is currently in use in the United States, and FUELSTOR, a European design that has just been introduced for applications of at-reactor or MRS storage in the U.S.

Methodology

The approach of the engineering assessment was to systematically review the identified spent-fuel transfer concepts in terms of the following:

a. Functional capabilities (See Table 1.)
b. Throughput capability (See Table 1.)
c. Storage capacity (See Table 1.)
d. Operating experience (See Table 2.)
e. Licensing experience (See Table 2.)
f. Cost (See Table 3.)
g. Projected construction schedule
h. Licensability

A brief review was made of overseas spent fuel transfer and storage facilities, specifically those in France (COGEMA) and Sweden (CLAB). The French facilities at La Hague use both dry spent-fuel transfer (TO facility) and wet spent fuel transfer (NPH facility). The design of the Swedish facility CLAB is based on the French NPH facility.

Technical data have been extracted from the referenced material in the form of technical drawings, narratives, and tabular listings of cost, schedule, and licensing information.

A general review was made of all 13 design configurations, using the available technical information. The objective was to identify the specific spent-fuel transfer concepts that were considered to be the most feasible for an early MRS deployment in terms of licensability, operational experience, design maturity, capability to meet MRS functional requirements, and the duration of construction.

For each of these spent-fuel transfer concepts selected for further analyses, detailed assessments were made in terms of the design capability to meet the expected functional requirements, operational experience, NRC licensability status, facility schedules, and cost. This additional level of information was developed by interactions with designers, equipment vendors, and the detailed review of relevant NRC licensing dockets.

A review was conducted to determine whether this work should be categorized as quality affecting; as explained in Attachment 2, the results of this review led to the recommendation that this report be considered as not quality affecting.

## II. SUMMARY OF MRS REQUIREMENTS

For the purposes of this assessment, the major MRS facility requirements were based on Volume III of the Waste Management System Requirements (WMSR) document, and the further requirements arising from the initiating DOE memorandum (Attachment 1).

WMSR Volume III

The December 1989 version of WMSR Volume III, "Monitored Retrievable Storage" defines the top-level technical requirements for the MRS facility in terms of ability to --

- Receive both truck and rail transportation casks
- Decontaminate transportation casks
- Inspect transportation casks
- Upend and handle transportion casks
- Unload spent fuel from transportation casks
- Inspect and verify received spent fuel
- Transport spent fuel to onsite storage
- Store spent fuel at the site
- Monitor stored spent fuel
- Ship spent fuel after onsite storage
- Withstand design-basis loadings from natural and man-induced phenomena

Additional requirements

Additional requirements that have been identified pertain to waste-acceptance rates and design flexibility (see Attachment 1). These requirements can be summarized as follows:

- Capability of starting waste acceptance at 300 to 600 MTHM per year in the years 1998 to 2000.
- Capability of increasing waste acceptance to approximately 1500 MTHM per year by 2001.
- Capability to increase waste acceptance to 3,000 to 4,000 MTHM per year after the repository

becomes operational, which is assumed to be in 2010.

- Flexibility in design so as not to preclude additional spent-fuel preparation functions, such as consolidation and encapsulation into final disposal waste packages.

The basic functional capabilities and sequence of operations for an MRS facility are depicted in Figure 1. It is to be noted that not all the design concepts provided by the MRS Management Team for assessment (see Attachment 1) were capable of fulfilling all of the functional requirements. The facility throughputs reported in Table 1 were based on single facility designs which were of the order of 400 MTHM/yr unless otherwise stated. For increased outputs, additional facility duplicates would be required. Additionally, some of the referenced design concepts were configured as mobile or non-permanent facilities for deployment at reactor sites.

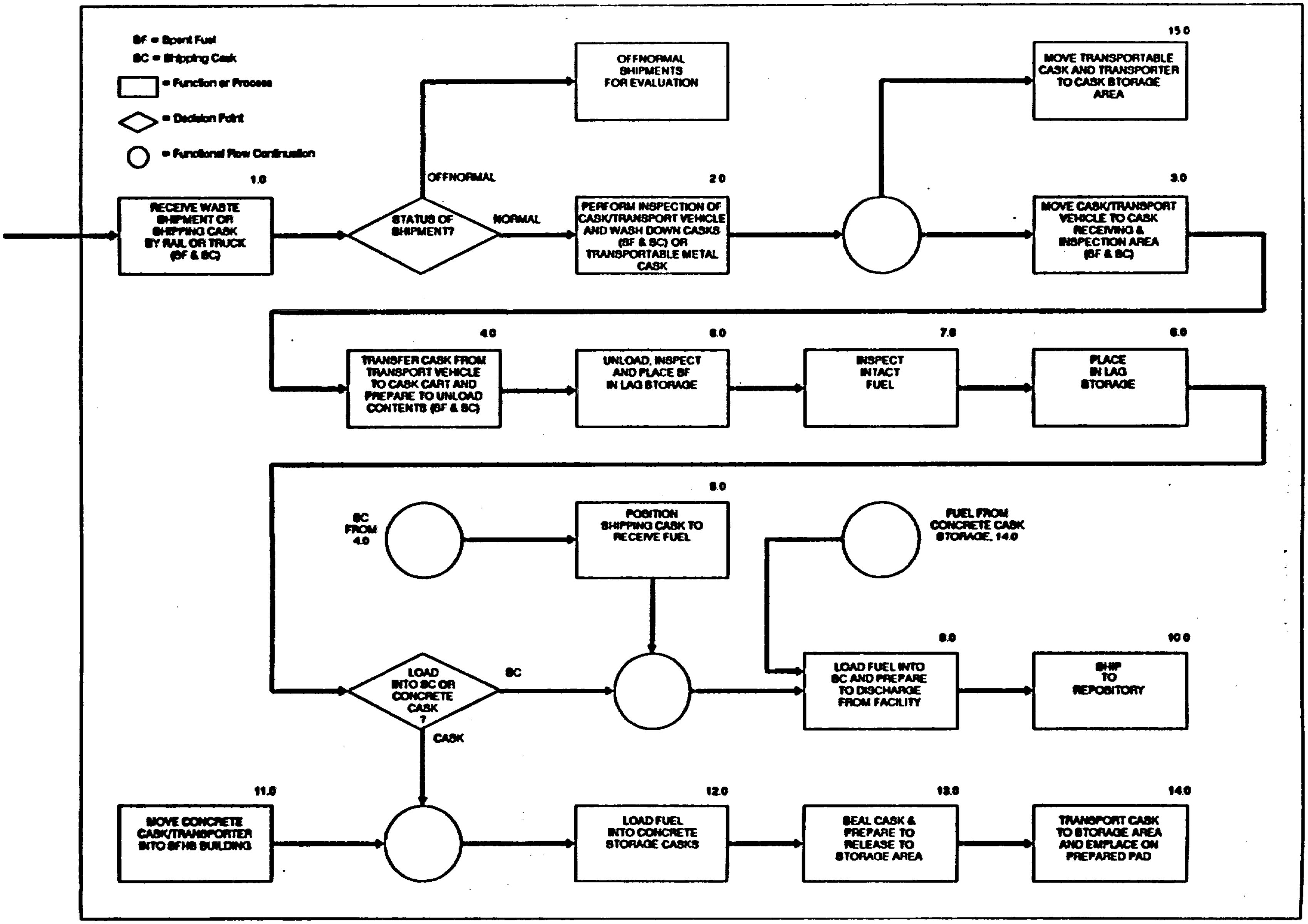


**Figure 1.** Material Handling Block Diagram.

7 0 2 5 0 3 5 6 2

## III. ENGINEERING ASSESSMENT OF MRS DESIGN ALTERNATIVES

Based on the order of references provided in Attachment 1, and the other design options considered appropriate, the following engineering assessments were developed. The design information being presented in this section has been derived directly from the reference material without detailed verification or modification.

1. Modular Vault Dry Storage (MVDS), vertical (Foster Wheeler Topical Report, NRC Docket M-46) - Type 1

   This modular concrete vault transfer and storage concept is based on concrete technology with fuel handling and natural air circulation cooling systems pioneered by the U.K. gas cooled reactor program of the 1970's.

   Modular concrete vaults consist of metal fuel storage tubes vertically arrayed and housed in a concrete structure. Each tube will store single assemblies of unconsolidated spent fuel, and each module will store up to 83 PWR or 150 BWR assemblies for a capacity of about 40 MTHM per module.

   The fuel storage tubes, made of carbon steel, are shielded and protected on all sides by the surrounding concrete structure. Each fuel storage tube penetrates the upper shield concrete, opening into the floor of a fuel handling bay and is sealed by a removable shield plug. Above the array of fuel storage tubes in the fuel handling bay, a shielded fuel handling mechanism moves on a trolley to transfer a spent fuel assembly from a cask-handling area at one end of the structure to any fuel storage tube in the array. Each fuel storage tube is connected to a common manifold leading to a gas system that fills the tube with the cover gas and subsequently maintains the cover gas. The walls of the concrete structure have built-in cooling channels to promote cooling by convective air flow around the fuel storage tubes. The cask-handling area is designed to accommodate standard truck and standard rail shipping casks. The other end of the concrete structure is designed for easy expansion of the system by the construction of more modules. (See Figures 2 and 3.)

   The minimum installation consists of two module arrays (about 80 MTHM), the cask-handling area, and the shielded fuel handling mechanism. The maximum size of the system is claimed to be technically unlimited, but for the purposes of the NRC topical report, the installation is limited to five modules (about 200 MTHM).

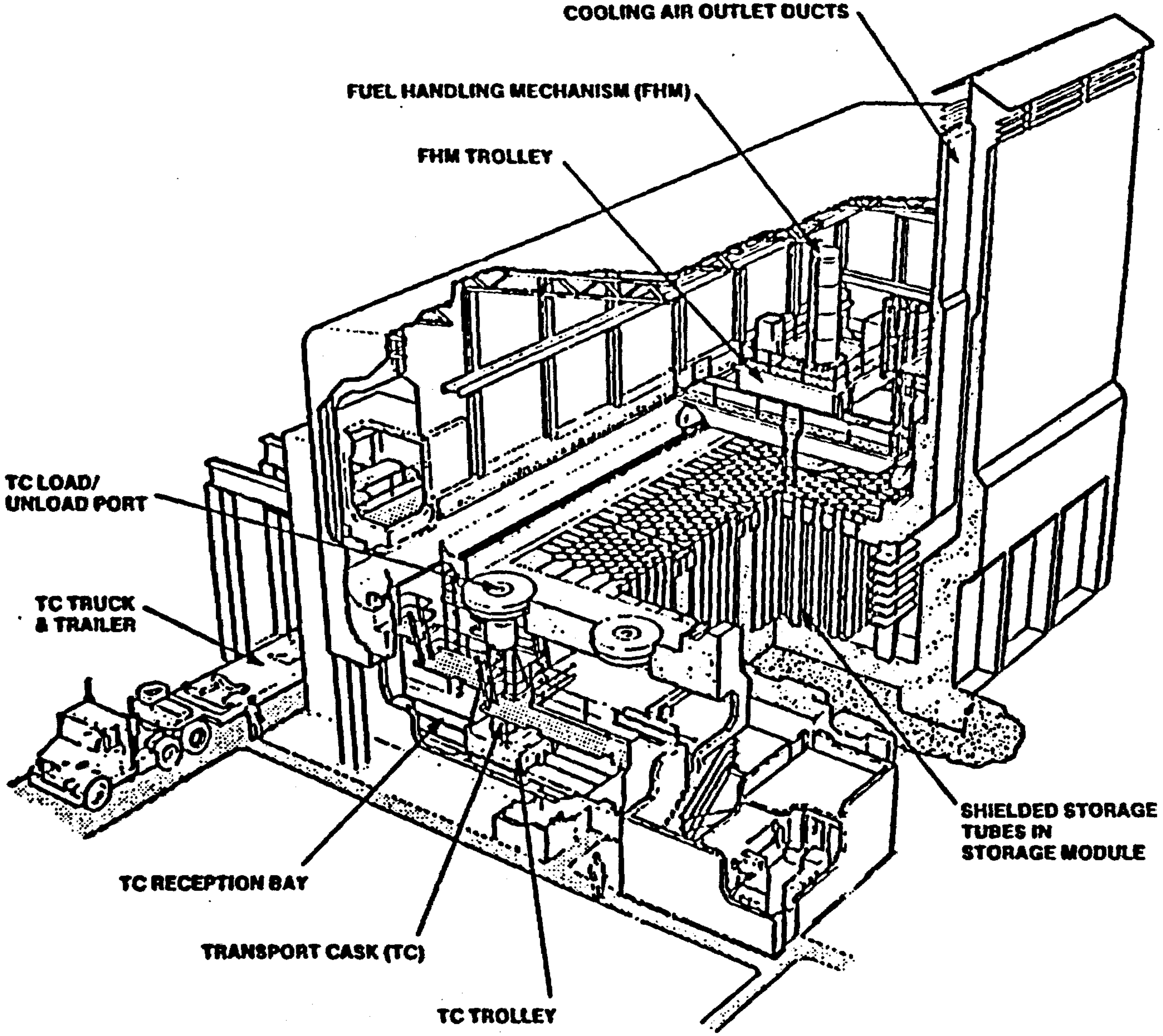


**Figure 2. Modular Vault Dry Storage (MVDS) Dry Vertical Transfer and Storage.**

FOSTER WHEELER CONCEPT
NRC TOPICAL REPORT M-46

TYPE 1

0407-0045DS 10/15/90

7035065

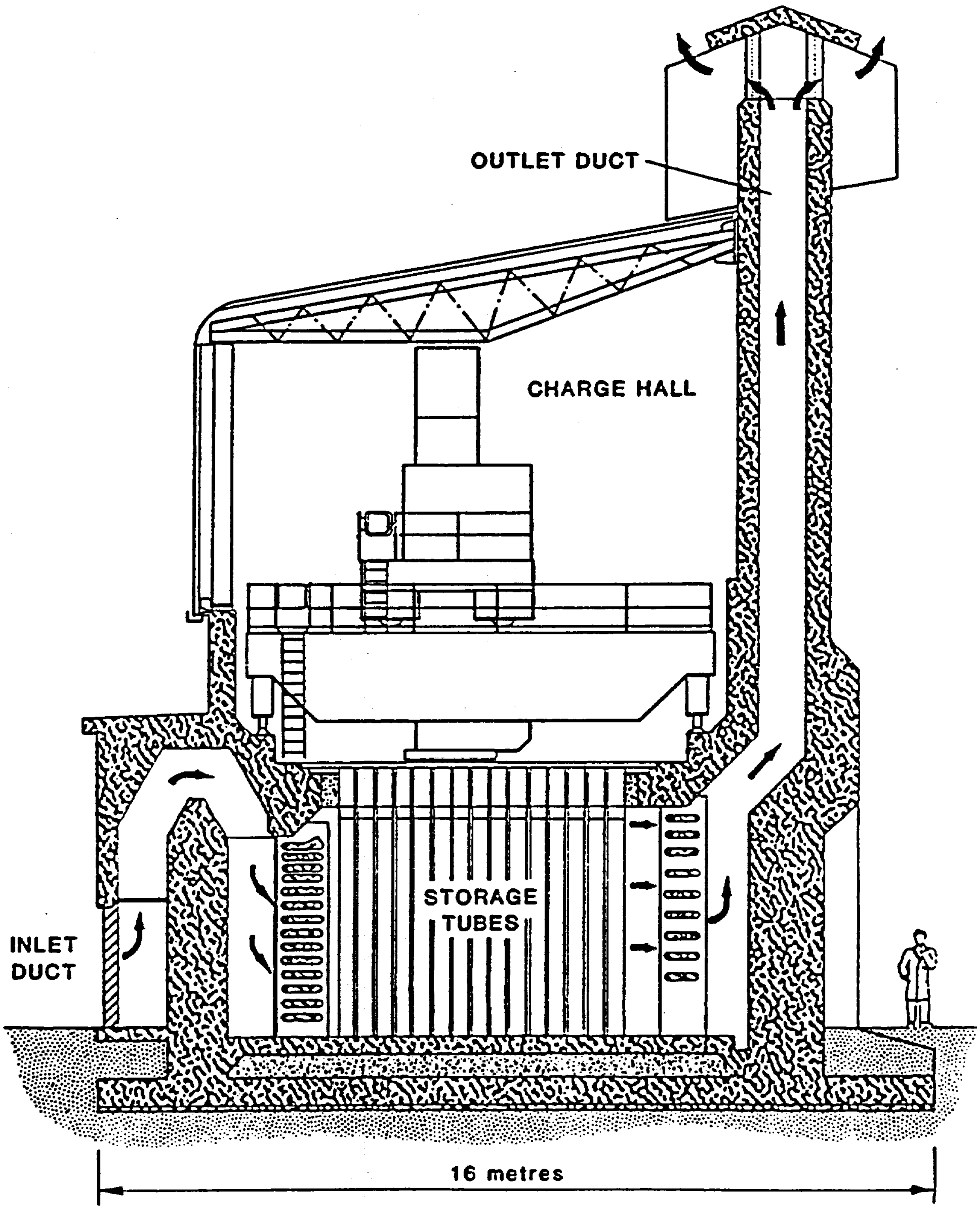


Figure 3. MVDS Cooling System Normal Operation.

The MVDS provides the means for both spent fuel transfer and integral facility storage deployed in concrete modules. All the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

The typical arrangement of an MVDS designed for a storage capacity of 200 MTHM of light water reactor fuel is shown in Figure 3. The throughput capacity has been stated at between 1500 - 2000 spent fuel assemblies per year which for a 2/3 PWR and 1/3 BWR mix would amount to between 600 and 800 MTHM/yr.

This concept has been in operation in England, U.K. since 1970 as stated in the letter dated March 31, 1988 from the utility CEGB to the U.K. vendor GEC. (Attachment 3.)

The NRC, in their letter dated March 22, 1988 to Foster Wheeler (Attachment 4), confirmed acceptance of the August, 1986 Topical Report for the Foster Wheeler MVDS (docket M-46) and the NRC staff has issued a Safety Evaluation Report (SER). Foster Wheeler have recently been awarded a contract from Public Service of Colorado (PSC) for the storage in an MVDS of the spent fuel from the Fort St. Vrain high temperature gas cooled reactor. PSC is scheduled to submit their License Application to the NRC by July, 1990 under 10 CFR Part 72 for an Independent Spent Fuel Storage Installation (ISFSI).

The DOE document, <u>Final Version Dry Cask Storage Study</u> (DOE RW-0220), dated February 1989, estimated total unit costs per kilogram of heavy metal, assuming 10 year old fuel and including licensing, construction, and operation at $110 for a capacity of 100 MTHM, dropping to $55 for a capacity of 500 MTHM, and $50 for a capacity of 1,000 MTHM.

Detailed cost, schedule and licensing analyses of this concept are contained in Section V.

2. <u>Equipment Concepts for Dry Intercask Transfer of Spent Fuel</u> PNL 4795-UC-85

This report by PNL was prepared for the DOE in 1983 and set out to provide brief pre-conceptual studies on the feasibility of four low-cost intercask transfer systems for use at a Federal Interim Storage (FIS) site. These four concepts are reviewed as follows.

a. <u>Dry transfer, vertical, shuttle</u> - Type 2

This concept, developed by G.A. Technologies, consists of a shielded fuel handling mechanism mounted on a bridge-like structure. The bridge allows shipping and storage casks in a vertical position, each on its individual transfer car, to be shuttled into position under the fuel handling mechanism. Adapters allow mating of the cask openings to the bottom of the fuel handling mechanism. Spent fuel is lifted from the shipping cask; the shipping cask is then moved back and the storage cask is moved into position to receive the fuel assembly or canister from the fuel handling mechanism. The casks are loaded onto the self-propelled transfer cars using an outside crane. The cask handling and shuttle systems are located inside a prefabricated metal building designed to act as a second level of confinement against potential releases of radioactive materials. (See Figure 4.)

The information provided for this concept assumes the facility is located on a host site that is able to provide all necessary infrastructure. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

An annual throughput of at least 525 MTHM/yr can be accommodated assuming truck transport casks are being unloaded in the system. Additional assumptions are receipt of only PWR fuel for 250 days/yr, working 24 hours/day operations.

In 1982 dollars, including 30% contingency, the original cost estimates for 400 MTHM are:

| | |
|---|---|
| Design and Engineering | $1.5 million |
| Capital Costs | $9.1 million |
| Operating Costs | $2.1 million |

These cost estimates include provisions of an overhead crane (100 Metric tons nominal capacity) and supporting structure for handling of the truck and rail shipping casks.

An estimate for implementation of this concept gave a duration of 24 months from start of design and development to operational status, not including licensing efforts.

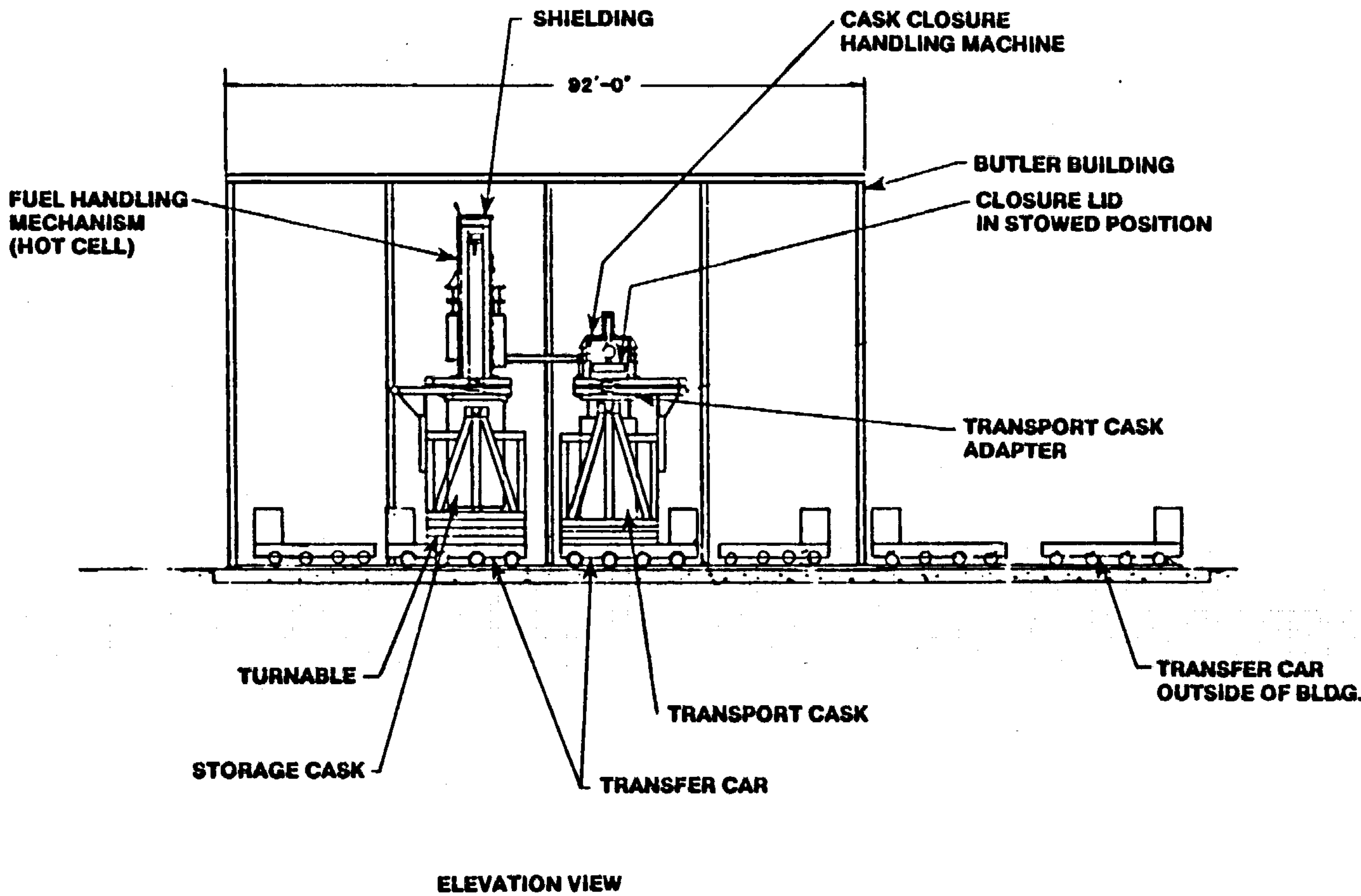


Figure 4. Shuttle Transfer, Dry Transfer, Vertical-Above Ground.

PNL REPORT
PNL-4795-UC-85

TYPE 2

0407-0045RJ 1/22/90

9 6 6 0 8 5 3 0 7

b. <u>Dry transfer, vertical, turntable</u> - Type 3

This concept, developed by Raymond Kaiser Engineers, consists of a large lifting crane and a large-diameter, shielded cylinder in a prefabricated metal building. The base of the cylinder is a large rotating turntable on which a transport and a storage cask are set. Transfers of spent fuel or canisters between casks are made by alternately rotating the turntable so the transport cask is under the lifting mechanism and a fuel assembly or canister can be removed, then rotating so that the receiving cask is in position to receive the fuel assembly as the lifting mechanism is lowered. Truck or rail transport casks can be accommodated and the receiving casks are assumed to be metal storage casks with a capacity of 24 PWR assemblies. Spent fuel, waste handling systems, and cask lid removal/installation are done inside the shielded turntable. The prefabricated metal building is designed to act as a second level of confinement against potential releases of radioactive materials. (See Figure 5.)

The information provided for this concept assumes the facility is located on a host site that is able to provide all necessary infrastructure. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

An annual throughput of up to 540 MTHM/yr can be accommodated assuming that 2 transport casks are in the system at one time; one being unloaded and one in preparation. Additional assumptions are 50% truck and 50% rail receipts of only PWR fuel for 250 days/yr, working 24 hours/day operations.

In 1982 dollars, including 30% contingency, the original cost estimates for 400 MTHM are:

| | |
|---|---|
| Design and Engineering | $2.2 million |
| Capital Costs | $11.0 million |
| Operating Costs | $2.3 million |

These cost estimates include provisions of an overhead crane (100 Metric tons nominal capacity) and supporting structure for handling of the truck and rail shipping casks.

An estimate for implementation of this concept gave a duration of 41 months from start of design and development to operational status, not including licensing efforts.

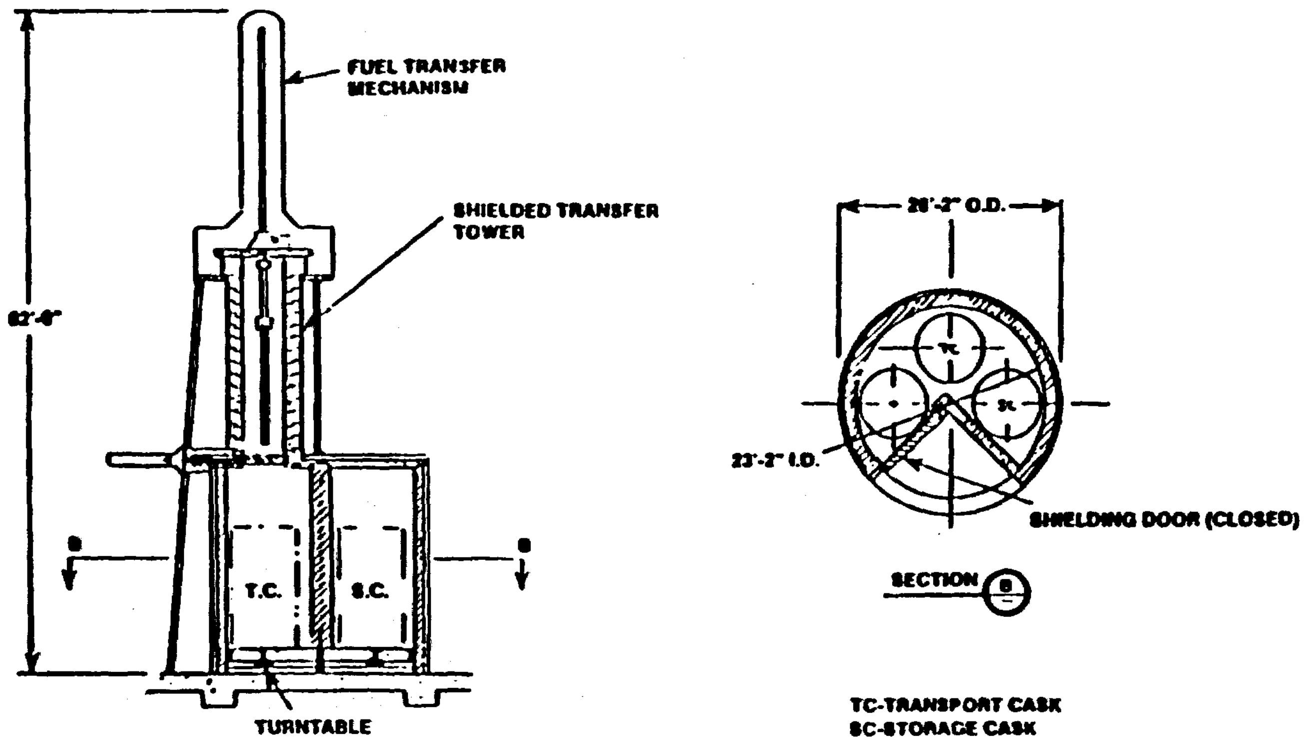


**Figure 5. Turntable Transfer, Dry Transfer, Vertical-Above Ground.**

PNL REPORT
PNL 4795-UC-85

c. Dry transfer, vertical, igloo - Type 4

This concept, developed by Raymond Kaiser Engineers, includes a large, rectangular hot cell (called fuel transfer chamber) made of an oval-shaped corrugated steel metal liner shielded by an earthen berm. The two types of casks are placed vertically on a single transfer car by an outside crane. The transfer car moves the two casks into the fuel transfer chamber (through an airlock chamber that is an extension of the fuel transfer chamber and is used for decontamination purposes). Spent fuel is transferred by alternately moving the transfer car to orient the two casks to their position under a fuel transfer tower. The fuel transfer tower, similar to that in the turntable concept, extends above the earthen berm. Some capability could be provided for repairing or recanning spent fuel or canisters in the fuel transfer chamber. Limited repair of the casks can be accomplished in the decontamination and air lock room. (See Figure 6.)

The information provided for this concept assumes the facility is located on a host site that is able to provide all necessary infrastructure. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

An annual throughput of up to 480 MTHM/yr can be accommodated assuming truck transport casks are being unloaded in the system. Additional assumptions are receipts of only PWR fuel for 250 days/yr, working 24 hours/day operations.

In 1982 dollars, including 30% contingency, the original cost estimates for 400 MTHM are:

| | |
|---|---|
| Design and Engineering | $1.2 million |
| Capital Costs | $7.0 million |
| Operating Costs | $2.0 million |

These cost estimates include provisions of an overhead crane (100 Metric tons nominal capacity) and supporting structure for handling of the truck and rail shipping casks.

An estimate for implementation of this concept gave a duration of 18 months from start of design and development to operational status, not including licensing efforts.

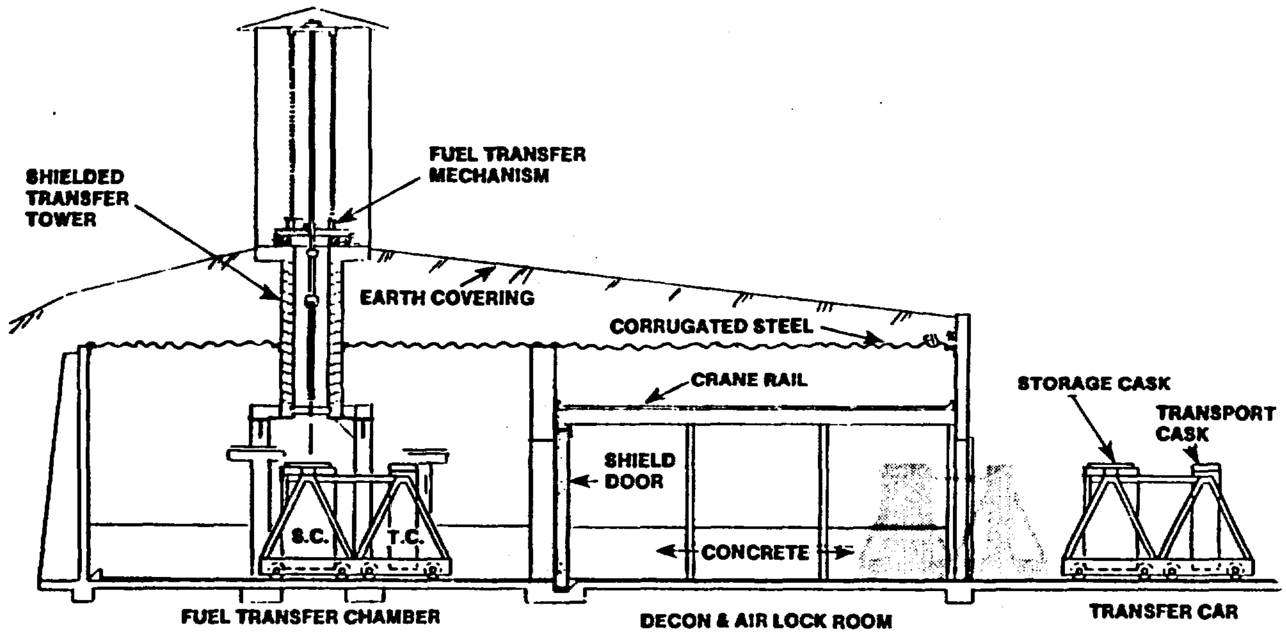


Figure 6. Igloo Transfer, Dry Transfer, Vertical-Above Ground.

PNL REPORT
PNL-4795-UC-85

9 2 1 5 3 0 5 7 2

TYPE 4

0407-0045RJ 1/22/90

d. Dry transfer, vertical, below grade, prefabricated hot cell - Type 5

The last concept, developed by G.A. Technologies, consists of a small hot cell (called fuel transfer room) that is made of prefabricated stacking concrete sections and that extends from a trench to above grade. Inside the metal building that houses the fuel transfer system and acts as a secondary confinement, a large 100 Metric tons bridge crane places the two types of casks vertically onto individual transfer cars located in a short, concrete-lined trench. The transfer cars, which have an integral hot cell shielding wall, move the casks into the fuel transfer room where the intercask transfer is accomplished by manipulators and in-cell cranes based on conventional concepts for cask and spent fuel handling. (See Figure 7.)

The information provided for this concept assumes the facility is located on a host site that is able to provide all necessary infrastructure. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

An annual throughput of up to 400 MTHM/yr can be accommodated assuming 50% truck and 50% rail transport casks are in the system. Additional assumptions are receipts of only PWR fuel for 250 days/yr, working 24 hours/day in two cask handling bays.

In 1982 dollars, including 30% contingency, the original cost estimates for 400 MTHM are:

| | |
|---|---|
| Design and Engineering | $1.2 million |
| Capital Costs | $8.1 million |
| Operating Costs | $2.0 million |

These cost estimates include provisions of an overhead crane (100 Metric tons nominal capacity) and supporting structure for handling of the truck and rail shipping casks.

An estimate for implementation of this concept gave a duration of 24 months from start of design and development to operational status, not including licensing efforts.

Detailed cost, schedule, and licensing analyses of this concept are contained in Section V.

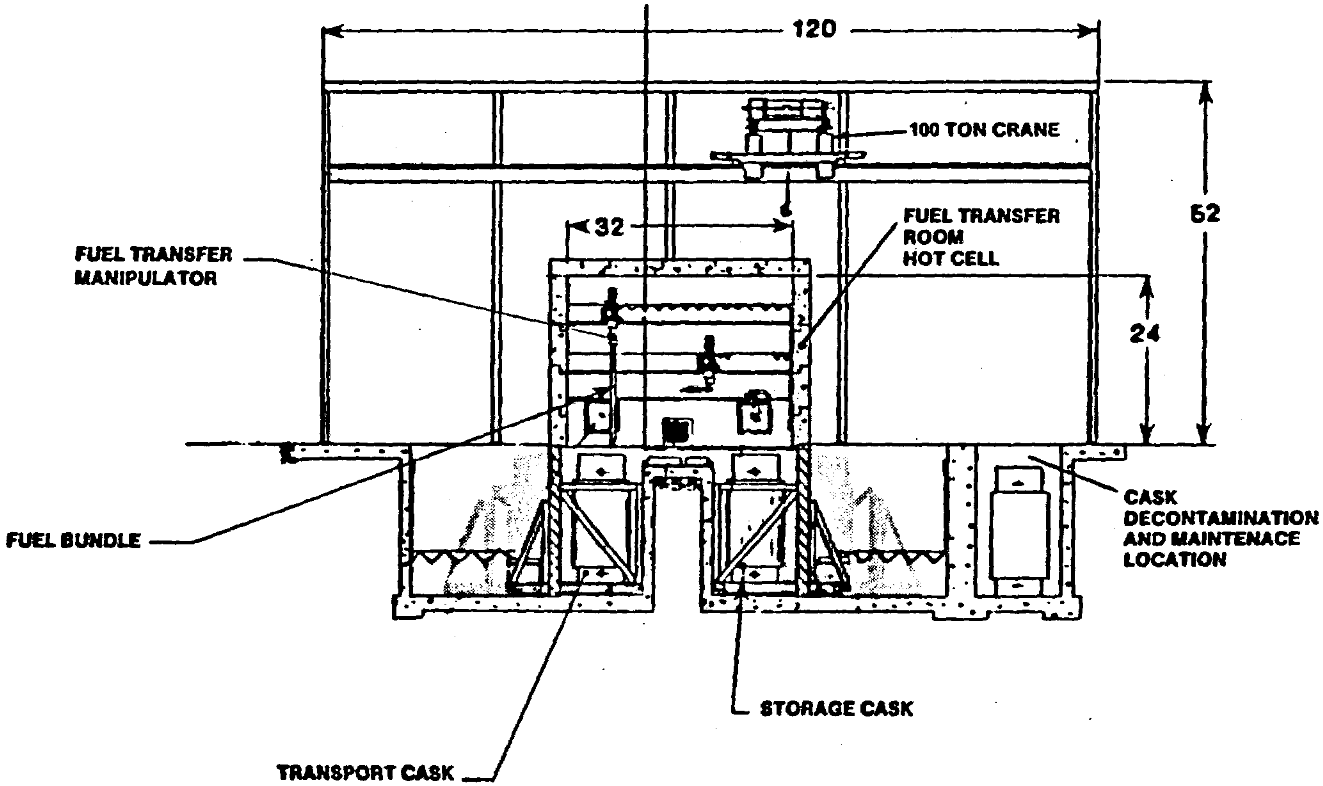


Figure 7. Prefabricated Hot Cell Transfer, Dry Transfer, Vertical-Below Ground.

PNL REPORT
PNL-4795-UC-85

TYPE 5

0407-0045RJ 1/22/90

9 1 2 5 3 0 7 5 0

3. Design Considerations for On-site Spent Fuel Transfer Systems EPRI NP-6425

This 1989 assessment by EPRI established design considerations for on-site spent fuel transfer systems and provided capital cost estimates for dry-to-dry and wet-to-dry cask transfer concepts which are reviewed as follows.

a. Dry transfer, vertical, fuel transfer mechanism (FTM) - Type 6

In the context of an MRS application, this design concept is reviewed on the basis of spent fuel transfer from any shipping cask to an MRS concrete storage cask.

This Temporary Site Transfer Facility, which is that contained in the NUS report TTC-0736, consists of a 40 feet by 12 feet by 34 feet high transfer structure. This structure is shipped to the site in five (5) assemblies which are mechanically assembled at the site and mounted on support columns over an existing rail spur for access underneath by the casks. Contained within this structure is the equipment necessary to remove the cask lids and transfer the fuel. The support systems and facilities consist of equipment and mobile structures which are leased from local distributors. All these systems are contained within an approximate 725 feet by 200 feet secured area which is sized to contain a maximum of five (5) rail cars after transfer operations. Once the site has been prepared, a rail car is brought on site, inspected, and set up under the transfer structure, next to the rail cask. Once in position the cask covers are removed and stored via the Cask Cover Handling Mechanism. After the cask covers have been removed a Fuel Transfer Mechanism is positioned over one of the fuel assemblies in the truck cask. The shielded transfer cell is then lowered down into the cask where a fuel grapple assembly engages the fuel. The fuel assembly is then lifted up into the shielded cell and transferred to the rail cask. This operation continues until all fuel has been transferred from the truck cask.

The information provided for this concept assumes the facility is located on a host site that is able to provide all necessary infrastructure. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

In 1986 dollars the original cost estimates for 1400 MTHM (100% of equipment capacity, 100% production time availability) are:

| | |
|---|---|
| Design and Engineering | $3.3 million |
| Capital Costs | $0.5 million |
| Annual Operating Costs | $3.2 million |

The disposal of the fuel debris from the Three Mile Island Unit 2 (TMI-Unit 2) power station utilized a transfer system similar to the Fuel Transfer Mechanism described above for removing fuel debris canisters from the pool into a shipping cask. The fuel debris operations for TMI-Unit 2 have involved on the order of 100 MTHM for spent fuel transfer with transfer operations spread over 3 - 4 years. (See Figure 8.)

b. <u>Wet transfer, vertical, fuel transfer mechanism (FTM)</u> - Type 7

Figure 9 illustrates a wet generic transfer concept. The storage or transport cask is placed in the bottom of a rectangular pool capable of holding two casks side-by-side (to accommodate cask-to-cask transfers). A shield and support structure (SASS) is mounted at the top of the pool. This then provides both support for the transfer device and shielding during the transfer operation. The SASS can be positioned over the appropriate cask fuel basket opening(s). Pool depth is about 28 feet, 10 feet more than the cask lid height.

The entire pool is enclosed by a light-weight building that provides secondary confinement and has a filtered exhaust. Access to the pool is via a removable roof panel. A mobile crane is used to place and remove the casks and transfer device. Pool cleanup is by a mobile radwaste treatment system.

The details of the transfer device alignment, lid handling, fuel handling, and contamination control mechanisms are well beyond this discussion. Nevertheless, the figure conceptually shows several approaches to satisfying the transfer system design requirements from the above sections. This design concept for wet transfer has not been developed in further detail.

However, in reviewing NRC licensed and overseas operating non-reactor wet transfer facilities, there are 3 locations where wet transfer of spent fuel is being done. These are (i) G.E. Morris spent fuel storage facility, Illinois, (ii) NPH facility at the

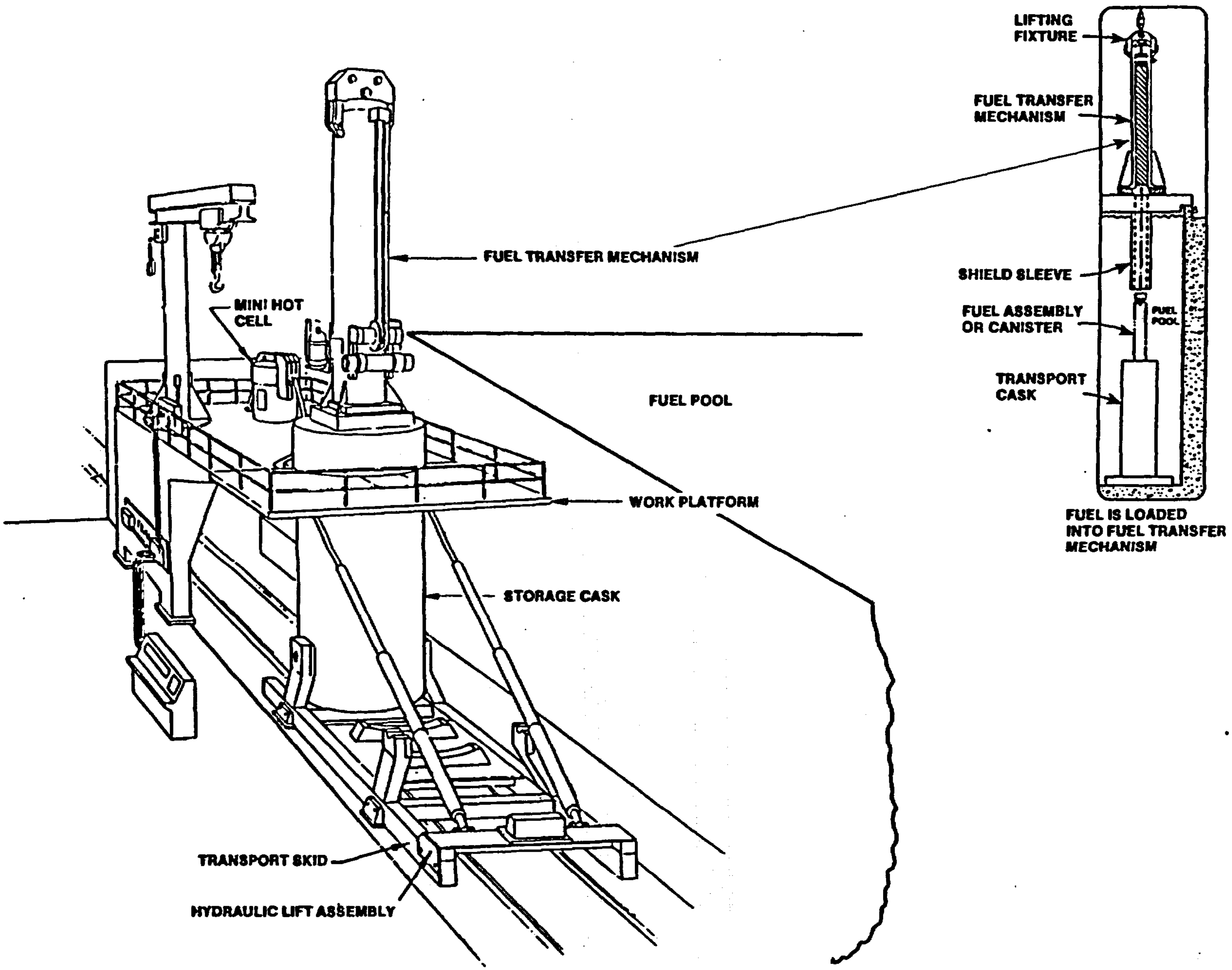


**Figure 8. Dry Transfer, Vertical TMI-Unit 2.**

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TYPE 6

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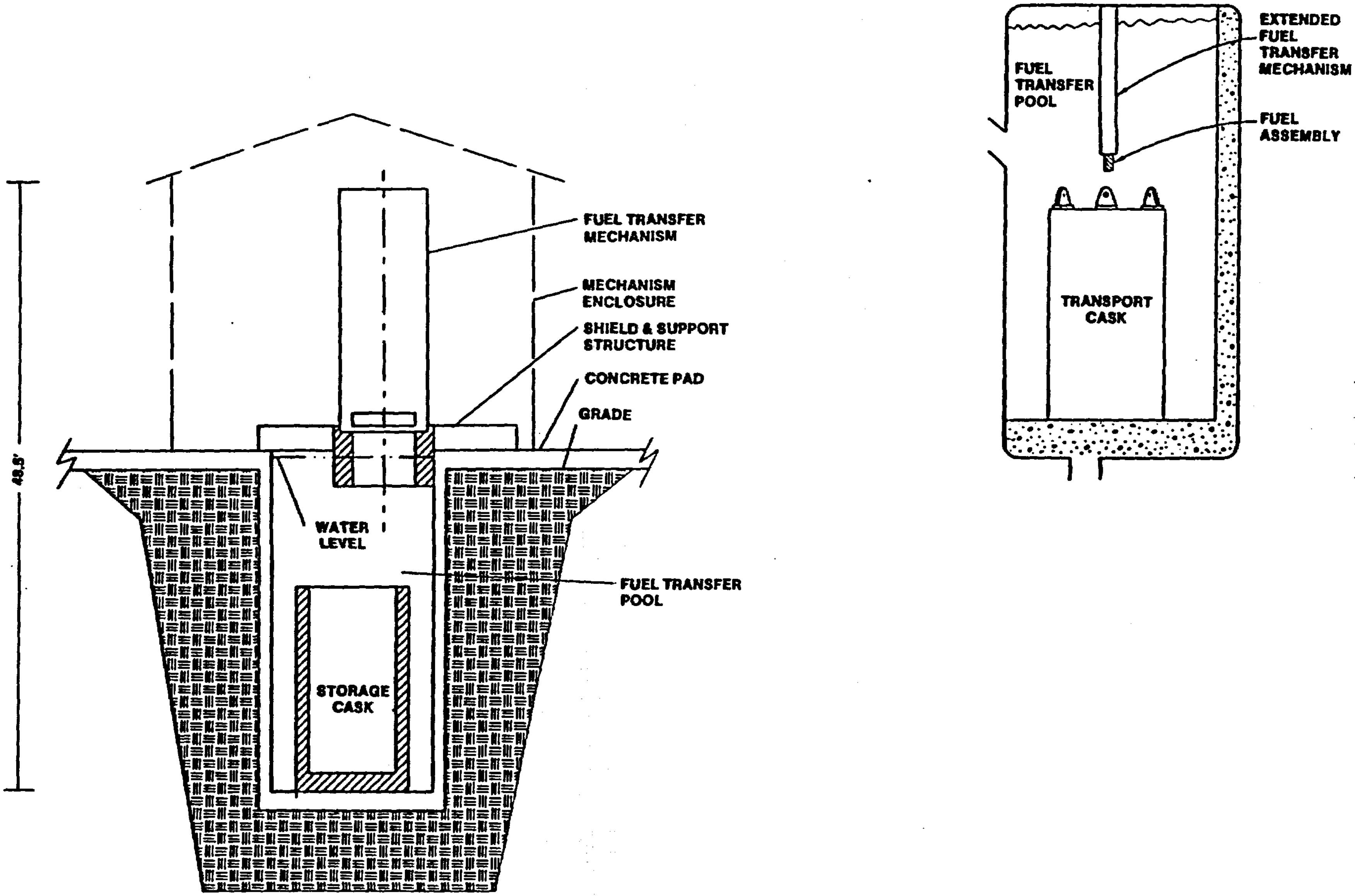


Figure 9. Wet Transfer, Vertical.

EPRI REPORT
EPRI-NP-6425

TYPE 7

COGEMA spent fuel reprocessing plant at La Hague, France, and (iii) the copy of the NPH facility at the CLAB spent fuel storage operation in Sweden. These 3 facilities are described briefly as follows.

(i) The GE - Morris facility has been licensed by the NRC under 10 CFR Part 72 as an Independent Spent Fuel Storage Installation (ISFSI) and has been in operation since 1986. This facility has an integral pool storage capacity of 700 MTHM of light water reactor spent fuel.

(ii) & (iii) This wet pool transfer method has been in use in France since 1981 at its La Hague/COGEMA NPH facility (See Figure 10), and has been in use since 1985 in Sweden at their CLAB facility. The waste is received by either truck or rail in transport casks. The exterior of the casks are cleaned and placed in a cask preparation cell where the cask is sleeved to cool the cask and the fuel temperature is lowered from a maximum air temperature of 360°C to approximately 40°C prior to immersion. The protective sleeve also provides a way to minimize cask contamination in the unloading pool. The cask is then transferred to the 45 feet deep unloading pool where it is immersed, the cap is removed, and the fuel is unloaded manually and placed in a storage container. The transport cask is removed, decontaminated, dried, and inspected for shipment.

The wet pool transfer method provides the means to transfer spent fuel using existing licensed technology and provides the flexibility to use a variety of storage casks. All the major functional requirements stated in the WMSR Volume III can be satisfied by this facility design with the exception of fuel storage. The facilities at COGEMA and CLAB are front end components of arrangements that provide wet pool storage.

The La Hague/COGEMA NPH facility has a throughput capability of 800 MTHM/yr with two independent transfer pools. Additional transfer capacity could be added by building more pools. In fact, however, for additional transfer capacity, COGEMA elected to adopt a dry transfer facility (TO facility) designed for 800 MTHM/yr on the basis of reduced operating costs and significant reductions in operator man-rem exposures made possible by extensive use of robotic equipment in the dry environment of the TO facility.

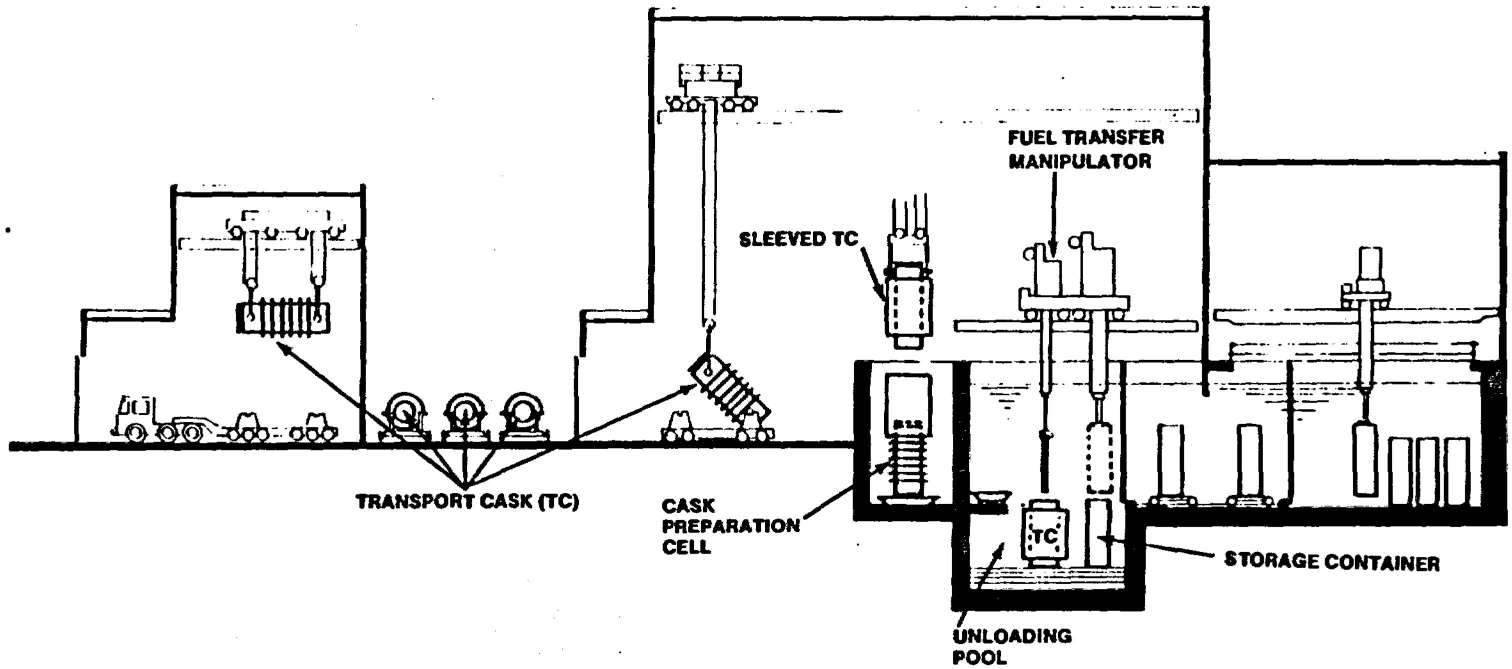


**Figure 10. NPH Wet Unloading Facility.**

LA HAGUE/COGEMA
SGN-NUMATEC

The La Hague/COGEMA NPH facility has been in operation since 1981 and the CLAB facility in Sweden since 1985. In addition, the La Hague/COGEMA NPH facility has been licensed by the French equivalent to the NRC, and the Swedish CLAB facility has been licensed in accordance with the Swedish Atomic Energy Act. However the NPH technology has no specific experience with the U.S. NRC.

Detailed cost, schedule, and licensing analyses of this concept are contained in Section V.

4. Dry Transfer Cask Design and Feasibility Study - Final Report NUS TTC-0736

This 1987 feasibility study, by NUS Corporation, identifies equipment and facilities required for dry transfer of spent fuel assemblies from an over-the-road cask to a rail cask. In the context of an MRS application, these design concepts are reviewed on the basis of spent fuel transfer from any shipping cask to an MRS concrete storage cask. The applicable concepts contained in this report are reviewed as follows.

a. Dry transfer, horizontal to vertical - Type 8

This concept consists of a fuel transfer station with truck cask and rail docking stations enabling spent fuel to be withdrawn horizontally from truck cask and, by means of a tilting hot cell mechanism, transferred vertically to a rail cask. The concept as described in the reference document does not provide for an enclosure building and the transfer station structure measures 25 feet in height with a plan footprint of 31'-0" x 13'-0". No information is provided for throughput capacity (MTHM/yr) for this transfer technology. (See Figure 11) Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

From the referenced data, no information is provided on facility costs or schedule durations. Also, there is no reported NRC licensing history for this concept.

b. Dry transfer, vertical, permanent facility - Type 9

The Permanent Transfer Facility consists of a 173 feet by 200 feet by 74 feet high Fuel Transfer Building situated within an approximate 1350 feet by 400 feet secured area. This area is sized to store a maximum of eight (8) loaded and (8) empty rail cars and to provide

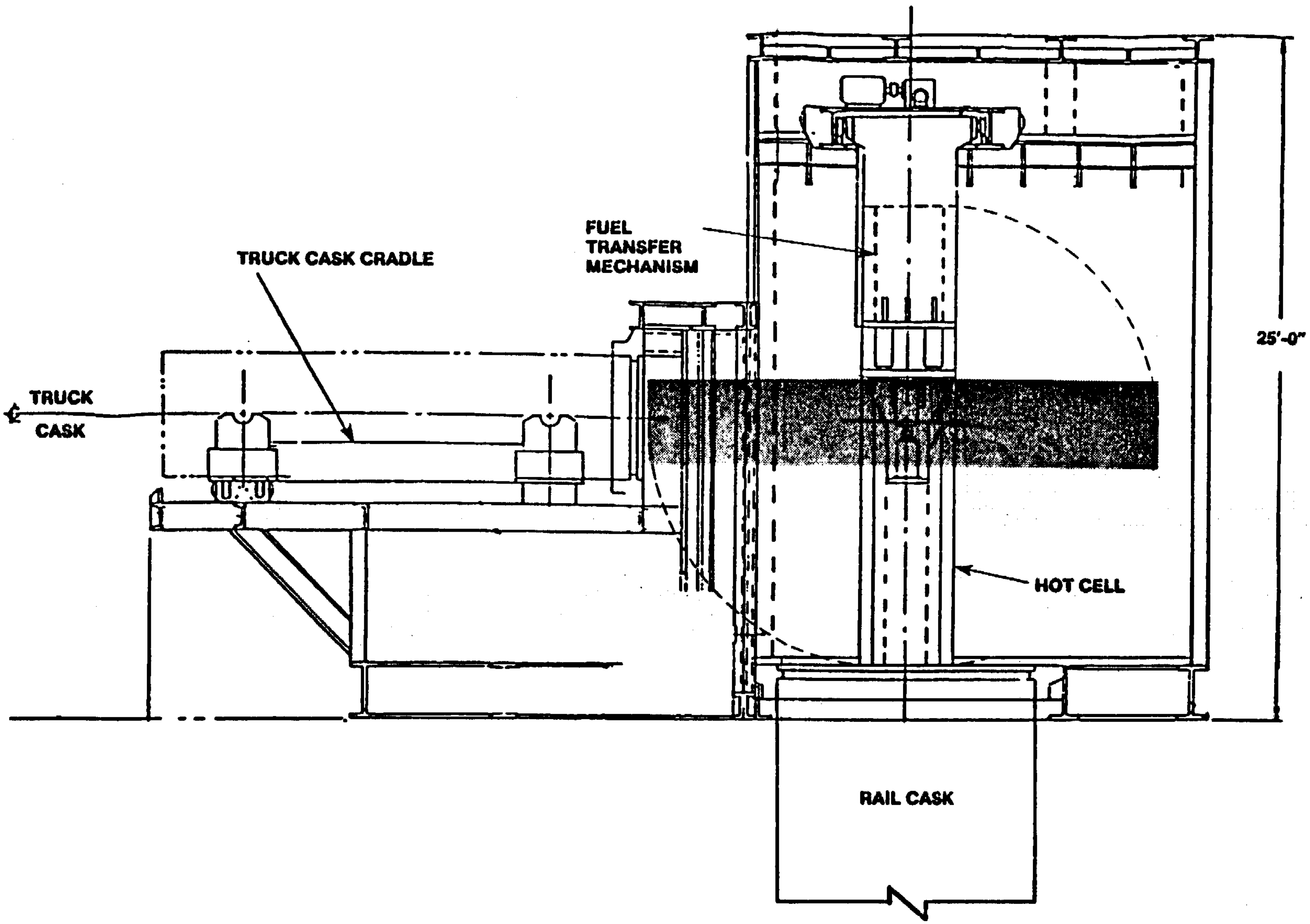


Figure 11. Dry Transfer, Horizontal to Vertical.

NUS REPORT
NUS-TTC-0736

TYPE 8

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on-site free movement but does not meet the requirements of 10 CFR Part 72 which mandates a 100 meter zone beyond a fuel storage or handling area. The Fuel Transfer Building consists of structural steel framing with insulated metal siding and a steel roof deck with rigid insulation and membrane roofing. Contained within this structure is an 84 feet by 48.5 feet by 26.5 feet high hardened concrete cell which contains the equipment necessary to transfer fuel.

This transfer cell consists of three bays, one for the rail cask, and two for the truck casks, with three stations in each bay. The first station is the load-in and load-out area, and cask decontamination area. The second station is the cask cover removal area, and contains the equipment, crane, stud tensioner, and cask cover support systems for removing, storing, and reinstalling the cask covers. The third station is the fuel transfer area and contains the equipment, fuel transfer mechanism, and cask docking systems for transferring fuel from one cask to another. (See Figure 12.)

This type of dry transfer concept has been employed by COGEMA at the TO facility of the French reprocessing plant at La Hague. This facility is sized for 800 MTHM/yr throughput and has been in operation since September, 1986. Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

This facility design concept shares many of the features of the Spent Fuel Handling Building (SFHB) described in the DOE MRS Position Paper of June, 1989. In reviewing the cost data developed for this NUS study, it is evident that there are very significant differences in capital costs and operations costs compared to those developed by PNL/R. M. Parsons for the SFHB. Based on the available information, there are no reasons to believe that the schedules and licensing durations would differ significantly from those being estimated for the SFHB.

c. <u>Dry transfer, vertical, below grade, fuel transfer mechanism (FTM)</u> - Type 10

This concept uses a shielded fuel transfer mechanism to transfer fuel between transport and storage casks. Although no specific throughput rate is stated, it is considered that each unit or module could achieve a rate of between 300 and 600 MTHM/yr based on a cask receipt modal split of 45%/55% truck/rail. (See

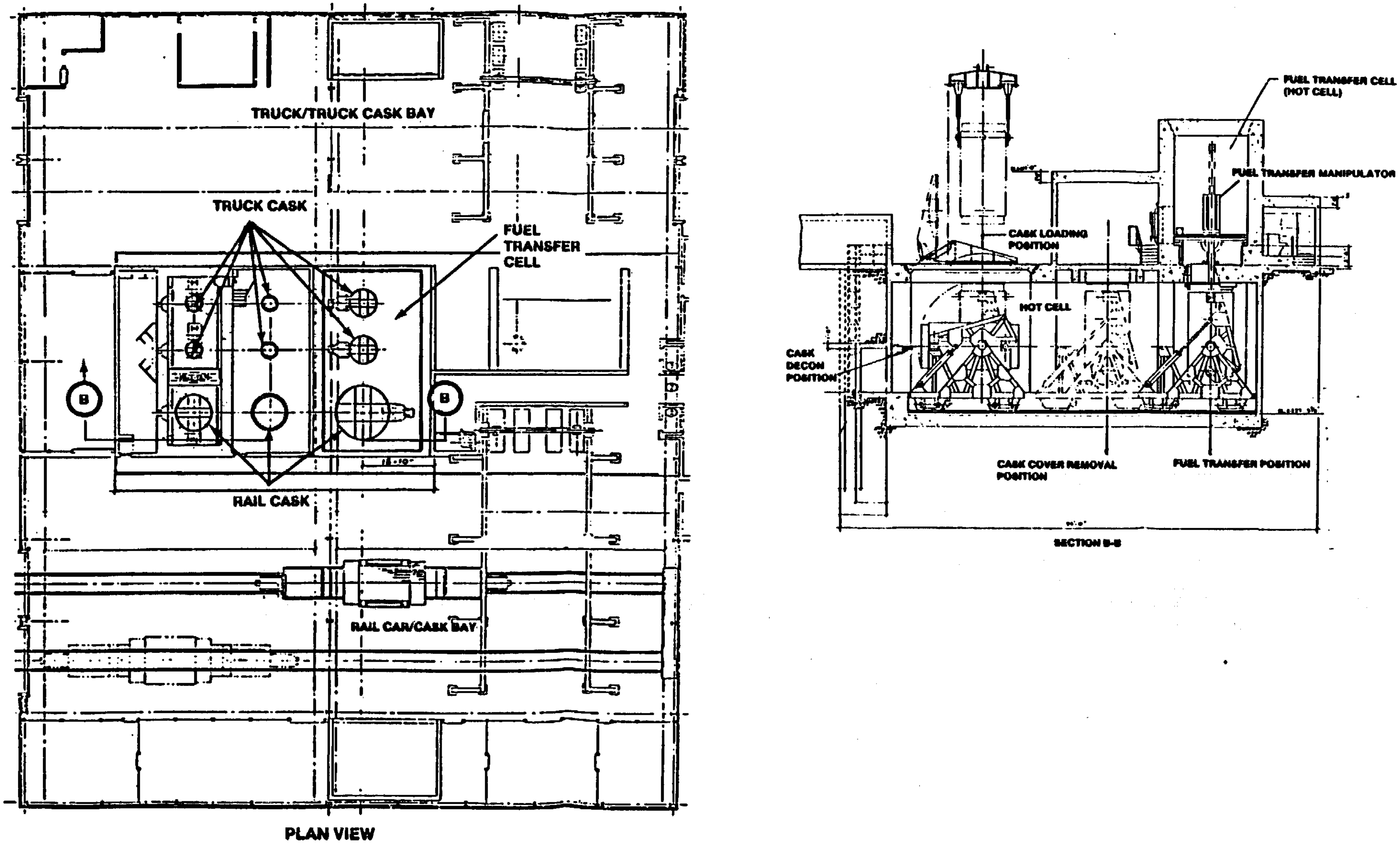


**Figure 12. Dry Transfer, Vertical-Above Permanent Transfer Facility.**

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Figure 13.) Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

From the referenced data, no information is provided on facility costs or schedule durations. Also, there is no reported NRC licensing history for this concept.

d. Dry transfer, horizontal, mobile hot cell - Type 11

This concept consists of a steel transfer structure within which truck and rail casks are docked horizontally and the spent fuel transfer is accomplished through a mobile hot cell with integral fuel transfer mechanism which travels between the docked casks. From the referenced document an enclosure building is not provided and the overall structure dimensions are for a plan footprint of 18 feet X 48 feet and 15 feet high. No throughput capacities (MTHM/yr) are provided. (See Figure 14.) Not all the major MRS functional requirements stated in the WMSR Volume III can be satisfied by this concept. (See Table 1.)

From the referenced data, no information is provided on facility costs or schedule durations. Also, there is no reported NRC licensing history for this concept.

5. Other Concepts

a. NUHOMS - Type 12

The spent fuel storage concept designed by NUTECH, Inc., a division of Pacific Nuclear Systems, and named NUHOMS (Nutech Horizontal Modular Storage), consists of a number of dry shielded fuel canisters (DSC) which are each housed in a horizontal concrete storage module.

The major components of the NUHOMS system are a stainless-steel canister, a concrete horizontal storage module, a transfer cask, and a special-purpose trailer. The canister includes an internal basket for maintaining the assemblies in a safe configuration. The transfer cask provides shielding from radiation, protects the canisters as they are moved from the storage pool to the dry-storage facility, and provides the precise alignment required to mate the transfer cask with the concrete storage module; it contains a hydraulic ram for loading the canister into the concrete module. The module provides radiation shielding and protects the canister in storage and the concrete-module dry storage facility contains a central

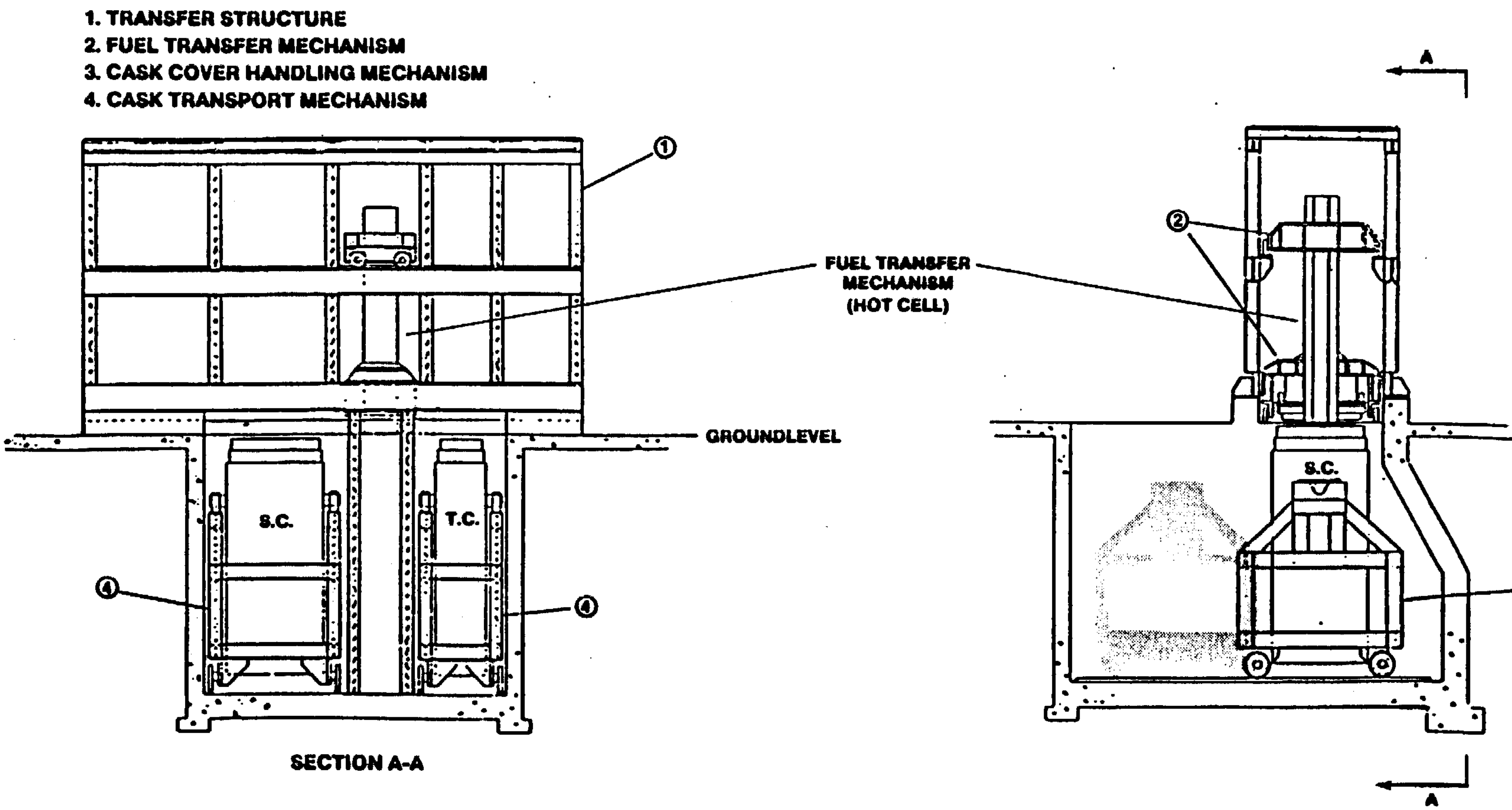


**Figure 13. Dry Transfer, Below Ground.**

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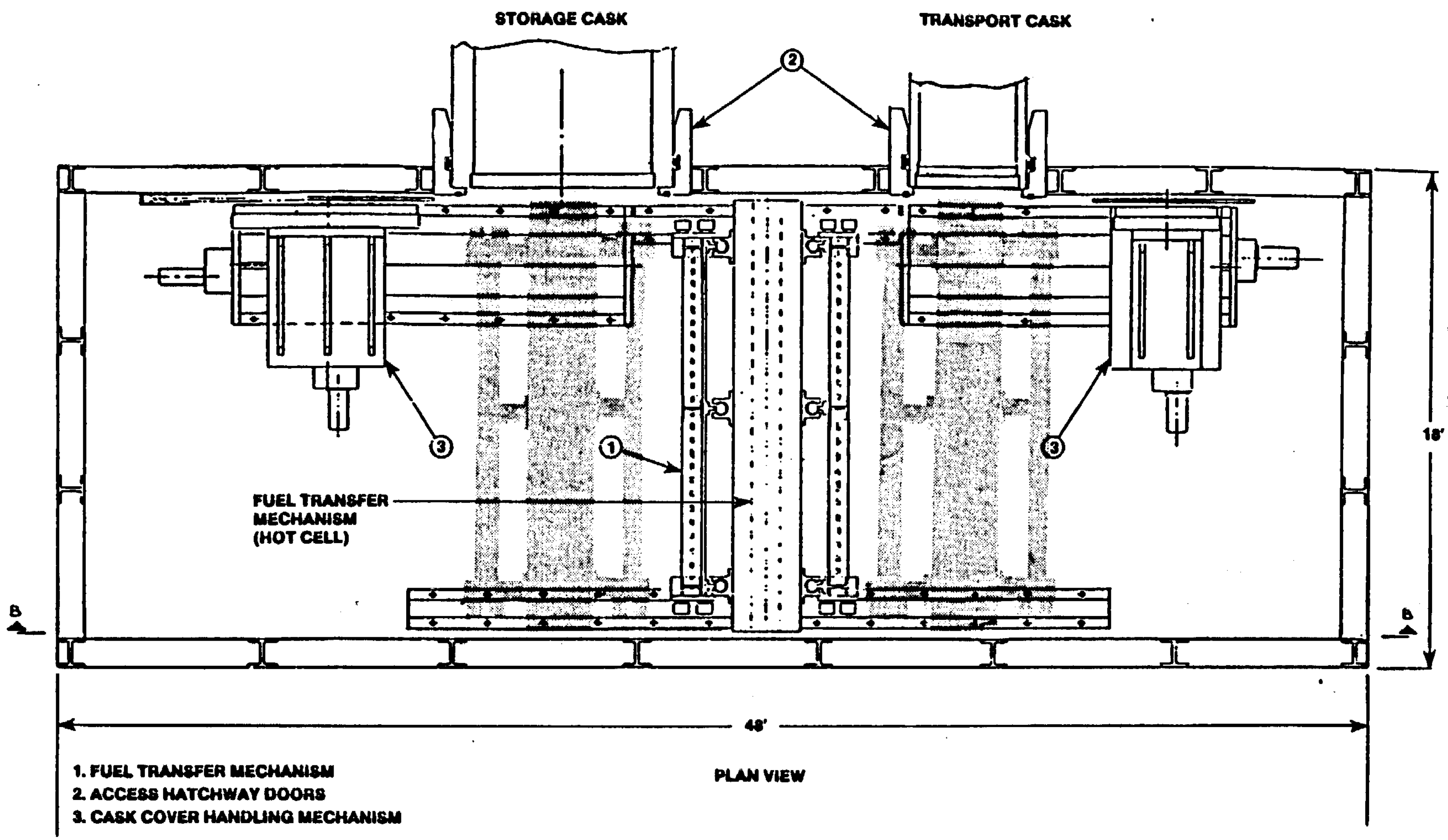


**Figure 14.** Dry Transfer, Horizontal Mobile Hot Cell.

NUS REPORT
NUS-TTC-0736

TYPE 11

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monitoring and security system. In terms of storage-pad area, horizontal concrete modules will typically require up to approximately 450 square feet per metric ton of heavy metal, depending on the capacity of each module.

The NUHOMS system has been developed primarily to meet at-reactor storage needs and is dependant therefore on at-reactor facilities, such as the fuel pool for loading the DSC with spent fuel and a site specific transfer cask for moving the spent fuel from the pool to the concrete storage modules. Due to this application history, the NUHOMS has not been customized for an MRS deployment and does not, therefore, meet all the WMSR Volume III requirements.

The NUHOMS fuel transfer operations are shown in Figure 15 including the major components of the Dry Shielded Canister (DSC) and Horizontal Storage Module (HSM).

The DSC has been designed for two spent fuel capacities and the design parameters are as follows.

| | | |
|---|---|---|
| DSC Capacity | 7 PWR<br>14 BWR | 24 PWR<br>52-60 BWR |
| DSC Length | 179 in. | 186.5 in. |
| DSC Diameter | 37 in. | 67.24 in. |
| DSC Material | SS | SS |
| DSC Thickness | 0.5 in. | 0.625 in. |
| DSC Weight (loaded) | 11 Tons | 40 Tons |

NUHOMS concrete modules have been licensed by NRC and are in operation at the CP&L - H. B. Robinson unit, and are under construction at the Duke Power - Oconee units.

From the DOE document <u>Final Version Dry Cask Storage Study</u> (DOE RW-0220), February 1989, costs, in 1988 constant dollars, for NUHOMS spent fuel at-reactor storage has been estimated as follows.

| | |
|---|---|
| NRC licensing | $300,000 - 1,000,000 |
| Storage facility | |
| Fixed cost | $500,000 - 1,000,000 |
| Variable cost ($/kg heavy metal) | 2 - 3 |
| Dry-loading equipment | |
| Fixed cost | $0 - 250,000 |
| Variable cost ($/kg heavy metal) | 0 - 3 |

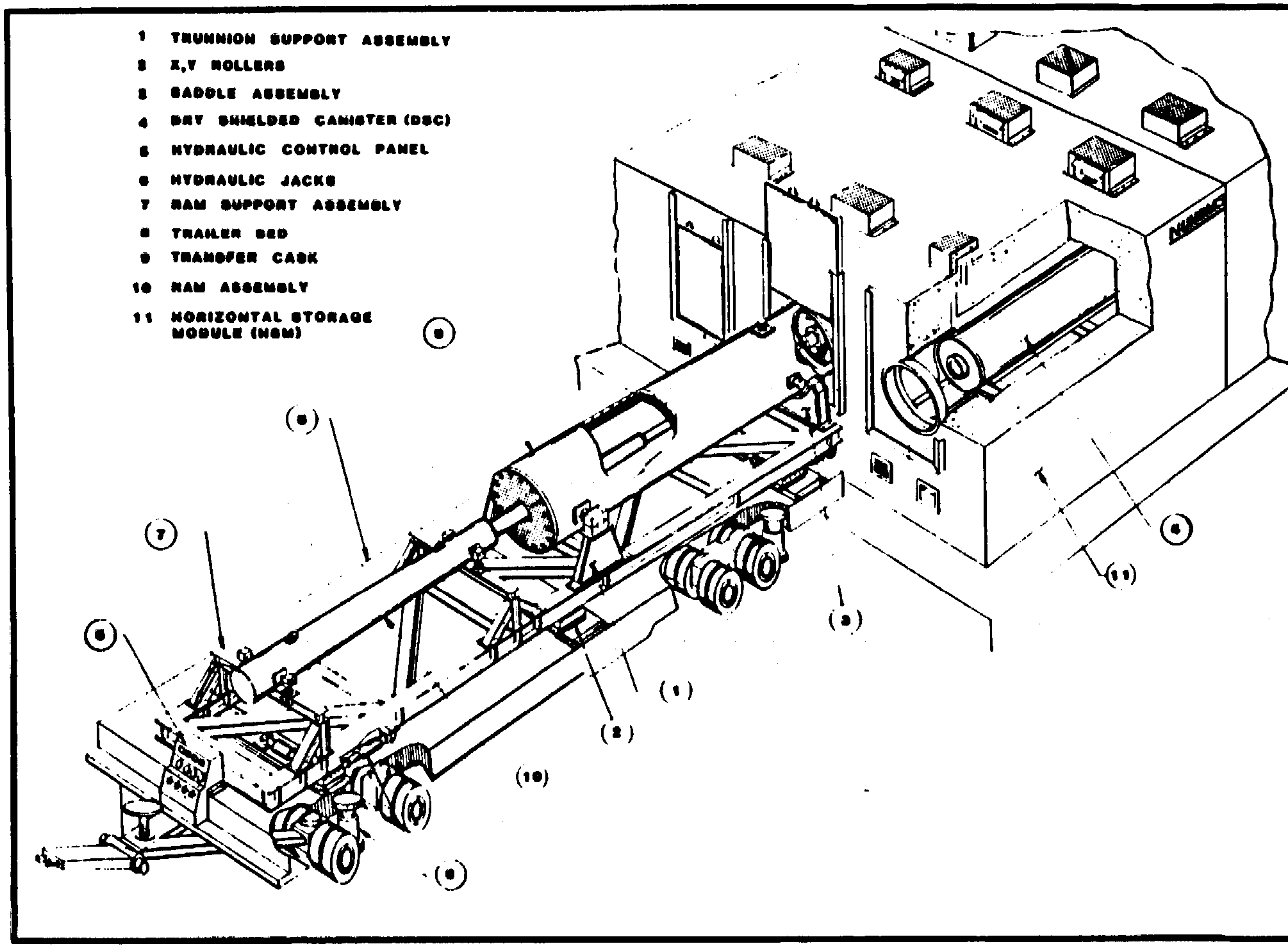



**Figure 15. NUTECH Horizontal Modular Storage.**

**NUHOMS**

| | |
|---|---|
| Canning cost for dry loading | |
| Fixed cost | $0 - 150,000 |
| Variable cost ($/kg heavy metal) | 0 - 10 |
| Cask costs ($/kg heavy metal) | 40 - 61 |
| Loading and placing the cask ($/kg heavy metal) | 1 - 4 |
| Unloading the cask ($/kg heavy metal) | 1 - 4 |
| Total costs | |
| Fixed cost | $800,000 - 2,400,000 |
| Variable cost ($/kg heavy metal) | 44 - 85 |

The construction schedule for the Duke Power - Oconee facility has been stated as follows.

| | |
|---|---|
| Award DSC/Transfer Cask fabrication contracts | 11/01/88 |
| Begin facility construction | 04/01/89 |
| Deliver transport equipment/cask | 08/01/89 |
| Deliver first DSC for dry runs | 11/01/89 |
| Install first fuel loaded DSC into Horizontal Storage Module (HSM) | 01/31/90 |

b. Modular Vault Dry Storage (MVDS), horizontal (FUELSTOR) - Type 13

At the January, 1990 Institute of Nuclear Materials Management (INMM) seminar in Washington, D.C., Advanced Nuclear Fuels Corporation (subsidiary of KWU - Siemens Generation, West Germany) introduced a dry spent fuel storage concept entitled FUELSTOR (FUel Encapsulation and Lag STORage facility). This concept is a vault type storage in which spent fuel assemblies are received, unloaded through a hot cell, and transferred to storage in canisters individually sealed and containing an inert gas atmosphere. The canisters are stored horizontally in specially designed racks within a concrete vault.

This concept of modular vault dry transfer and storage is similar to the Foster Wheeler MVDS in that it employs a passive air heat transport system and can be deployed in concrete modules with modules added in increments for additional capacity. The fuel loading in this concept is arranged horizontally whereas in the Foster Wheeler MVDS it is arranged vertically.

This design concept would meet the WMSR Volume III requirements with the exception of monitoring of the stored spent fuel. The KWU approach to this requirement has been to provide a double barrier protection by means of the sealed canisters. The canister placement appears to be limited by the first-in/last-out feature for fuel removal and the canister racks' height of 31 tiers appears to be predicated on canister/rack compressive dead weight loading.

Figure 16 shows an artist's impression of a facility sized for 500 MTHM and configured for an at-reactor application. Figure 17 similarly shows a 3,000 MTHM storage facility arranged for away-from-reactor locations.

Figure 18 shows engineering outline plans and elevations for the 500 MTHM facility.

The design throughput rates interpreted from the available technical data range between 200 to 800 MTHM/yr for the facility concepts presently configured. This concept has been developed in West Germany and is being marketed in the U.S. Both the 500 MTHM and the 3,000 MTHM facility designs can be expanded in modules. Currently there are no operating experiences or demonstration plants and no NRC or other licensing experiences. This design has not been evaluated by licensing authorities in the country of origin (West Germany) and no firm date has been established for submitting a topical report to the NRC.

Based on the available literature on FUELSTOR and answers to questions, the following cost and construction estimates have been provided.

| | 500 MTHM | 3,000 MTHM |
|---|---|---|
| Capital costs | $20 million (FY 1990) | $75 million (FY 1990) |
| Unit costs based on full facility storage | $36 - 40/kg HM | $25/kg HM |

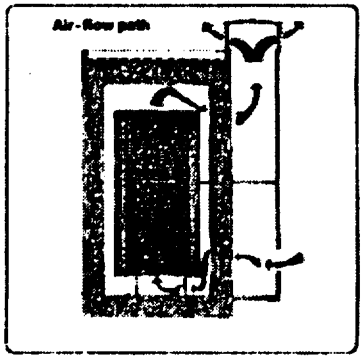
# FUELSTOR

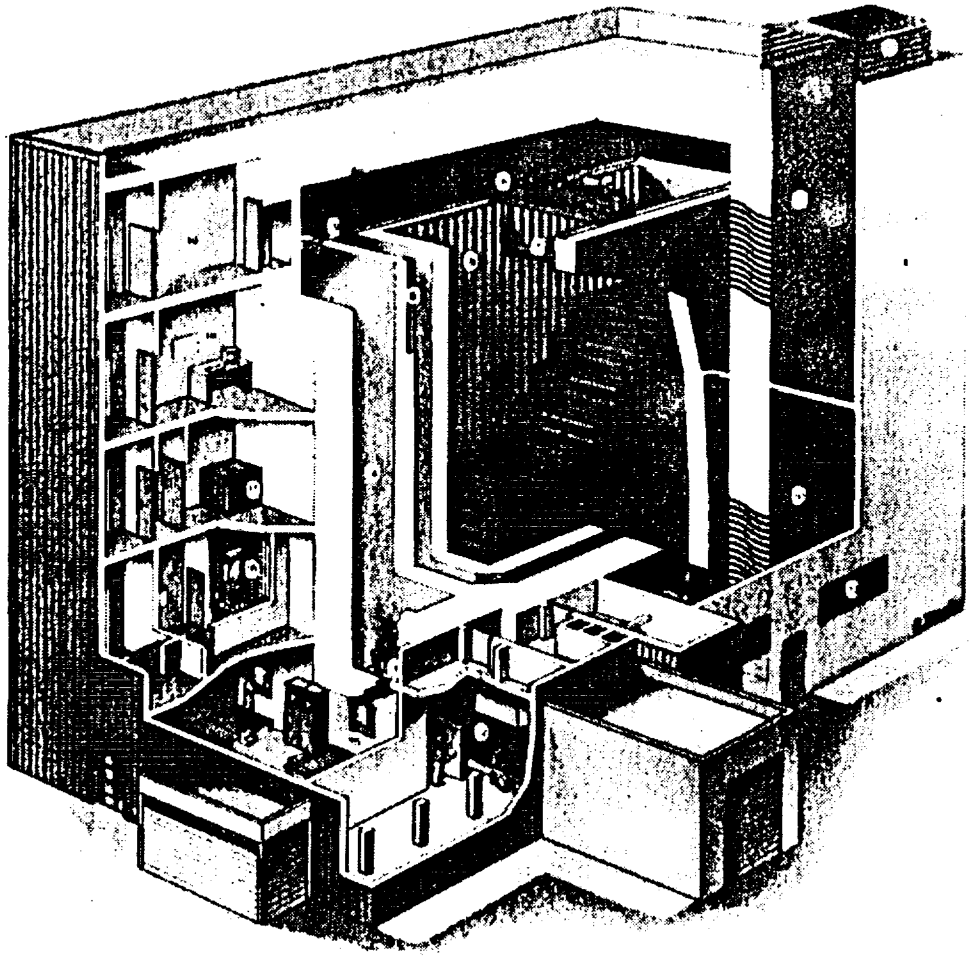
## FUEL ENCAPSULATION AND LAG STORAGE FACILITY

**For at-reactor dry storage of spent fuel**

**Main technical features**

- Passive cooling by natural convection ensuring low fuel temperatures
- Low initial storage temperature resulting in no restrictions regarding the length of the storage period
- Sealed canister storage for double leak protection
- Horizontal placement of helium-filled canisters in storage vault
- Reinforced concrete construction for safe shielding resulting in radiation levels outside the building below permissible dose of unrestricted area (ALARA)
- Reinforced concrete construction to withstand the effects of natural phenomena and man - induced events such a earthquakes, tornado missiles and aircraft crashes
- Nuclear criticality safety is ensured by the building design as well as spent fuel canister arrangement
- Store is easily expandable by modules
- Low land consumption due to compact spent fuel storage
- Nuclear safeguard provisions



**Technical data**

| | | | |
|---|---|---|---|
| Storage capacity | [illegible] | [illegible] | |
| [illegible] | 1000 | [illegible] | 15.0 m |
| [illegible] | - | [illegible] | 9 m |
| [illegible] | 2 3 | [illegible] | 10 m |
| [illegible] | 450 mm | Building dimensions | |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | [illegible] | [illegible] | 25.4 m |
| [illegible] | 30 °C | [illegible] | 17 m |
| [illegible] | 130 °C | [illegible] | 21 m |
| [illegible] | 250 °C | [illegible] | |
| [illegible] | [illegible] | [illegible] | 7.5 m |
| [illegible] | [illegible] | [illegible] | 17 m |
| | [illegible] | [illegible] | 21 m |

**Key to FUELSTOR storage facility**

6 Loading machine
7 Canister
9 Loading machine rails
10 Air inlet ducts
11 Air outlet ducts
12 Store exhaust air stack
13 Weather grid
14 Facade
15 Shielded operating position
16 Washroom
17 Switchgear
18 Office
19 Access repair and maintenance

**ADVANCED NUCLEAR FUELS**
CORPORATION

TYPE 13

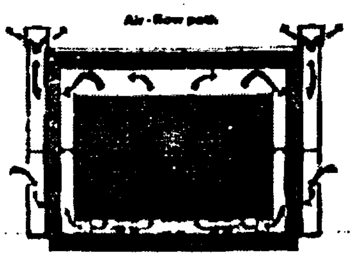
Figure 16: FUELSTOR

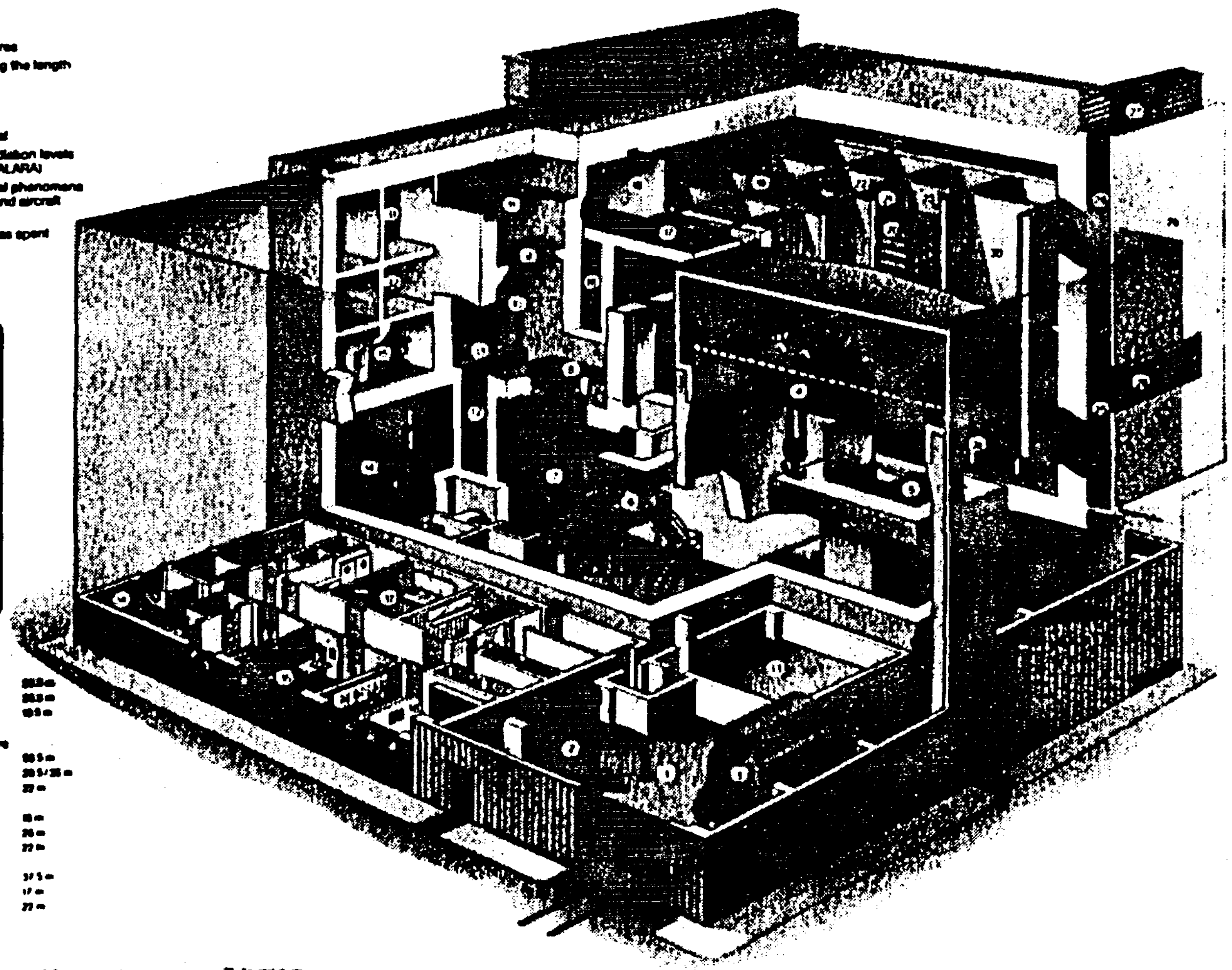
# FUELSTOR FUEL ENCAPSULATION AND LAG STORAGE FACILITY

**For away-from-reactor dry storage of spent fuel**

### Main technical features

- Passive cooling by natural convection ensuring low fuel temperatures
- Low initial storage temperature resulting in no restrictions regarding the length of the storage period
- Sealed canister storage for double leak protection
- Horizontal placement of helium-filled canisters in storage vault
- Simple reverse handling procedure for fuel removal to final disposal
- Reinforced concrete construction for safe shielding resulting in radiation levels outside the building below permissible dose of unrestricted area (ALARA)
- Reinforced concrete construction to withstand the effects of natural phenomena and man - induced events such a earthquakes, tornado missiles and aircraft crashes
- Nuclear criticality safety is ensured by the building design as well as spent fuel canister arrangement
- Store is easily expandable by modules
- Low land consumption due to compact spent fuel storage
- Nuclear safeguard provisions



### Technical data

| | | | |
|---|---|---|---|
| Storage capacity | 3000 MTU | Vault storage dimensions | |
| Spent fuel canisters | 6000 | depth | [illegible] |
| PWR fuel assemblies per canister | 1 | width | [illegible] |
| BWR fuel assemblies per canister | 2 - 3 | height | 10.5 m |
| Canister pitch | 450 mm | Building dimensions | |
| Max. receiving rate (SC = Shipping cask) | 170 SC/a | - loading/storage building | |
| Maximum receiving rate | 4 SC/week | depth | 88.5 m |
| Air inlet temperature | 30 °C | width | 20.5/35 m |
| Maximum air outlet temperature | 130 °C | height | 22 m |
| Maximum fuel cladding temperature | 250 °C | - auxiliary building | |
| Decay heat of irradiated fuel | 2 kW/tgU | depth | 18 m |
| Maximum surface dose rate | [illegible] | width | 26 m |
| | [illegible] | height | 22 m |
| | | - receiving building | |
| | | depth | 37.5 m |
| | | width | 17 m |
| | | height | 22 m |

### Key to FUELSTOR storage facility

9 Unloading cell crane
10 Fuel assembly grab
12 Interim fuel assembly store
16 Transfer shaft
17 Traversing platform
18 Steel door
19 Loading machine
20 Canister in storage position
22 Loading machine rails
23 Partition walls
24 Canister support
25 Air inlet ducts
26 Air outlet ducts
27 Store exhaust air stack
28 Weather grid
29 Facade
30 Storage wall
31 Exhaust air filter room
32 Service room
33 Hot workshop
34 Gate (Personnel Entrance)
35 Cold workshop
36 Office
37 Washroom

**ADVANCED NUCLEAR FUELS CORPORATION**

TYPE 13

Figure 17: FUELSTOR

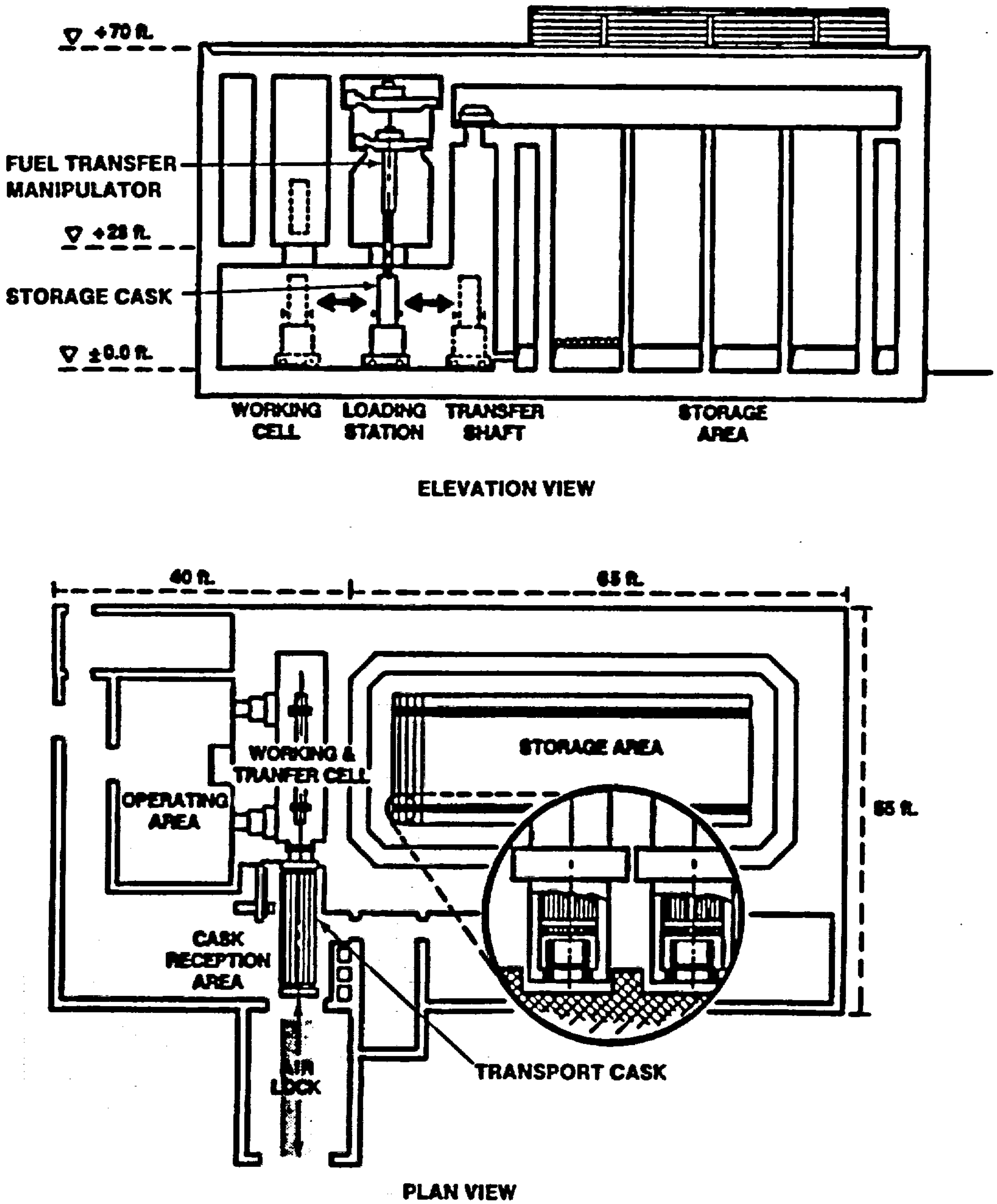



Figure 18. Fuelstor

TYPE 13

| | | |
|---|---|---|
| Annual operating costs during fuel handling operations | $0.5 - 1.0 million | $3 - 3.5 million |
| Estimates for incremental modular expansion | Not available | $15/kg HM |
| Construction durations | 18 months | 24 - 36 months |

This concept is closely related to type 1 (Foster Wheeler MVDS) but not as mature in terms of design development, NRC licensing, or operating experience.

## IV. COMPARISON OF DESIGN ALTERNATIVES

The 13 spent fuel transfer concepts reviewed lend themselves to family groups in five categories describing their basic transfer modes and equipment as follows.

| | |
|---|---|
| Category (A) | Dry transfer by use of a shielded fuel transfer mechanism or device. (See Figure 5 for a typical example.) |
| Category (B) | Dry transfer by use of a permanent or prefabricated hot cell facility. (See Figure 7 for a typical example.) |
| Category (C) | Dry transfer in dry shielded canisters. (See Figure 15 for a typical example.) |
| Category (D) | Wet transfer in pool. (See Figure 9 for a typical example.) |
| Category (E) | Modular concrete dry transfer and storage (See Figure 2 for a typical example.) |

The design configurations within each category were examined to determine the most suitable for further analysis. For the conceptual designs examined within these categories, the following determinations were made.

<u>Category (A)</u> comprises Types 2, 3, 4, 6, 8, 10, and 11 and these are individually assessed as follows:

<u>Type 6</u>.
The only operating experience for this spent fuel transfer concept is that designed for the approximately 100 MTHM of TMI - Unit 2 fuel and is based on a fuel transfer device that unloads from a wet pool cask. To upgrade this design for the throughputs being specified (400 MTHM/yr minimum) the Fuel Transfer Device would require extensive modifications and demonstration trials to meet anticipated NRC requirements. It is considered that this design is severely constrained in terms of equipment qualification and that it should be eliminated from further consideration accordingly.

<u>Type 8</u>.
This concept involves a tilting hot cell device for transferring between transport and shipping casks. It is anticipated that the NRC qualification of such a mechanism would require extensive design reviews and cold fuel and hot fuel demonstration programs. There are no concepts of this type being proposed by fuel

handling vendors and estimates of costs and schedules for demonstrating this technology would be speculative at best. For example, the work on dry rod consolidation sponsored by the DOE through INEL involved customized fuel handling equipment development which was budgeted at about $30 million and was scheduled over a 3 1/2 year duration. The uncertainty associated with obtaining NRC approval of this concept at an early date should eliminate this type from further consideration for rapid deployment at an MRS facility.

Types 2, 3, 4, 10, and 11.
These types all incorporate complex fuel handling mechanisms or devices which suffer from the same disadvantages as Type 8 as far as NRC approval is concerned and therefore should be eliminated from further consideration.

Category (B) comprises Types 5 and 9 which are individually addressed as follows:

Type 5.
This concept is a unit facility design estimated to be capable of between 300 and 600 MTHM/yr throughput and incorporates a prefabricated modular hot cell with unloading trenches below grade and fuel transfer by commercially available electro-mechanical manipulators. This concept's simplicity, ease of construction, and apparent absence of significant NRC licensing issues commend it for further examination.

Type 9.
This design is for a full function permanent fuel handling facility similar to the Spent Fuel Handling Building (SFHB) developed by PNL/R. M. Parsons for the 1989 MRS System Studies. From the information provided in the reference material, it appears unlikely that the construction for this concept would be any less than the 26 to 30 months being estimated for the SFHB and therefore this design is considered to be unsuitable for facilitating early MRS waste acceptance. Similarly, a review of the TO facility at the COGEMA, La Hague, France facility for the 800 MTHM/yr throughput design revealed a construction duration of 39 months. (See Appendix B for COGEMA data on the TO facility.)

Category (C) comprises Type 12.

The use of NUHOMS (NUTECH) dry shielded canisters (DSC) in concrete storage modules is being employed in several at-reactor storage applications. The use of NUHOMS for an early deployment MRS facility would be dependant on the transportation and transfer capability for the DSC's measuring 70 inches diameter by 190 inches long and weighing approximately 40 tons by NRC certified casks. It is understood that the current DOE transport cask procurement plan does not include a custom designed NUHOMS DSC transporter. Development of such a cask option would require deployment of significant design and testing resources in the near term. Even if and when such a cask became available in the system, its use would be limited to those reactors that have crane capacities over 100 tons. The deployment of NUHOMS at a customized MRS facility would require an extensive spent fuel transfer hot cell capable of dry loading and sealing the 40 ton DSC and a transfer cask for insertion into the concrete modules. It should be noted that the NRC license under 10 CFR Part 72 for NUHOMS is based on wet transfer, not dry transfer. In view of these uncertainties, the use of NUHOMS at an early phased MRS is not being considered further at this time.

Category (D) comprises Type 7.

Wet spent fuel transfer is the NRC licensed technology at over 100 facilities in the U.S. using 10 CFR Part 50 regulations. Additionally, a GE facility at Morris, Illinois has been licensed as an Independent Spent Fuel Storage Installation (ISFSI) under 10 CFR Part 72 regulations. This mode of fuel transfer operations would meet the WMSR Volume III functional requirements. The discriminating aspects of wet to dry transfer are well understood and can be briefly stated as (1) the need for active equipment for pool cooling and water clean-up adding to capital and operating costs, and (2) the potential impacts on spent fuel cladding integrity due to wet/dry/wet/dry environment cycling from reactor storage/transport/MRS wet transfer/MRS dry storage conditions. However, based on the extensive experience with this technology, it is considered a candidate for further examination.

Category (E) comprises Types 1 and 13 which are individually addressed as follows:

Type 1.
The Modular Dry Vault Storage (MVDS) design being marketed to U.S. utilities by Foster Wheeler - GEC meets all the WMSR Vol III functional requirements and the throughputs being specified. Based on statements made by Foster Wheeler on their recent contract from

Colorado Public Service for dry storage of Fort St. Vrain spent fuel, deployment of modular units with capacities of 400 MTHM could be achieved within 12 months after start of construction. It would appear that this concept is a candidate for further detailed evaluation for use as an early phased MRS.

Type 13.
This concept is a vault type storage in which spent fuel assemblies are received, unloaded through a hot cell, and transferred to storage in canisters individually sealed in an inert gas atmosphere. This concept stores spent fuel in canisters horizontally and is being marketed in the U.S. under the name "FUELSTOR." It meets the functional requirements for transfer and storage with the exception of spent fuel monitoring. The canisters are stored horizontally in specially designed racks within a concrete vault. This concept is closely related to the Foster Wheeler MVDS but not as mature in terms of design development, NRC licensing, or operating experience and is, therefore, not considered further at this time.

The overall assessments of the 13 MRS design concepts reviewed are contained in Table 1 - Functional Capabilities, Table 2 - Licensing and Operating Experiences, and Table 3 - Preliminary Cost Estimates. Three concepts have been identified, namely MVDS (Type 1), prefabricated hot cell (Type 5), and wet transfer (Type 7) that are considered to have the potential for early spent fuel acceptance at an MRS, based on the evaluation criteria of design maturity, NRC licenseablity, operational experience, and potential for short construction durations.

## Table 1

**Comparison of MRS design alternatives capabilities to meet the MRS functional requirements**

| Functional Capability / Technical Type | Type 1. Foster Wheeler MVDS | Type 2. Dry transfer, vertical, shuttle | Type 3. Dry transfer, vertical, turntable | Type 4. Dry transfer, vertical, igloo | Type 5. Dry transfer, vertical, below grade, prefabricated hot cell | Type 6. Dry transfer, vertical, fuel transfer mechanism (FTM) | Type 7. Wet transfer, vertical, FTM | Type 8. Dry transfer, horizontal to vertical | Type 9. Dry transfer, vertical, permanent facility | Type 10. Dry transfer, vertical, below grade, FTM | Type 11. Dry transfer, horizontal, mobile hot cell | Type 12. NUHOMS | Type 13. FUELSTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Receives both truck and rail transportation casks | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes | No | No | Yes |
| Ability to decontaminate transportation casks | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | No | No | No | Yes |
| Ability to inspect transportation casks | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | No | No | No | Yes |
| Upending and transport cask handling | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | No | No | Yes |
| Ability to unload spent fuel from transportation casks | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | Yes |
| Ability to inspect and verify received spent fuel | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | No | No | No | Yes |
| Ability to transport spent fuel to onsite storage | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Ability to store spent fuel onsite (1) | Yes | No | No | No | No | No | No | No | No | No | No | Yes | Yes |
| Ability to monitor stored spent fuel (1) | Yes | No | No | No | No | No | No | No | No | No | No | Yes | No |
| Ability to ship spent fuel after onsite storage | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Ability to withstand design basis loadings from natural and manmade phenomena | Yes | NA | NA | NA | NA | Yes | Yes | NA | Yes | NA | NA | Yes | Yes |
| Estimated facility throughput capacity, MTHM/yr | 400 (2) | 525 (2) | 390 - 540(2) | 480 (2) | 435 (2) | NA | 400 (2) | NA | 400 - 3000 | NA | NA | 400 (2) | 500 - 3000 |
| Impact on future packaging capabilities | None | None | None | None | None | None | (3) | None | None | None | None | None | None |

Notes

(1) The No statement implies the facility concept is not designed for integral spent fuel storage; storage capability would be provided in the form of concrete storage casks or other methods.

(2) Throughputs quoted on a per facility basis; increases up to 4,000 MTHM/yr would require additional module duplicates.

(3) Wet/dry operations could cause fuel cladding degradation with consequent impact on fuel disassembly and consolidation operations.

Table 2

Comparison of MRS design alternatives operating and licensing experiences

| Technical Type / Operating and Licensing Experience | Type 1. Foster Wheeler MVDS | Type 2. Dry transfer, vertical, shuttle | Type 3. Dry transfer, vertical, turntable | Type 4. Dry transfer, vertical, igloo | Type 5. Dry transfer, vertical, below grade, prefabricated hot cell | Type 6. Dry transfer, vertical, fuel transfer mechanism (FTM) | Type 7. Wet transfer, vertical, FTM | Type 8. Dry transfer, horizontal to vertical | Type 9. Dry transfer, vertical, permanent facility | Type 10. Dry transfer, vertical, below grade, FTM | Type 11. Dry transfer, horizontal, mobile hot cell | Type 12. NUHOMS | Type 13. FUELSTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NRC - 10 CFR Part 72 License | No(1) | None | None | None | None | None | GE (2) Morris | None | None | None | None | Yes | None |
| NRC topical report | Yes | None | None | None | None | None | NA | None | None | None | None | Yes | None |
| Overseas licensing experience | U.K. | None | None | None | None | None | World wide | None | COGEMA, France | None | None | None | None |
| Date of design concept study | NA | 1983 | 1983 | 1983 | 1983 | 1980 | NA | 1986 | 1987 | 1986 | 1986 | NA | 1990 |

NA = NOT APPLICABLE

Notes: (1) According to the project schedule for Fort St. Vrain, the license application will be submitted in June, 1990.

(2) Licensed at 112 nuclear power plants under 10 CFR Part 50 and at GE-Morris facility in 1971 under 10 CFR Part 70 and in 1981 under 10 CFR Part 72.

Table 3

Cost comparisons of MRS design alternatives for nominal throughput of 400 MTHM/yr

| Technical Type | Type 1. Foster Wheeler MVDS | Type 2. Dry transfer, vertical, shuttle | Type 3. Dry transfer, vertical, turntable | Type 4. Dry transfer, vertical, igloo | Type 5. Dry transfer, vertical, below grade, prefabricated hot cell | Type 6. Dry transfer, vertical, fuel transfer mechanism (FTM) | Type 7. Wet transfer, vertical, FTM | Type 8. Dry transfer, horizontal to vertical | Type 9. Dry transfer, vertical, permanent facility | Type 10. Dry transfer, vertical, below grade, FTM | Type 11. Dry transfer, horizontal, mobile hot cell | Type 12. NUHOMS | Type 13. FUELSTOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 Dollars (millions) | 52.0 | 15.3 | 18.6 | 10.2 | 43.8 | 7.2 | 121.3 | NA | 16.0 | NA | NA | 25.8 | 21.5 |
| Notes | (1) | (2) | (2) | (2) | (3) | (4) | (5) | | (6) | | | (7) | (8) |

NA= NOT AVAILABLE

NOTE: All cost data are derived from reference documents, and specific completeness has not been verified from authors.

(1) For a break down of costs see Table 4.

(2) Cost of transfer facility only. Costs do not include BOP facilities, decommissioning, and cost of concrete storage cask facility or casks for 400 MTHM.

(3) For a break down of costs see Table 5.

(4) Covers cost of transfer mechanism only. Costs do not include decommissioning, licensing, and start up cost; will use existing site BOP facilities.

(5) For a break down of costs see Table 6.

(6) Total facility cost with a 30 year life. Yearly operating cost $6.4 million. Facility has all BOP facilities with a throughput of 2700 MTHM/yr. Cost of concrete storage cask facility or casks not included.

(7) No BOP facilities included. Cost derived from average of fixed and variable cost. The total fixed costs are between $0.8 and $2.4 million and the variable cost is between 44 and 85 dollars per Kg of heavy metal. Average fixed costs have been based on $1.6 million and average variable cost based on 64.5 dollars per Kg of heavy metal. Costs are based on 400 MTHM of storage.

(8) 500 MTHM facility at full capacity.

## V. FURTHER ANALYSES OF THE MOST FEASIBLE CONCEPTS

The most feasible MRS design concepts with the potential for early spent fuel acceptance were evaluated further through contacts with vendors, operators, and a detailed review of licensing information available.

The cost estimates being presented are preliminary in nature and do not represent a rigorous, grounds-up cost estimate. Based on the summary cost data contained in appendix B, every effort has been made to present cost estimates which are on a comparable level. However, due to the lack of detailed cost data available for each of these designs, these cost estimates should not be misinterpreted as representing a true one-to-one comparison of these various technologies.

### 1. Modular Vault Dry Storage, vertical - Type 1

#### a. Design and operations assessment

This MVDS concept provides the capability to dry transfer spent fuel from any shipping cask and also provides spent fuel storage capabilities meeting all the MRS requirements stated in WMSR Volume III and the further requirements referred to in Attachment 1. The vendor of the design being assessed, Foster Wheeler - GEC, has developed a range of options encompassing (i) a topical report to the NRC of a modular design based on light water reactor spent fuel transfer and storage for about 200 MTHM initial capacity, (ii) a modular design custom designed for the Colorado Public Service unit at Fort St. Vrain for an initial capacity of about 200 MTHM of graphite spent fuel, and (iii) a full capacity MRS of 15,000 MTHM. Further details of these design evolutions are contained in Appendix A.

#### b. Licensing assessment

The licensing of any MRS, under 10 CFR Part 72, is a single stage process in which all information (including a complete and final design, quality control procedures, etc.) needed to support the license application is available and complete before a material possession license can be granted prior to the start of MRS construction. Information can be made available, early, to NRC for evaluation and review in the form of a licensing topical report. A licensing topical report generally provides information on a specific subject and NRC approval is sought, and if granted, is later referenced in the license application.

The Modular Vault Dry Storage (MVDS) has been chosen by the Public Service Company of Colorado for storage of spent fuel from its Fort St. Vrain High Temperature Gas Cooled Reactor as an ISFSI. A generic topical report for the MVDS was submitted by Foster-Wheeler and was approved by the NRC in 1988. The concept reviewed by the NRC in the generic topical report provides a design which involves storing irradiated light water reactor (LWR) fuel in individual vertical storage tubes (canisters, thereby meeting 10 CFR Part 72 requirement for maintaining spent fuel cladding integrity) retained within a concrete structure forming the storage vault. This concept also provides, within one unit, ready retrievability of spent fuel; thereby inhibiting the release of radioactive materials to the environment during spent fuel transfer and storage operations.

NRC review of an MRS facility utilizing this MVDS concept may be expedited since the topical report for a specific MRS design utilizing the MVDS concept has been approved and a specific topical report could also be available for referencing in the license application. Due to unitized construction, the MVDS incorporates both the transfer and storage elements in one module and thereby facilitates expedited NRC review. Addition of identical modules to increase storage capacity would not raise any additional licensing issues and could be handled as a license condition to the original materials possession license. However, if the design were to be changed such that there would exist an unreviewed safety question, then a license amendment would be required.

NRC review of an MRS license application utilizing an MVDS system is estimated to take approximately 18 months. The duration is based on the current availability of a topical report on this MVDS concept and the practical experience of obtaining a license under 10 CFR Part 72 for an Independent Spent Fuel Storage Installation (ISFSI) at Fort St. Vrain.

c. <u>Schedule assessment</u>

| | | |
|---|---|---|
| Total Implementation Schedule | - | 28 months |
| Design/Procurement/Fabrication | - | 22 months |
| Construction and Testing | - | 10 months |

The total implementation schedule includes all design, procurement, construction and testing of the facility to begin initial waste acceptance. Some design and procurement activities are conducted in parallel with construction. Therefore, the implementation schedule may be less than the sum of these activities.

This analysis is based upon data furnished by Foster Wheeler for the Fort St. Vrain interim storage facility and for a prototype MRS interim storage facility capable of transferring 400 MTHM annually to dry storage. As described in Section III and Appendix A of this paper, the Fort St. Vrain facility provides modular dry vault storage for spent fuel. This facility is scheduled to begin civil construction in February, 1991. The Fort St. Vrain facility is currently under design and procurement and so for this reason the project provides a relatively reliable database of schedule information when compared to projects in the conceptual phase. Additionally, the Foster Wheeler experience in constructing modular dry vaults in the United Kingdom increases our confidence that the schedule for the Fort St. Vrain facility is understood and therefore forecasting the schedule for design, procurement, and construction of a similar facility for the MRS can be done with some confidence.

<u>Design schedule</u>

The Fort St. Vrain project summary schedule shows a total duration for all design and long-lead procurement activities of 22 months. This duration includes design development from conceptual through Title II for construction. Civil design and procurement activities associated with the vault structure, unloading bays,and mat require approximately 14 months. The design schedule includes the time necessary to fabricate and procure the fuel handling and storage systems for the unloading bay and vault. The Fort St. Vrain design is packaged for completion in phases to accommodate construction activities being conducted in parallel. The last item in the design and procurement sequence is the fuel handling machine and associated systems. The Fort St. Vrain schedule indicates that none of these design activities are on the critical path.

Licensing schedule

The Fort St. Vrain facility will be licensed under 10 CFR Part 72. The project summary schedule calls for a NRC license application review period of approximately 12 months. We assume this duration is based upon consideration of the approved topical report. The Fort St. Vrain schedule also indicates that four months into the NRC review, a limited work authorization is granted to begin civil and foundation work.

Construction schedule

Construction of the Fort St. Vrain facility is currently scheduled to begin in February 1991 with acceptance of spent fuel starting 11 months later in December 1991. The 11 month duration for construction and testing in the project summary schedule assumes site preparation work of approximately 6 months prior to February 1991. Thereafter, the facility is constructed in sequence to complete the foundation, concrete vault structures, charge face, and finally mechanical and electrical installations. A testing period of two months (presumably cold testing) and one month for demonstration testing is included in the total 11 month construction schedule.

4. Cost assessment

The cost estimates presented in this section for the MVDS concept as described in Section III.1 are based on information and cost data presented in Appendix B and D for a 400 MTHM/yr throughput facility. All costs are expressed in constant 1989 dollars using cost escalation factors taken from the Engineering News Record (ENR) Construction and Building Cost Indexes. Bases and details of the cost estimates are given in Appendicies B, C and D.

Design, engineering, and construction costs

Construction costs for this MVDS concept include costs for the cask receiving bays, storage vaults, associated equipment, storage wells for off-normal repairs and storage tubes for 800 MTHM's of spent fuel. Design and engineering services and procurement costs are estimated separate from construction. Included in all estimates are costs for overhead, profit, and some unknown level of contingency. Table 4 provides a summary of the total costs for design, engineering, and construction.

Annual operating and maintenance costs

Annual labor costs for this MVDS concept are based on a crew size of 5 full time equivalents working one shift per day, 150 days per year (400 MTHM/yr throughput). Maintenance costs are estimated as a percentage of total construction costs. Table 4 provides a summary of the annual operating and maintenance costs.

Decommissioning cost

Decommissioning costs for this MVDS concept are estimated as ten percent of the total capital construction cost. The decommissioning costs are shown in Table 4.

2. Prefabricated hot cell with below grade transfer trenches, vertical - Type 5

a. Design and operations assessment

This concept does not contain technology or any special features that would cause concern for lead time development. Construction of the structural features is straightforward and equipment would not be significantly different from that already in use at numerous nuclear facilities. However, a facility of this type, never having been constructed, has not had the level of scrutiny that the other alternatives have had. A major advantage of this system includes the simplicity of design with its attendant reduction in cost and schedule requirements. A major disadvantage could be the very simplicity that makes this concept attractive due to the fact that this concept has had no exposure to practical applications. Crucial capabilities for handling off-normal fuel or operator error could be missing. Ramping up throughput capabilities beyond 400 MTHM/yr would probably involve additional transfer facilities

## Table 4

### Cost Summary for a Modular Vault Dry Storage Facility at 400 MTHM/year Throughput - Type 1

(Costs are in constant 1989 dollars)

| | Cost x $ 1000 |
|---|---|
| **Design, Engineering and Construction** | |
| 1. Design | 1,100 |
| 2. Engineering services and procurement | 5,495 |
| 3. Construction | 44,038 |
| Total | 50,633 |
| **Two Years of Annual Operating and Maintenance** | |
| 1. Labor | 320 |
| 2. Maintenance (2% of construction) | 1,146 |
| Total | 1,466 |
| Initial total facility and 2 years of operation costs (1st Phase MRS that stores 800 MTHM of fuel, without decommissioning) | 51,779 |
| Decommissioning (10% of construction) | 4,404 |



7 0 3 5 8 0 7 0 9

for each 400 MTHM increment.

b. <u>Licensing assessment</u>

The licensing of any MRS, under 10 CFR Part 72, is a single stage process in which all information (including a complete and final design, quality control procedures, etc.) needed to support the license application is available and complete before a material possession license can be granted prior to the start of MRS construction. Information can be made available, early, to NRC for evaluation and review in the form of a licensing topical report. A licensing topical report generally provides information on a specific subject and NRC approval is sought, and if granted, is later referenced in the license application.

The prefabricated hot cell made for intercask transfer involves the transfer of fuel from the shipping cask, by remote means in a hot cell, to a dedicated storage cask. The prefabricated hot cell would be licensed under 10 CFR Part 72 which may raise the following potential issues:

- NRC would have to review the hot cell and the dedicated DOE storage cask as a separate unit unlike the MVDS where the transport and storage elements, due to unitized construction, are in one module. However, if the concrete storage casks are certified, this would not be a significant licensing issue.

- A hot cell licensed for, say, 300 MTHM throughput could not be utilized for 600 MTHM throughput without changes to the hot cell which would require a license amendment since it would be necessary for NRC to review new safety related issues. However, adding an additional identical hot cell for increasing throughput would not require a license amendment but could be handled as a license condition to the materials possession license.

- Absence of an NRC approved topical report may not result in an expedited review of the license application.

- As currently conceived, the hot cell transfer facility is temporary in nature and will be removed upon the completion of a permanent spent fuel handling building. In this case, the license application must contain information addressing the need to decontaminate, dismantle, and decommission the hot cell; thereby further delaying the NRC review.

NRC review of a license application incorporating the hot cell design is estimated to be at least 24 months in duration due to -

- the fact that since the structure, as conceived in the reference conceptual design material, is temporary in nature and will be removed while the MRS Spent Fuel Handling Building (SFHB) is in operation. This will require the submission and subsequent detailed review by the NRC of decommissioning plans, procedures, etc. However, this design concept could readily be arranged as a permanent facility to provide back-up and surge throughput capability for the full scale MRS SFHB facility.

- the lack of easy retrievability of spent fuel in case of an accident, etc. would extend NRC review time since the NRC may require design changes to prevent the release of radioactive materials.

- the lack of available topical reports or prior licensing experience.

c. <u>Schedule assessment</u>

| | | |
|---|---|---|
| Total Implementation Schedule | - | 24 months |
| Design/Procurement/Fabrication | - | 21 months |
| Construction and Testing | - | 13 months |

The implementation schedule includes all design, procurement, construction and testing of the facility to begin initial waste acceptance. Some design and procurement activities are conducted in parallel with construction. Therefore, the implementation schedule may be less than the sum of these activities.

The trench concept is described in a 1982 paper by GA Technologies and contains a summary schedule for the design, construction, and testing of the concept. The schedule is based upon the concept of constructing a temporary hot cell within a pre-fabricated structure with some underground development (trenching) necessary to enable fuel transfer. The technology and equipment selected have been tested and utilized for previous applications, but apparently not with the NRC's review. As such, the paper offers no insight into the possible licensing time required for such a facility. Similarly, a facility for transfer and storage as envisioned for the MRS has not been constructed previously using this trench concept and so the schedule is preliminary. The entire implementation schedule has a duration of approximately 24 months but only addresses the transfer facility. Durations for storage development have been derived from the MRS System Study Task C. It is assumed that the storage concept selected would be concrete casks set upright on pads adjacent to the transfer facility. As such, the pads could be constructed in parallel with the facility.

<u>Transfer facility design schedule</u>

Engineering and design for the trench concept is estimated to require 11 months which presumably includes conceptual through Title II design. The schedule suggests phased design development to allow early procurement and site preparation prior to completing the design.

Procurement and fabrication begin 8 months prior to the start of construction and continue for a total of 18 months. If concrete casks are used, the lifting requirements may require early design and procurement of a crane larger than the paper discussed in order to achieve the planned schedule of 24 months.

<u>Transfer facility licensing schedule</u>

The transfer facility described in the study is a temporary structure and given the licensing concerns identified in Section V.2.b, it is possible that the design as proposed would be modified to more effectively address structural requirements for seismic or accident-based scenarios. This concern poses additional schedule risk in the NRC review period and the facility construction duration.

Transfer facility construction schedule

As shown in Diagram 1, 11 months is planned for construction and equipment installation. Site preparation is estimated at six months and begins three months prior to the start of construction. Testing activities begin four months prior to the completion of facility construction and continue for two months after. It is assumed that this 6 month period includes both the hot and cold testing necessary to begin operations.

The schedule for concrete storage pad construction is 24 months for 1,500 MTHM as reported in MRS System Study Task C. Initial pad construction would occur in parallel with the transfer facility. It is assumed that pad construction could continue while storage would begin on completed pads. It is assumed that any physical interface between the transfer facility and storage could be accomplished without impact to the schedule.

d. Cost assessment

The cost estimates presented in this section for the trench concept as described in Section III.2.d are based on information and cost data presented in Appendix B for a 400 MTHM/yr throughput facility and concrete storage cask costs developed for the MRS Systems Study. All costs are expressed in constant 1989 dollars using cost escalation factors taken from the Engineering News Record (ENR) Construction and Building Cost Indexes. Bases and details of the cost estimates are given in Appendixes B and C.

Design, engineering, and construction costs

The construction costs for the trench concept include costs for the Butler-type building, high-density shielding for the transfer cell, storage cask manufacturing facility, 300 ton overhead bridge crane, transfer cars and storage cask transporters, and all necessary equipment for operation. The cask manufacturing facility cost is a one-time capital expenditure. If dry cask storage is utilized at the MRS, the cask manufacturing facility could service the MRS for its entire operating life. Also included are indirect, overhead, profit, and 30 % contingency costs. Design costs and the indirect costs for engineering services, procurement, construction management, and quality assurance allowance are estimated as a percentage of total construction costs. Table 5 provides a summary of the total costs for design, engineering, and construction.

Annual operating and maintenance costs

Annual labor costs for the trench concept is based on a crew size of approximately 10 full time equivalents working three shifts per day, 250 days per year. Included are costs for enough concrete storage casks to store 400 MTHM/yr assuming a 2:1 ratio by weight of PWR to BWR fuel. The costs of consumables are estimated using a percentage of the labor costs and maintenance costs are based on a percentage of construction costs. Table 5 provides a summary of the annual operating costs.

Decommissioning cost

Decommissioning costs for the trench concept are estimated as ten percent of the total capital construction cost including storage casks for 800 MTHM. The decommissioning costs are shown in Table 5.

3. Wet pool transfer below grade, vertical - Type 7

a. Design and operations assessment

The wet pool transfer methods presented here are the generic EPRI concept, La Hague/COGEMA, CLAB, and the GE - Morris Operation. The basic operational characteristics of this type of transfer can be seen in Figure 10. Of the four methods looked at, three are operational and one is theoretical. The EPRI method uses a combination of both mobile Hot Cell and Wet Pool transfer. This method has not been put in to practice. The La Hague/COGEMA, CLAB, and the GE - Morris Operation essentially use the same operational methods with differences being only in techniques. The advantages of wet pool transfer are capability of receiving all types of casks which leads to operating flexibility with the facility of handling fresher and hotter spent fuel by ease of heat transfer through water compared to air cooling. Also, wet pool transfer is licensed in both this country and abroad. The disadvantages are the need to have extensive decontamination

Table 5

Cost Summary for a Trench Concept/Concrete Storage Cask Facility at 400 MTHM/year Throughput - Type 5

(Costs are in constant 1989 dollars)

| | Cost x $ 1000 |
|---|---|
| **Design, Engineering and Construction** | |
| 1. Design and engineering services | 911 |
| 2. Construction (transfer facility) | 11,293 |
| 3. Construction (cask manufacturing)* | 16,195 |
| Total | 28,399 |
| **Two Years of Annual Operating and Maintenance** | |
| 1. Labor | 3,098 |
| 2. Consumables (10% of labor) | 310 |
| 3. Maintenance (2% of transfer facility) | 452 |
| 4. Storage casks for 800 MTHM (58 casks) | 11,566 |
| Total | 15,426 |
| Initial total facility and 2 years of operation costs (1st Phase MRS that stores 800 MTHM of fuel, without decommissioning) | 43,825 |
| Decommissioning (10% of construction and storage casks for 800 MTHM) | 3,905 |

* One-time cask manufacturing facility cost

facilities for both the casks and the pool water, thereby leading to extra waste disposal problems, and the need for active pool cooling and cleaning leads to more equipment requiring maintenance. Additionally, there are concerns for fuel cladding integrity with wet transfer prior to dry storage at an MRS facility.

Further, it should be noted that the French, in choosing to expand their receiving facility at La Hague, chose to use a dry transfer method (Permanent Hot Cell) which provided the opportunity to fully automate its operations and reduce operator radiation exposure four fold from an average of 198 mrem/yr to 50 mrem/yr per person.

b. <u>Licensing assessment</u>

The licensing of any MRS, under 10 CFR Part 72, is a single stage process in which all information (including a complete and final design, quality control procedures, etc.) needed to support the license application is available and complete before a material possession license can be granted prior to the start of MRS construction. Information can be made available, early, to NRC for evaluation and review in the form of a licensing topical report. A licensing topical report generally provides information on a specific subject and NRC approval is sought, and if granted, is later referenced in the license application.

Wet Pool transfer at-reactor sites is being performed at over 112 nuclear power plant sites in the U.S. and is evaluated by NRC under 10 CFR Part 50. Wet Pool Transfer at an MRS facility would be evaluated by NRC under 10 CFR Part 72. Although some of the following issues have been addressed within the larger framework of the licensing of a nuclear power plant, a wet pool transfer at an MRS facility will have to be evaluated with respect to the same issues addressed earlier at nuclear power plant sites.

- Design basis accidents for the spent fuel pool.
- Theft and sabotage causing accidental release of radioactivity.

- A rigorous evaluation of the transfer pool such that the water purity and pool water level can be maintained.

- Emergency plan to cover accidental spill of pool water.

- Effect of wet/dry/wet/dry environmental cycling on spent fuel cladding integrity due to At-Reactor Storage/Transportation/MRS Storage/Transportation/Repository conditions.

- Decontamination and clean up procedures where there is likelihood that contaminants have spread to inaccessible areas.

- Two separate courses of evaluation, albeit within a single license application review, which will have to be undertaken by the NRC in order to assess the transfer (wet pool mode) and storage (dry concrete cask) aspects of the MRS facility. However, if the concrete casks were certified, this would not be a significant licensing issue.

An NRC review in this case is estimated to take approximately 20 months. The licensing experience is either at reactor sites under 10 CFR Part 50 or at the only ISFSI operated by GE in Morris, Illinois, which was licensed in 1971 for storing 100 MTHM and was upgraded to store 700 MTHM in 1975. The GE facility was originally licensed under 10 CFR Part 70 and its license was renewed under 10 CFR Part 72 in 1980. Licensing of an MRS/ISFSI with wet pool transfer under 10 CFR Part 72 is therefore based on very limited licensing experience.

c. <u>Schedule assessment</u>

| | | |
|---|---|---|
| Total Implementation Schedule | - | 58 months |
| Design/Procurement/Fabrication | - | 50 months |
| Construction and Testing | - | 28 months |

The implementation schedule includes all design, procurement, construction and testing of the facility to begin initial waste acceptance. Some design and procurement activities are conducted in parallel with construction. Therefore, the implementation schedule may be less than the sum of these activities.

The summary project schedule for the wet pool transfer facility is based upon a schedule furnished by SGN for a 400 MTHM facility proposal. The entire schedule for implementation from conceptual design through final testing is just under 5 years (58 months). (See Appendix B for vendor supporting data.)

<u>Transfer facility design schedule</u>

The SGN summary schedule shows a total of 30 months from conceptual through Title II design to the start of construction. Conceptual and Title I design efforts require 18 months before starting Title II work. Title II design work parallels the majority of the construction phase, but begins 12 months prior to the start of construction. Procurement requires a total of 20 months and is phased to accommodate the installation of the various systems during construction. In the project schedule, the pool crane is ordered six months before the start of facility construction in order to meet the schedule for mechanical erection and is noted as a long lead item.

<u>Transfer facility licensing schedule</u>

Although no domestic licensing schedule estimates were provided, we anticipate some advantages in the licensing review period due to the many existing pool facilities operating under 10 CFR 50 licenses in the United States.

<u>Transfer facility construction schedule</u>

The construction of the facility requires approximately 30 months including site preparation and a nine month testing period that begins four months prior to the completion of construction. Total duration for construction and testing work is 28 months. Civil work begins 10 months prior to any system installations and must finish before mechanical erection begins. The balance of plant appears to be performed in parallel with the completion of civil work.

d. <u>Cost assessment</u>

The cost estimates presented in this section for the wet transfer concept as described in Section III.3.b are based on information and cost data presented in Appendix B for a 400 MTHM/yr throughput facility and concrete storage cask costs developed for the MRS Systems Study. All costs are expressed in constant 1989 dollars by using cost escalation factors taken from the Engineering News Record (ENR) Construction and Building Cost Indexes. Bases and details of the cost estimates are given in Appendixes B and C.

Design, engineering, and construction costs

Construction costs for the wet transfer concept includes costs for sitework and concrete, cask receiving hall, cask preparation cell (before and after unloading), cask unloading pool, storage cask manufacturing facility, 300 ton overhead bridge crane, storage cask transporter, and all the necessary equipment for operation. The cask manufacturing facility cost is a one-time capital expenditure. If dry cask storage is utilized at the MRS, the cask manufacturing facility could service the MRS for its entire operating life. Costs include overhead, profit, and some unknown level of contingency. Table 6 provides a summary of the total design, engineering, and construction costs.

Operating costs

Annual labor costs for the wet transfer concept is based on a crew size of 9 full time equivalents working five shifts per day, seven days per week. Included are costs for enough storage casks to store 400 MTHM/yr assuming a 2:1 ratio by weight of PWR to BWR fuel. Maintenance costs are estimated as a percentage of construction costs. An unknown level of costs for contingency is included in the estimate. Table 6 provides a summary of the annual operating costs.

Decommissioning cost

Decommissioning costs for the wet transfer concept are estimated as ten percent of the total capital construction cost including storage casks for 800 MTHM. The decommissioning costs are shown in Table 6.

## Table 6

Cost Summary for Wet Transfer Concept/Concrete Storage Cask Facility at 400 MTHM/year Throughput - Type 7

(Costs are in constant 1989 dollars)

| | Cost x $ 1000 |
|---|---|
| **Design, Engineering and Construction** | |
| 1. Design and engineering services | 12,522 |
| 2. Construction (transfer facility) | 65,738 |
| 3. Construction (cask manufacturing)* | 16,195 |
| Total | 94,455 |
| **Annual Operating and Maintenance** | |
| 1. General operating (includes labor) | 8,696 |
| 2. Maintenance (5% of transfer facility) | 6,574 |
| 3. Storage casks for 800/MTHM (58 casks) | 11,566 |
| Total | 26,836 |
| Initial total facility and 2 years of operation costs (1st Phase MRS that stores 800 MTHM of fuel, without decommissioning) | 121,291 |
| Decommissioning (10% of construction and storage casks for 800 MTHM) | 9,350 |

* One-time cask manufacturing facility cost

## VI. SUMMARY OF RESULTS AND CONCLUSIONS

### 1. Design and operations assessment

The MVDS by Foster Wheeler - GEC has its origins in the U.K. facility at Wylfa where it has been in operation since 1971 for transfer and storage of MAGNOX fuel. In its development for U.S. and other overseas customers, it has kept essentially constant modular facility dimensions and adapted the spent fuel transfer and storage positions provisions to suit requirements of light water and high temperature graphite spent fuel. The fuel transfer technology is simple and has not, for example, required the introduction of the advanced robotic automation evident from the COGEMA TO dry transfer facility at La Hague, France. This MVDS, in its most recent form for the Fort St. Vrain ISFSI, is being designed, licensed, and constructed on a fixed priced penalty contract on an accelerated schedule.

Diagram 1 has been prepared for levels of comparisons of the three concepts examined using design maturity and operating experience as the principal discriminating criteria.

Based on design maturity and operating experience as ranking discriminators, the prefabricated hot cell concept would be ranked behind the MVDS and water transfer concepts. From a design development potential point of view, it does offer prospects of acceptance by the NRC due to its inherent simplicity. To have any confidence in meeting the DOE schedule requirements for the MRS, it would require vendor support and encouragement from the DOE to facilite the NRC licensing review process by submission of a topical report as soon as possible.

The wet transfer method offers the advantages of known, NRC licensed, and practiced technologies, with the attendant disadvantages of increased capital and operational costs by the additional low level waste being generated in the system, and by the necessity of active transfer pool cooling systems. In addition it carries the burden of having to show that wet-dry operations at an MRS don't impair the spent fuel cladding integrity.

### 2. Licensing assessment

An examination of the licensing assessment of the three concepts reveals that in terms of licensing experience, ease in meeting 10 CFR Part 72 requirements, prior NRC review in the form of topical reports, and NRC duration

## Diagram 1

### Design Configurations
### Level of Confidence Comparison

| | MVDS (Type 1) | Prefabricated Hot Cell (Type 5) | Wet Pool Transfer (Type 7) |
|---|---|---|---|
| Design Maturity | Medium (1) | Low (2) | High (3) |
| Operating Experience | Medium (1) | None | High (3) |
| NRC Licensing Experience | Medium (4) | None | High (5) |

Notes:

(1) Based on design origins derived from a single overseas facility storing gas cooled reactor fuel.

(2) Based on the lack of a complete conceptual design.

(3) Based on fully proven facilities at 112 nuclear power reactors and one Independent Spent Fuel Storage Installation (ISFSI) in the US.

(4) Based on approved generic topical report. This will become "High" upon issuance by NRC of safety evaluation report (SER) following submission of license application by Public Service of Colorado for the Fort St. Vrain facility.

(5) Based on 112 nuclear power plants licensed under 10 CFR Part 50 and one away from reactor ISFSI licensed under 10 CFR Part 72. (However, no license has been issued for a separate site, stand alone ISFSI which is analogous to a potential MRS facility.)

of review (as it is affected by maturity of design, retrievability of spent fuel, and safety related issues) the MVDS concept of transfer and storage provides the greatest ease in licensing. Diagram 1 provides the levels of comparisons for NRC licensing experiences for these three concepts.

The wet pool method of inter-cask transfer has been licensed by the NRC at over 112 nuclear power plants under 10 CFR Part 50 but only once at an away-from-reactor ISFSI under 10 CFR Part 72. However, the wet pool method has not been licensed at a separate-site, stand-alone ISFSI which is analogous to a potential MRS facility. The relative lack of ease in licensing is due mainly to the effects of wet/dry/wet/dry environmental conditions on the integrity of spent fuel cladding and the potential emergence of contentious issues such as the safety aspect of the water pool as it relates to the release of radioactivity due to accidents, sabotage, etc.

The prefabricated hot cell concept of inter-cask transfer would be difficult to license due to an absence of prior licensing experience, lack of a generic topical report, uncertainties caused by lack of redundancy in the quality affecting systems, and decommissioning of a temporary structure (hot cell) while the MRS is in operation.

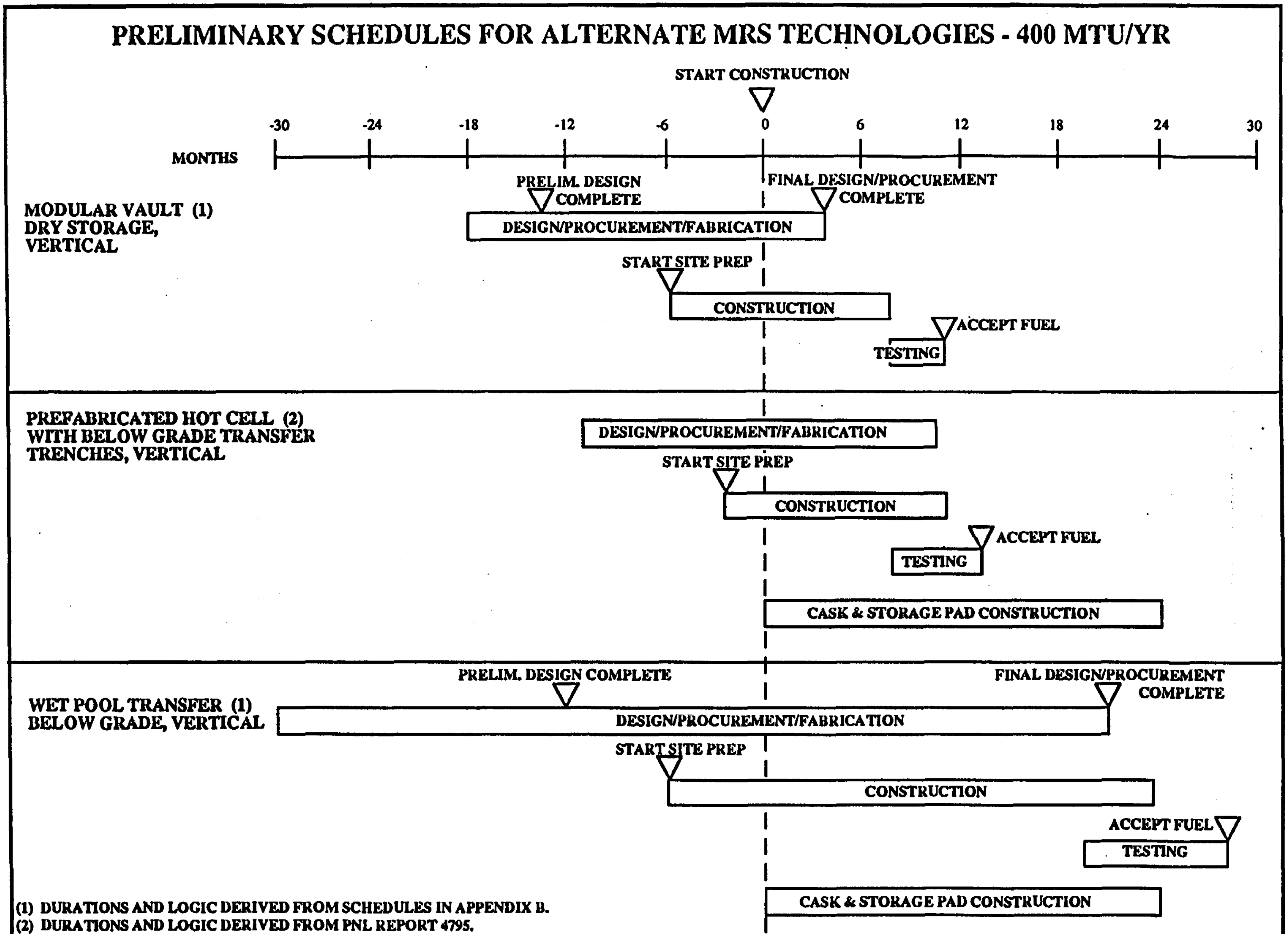
3. <u>Schedule assessment</u>

The implementation schedules for the three concepts identified in Section V are shown together in Diagram 2. The time scale allows the reader to compare the elapsed time for design, construction, and final testing of these facilities.

The modular vault dry storage facility implementation schedule is the shortest in comparison to the other technology alternatives. We attribute this to the modular concept which allows for prefabrication of the containment structures off-site (in advance of any site preparation). Also, the vault concept and the shielded fuel handling system reduces the external facility structure to mainly steel work. This approach appears to minimize the construction time.

The pre-fabricated hot cell facility described in Section V.2 is a temporary structure and therefore the schedule appears conservative for design and erection of the facility in comparison with permanent concrete structures. But given the licensing concerns

DIAGRAM 2

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identified in the same section, it is possible that the design as currently proposed would be modified to more acceptably address functional requirements for retrieval of stored fuel for inspection by the NRC; and structural requirements for seismic or accident-based scenarios. This would increase the time necessary to design and construct the facility. Also, modifications to the engineered approach may be necessary if the public or the NRC express concerns about DOE's ability to complete the Spent Fuel Handling Building within the reference 30 months and without extending initial waste acceptance operations at the Simple Receipt Facility. These concerns lead to the conclusion that 24 months for design and construction of the prefabricated hot cell concept is probably minimal.

One of the most significant aspects of the wet pool transfer facility presented in Section V.3 is the extended period for engineering and design work with the conceptual design beginning 30 months before the start of construction. This appears to be a long time for a facility using established technology and which has the benefit of previous applications including the NPH facility in La Hague, France. Since the project schedule reviewed is for another client, it should be recognized that the project may have some specific design requirements peculiar to that facility which would explain the extended duration. Similarly, the construction schedule is the longest (28 months) of the three facilities. This may be due to the excavations required for the pool but further investigations should be conducted to better understand this schedule.

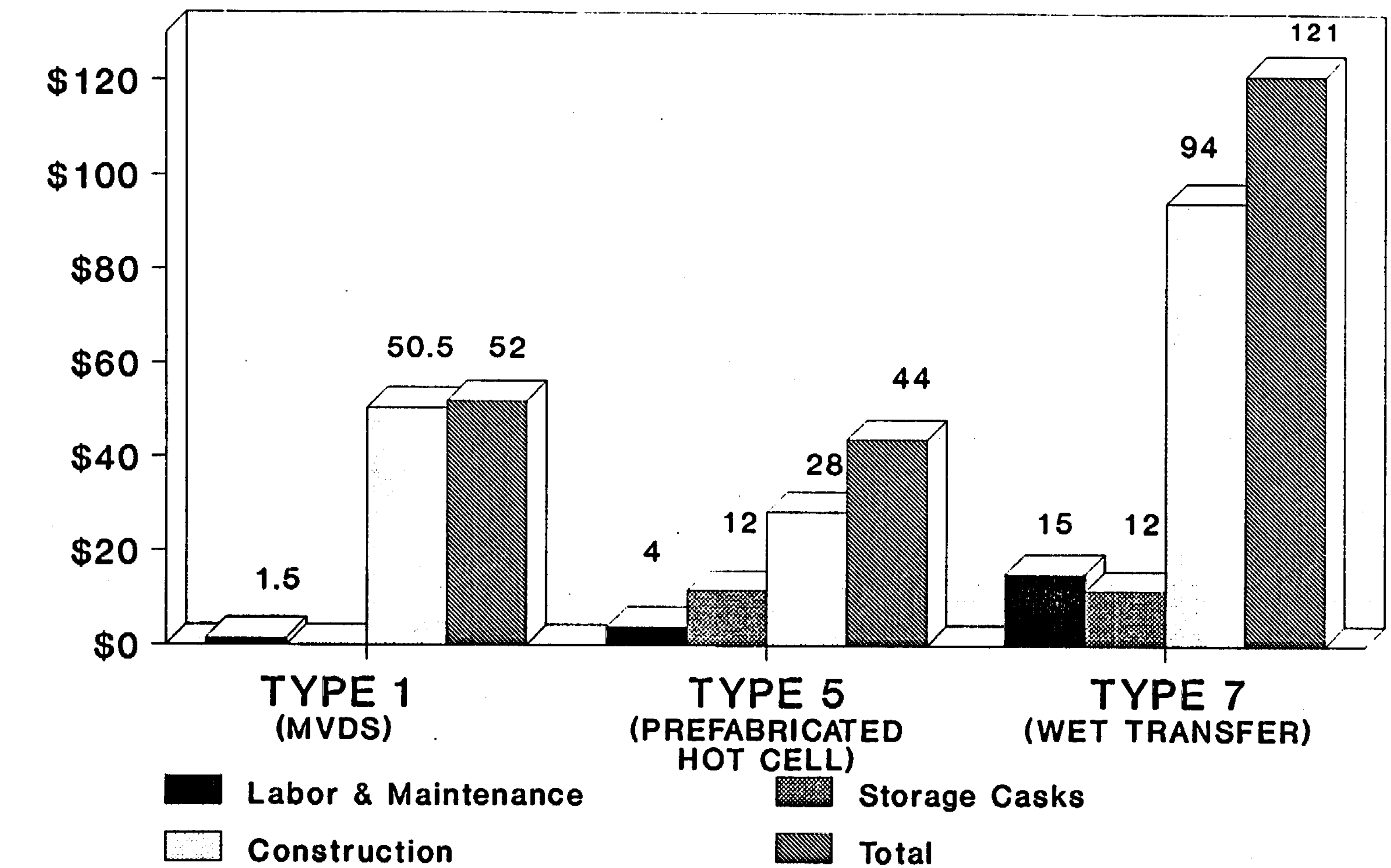
The NRC license review period is a function of the site specific data and the NRC experience with the engineered approach for the facility. With regard to these three technologies, the modular vault dry storage and wet pool transfer concepts have had previous NRC review. This fact should allow for some planned reduction in the time required for NRC review of the MRS if one of these technologies was selected.

4. <u>Cost assessment</u>

Diagram 3 is a graphic comparison of the costs as a function of storage for the MVDS, trench, and wet transfer concepts. The graph is the initial total facility costs and 2 years of operations costs for a 400 MTHM/yr throughput with a total storage of 800 MTHM. There are no decommissioning costs shown on Diagram 3. It is important to note that Types 5 and 7 have higher initial capital costs partially due to the required cask manufacturing facility for start of

# DIAGRAM 3.

## Initial Total Facility and Two Years of Operation Cost

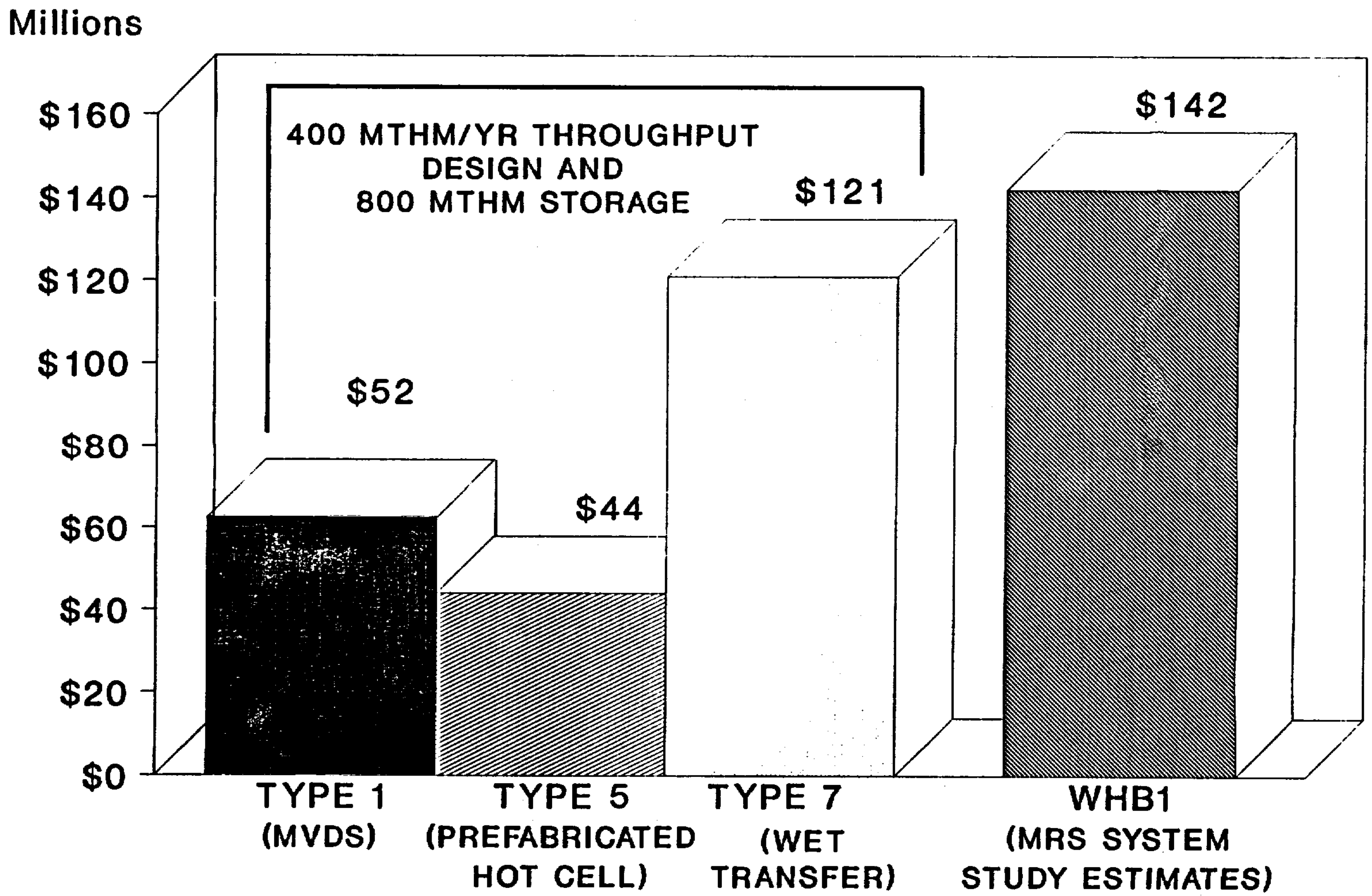



(400 MTHM/year throughput, 800 MTHM storage, no decommissioning)
Preliminary estimates only based on unverified input data contained in Appendix B and D.

storage of gas reactor spent fuel for over 20 years and is currently being developed for storage at the Public Service of Colorado facility at Fort St. Vrain, for about 300 MTHM LWR spent fuel equivalent. On this basis the level of confidence in the cost estimates is considered medium. The trench concept has no prototype or commercial experience and thus, the level of confidence in estimated costs is low. (Note: In September 1990 Ralph M. Parsons completed a pre-conceptual design study with cost estimates for OCRWM, of a simplified spent fuel transfer facility. PNL-7400 which provided detailed cost estimates with individual cost account breakdown which could be categorized as being at a high level of confidence). The wet transfer concept has been used for many years in commercial nuclear facilities around the world and the costs being reported are based on a specific overseas front end spent fuel reprocessing facility at COGEMA, France, designed for 800 MTHM/ year throughput. The extrapolation of overseas costs from the customized reprocessing facility have tended to make these estimates conservatively high.

Diagram 4 contains a summary comparison of costs for Types 1, 5, and 7 along with the summary costs for a waste handling facility contained in the 1989 MRS System Studies. All costs are expressed in 1989 dollars. The engineering, design, and construction costs for Types 1, 5, and 7 are for a waste handling facility that has 400 MTHM/yr throughput along with 800 MTHM storage. The costs for two years of operations and maintenance are also in the Type 1, 5, and 7 totals. To attempt to provide a cost comparison surrogate from facilities designed to OCRWM program standards, the cost for waste handling building 1 (WHB1) was taken from the MRS System Studies cost estimate for the initial waste handling facility at the two phase repository contained in Case 1. The WHB1 is designed for a 400 MTHM/yr throughput and for a small amount of temporary storage. The summary cost estimate for the Case 1 - WHB1 is contained in Table 7. The total cost for WHB1 reflects the engineering, design, and construction costs for the facility along with two years of operations and maintenance. The cost of storage casks with a capacity of 800 MTHM was added to the WHB1 total.

## DIAGRAM 4.
### PRELIMINARY COST ESTIMATES AND COMPARISONS
### INITIAL TOTAL FACILITY AND TWO YEARS OF OPERATION COST




Preliminary estimates only for Types 1, 5, and 7 based on unverified input data contained in Appendix B and D.

Table 7

Cost Summary for Waste Handling Building 1 (WHB1), Two Phase Repository, 400 MTHM/year Throughput

(Costs are in constant 1989 dollars)

| | Cost x $ 1000 |
|---|---|
| **Design, Engineering and Construction** | |
| 1. Design, engineering & construction | 99,156 |
| 2. Construction (cask manufacturing)* | 16,195 |
| Total | 115,351 |
| **Two Years of Annual Operating and Maintenance** | |
| 1. Labor | 3,016 |
| 2. Utilities | 910 |
| 3. Maintenance | 11,458 |
| 4. Storage casks for 400 MTHM (29 casks) | 11,566 |
| Total | 26,950 |
| Initial total facility and 2 years of operation costs (1st Phase MRS that stores 800 MTHM of fuel, without decommissioning) | 142,301 |
| Decommissioning | 7,956 |

* One-time cask manufacturing facility cost

VII. **REFERENCES**


1. Foster Wheeler - GEC - Modular Vault Dry Storage (MVDS).

2. PNL-4795-UC-85 Equipment concepts for dry inter cask transfer of spent fuel - July 1983.

3. EPRI-NP-6425 Design considerations for on-site spent fuel transfer systems - June 1989.

4. NUS-TTC-0736 Dry Transfer Cask Design and Feasibility study - Final report - September 1987.

5. NUREG-0709 Safety Evaluation Report Spent Fuel Transfer and Storage Facility - G.E. Morris, July, 1981.

6. NUTECH (NUHOMS) Pacific Nuclear Systems Spent Fuel Storage concept.

7. FUELSTOR

8. Final Version Dry Cask Storage Study, DOE RW-0220, February, 1989.

9. COGEMA American Nuclear Society Annual Meeting, Dallas, Texas, USA, June 7-11, 1987, NUMATEC, SGN.

10. CLAB International Atomic Energy Agency, IAEA-TECDOC-418.

## APPENDIX A

Appendix A

Description of the design development of the MVDS concept by Foster Wheeler - GEC.

The Foster Wheeler - GEC design for MVDS has evolved from the original facility at Wylfa in the U.K. through several phases in its U.S. development. The U.S. development phases have taken the form of 1) topical report (Docket M-46) for at-reactor LWR fuel storage as an ISFSI, 2) fixed priced contract with Colorado Public Service (Fort St. Vrain) for HTGR fuel storage at an ISFSI with the license application to NRC to be based modifications to the topical report, and 3) an MRS facility design for about 15,000 MTHM storage based on modular expansion in 2,000 MTHM increments. These individual designs are described as follows:

1) TOPICAL REPORT (DOCKET M-46) FOR AN ISFSI

Foster Wheeler in collaboration with GEC (U.K.) submitted a topical report to the NRC (docketed under Project M-46) in August 1986 for a design of Modular Vault Dry Storage (MVDS) for light water reactor irradiated spent fuel. The enclosed Figures A-1, A-2, depict this storage concept which is arranged for the vertical storage of the spent fuel assemblies in individual shielded storage tubes (SST), and the matrix of storage tubes are housed within a concrete vault module (VM) that provides the bulk radiation shielding. The spent fuel assemblies are stored dry and their decay heat is removed by a once-through natural thermal siphonic system using ambient air flowing over the external surfaces of the SST'S. The spent fuel is transported from the commercial reactor pools to the MVDS using any type of transport cask (TC) and the TC is received in the Transfer Cask Reception Bay (TCRB) where it is removed from its transporter and prepared for unloading through the transfer port to the Fuel Handling Machine (FHM). Once within the FHM the individual spent fuel assemblies are taken to the SST's storage positions and after insertion are sealed with an engineered seal plug. The internal volume of the SST can be arranged for an air or inert gas (nitrogen) environment dependant on fuel temperature limitations.

The topical report has been devised for NRC review under 10 CFR Part 72, Independent Spent Fuel Storage Installation (ISFSI), for spent fuel storage for at least 20 years, and has been tailored for at reactor applications in the form of a minimum of 2 modules (equivalent to 80 PWR/150 BWR per module or about 80 MTHM) or a maximum of 5 modules at about 400 MTHM total.

NRC,Irradiated Fuel Section, Fuel Cycle Safety Branch issued the Safety Evaluation Report (SER) in March 1988 and specific technical positions arising from the SER comments were stated as follows.

(a) O-ring Seals. The 20 years lifetime for the O-ring seals on the storage standpipe tubes (SST's) plugs were not found to be acceptable by NRC based on current supporting data submitted with the topical report (TR). NRC stated that with in-service inspection procedures the 20 year seal life time could be justified but for the purposes of this TR review a 5 year seal lifetime would be imposed.

(b) Accident Recovery Operations. For protection against the hypothetical off-normal event of dropping a fuel assembly in the SST due to malfunction of the FHM grapple or hoist, NRC had accepted FW-GEC design arguments for a single failure proof FHM, on the basis of operating experience with such designs for on-load refueling operations for gas-cooled reactors. Any fuel debris arising from such an event would be retained within the SST and with air cooling always available it would be assumed that there would be no restraints on the time needed to effect recovery.

(c) Air Cooling. FW-GEC preferred air storage for the spent fuel in the SST's as it presented a more relaxed storage regime than that resulting from an inerted system employing a nitrogen gas to give a non-oxidizing environment. FW-GEC had presented their safety case to NRC for fuel cladding integrity during dry storage on the basis of the low fuel temperature achievable, (180°C peak fuel pin temperature with air inlet ambient at 38°C), and that all fuel cladding degradation in an oxidizing environment was temperature dependent. NRC were aware of these factors but stated that adequate data does not exist currently at low temperatures to validate correlations being proposed by FW-GEC. The inerted nitrogen gas system proposed by FW-GEC was considered satisfactory for meeting the requirements of 10 CFR 72.72 (h), subject to the above comments for amending the 20 year O-ring seal lifetimes to 5 years for design purposes.

2) APPLICATION OF MVDS FOR FORT ST. VRAIN HTGR FUEL STORAGE ISFSI (Reference INMM meeting Jan. 1990 presented by Foster Wheeler - GEC.)

The Public Service of Colorado (PSC) design for the Fort St. Vrain ISFSI has a total capability to store 1482 fuel blocks and the 37 metal clad reflector blocks. In addition 6 (six) fuel blocks each containing a Californium neutron source have to be stored. The neutron sources increase the normal fuel block neutron source term very considerably.

The site specific storage parameters for FSV fuel are summarized and compared with the parameters used in the MVDS Topical Safety Analysis Report (TSAR). The comparison shows that the TSAR bounds the important design parameters except the neutron flux level associated with the neutron source fuel blocks.

Application of the MVDS design to FSV required adaptation of certain features to meet the storage need specified by PSC, based on the lowest capital cost. The major factors influencing these changes were stated as follows:

(a) The nature of the HTGR fuel is significantly different to the LWR types originally considered in the TSAR. Despite the disparity of material, form and enrichment to LWR fuel, the HTGR fuel parameters have the least influence on the MVDS design given the decision to containerize the fuel blocks at the reactor. The reflector blocks are also accommodated because they have the same cross section as fuel blocks, same handling features and half the physical length. Two reflector blocks stacked are therefore dimensionally equal to one fuel block.

(b) The standard fuel route equipment at FSV results in six fuel blocks being loaded into the inner container of the existing and licensed FSV Shipping Cask. The Inner Container dimensions are not dissimilar to the standard TSAR fuel storage tube for PWR fuel and also provides a high integrity sealed containment boundary with a shielded closure. These similarities and the practical desire to utilize the existing and proven reactor building refuelling route resulted in the decision to containerize the fuel blocks at the reactor by placing them into a containment boundary very similar to the existing Inner Container. The proposed use of the existing Shipping Casks for site transfer of fuel to the ISFSI and potentially for subsequent movement of fuel to MRS or the repository, completed the concept modification logic.

(c) Utilization of the containerization procedures at the reactor building has the added advantage of providing an uncontaminated fuel route to the ISFSI and for all normal operations within the MVDS, thus eliminating the need for contamination control and monitoring systems that were incorporated in the TSAR design.

The MVDS transfer and storage design is being deployed at the Fort St. Vrain facility. The comparisons to the topical report filed with NRC are briefly as follows

| Parameter | TSAR | FSV |
|---|---|---|
| Spent fuel positions per module | Intact fuel assemblies 100 PWR, 200 BWR | 45 canisters, 18" dia. |
| Heat Load/Storage Location | 1 kw | 0.7 kw (average) |
| Fuel loading rate (spent fuel assemblies per year) | 1500-2000 assemblies | Approx. 1000 canisters |
| Decay Period | 5 years | 400 days |
| Fuel Source - Normal Assembly | | |
| Gamma/Storage Location | 9.32 X $10^{15}$ MeV/sec | 1.52 X $10^{15}$ MeV/sec |
| Neutron/Storage Location | 5.17 X $10^{8}$ N/sec | 2.08 X $10^{6}$ N/sec |
| Fuel Source - Neutron Source Assembly | | |
| Gamma/Storage Location | | 1.52 X $10^{15}$ MeV/sec |
| Neutron/Storage Location | | 5.61 X $10^{10}$ N/sec |
| Ambient Temperatures | -20°F to 100°F | -32°F to 102°F |
| Flood Levels | Site specific | 6ft |
| Seismic Ground Acceleration | 0.25 | 0.1 |
| Seismic Spectrum | Reg. Guide 1.61 | Reg. Guide 1.61 |
| Tornado Missile | Nureg 0800 II | Site specific |
| Tornado Maximum Velocity | 360 mph Reg. Guide 1.76 | 300 mph |
| Snow Loading | 100 psf | 30 psf |

(d) The minimum specified Public Service of Colorado storage need was 250 fuel blocks or total storage of 45 Inner Containers with the option to increase the storage capacity to 1482 fuel blocks.

The MVDS facility arrangement is shown in figures A-3 through A-6. The FSV MVDS comprises six vault modules each containing forty-five individual storage containers. The fuel blocks or other items to be stored are loaded into Fuel Storage Containers (FSC's) at the reactor building using the existing fuel handling equipment. The FSC's are transported from the reactor building to the MVDS building in the FSV Shipping Cask. In the Cask Reception Bay, the Shipping Cask is lifted from the site trailer and parked in a Cask Load/Unload Port using the MVDS overhead crane. In the Load/Unload Port the FSV Shipping Cask closure lid can be removed and parked. Use of a Fuel Handling Machine (FHM) and an independent shielding isolating valve mounted above the Shipping Cask allows the FSC to be safely raised in the FHM. The building crane moves the FHM to the selected storage location which has been previously prepared by removal of a shield plug and installation of a second shielding isolation valve. The FHM lowers the FSC into the vault storage position, the FHM is removed, the shield plug replaced and the valve moved to the next storage location to be filled. From this position the equipment is used to remove an empty FSC from the vault and transfer this to the FSV Shipping Cask in the Load/Unload Port. Return of the FSV Shipping Cask to the reactor building with the empty FSC allows the cycle to be repeated. Two FSV Shipping Casks are available, therefore loading/unloading will normally be conducted simultaneously at the reactor building and the MVDS building.

3) MVDS DESIGNED AS AN MRS FOR 14,500 MTHM STORAGE

The MVDS as configured for an MRS application has been arranged for expansion in longer modules of about 180 MTHM capacity. Figures A-7, A-8, and A-9 depict how this can be accomplished. In this arrangement, a centralized Fuel Receipt Building with fuel transfer casks unloaded between modules has been envisioned. In addition, balance of plant facilities in the form of Administration and Services Buildings have been included.

For an MRS, the MVDS has been arranged to take the form of two arrays of 40 modules (7250 MTHM) each for a total capacity of 14,500 MTHM spent fuel storage. The rate of expansion has been configured on the basis of 4 stages of 20 modules as shown in Figure A-10.

The following extracts are from the vendors statements for a typical procedure which can be adopted to extend an existing MVDS.

(a) Figure A-11 shows how the major part of the civil and building works can be completed without interfering with the operation of the existing MVDS. The shielding thicknesses allow uninterrupted construction work to be carried out behind the barrier fence. A minimum clearance space is crafted by the cantilevered sections of the new and existing MVDS structures to enable, foundations to be constructed, concrete to be placed and the structural steelwork and cladding completed to within one bay of the existing building. For convenience, the Fuel Handling Machine (FHM) rails are temporarily fitted into position using the civil construction cranes.

(b) A temporary structure and crane is attached to the end of the new building and is used primarily to install the charge face structures. This structure will have been used when the existing MVDS was constructed and will have been stored for use at this time. This temporary structure is shown in position on figure A-12.

An "A" frame hoist is mounted on top of the gantry. This "A" frame is free to travel along the length of the gantry. The "A" frame has a height of lift which enables the SST'S to be carried over the charge face and lowered into the charge face structure. The "A" frame is also used to install the charge face slabs, SST, plugs, etc. A temporary hatch enables these items to be lifted into the building if inclement weather conditions require the ends of the building to be temporarily closed.

(c) When removing the removable gable end from the existing MVDS it is desirable to minimize the ingress of windborne snow or rain into the charge face area. Although surface water drainage is provided to remove aqueous arisings from the charge face the temporary barrier will maintain a more acceptable working environment if extreme weather conditions prevail during the short period of time when the removable gable end is being moved to the far end of the new building, see Figure A-13.

The temporary barrier will be in the form of scaffolding and plastic sheeting. The depth of this structure will restrict travel of the FHM and prevent loading the outermost storage tubes. This restriction is short term.

(d) Figure A-14 shows in outline the procedure for dismantling the removable gable end.

The temporary crane shown is typical-only, but, for the purposes of this procedure, is a Liebherr L.T. 1300. It has the capacity to lift a maximum sized precast concrete wall section weighing 12.5 tons at a radius of 79'-0" with a boom length of 207'-0".

The precast concrete units and heavier steel columns are transferred by lorry and off-loaded using the temporary gantry at the end of the new building.

When the removable gable has been transferred to the end of the building the temporary crane is moved to the end of the building and used to erect the removable gable in it's new location.

During this time the link bay purlins and cladding are constructed thus sealing the building and enabling the temporary barrier to be dismantled and removed, see Figure A-15.

The temporary crane is used to dismantle the temporary structure and gantry.

While the removable gable end is being dismantled and the temporary barrier is both erected and dismantled the loading of spent fuel into the existing MVDS is strictly controlled.

(e) The FHM rails are now aligned and levelled to the existing MVDS rails and the power supplies extended into the new building. The FHM can now travel into the new building, see Figure A-16. The other services such as the ventilation system can also be extended from prepared termination points.

The temporary access hatch can now be sealed and commissioning of the extended MVDS carried out.

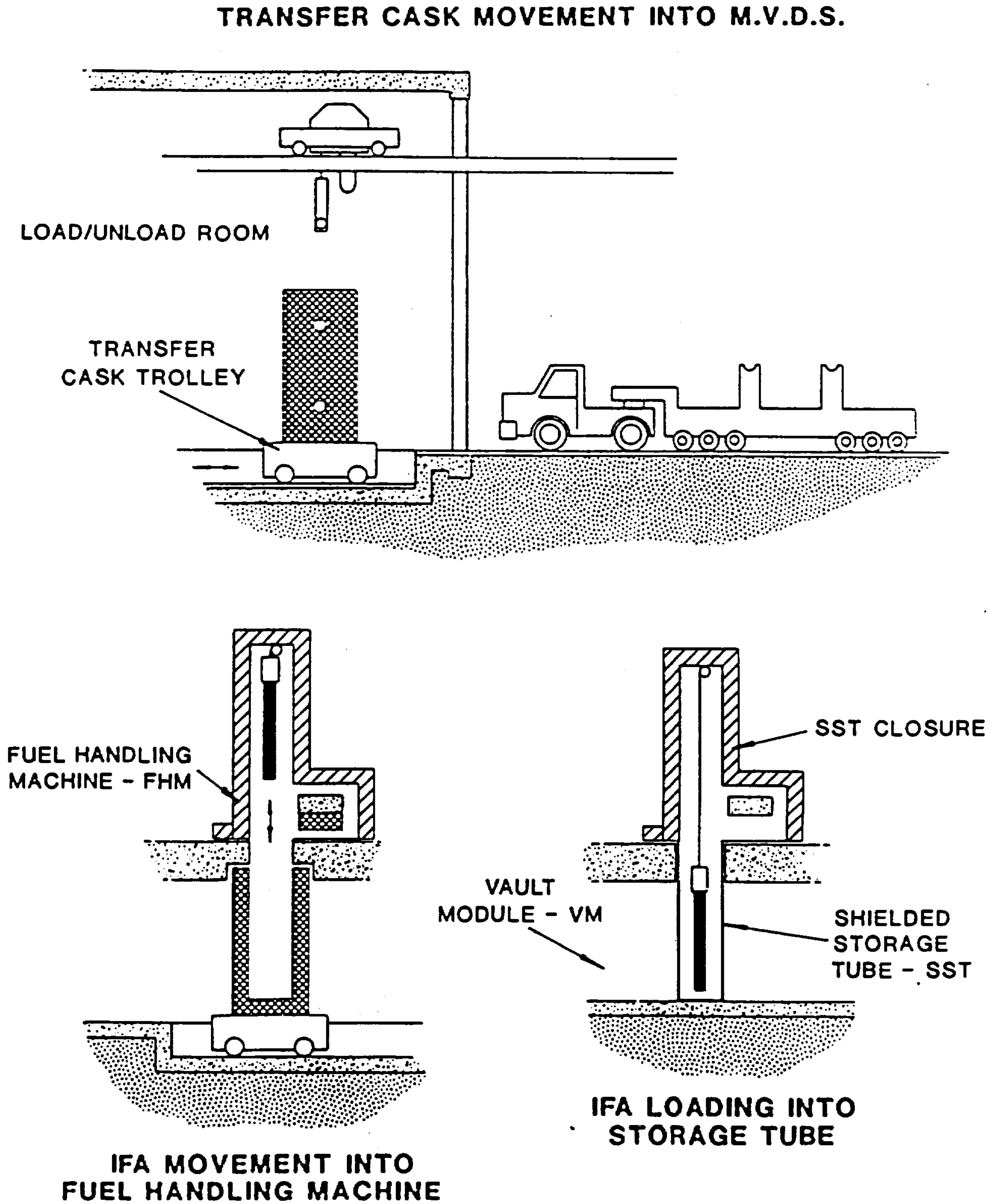



Figure A-1. MVDS Basic Sequence of Operations.

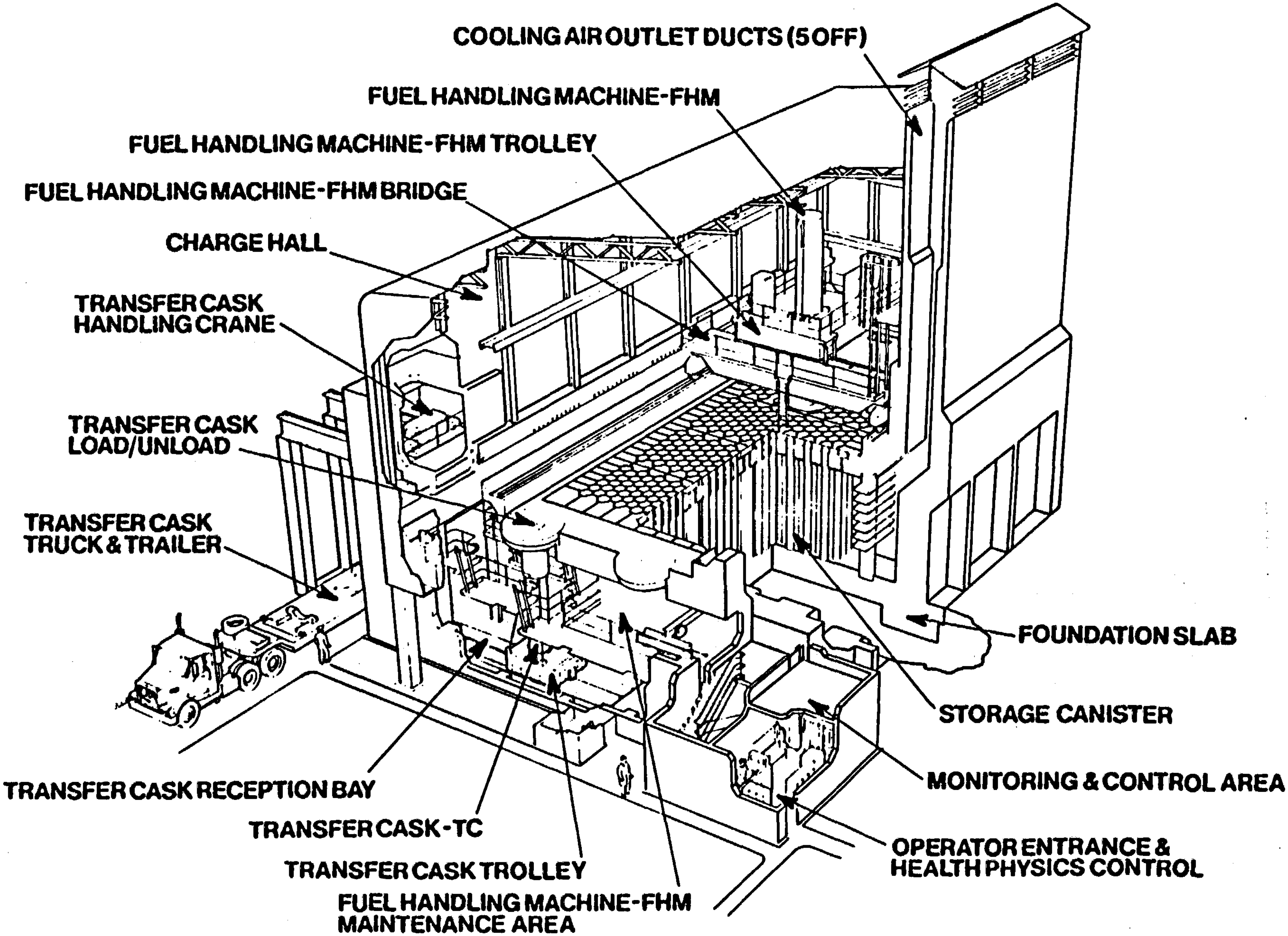



Figure A-2. Topical Report Modular Vault Dry Store-MVDS Typical 200 MTU PWR Spent Fuel Facility.

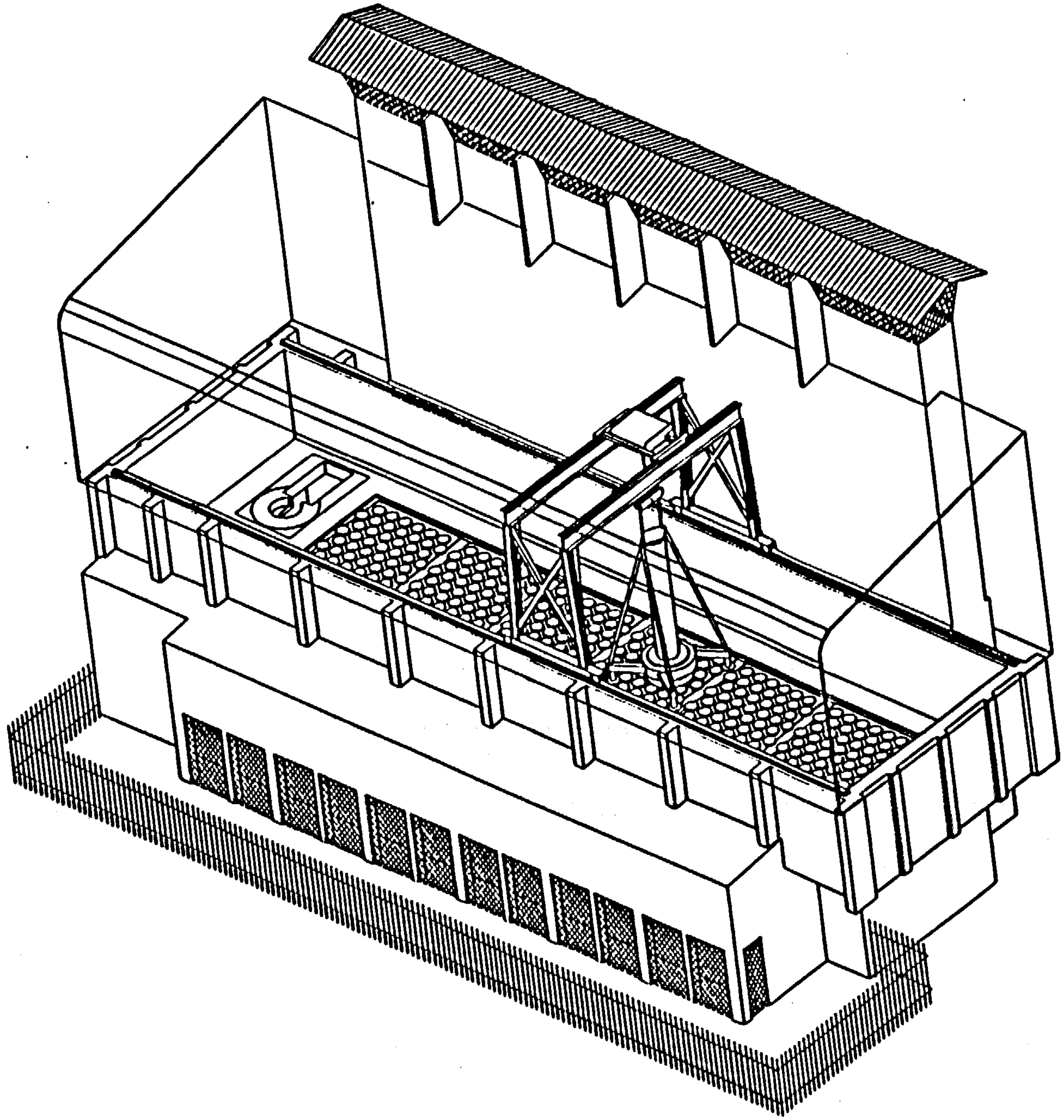


Figure A-3. MVDS Fort St. Vrain.

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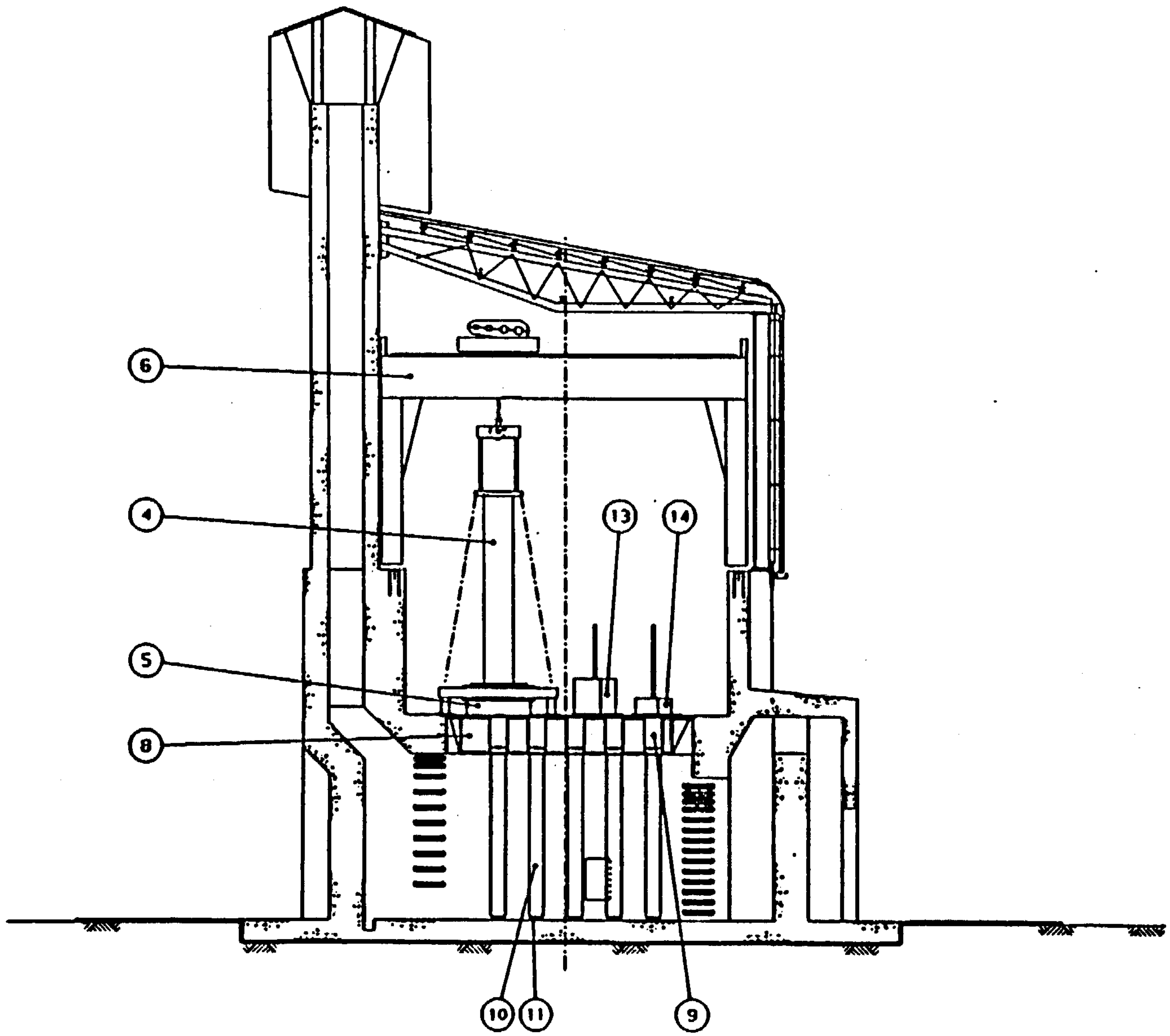



SECTION Y-Y
(FROM SHEET 1)

**Figure A-4** MVDS Fort St. Vrain.

0407-0045RJ 1/30/90

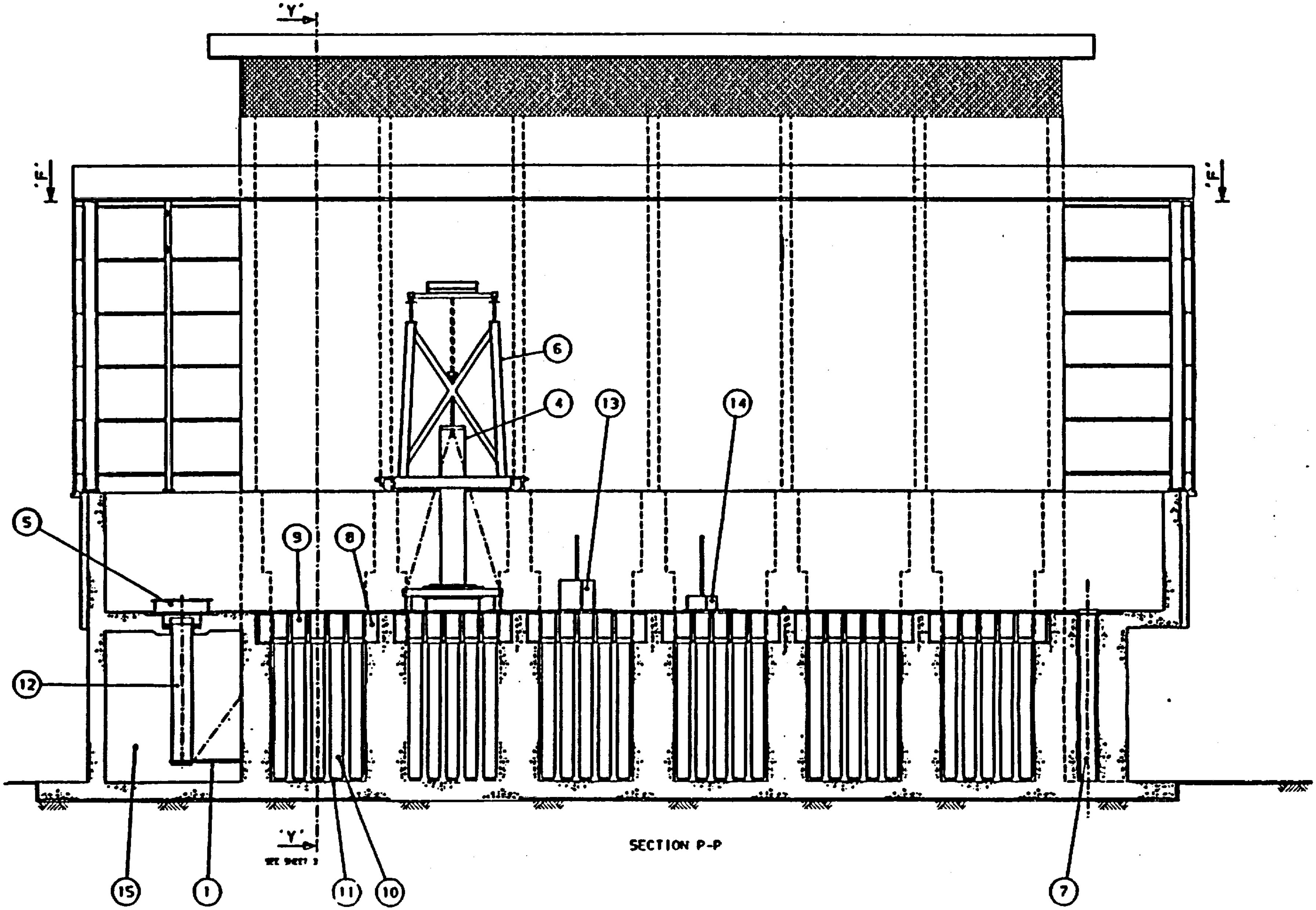
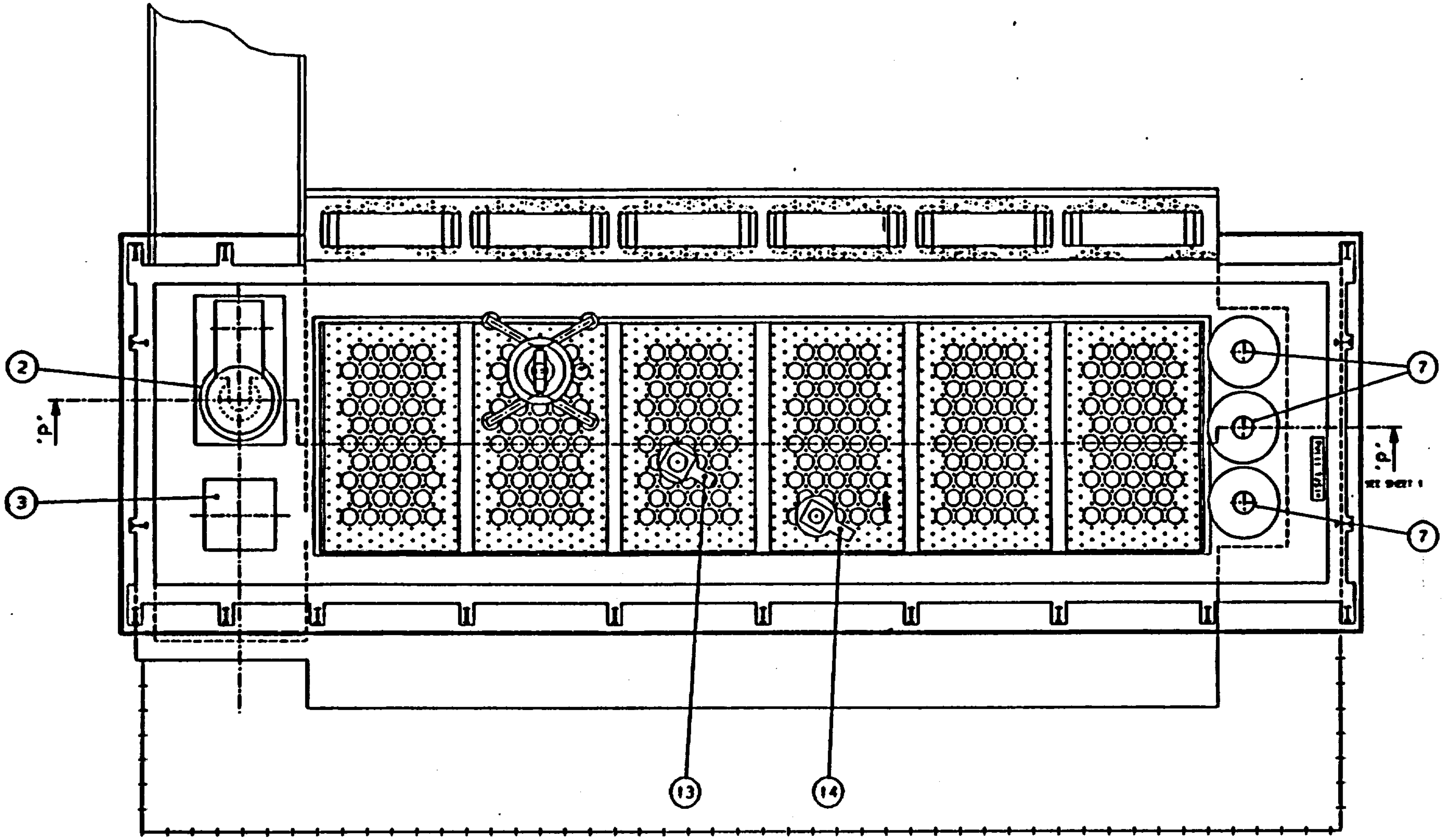



Figure A-5. MVDS Fort St. Vrain.

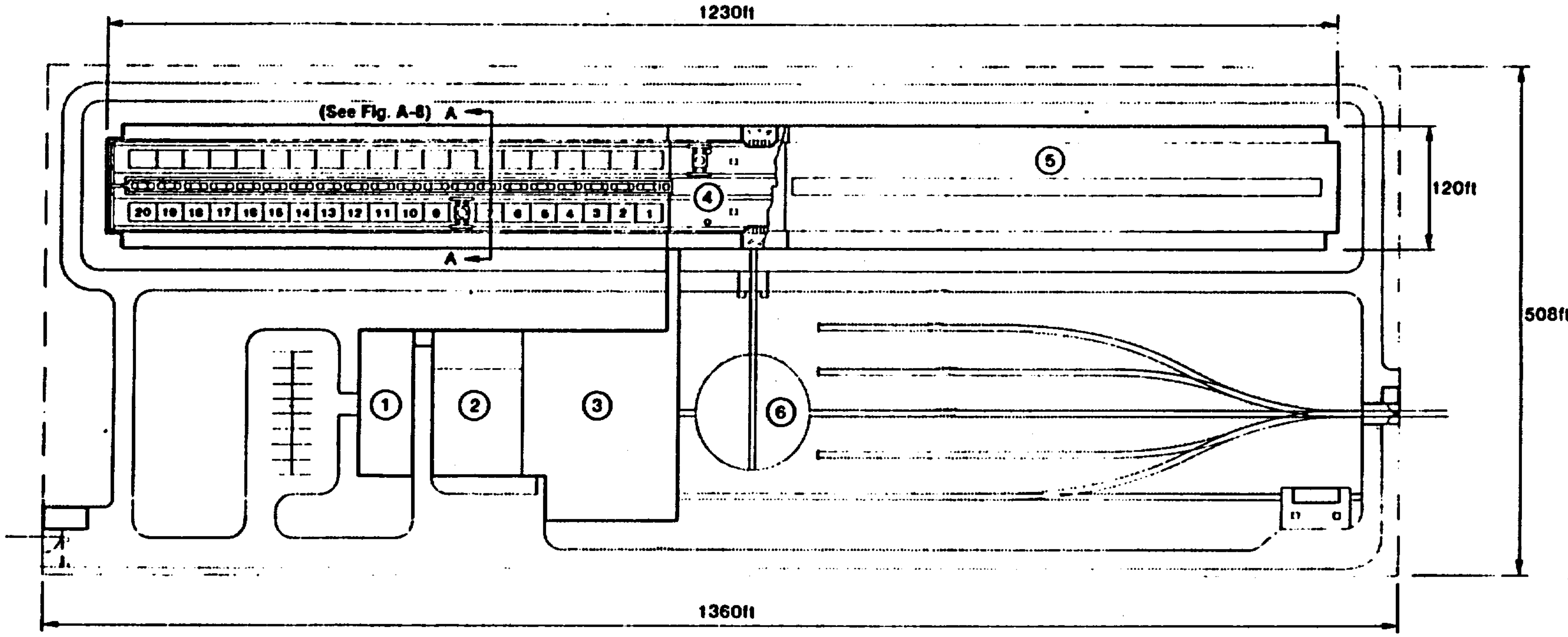
0407-0045RJ 1/30/90




SECTION 'F-F'

Figure A-6. MVDS Fort St. Vrain.

7 0 5 5 0 0 7




LEGEND:

1. Administration Building
2. Services Building
3. Fuel Receipt Building
4. Head-End Facility (See Fig.3)
5. MVDS - Arranged with 20 modules on both sides of Head-End
6. Flat Roll Turntable

STORE CAPACITY:

40 Modules/7250 MTU*/19000 Fuel Assemblies.*

* Using weighted average for PWR & BWR Fuel of 0.38 MTU/ASSY.

Figure A-7. MVDS (LWR) Central Dry Store Typical Site Plan.

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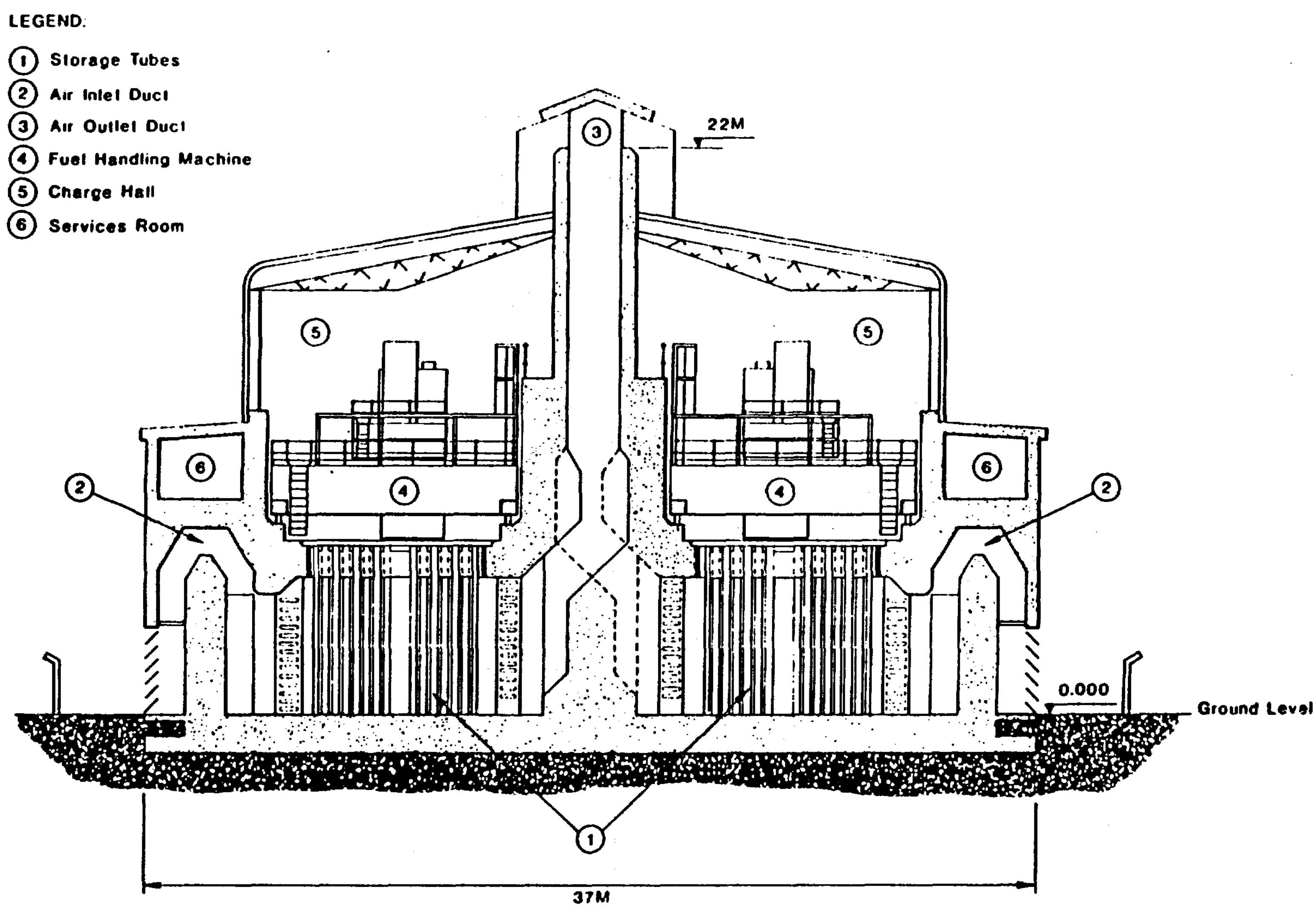


Figure A-8. MVDS (LWR) Central Dry Store Storage Vault Module Cross Section A-A (See Fig. A-7).

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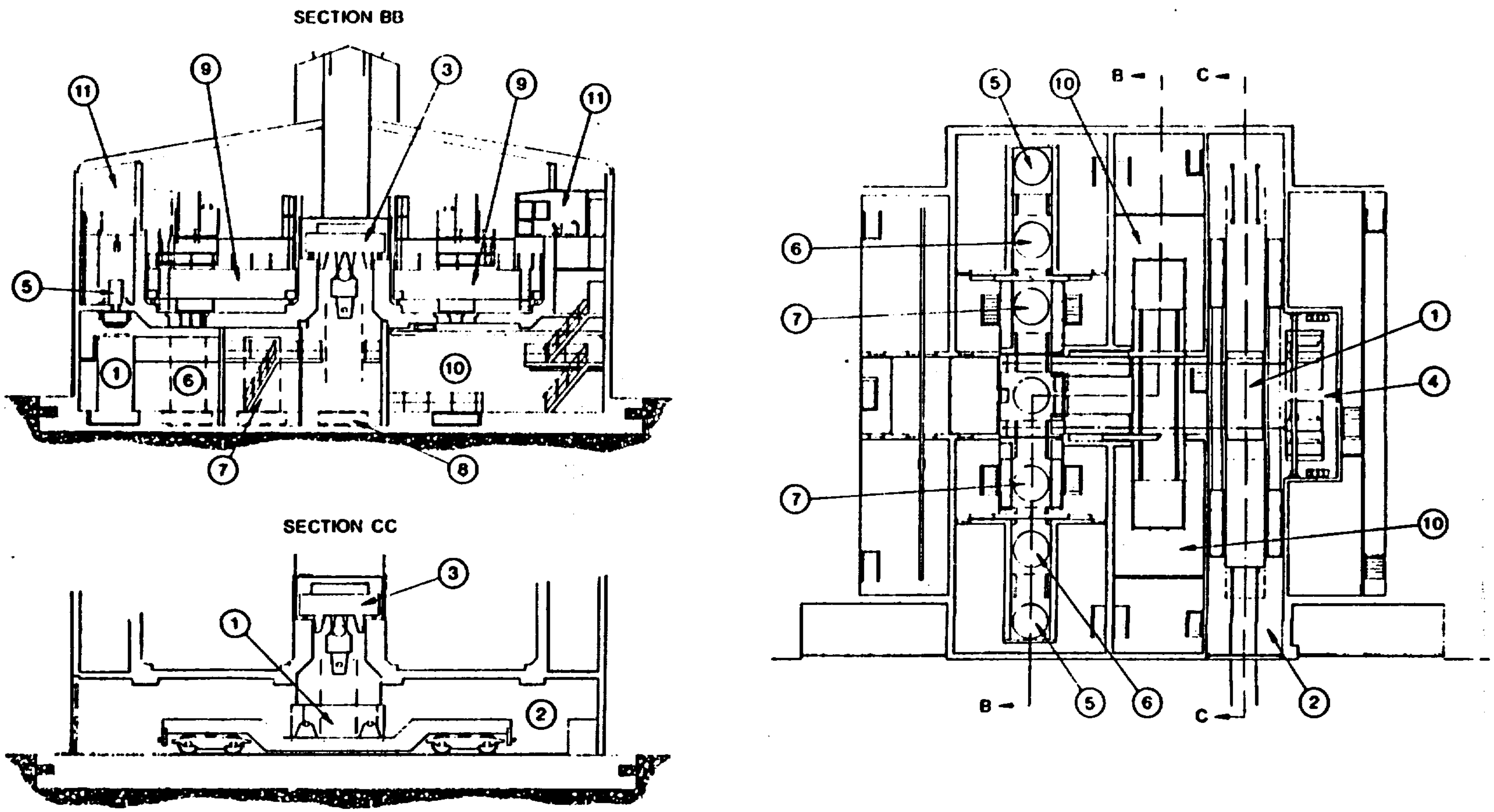


**LEGEND:**

1. On-site Fuel Transfer Cask (TC)
2. TC Flat Roll Rail Receipt Bay
3. Transfer Cask (TC) Handling Crane
4. TC Impact Limiter Lay Down Area
5. TC Lid Lift Machine
6. TC Load/Unload Station
7. TC Preparation Station
8. TC Trolley
9. Fuel Handling Machine (FHM)
10. FHM Maintenance Area
11. Central Monitoring/Control Room

**Figure A-9. MVDS (LWR) Central Dry Store Head-End Facility (See Fig. A-7).**

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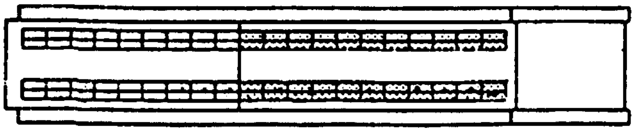
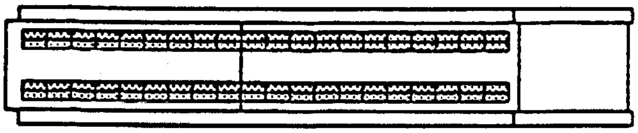
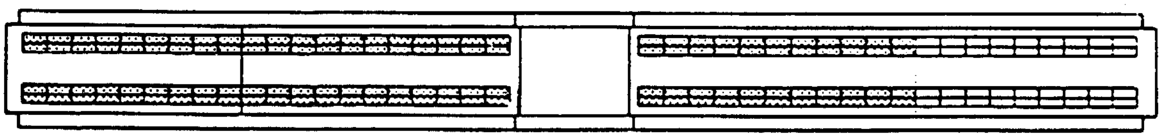


Civil Structures are equal to Storage Modules

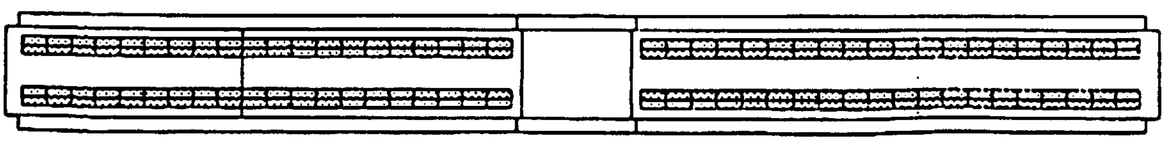
**PHASE I (50% Civil Structure - 25% Storage Locations)**



**PHASE IA (50% Civil Structure - 50% Storage Locations)**



**PHASE II (100% Civil Structure - 75% Storage Locations)**



**PHASE IIA (100% Civil Structure - 100% Storage Locations)**

**Figure A-10.** MVDS Expansion Phases.

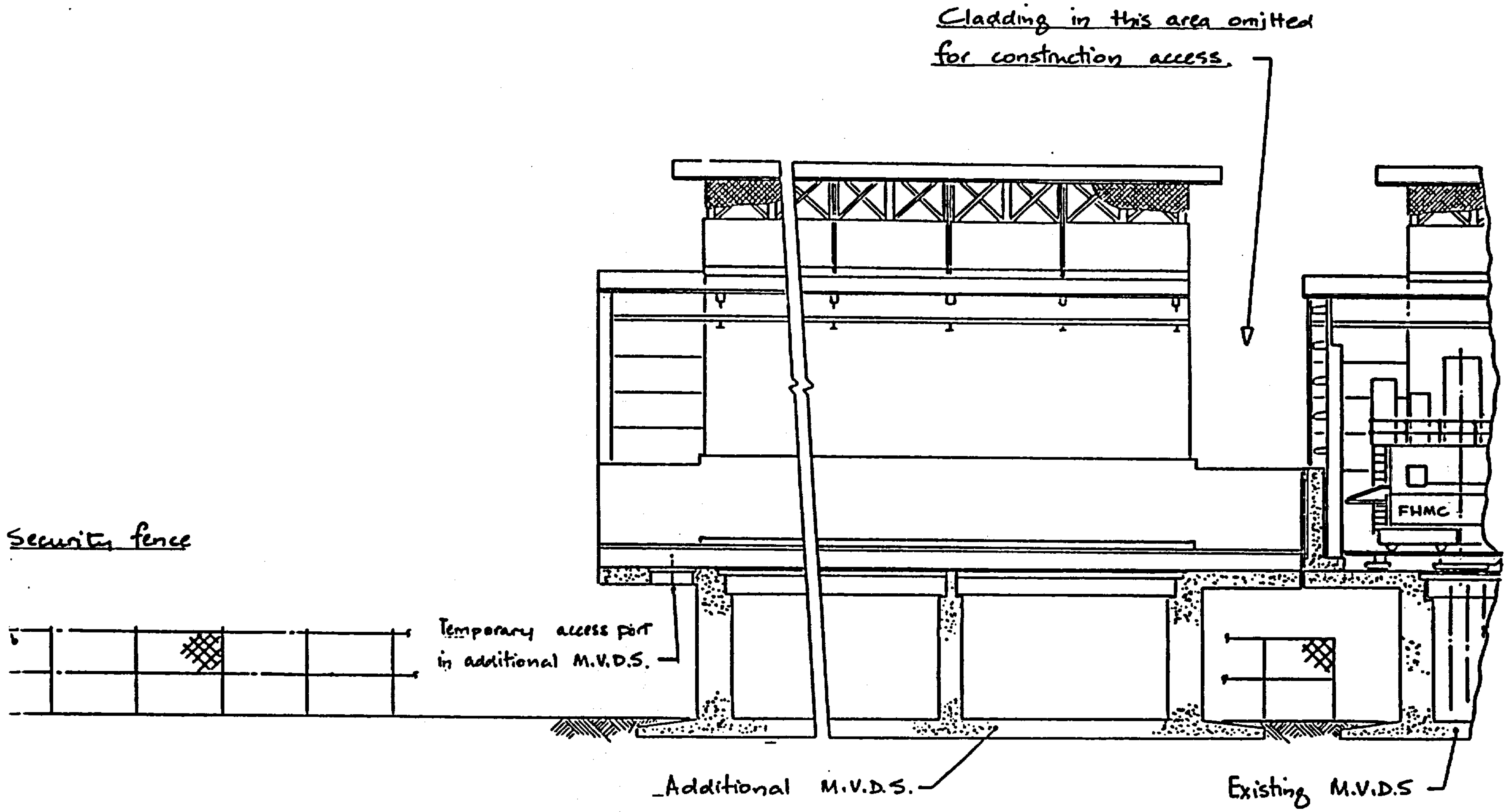



**Figure A-11.** MVDS Module Contruction Sequence.

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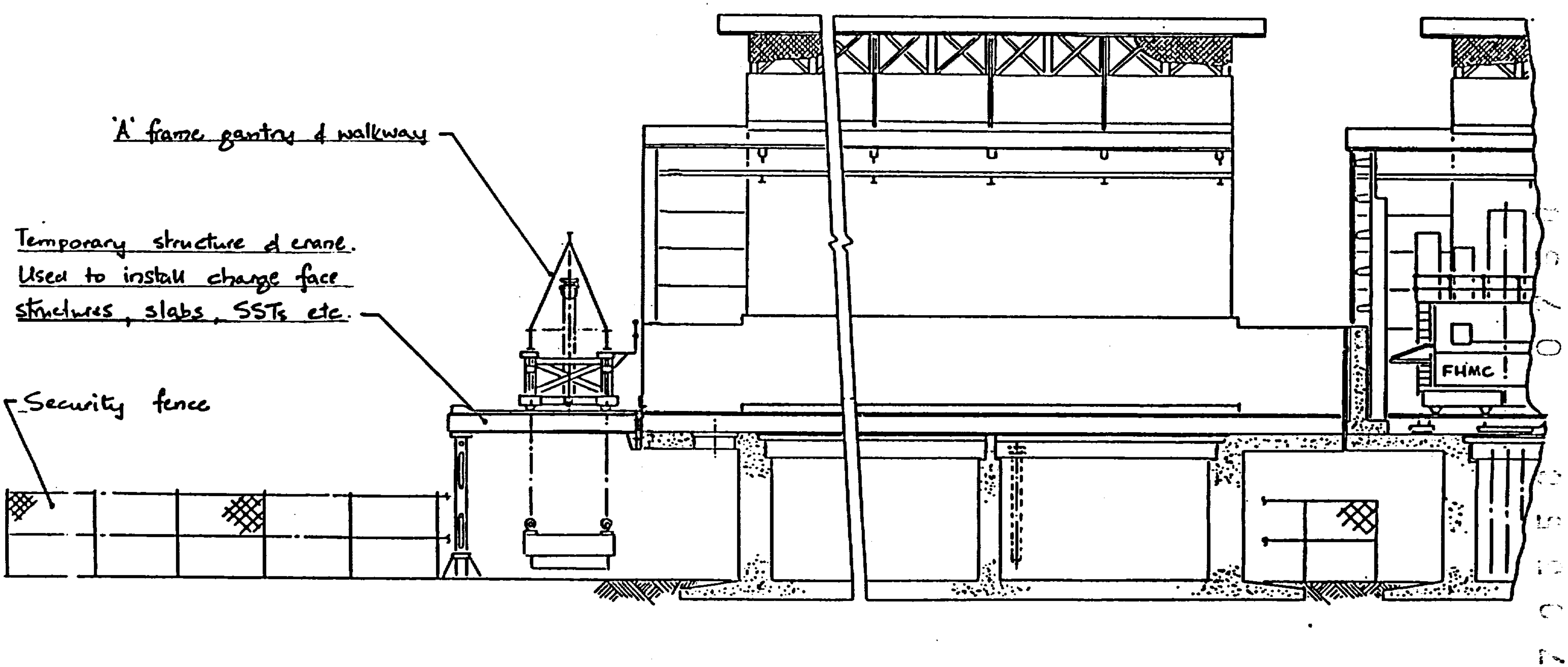


**Figure A-12. MVDS Module Costruction Sequence.**

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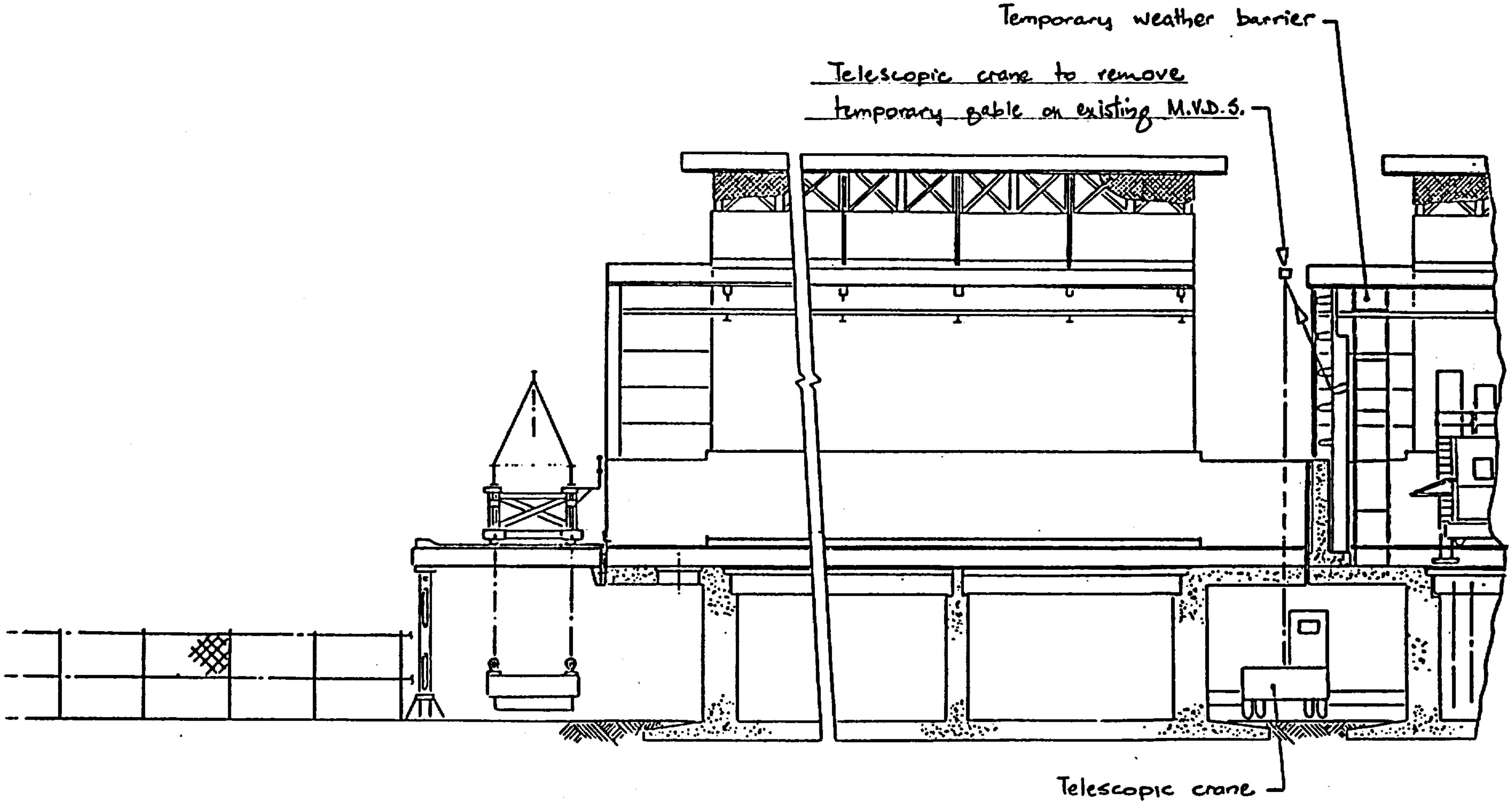


Figure A-13. MVDS Module Costruction Sequence.

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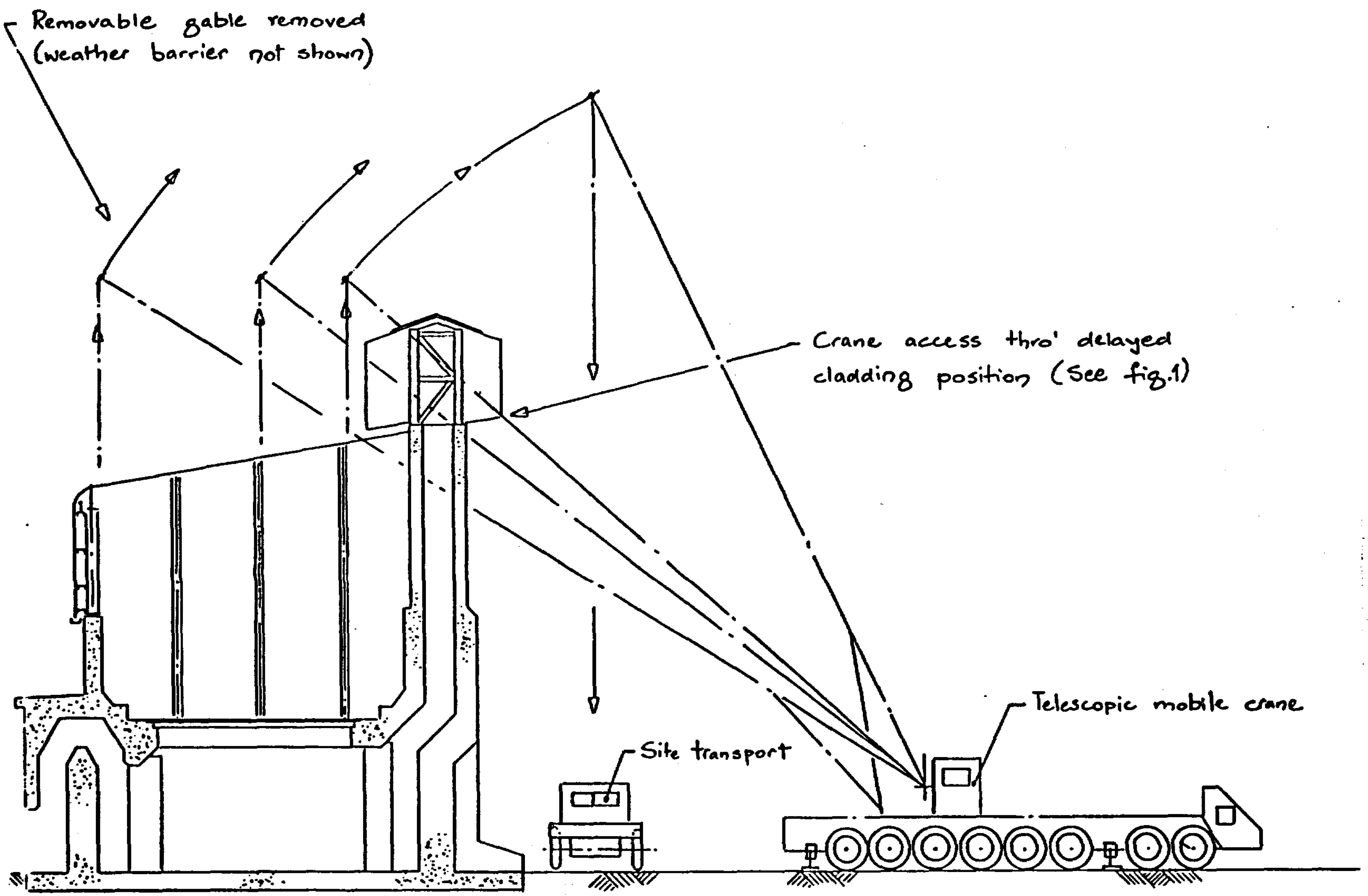



**Figure A-14.** MVDS Module Costruction Sequence.

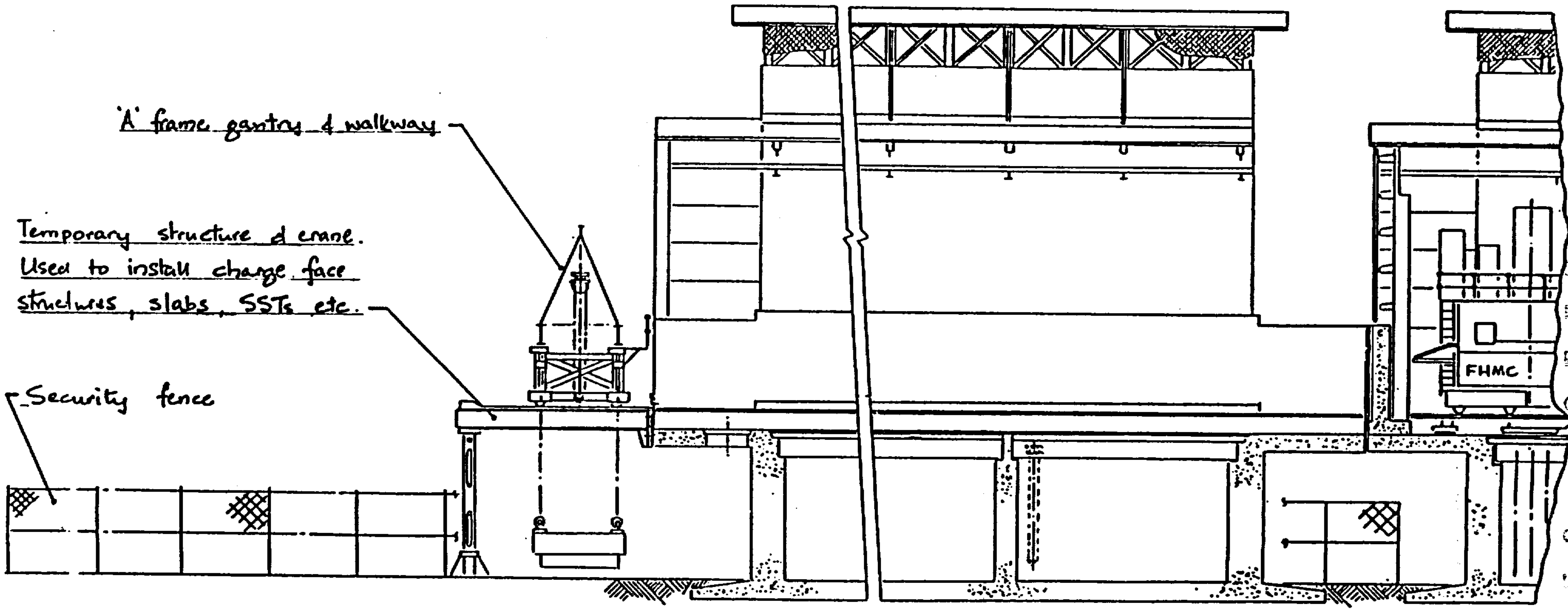



**Figure A-15. MVDS Module Costruction Sequence.**

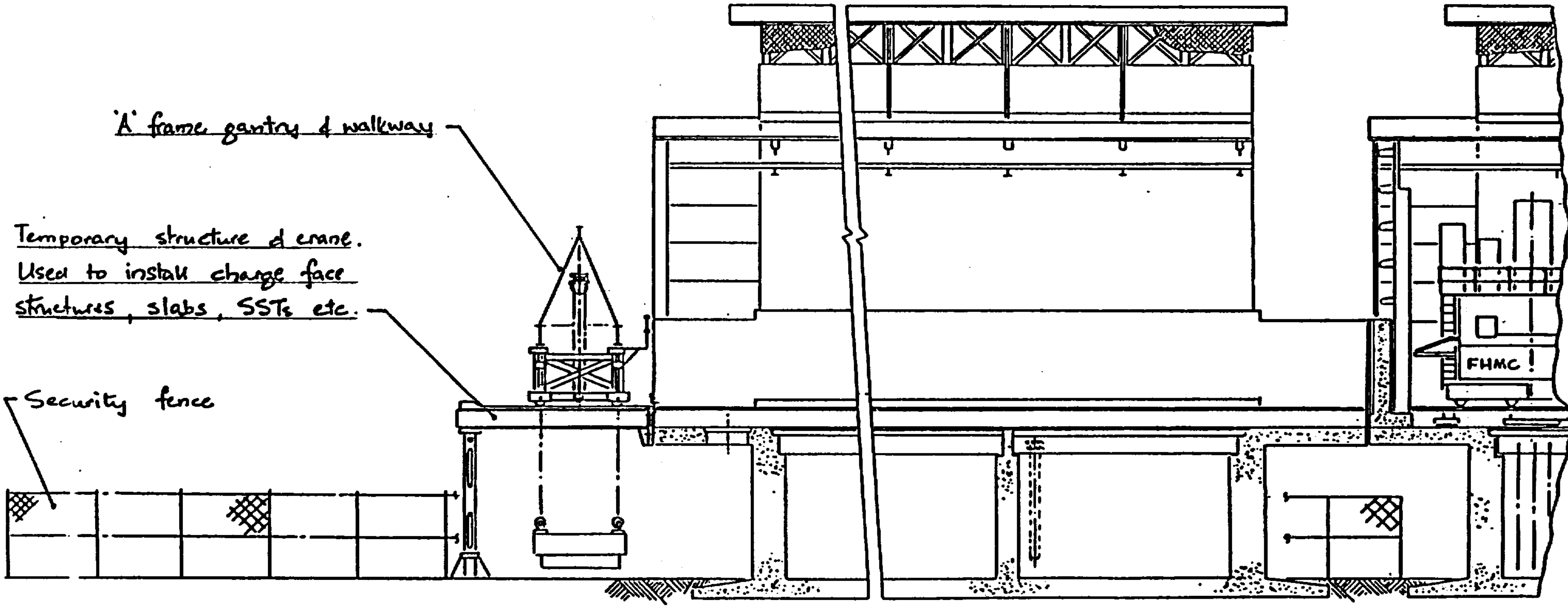



**Figure A-16.** MVDS Module Costruction Sequence.

0407-0045RJ 1/30/90

**APPENDIX B**

**VENDOR SUPPLIED INFORMATION**

FW ENERGY APPLICATIONS, INC.

8 PEACH TREE HILL ROAD • LIVINGSTON, NEW JERSEY 07039 • PHONE 201-535-2354

January 26, 1990

Office of Civilian Radioactive
Waste Management
Department of Energy
RW-222
Washington D.C. 20585

Attention: Mr. Krish Mutreja

Dear Mr. Mutreja:

Foster Wheeler Energy Corporation is pleased to submit to you our budgetary estimate for the supply of our MVDS for use in an MRS facility. We are available at your convenience to discuss any aspect of our MVDS or of our estimate.

As you know, the time available to prepare this estimate was short. This required us to use our engineering judgement based on existing contracts and studies as the basis of our estimate. In addition, we used the following data supplied by you:

- o Receive 400 MTU per year.
- o 45% of the shipments will be received via truck while the remaining 55% will be via rail.
- o The ratio of PWR to BWR fuel received will be 2:1.

I have enclosed three sketches which were prepared as a part of another study, but which fairly represent the configuration as we see it for an MRS. This configuration is based primarily on the design of the MVDS approved by the NRC as a part of our topical report, however, certain subtle changes have been made, as we discussed by phone on 1/24/90. Namely, the module has been rotated 90°, eliminating the 3 foot thick wall allowing an increase of positions to 100 for PWR fuel assemblies and 200 for BWR assemblies.

As can be seen in the sketches, we have orientated the modules to provide a "back-to-back" facility with a central receiving bay. The receiving bay is also redundant in that it contains two fuel handling machines. This provides for increased reliability and allows for two casks to be unloaded in parallel.

Our budgetary estimate for this configuration, capable of storing 400 MTU/year for approximately 10 years is as follows:

1. The Receiving bay, as shown on the attached sketch, including the Fuel Handling Machines and the Transfer Cask Handling Crane is approximately $16,000,000.

2. The Charge Halls as shown at approximately $20,000 per position with the capability to store 100 PWR assemblies. We are in the process of developing our pricing for BWR assemblies.

These estimated prices are exclusive of the following:

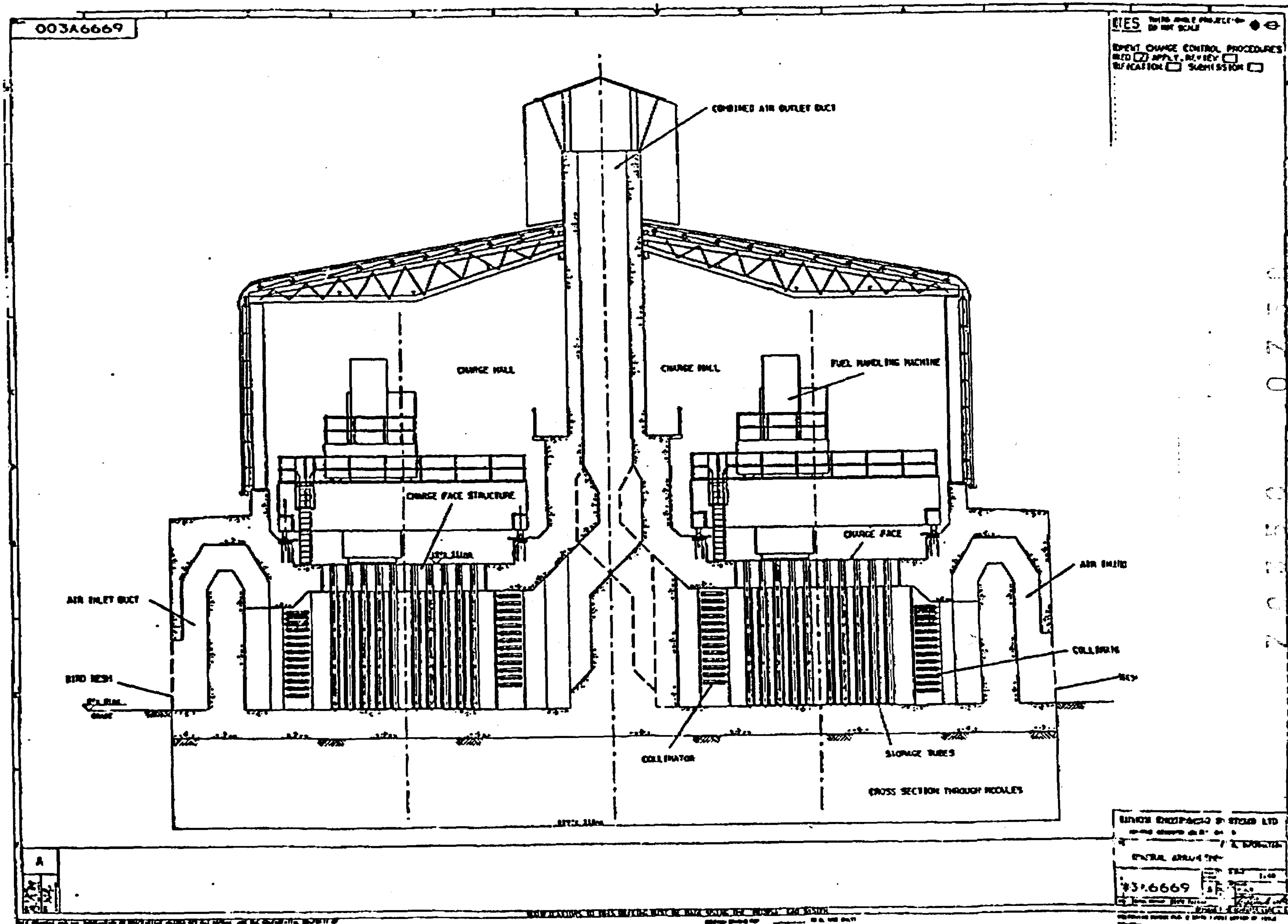
- o Site preparation, grading and landscape
- o Administrative Building
- o Roads and parking
- o Licensing
- o Bringing utilities to site
- o Any foundation beyond the mat

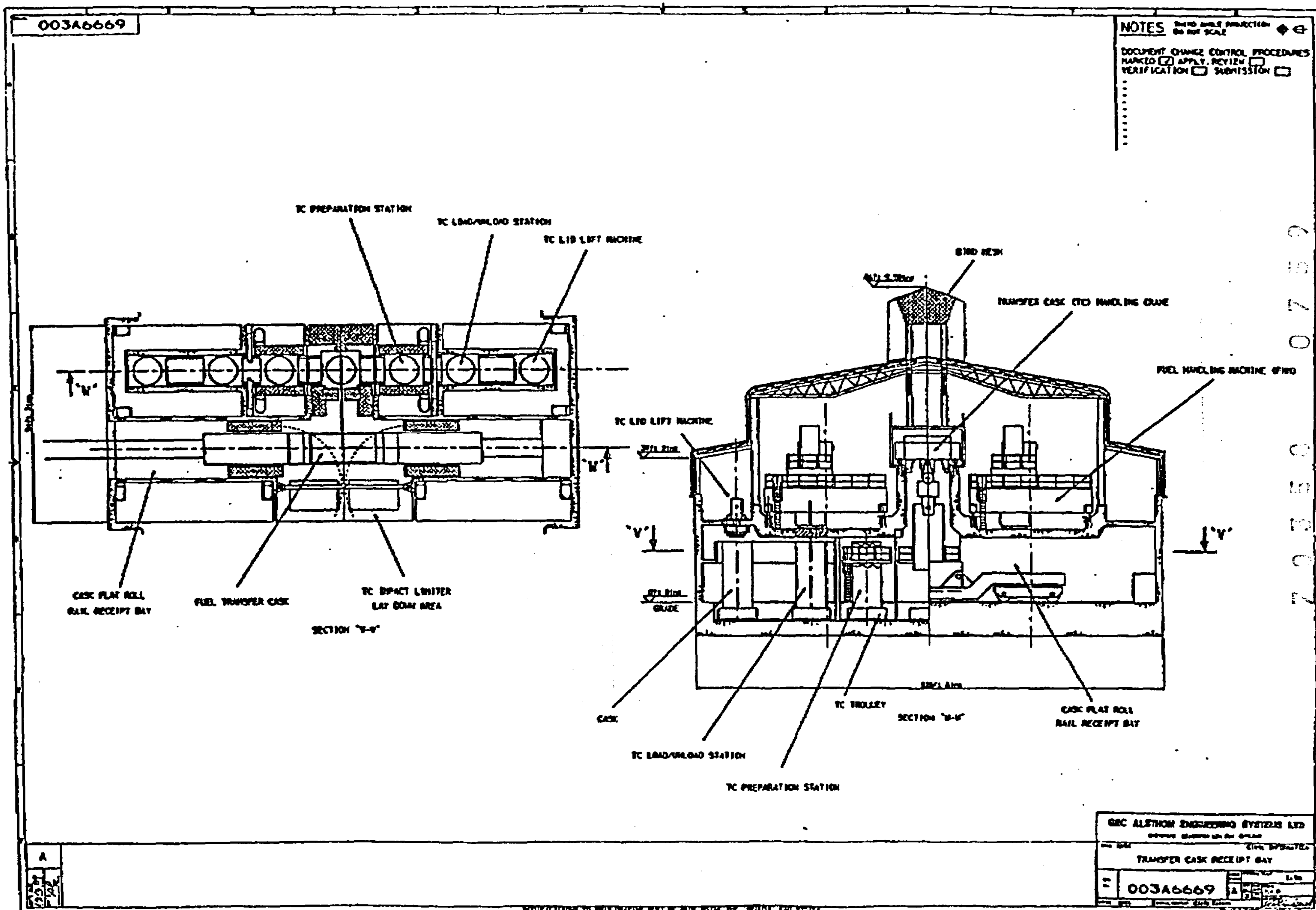
As I mentioned, this is a budgetary estimate. We are working towards refining our numbers slightly, but with the time constraints you must appreciate that they will still be of a budgetary nature. We are also preparing the cost and schedule information in a format consistant with your 1/24/90 telefax and will have this information ready for you on Friday 2/2/90.

As Agru mentioned on the phone, we have performed a detailed study for a Far East utility for a twin unit BWR application. Conduct of such a study provides the opportunity to prepare rather realistic schedules and costs. The next time we are in Washington, we will be prepared to discuss the elements of the study we have conducted and how we might extrapolate this work towards the MRS.

Should you have any questions, please call me at (201) 535-2271 or

JAN-26-90 WED 15:11 P.01



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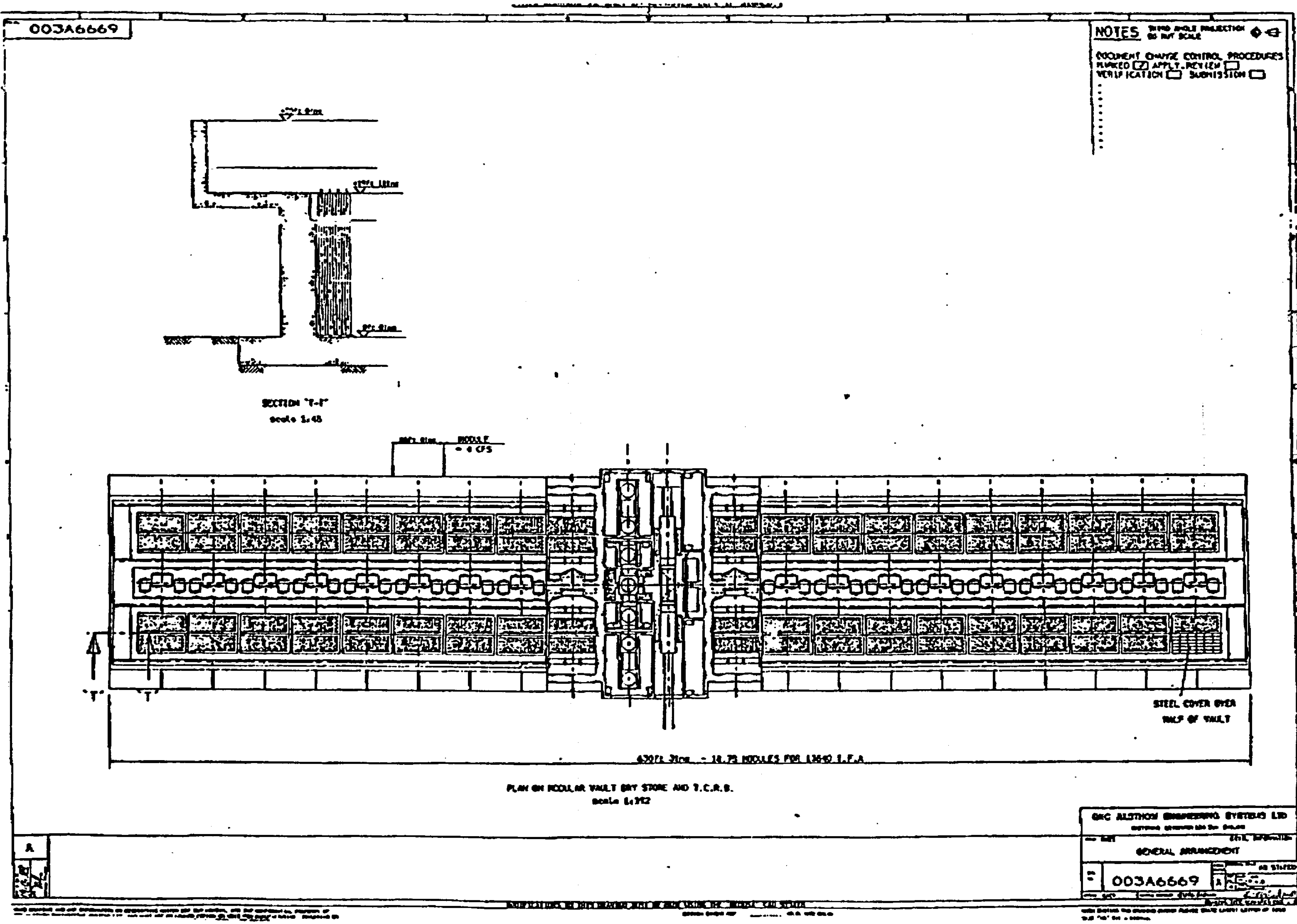
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NOTES
DOCUMENT CHANGE CONTROL PROCEDURES
VERIFICATION SUBMISSION
SECTION "T-T"
MODULE
STEEL COVER OVER
HALF OF VAULT
"T" "T"
PLAN ON MODULAR VAULT DRY STORE AND T.C.R.B.
GEC ALSTHOM ENGINEERING SYSTEMS LTD
GENERAL ARRANGEMENT
003A6669
AS STATED

FW ENERGY APPLICATIONS, INC.

8 PEACH TREE HILL ROAD • LIVINGSTON, NEW JERSEY 07039 • PHONE 201-535-2354

January 31, 1990

Mr. Roland Liverpool
Roy F. Weston, Inc.
955 L'Enfant Plaza SW
8th floor
Washington D.C. 20024

Dear Mr. Liverpool:

In response to your telefax of 1/24/90, FWEA is providing the additional detail information you requested. I have restated your question with our response.

Should you have any questions or require any additional information, please call me at (201) 535-2271.

Very truly yours,

R. J. Bosch
Commercial Director

RJB/gd
cc/K. Mutreja (DOE)

Attachments

SCHEDULE QUESTIONS

1) What was the design development schedule for the facility beginning with conceptual design for a specific site?

Please see the attached schedule of activities.

2) What was the time required for regulatory review and acceptance of the license application to construct the facility? What was the incremental time to obtain regulatory approval to operate?

Generic Topical Report was submitted to the U.S. NRC in September 1986 and a letter of approval was issued in March 1988. At least last three months of this review period was used in evaluation of the Storage container drop analysis which is not required because the lifting mechanism is single failure proof. For Fort St. Vrain, the plan is to submit the SAR and Environment Report (ER) in June 1990 and the NRC has indicated that the ER will be approved by January 1991, whereby site work can be initiated. The design proposed for MRS is exactly similar to the one contained in our topical report and based on the above, we expect to receive NRC approval in one years time.

3) What was the schedule to construct the facility thru readiness to <u>begin</u> hot testing? Which activities within the construction schedule were on the critical path?

See the attached schedule. This is approximately 26 months. The critical path is shown on this schedule. Please note that the attached schedule is conservative. It can be improved by use of multiple sub-contractive, and parallel activities and extended multiple shift work.

4) What major system elements required long-lead procurement in advance of construction? Please note which were not off-the-shelf. What significant durations were required for long lead.

The long lead procurement for the MVDS is the Charge Face Structure and the Fuel Storage containers.

These items require a procurement cycle of approximately 40 weeks.

COST QUESTIONS:

1) What is the breakdown of fixed capital costs: design, construction, equipment, engineering services and procurement, and construction management with overhead, profit, and contingency detailed separately?

Receiving Hall $1,000

| | Total |
|---|---|
| Design | 1,100 |
| Construction | 6,985 |
| Equipment | 6,230 |
| Engineering Serv. & Procurement | 1,685 |
| | 16,000 |

Charge Halls $1,000

| | |
|---|---|
| Design | Included Above |
| Construction | 940 |
| Equipment | 840 |
| Engineering Serv. & Procurement | 220 |
| | 2,000 |

2) What is the estimated operating staff requirements (full-time equivalents) including annual work days and daily shifts?

Typically each receiving bay can be operated with two operators and a HP technician. Similarly, the charge halls can operate with two operators and an HP technician. Assuming a continuous operation of unloading the transportation cask and loading the storage tubes, a total of 5 full time employees per shift are estimated, since the HP technician could perform the required quired tasks in support of the two operating crews. At 400 MTU loading per year assuming a 2:1 PWR/BWR receipt, then approximately 30 weeks of continuous operation on a 5 day, 8 hr shift would be required. Therefore, 6000 full time equivalent hours are required at a receiving rate of 400 MTU per year. The facility has the capacity to handle up to 1600 MTU/year with the addition of a second shift and working a 10 hour 5 day shift schedule.

3) What is the average operating hourly or yearly labor costs (including indirect costs) utility demand, consumables and maintenance with contingency costs separate? If operating

costs can be expressed as $/per year or $/MTU that would be acceptable.

Based upon operating experience on existing equipment, we estimate the O & M costs to be approximately $200-300 per year per MTU.

## Utilities

Attached is a list of electrical equipment and associated load ratings.

Water is normally not used in the operation of the facility but provisions are made in the event it is required for washing or decontamination of cask and other equipment.

| Load Rating | Fuse | Description | Motor | Comments Control |
|---|---|---|---|---|
| | 250A | Main Isolator (Incomer) | No | 250A |
| | 32A | FHM and FHMC | No | |
| 35HP | 100A | 25T Crane Feed | No | |
| 30HP | 100A | T.C. Trolley Compressor | No | |
| 1HP | 6A | LUP Jacks | No | |
| 1/2HP | 4A | Area Hoists | No | |
| 1HP | 6A | Area Door | No | |
| 1HP | 6A | 3T C.H. Hoist | No | |
| 25HP | 200A | Vent Fan (N) | Yes | |
| 25HP | 100A | Vent Fan (S) | Yes | |
| 1/4HP | 2A | Vent Fans Dampers | Yes | Four required |
| 2HP | 16A | Depression Fan (NSS) | Yes | |
| 7.5HP | 32A | Air Fan (N) | Yes | |
| 7.5HP | 32A | Air Fan (S) | Yes | |
| 12KW | 20A | Heater | No | Interlocks req. |
| 24KW | 35A | Heater | No | Interlocks req. |
| 1/4HP | 2A | Air Fan Dampers | Yes | Four required |
| 7KVA | 20A | Lighting Transformer | No | |
| 5KVA | 15A | Power Transformer | No | |
| 2KVA | 10A | Instrument Transformer | No | |

4) What are the decommissioning costs or the percentage of construction capital costs estimated for decommissioning.

Decommissioning costs for MVDS will be lower than other available technologies because the entire facility, except the storage container and FHM cavity, can be demolished using standard methods used for civil structures.

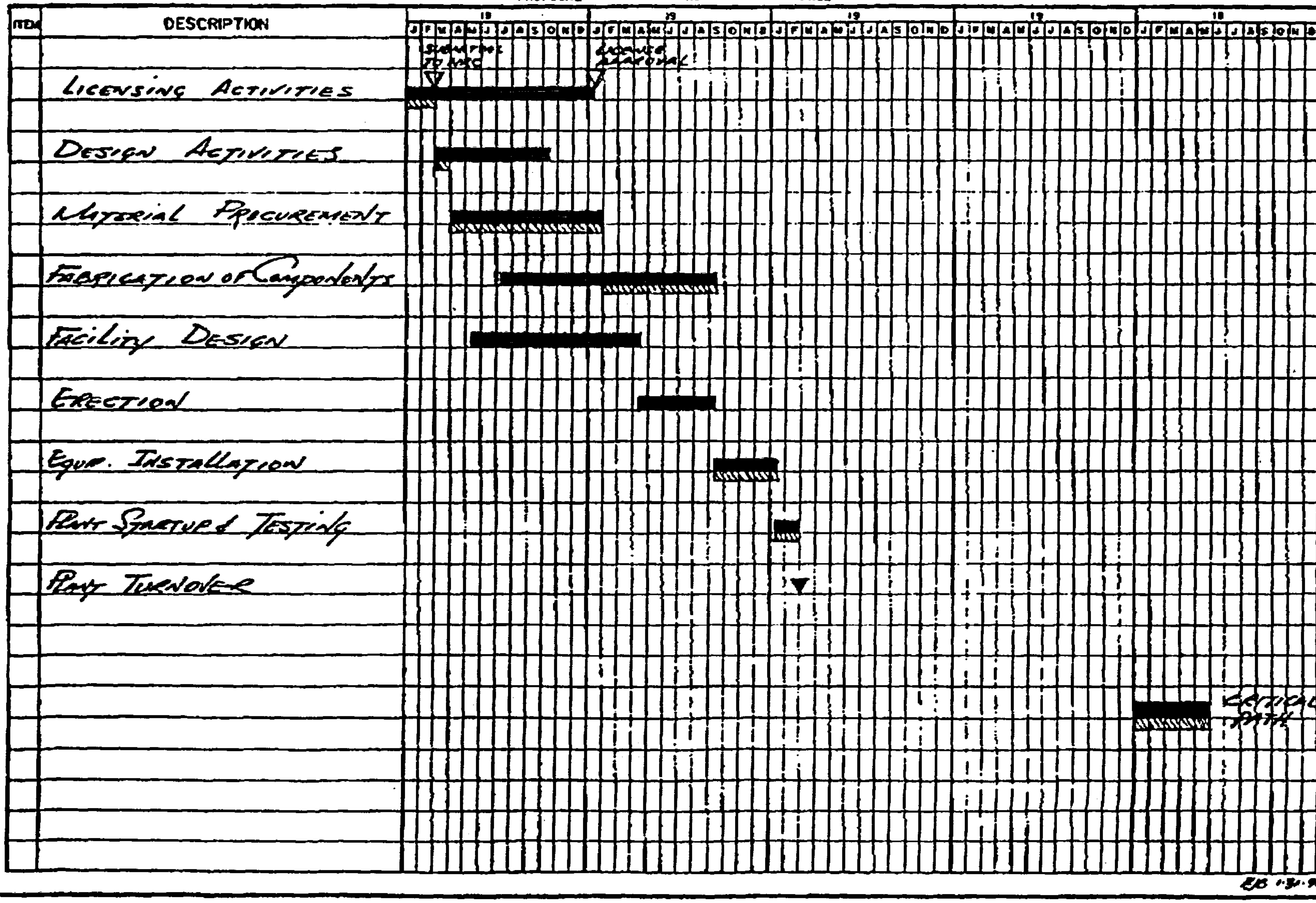
Storage containers which are 13" in diameter, even for PWR assemblies, can be easily decontaminated, cut up, and compacted using currently available equipment. Inside activated liner of FHM can be disposed of similarly.

Due to limited time we were unable to derive decommissioning costs but would welcome the opportunity to work with DOE in the development of detail costs.

# FOSTER WHEELER ENERGY CORPORATION

MRS - 400 MTU/YR

PROPOSAL NO PAGE



PTS → CAH

1/3

TO: A. Engebretson/Weston

FROM: P. Saverot/NUMATEC

DATE: 26 January 1990

SUBJECT: TO Dry Unloading Facility Cost and Schedule Questions

SGN has completed the design engineering and installation of a spent fuel receiving/handling facility named TO; SGN was awarded the contract by COGEMA in 1980, active operation began in September 1986. The facility supports the operation of the La Hague reprocessing plant. The TO facility provides the structures, equipment, and services to receive, unload and transfer shipments of spent fuel assemblies for emplacement in storage. The TO facility includes a receiving and shipping building, a cask preparation cell, and a cask unloading and loading cell which features dry unloading of transportation casks with a maximum residual heat release of 85kw.

A major requirement receiving strong emphasis throughout the execution of the contract was remote and automatic operation of the system in a centralized process mode coupled with high equipment reliability and operating availability. The reduction of individual dose rates to less than 0.5 rem per year was also taken into consideration. The TO facility throughput capacity is 1400 MTU/year of spent fuel, based on 365 days/year operation and a 50% load factor, for a single unloading line.

The TN12, TN13, TN17 and MARK III type casks shipped to this facility are 7.5 feet in diameter and 22.5 feet long with a weight of 110 tons. They can contain up to 12 PWR fuel assemblies or 30 BWR fuel assemblies.

Shipping casks enter the TO receiving cell on a trolley which is positioned on a "Go-Between" rotating plate. This intermediate storage position increases the availability of the receiving area since a fully loaded cask can be stored in this area while an unloaded cask is shipped out. The necessary inspection, radiation monitoring and contamination monitoring are performed in the receiving and shipping area.

Impact absorbers, weather covers and other cask shipping equipment are then removed with the overhead crane of the cask preparation cell.

A 130 ton rated capacity bridge crane is used to raise the cask onto a self-propelled dolly for the following operations:

- inspection of the cask closing systems
- monitoring of the internal atmosphere of the cask cavities using special containment tools
- detection of damaged fuel elements by a Kr 85 counting method in the cask internal cavity
- removal of the cask cover and unscrewing of the cask plug
- installation of the connecting devices for the connection operations with the unloading cell.

Upon completion of these tasks, the cask is transferred into the fuel unloading bay below the unloading cell. The connection between the internal cavity of the cask and the unloading cell is made by a connecting device which guarantees the necessary containment while limiting the surface contamination. The containment of the cell and of the cask cavity is provided by the connecting device and by the cask itself.

Once the cask is in the connecting position, a mechanical device is lowered from the cell and is connected to the cask. The cask plug is removed by a gripper and stored inside the cell. A special system ensures that the upper face of the plug remains clean during all unloading operations. After the cask is opened, the BWR or PWR spent fuel elements ar removed from the cask one by one with a remotely controlled handling crane. The integrity of each fuel element is checked before being transferred to lag storage. When the unloading operations have been completed, the cask seals and plug are then replaced, and the cask cavity is rinsed and dried, using a vacuum pump and a cold trap. This operation is necessary to meet the specifications set forth by the European Transportation Authorities as well as to prevent corrosion of the structures. Monitoring of the irradiation and contamination levels of the cask is performed before the cask is loaded onto its carrier.

A cask maintenance cell associated with the receiving and handling facility conducts various operations including modification of cask internal structures, lid seal replacement, etc. All the operations conducted in this maintenance unit are remotely performed. The TO facility, as installed, meets the following specifications set forth by COGEMA:

1. A fast turnaround of the casks. The four main work stations (shipping and receiving area, preparation before unloading, unloading area and preparation after unloading) are located around the rotating plate where casks are transferred on three self-propelled dollies. A single unloading bay can unload 1400 MTU/year. Pathways of casks have been carefully studied both to maximize the utilization and the throughput of the facility as well as to reduce the facility size. After a year of active operation, the motorization components have been dismantled by telemanipulation and no anomaly has been found.

2. A substantial reduction of the total dose rate to operating personnel due to fully automated operations, remote control features and modular remote maintenance of equipment. The system meets both letter and the spirit of ALARA requirements. Cask movements in the facility are carried out from the centralized control room. The cask transfer dolly, the rotating plate and the air lock entry and exit doors are driven by a programmable controller. Unloading of fuel assemblies and their transfer to the storage area is also performed from the centralized control room. The automated management production control systems knows the characteristics of the cask to be unloaded and passes all the necessary data, internal fuel arrangement, type of fuel assemblies, to the fuel handling crane robot, i.e., type of cask, internal arrangement, type of fuel assemblies, type of canister filling. The operator in the control room controls the transfer of the dollies and the cask unloading cycles (cask positioning on the unloading bay, cask opening, fuel assembly unloading, transfer to storage, and monitoring of the empty cask.)

The facility features several items of advanced equipment designs, such as:

- A tight connecting device which allows the cask to open without any possible contamination of the external surface of the cask and of the plug. A significant R&D program has been conducted since 1979 to solve the main problem related to dry unloading technology, i.e., the containment of the fuel assemblies before and during the unloading sequences. A full scale mock-up was constructed to study the deposition of radioactive particulates in the dry connecting system. It features a hatch cover valve plug, which is a floating slab. This system allows the operator freedom from limits imposed by the geometrical and positioning tolerances. The system tolerates horizontally slope of 5 mm/m, changes in radial position of +55 mm, and height variances up to +65 mm; these three tolerances can be combined together.

- A remotely operated fully stainless steel lined spent fuel handling crane. The crane is able to record two cask cavity coordinates to adapt itself to the fuel elements configuration. This orientation enables the fuel elements to be gripped inside the cask and allows the camera to read the fuel element identification number. The camera can also probe the empty cask once the fuel assemblies have been unloaded. Special grippers can be adapted to grasp all types of fuel assemblies, and the crane is fitted with safety sensors such as limit switches, proximity detectors and dynamometric weight indicators. The crane is capable of an accuracy of about ±2 mm in the x and y axes. It is seismic designed, and

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operated through a programmable controller.

Table 1

| | TO dry cask unloading | NPH wet cask unloading |
|---|---|---|
| Design Development Schedule | 18 months | 16 months |
| Time required for regulatory review | See exhibit 1 | See exhibit 1 |
| Duration of construction thru readiness to begin hot testing | 39 months | 35 months |
| Activities on the critical path during construction | unloading cell including cell lining and fuel handling crane | Pool lining<br>Pool crane |
| Long lead procurement items | Fuel handling crane (18 months) | Pool crane (20 months) |

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Note 1.

There are two types of cask unloading facilities at La Hague: NPH and TO. The NPH facility is a wet unloading facility consisting of two lines with a combined capacity of 800 MTU/year. Each line has a cask receiving hall, two cask preparation cells (before and after unloading) and an unloading pool connected to the NPH storage pool by a channel. The TO dry cask unloading facility has a capacity of 800 MTU/year with only one line in a completely dry cell environment. The dry technology was selected in the early 1980's to reduce operator exposure by reliance on automatic and remote operations, to minimize downtime for maintenance as well s secondary waste production and increase the throughput. The TO technology is a "first of a kind" innovation adapted to centralized spent fuel receiving and unloading facilities and the MRS Commission has shown interest in this technology.

The available figures for the year 1988 are as follows:

1) 135 casks have been unloaded at TO while 137 casks were unloaded at NPH;

2) There are 50 operators at TO (10 x 5 shifts) and 45 operators at NPH;

3) The average individual integrated dose rate is 188 mrem/year/operator at NPH while it is 50 mrem/year/operator at TO;

4) The integrated dose rate per cask unloaded is 70 mrem/cask (NPH) while it is 16 mrem/cask at TO.

The dry cask unloading concept has allowed for the decrease in the integrated dose rate by a factor of 4 compared to the wet unloading technology. COGEMA, the operator of both facilities, attributes a factor of 2 to the high degree of automation (fully remote operation and remote maintenance with modular designed equipment) and a factor of 2 to the lower number of operations at TO compared to NPH.

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Note 2.

Over 2,000 transportation casks carrying more than 6,000 MTU from 59 western European and Japanese reactors have been received at La Hague (France) since 1977. The coming years will lead to the transport of 13,000 MTU in 3,000 cask movements. COGEMA uses dry casks developed by the Transnuclear group. The TN-12 cask, for example, holds 12 PWR fuel elements with a thermal release of 85 KW. The cask can alternatively hold 30 BWR fuel elements.

The TO facility is designed for fully automated operations and therefore only "standard" casks are unloaded in this facility while NPH receives casks of all types. Characteristics of the "TO" casks are given below:

| | Loaded Weight | Capacity | |
|---|---|---|---|
| TN 17/2 | 72 tons | 17 BWR | 6PWR |
| TN 12/2 | 102 tons | 30 BWR | 12 PWR |
| LK 100 | 102 tons | - | 12 PWR |
| TN 13/2 | 105 tons | - | 11 or 12 PWR |

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Breakdown of investment costs

| | TO dry cask unloading facility | NPH wet cask unloading facility |
|---|---|---|
| Design & engineering services | 22% | 16% |
| Civil engineering | 14% | 20% |
| Piping, process equipment | 47% | 47% |
| Process instrumentation & control | 8% | 7% |
| Pre-operating costs | 9% | 10% |

Operating staff requirements

| | TO dry cask unloading facility | NPH wet cask unloading facility |
|---|---|---|
| Number of unloaded casks in 1988 | 135 | 137 |
| Spent fuel equivalent (MTU) | 438 | 706 |
| Number of operators | 10 X 5<br>50 operators | 9 X 5<br>45 operators |
| Operating mode | 5 shifts,<br>7 days per week | 5 shifts,<br>7 days per week |

Operating costs

At this time, this data is considered proprietary when we provide free information to allow you to understand the COGEMA group capabilities more thoroughly. NUMATEC, through COGEMA (the operator of the fuel cycle facilities in France) and SGN (the designer of these facilities) can perform any analysis of interim fuel storage and transfer operations based on their unique experience.

NUMATEC's advantage in providing such technical support services results from the fact that US firms that have had experience in designing hot cells and related nuclear facilities have not had the advantage of being intimately involved in the operation of the facilities and in modifying subsequent designs to include consideration of actual facility performances.

In contrast to this, NUMATEC has a continuing involvement in connection with facilities which its parent companies have designed and operated and therefore is in the unique position to intuitively understand how a specific design feature might impact system performance.

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Decommissioning Costs

Decommissioning cost data can not be released due to the inherently proprietary nature of this information.

COGEMA and SGN have developed information on the technology, safety and costs for decommissioning such nuclear facilities at the end of their operating lives. These studies, based on real projects, should prove invaluable to Weston in providing increased assurance of the workability of the systems designs, the minimization of personnel exposure due to radiation, the planning and preparation of real decommissioning costs escalated to various times in the future.

Again, NUMATEC can provide a critical window of opportunity to capitalize on the availability of proven technologies and studies backed by operating experience to ensure that lessons learned are incorporated into the implementation of the US program.

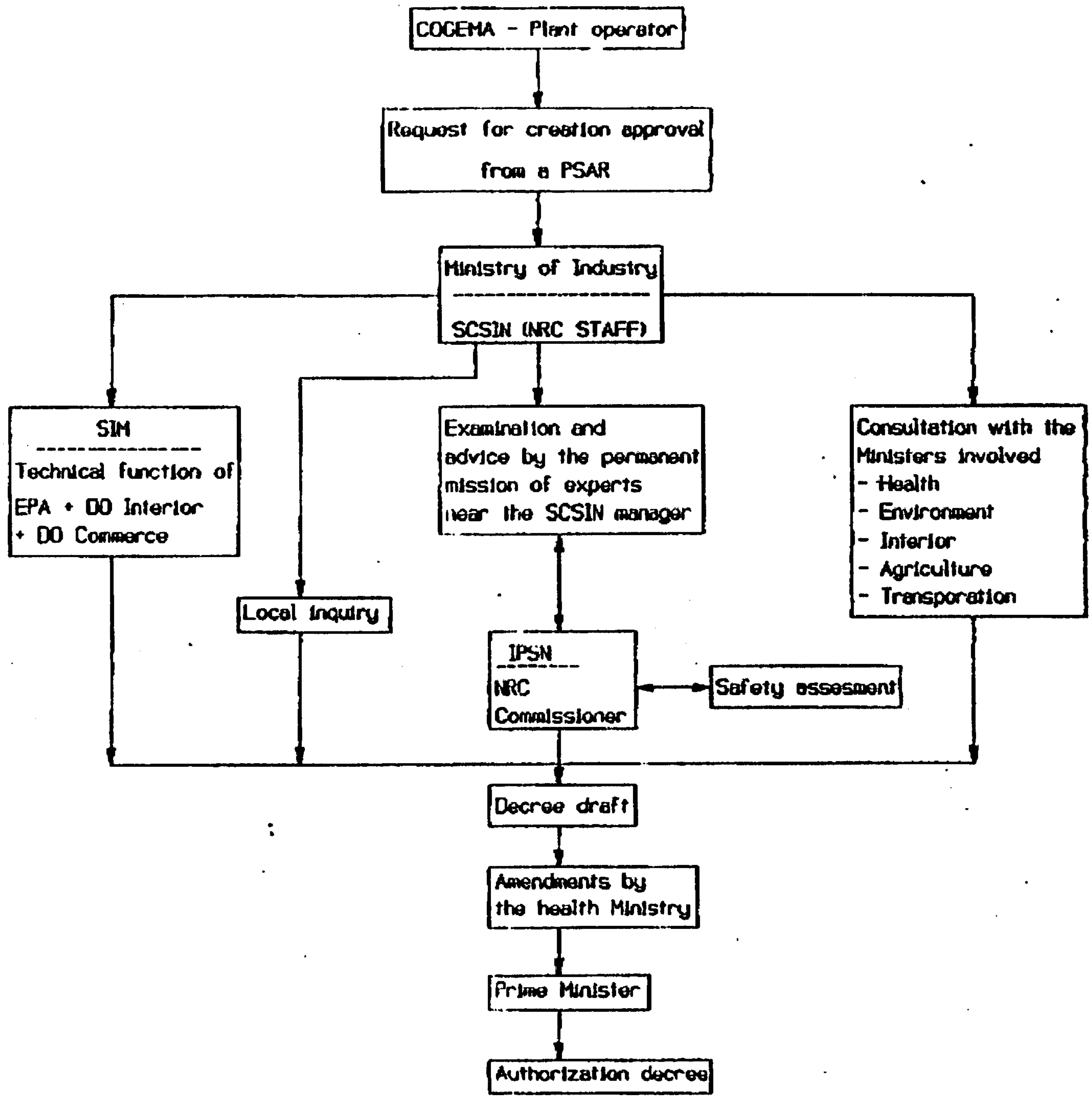
For your information, a provision of 30% of the investment cost is a minimum figure to have in mind.

9/13

Exhibit 1

As explained during our January 24 meeting, the Safety Analysis report has to be available at least 6 months before the start up of the facility.

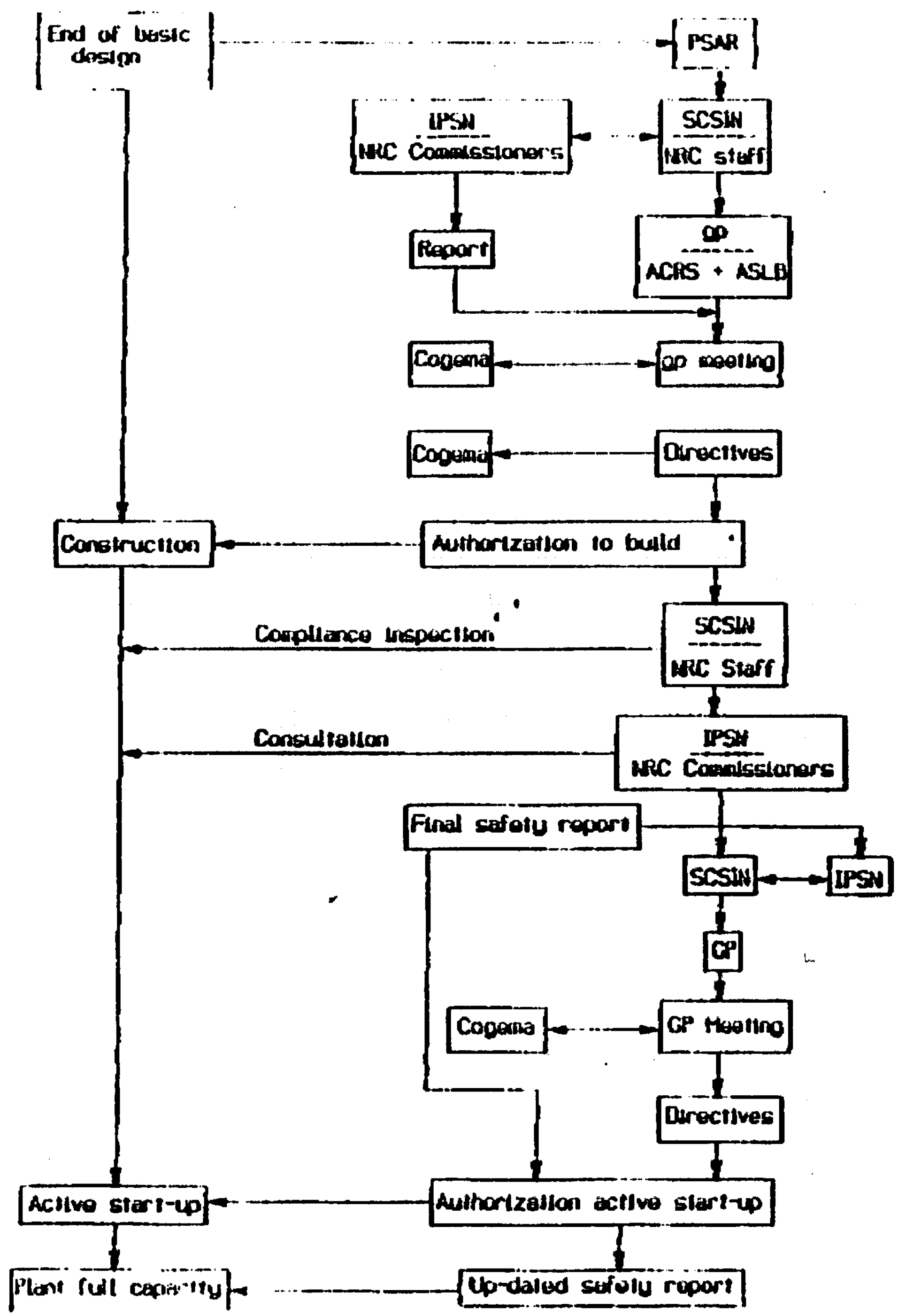
# AUTHORIZATION PROCEDURE FOR CREATING NUCLEAR INSTALLATIONS






10/13

# APPROVAL PROCEDURE AS PART OF THE UP3 REPROCESSING PLANT COMPLEX

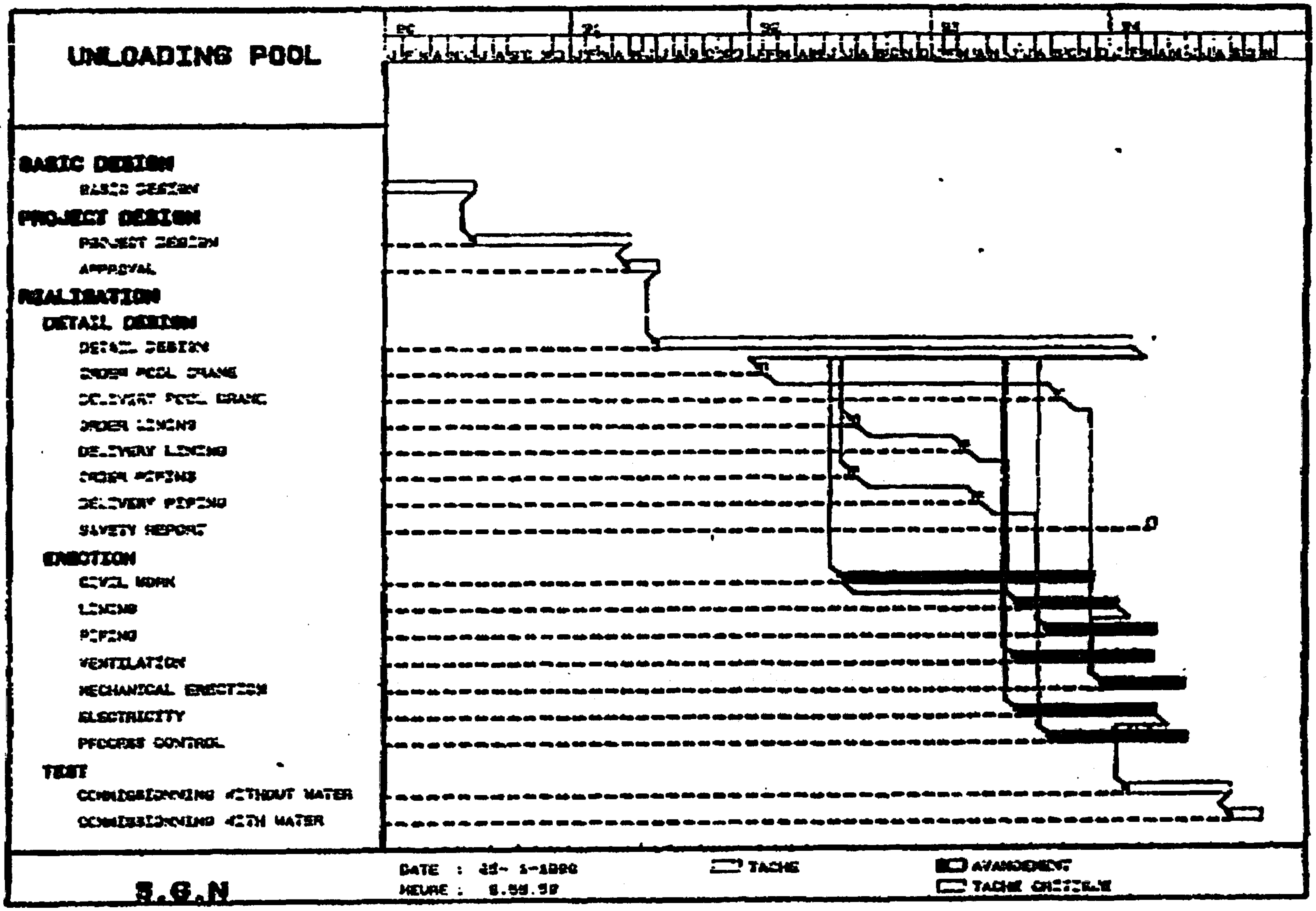





11/13

Exhibit 2

**Exhibit 2 delineates the time schedule achieved by SGN for the design, construction and testing of a wet unloading facility.**


UNLOADING POOL
BASIC DESIGN
BASIC DESIGN
PROJECT DESIGN
PROJECT DESIGN
APPROVAL
REALISATION
DETAIL DESIGN
DETAIL DESIGN
ORDER POOL CRANE
DELIVERY POOL CRANE
ORDER LINING
DELIVERY LINING
ORDER PIPING
DELIVERY PIPING
SAFETY REPORT
ERECTION
CIVIL WORK
LINING
PIPING
VENTILATION
MECHANICAL ERECTION
ELECTRICITY
PROCESS CONTROL
TEST
COMMISSIONING WITHOUT WATER
COMMISSIONING WITH WATER
S.G.N
DATE :
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TACHE
AVANCEMENT
TACHE CRITIQUE

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**Foster Wheeler Fort St. Vrain Schedule**

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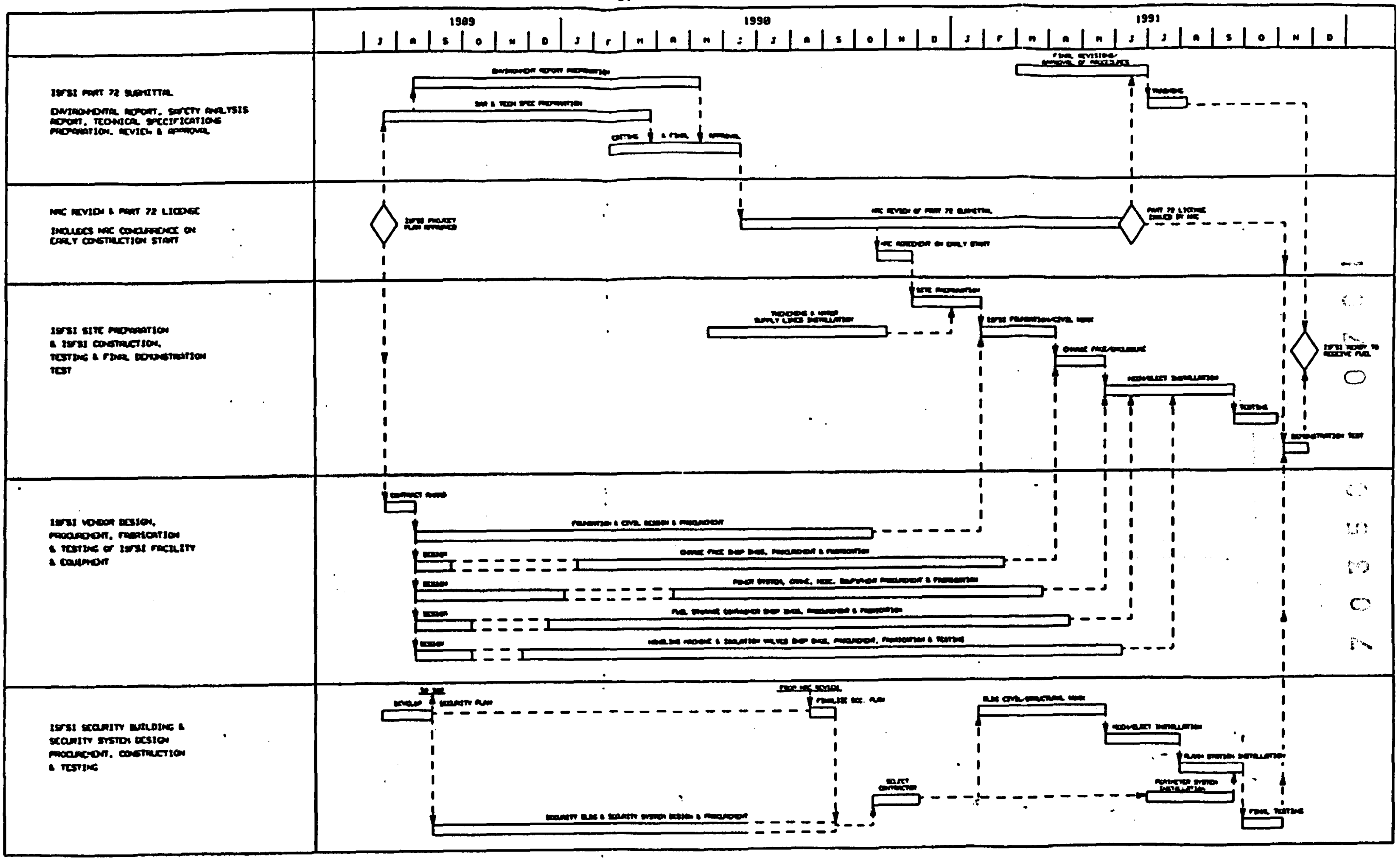
# ISFSI PROJECT SUMMARY SCHEDULE



# APPENDIX C

## SUPPORTING INFORMATION FOR COST ESTIMATES OF THE MODULAR VAULT DRY STORAGE (MVDS), TRENCH, AND WET TRANSFER CONCEPTS FOR A 400 MTHM/YR THROUGHPUT FACILITY WITH 800 MTHM OF STORAGE

TABLE C-1 - Cost Summary for the Modular Vault Dry Storage (MVDS) Facility

(All costs are expressed in thousands of constant 1989 dollars.)

| Design, Engineering & Construction (Ref. C-2 and and Appendix D) | Costs |
|---|---|
| **Receiving Hall:** | |
| Design | 1,100 |
| Engineering services and procurement | 1,685 |
| Construction | 6,985 |
| Equipment | 6,230 |
| Subtotal | 16,000 |
| **Charge Halls (800 MTHM storage in tubes):** | |
| Construction | 16,277 |
| Equipment | 14,546 |
| Engineering services and procurement | 3,810 |
| Subtotal | 34,633 |
| Total design, engineering & construction | 50,633 |
| **Annual Operating & Maintenance Costs** | |
| Labor @ $26.67/hour (Ref. C-3) * | 160 |
| Maintenance (2% of construction) | 573 |
| Total annual O & M | 733 |

* Cost taken from Ref. C-3 in mid-1988 dollars and escalated to mid-1989 dollars using escalation factors from Ref. C-1.

TABLE C-2 - Trench Concept: Cost Summary for the Fuel Transfer and Concrete Storage Cask Manufacturing Facilities

(All costs are expressed in thousands of constant 1989 dollars.)

| Direct Costs (Ref. C-4) | Costs * |
|---|---|
| Sitework and concrete | 227 |
| Building | 1,031 |
| 300 ton bridge crane | 2,000 |
| Shielding | 177 |
| Transfer cars | 566 |
| Decon coating | 67 |
| Transfer equipment | 587 |
| Decontamination system | 133 |
| Change room | 42 |
| Electrical equipment | 142 |
| HEPA filter system | 28 |
| Control trailer | 28 |
| Storage cask transporter (Ref. C-3) | 1,064 |
| Total direct costs | 6,092 |
| Overhead & profit (15%) | 914 |
| Subtotal | 7,006 |
| Engineering services & procurement (10%) | 701 |
| Construction management (4%) | 280 |
| QA allowance (20%) | 1,401 |
| Subtotal | 9,388 |
| Contingency (30%) | 2,816 |
| Total transfer facility capital costs | 12,204 |
| Minus eng. services with 30% contingency | 911 |
| Total transfer facility construction costs | 11,293 |
| Cask Manufacturing Facility (Ref. C-3) | 16,195 |
| Total design, engineering & construction costs | 28,399 |

Table C-2 (Continued)

| Annual Operating & Maintenance Costs (Ref. C-4) | |
|---|---|
| Labor @ $26.67/hour | 1,549 |
| Consumables (10% of labor) | 155 |
| Maintenance (2% of transfer facility constr.) | 226 |
| Storage casks for 400 MTHM (29 casks, Ref. C-3)** | 5,783 |
| Total annual O & M | 7,713 |

* Costs escalated from mid-1982 dollars to mid-1989 dollars using escalation factors from Ref. C-1 except were noted.

** Unit cask cost of $199,400 calculated from Ref. C-3 escalated to mid-1989 dollars using escalation factors from Ref. C-1.

TABLE C-3 - Wet Transfer Concept: Cost Summary for the Fuel Transfer and Storage Cask Manufacturing Facilities

(All costs are expressed in thousands of constant 1989 dollars.)

| | |
|---|---|
| Total Capital Costs of Wet Transfer Facility (Ref. C-5) | 78,260 |
| Breakdown of capital costs (Ref. C-6) | |
| Design and engineering services (16%) | 12,522 |
| Construction: | |
| Civil engineering (20%) | 15,652 |
| Piping, process equipment (47%) | 36,782 |
| Process instrumentation & control (7%) | 5,478 |
| Pre-operating costs (10%) | 7,826 |
| Subtotal construction | 65,738 |
| Subtotal design, engineering & construction | 78,260 |
| Cask Manufacturing Facility construction | 16,195 |
| Total capital costs | 94,455 |
| Annual Operating & Maintenance Costs (Ref. C-5) | |
| Operating (includes labor) | 4,348 |
| Maintenance (5% of transfer facililty) | 3,287 |
| Storage casks for 400 MTHM (29 casks, Ref. C-3)* | 5,783 |
| Total annual O & M | 13,418 |

* Unit cask cost of $199,400 calculated from Ref. C-3 escalated to mid-1989 dollars using escalation factors from Ref. C-1.

Appendix C References

C-1. Engineering News Record, "ENR Cost Indexes in 20 Cities, 1961 - 1989", Quarterly Cost Report, December 1989

C-2. Telefax from R. J. Bosch, FW Energy Application, Inc., to Roland Liverpool, Roy F. Weston, Inc., dated January 31, 1990

C-3. Ralph M. Parsons, "MRS Action Plan Task B Report: Analyses of Alternative Designs and Operating Approaches for a Monitored Retrievable Storage Facility", PNL-6770, December 1988

C-4. Schneider, K. J., "Equipment Concepts for Dry Intercask Transfer of Spent Fuel", PNL-4795, July 1983

C-5. Telephone conference with C. Hutchinson, NUMATEC, and P. Gibson, Roy F. Weston, Inc., dated January 30, 1990, Subject: NPH & TO Facility Capital & Operating Costs

C-6. Telefax from P. Saverot, NUMATEC to A. Engebretson, Roy F. Weston, Inc., dated January 26, 1990, Subject: TO Dry Unloading Facility Cost and Schedule Questions

**APPENDIX D**

**REVISION TO VENDOR DATA SUBMITTED TO DOE FOR INFORMATION PURPOSES IN APPENDIX B**

**ATTACHMENT 1**

MRS Management Team memorandum, 12/20/89

DOE F 1325.8
(10-88)

United States Government

HQO.891220.0003

Department of Energy

# memorandum

DATE: DEC 20 1989

REPLY TO ATTN OF: RW-20

SUBJECT: Design Considerations for a Phased MRS Facility

TO: Chief, Surface Facilities and Waste Package Branch, RW-222

While developing the MRS Strategy Paper it has become evident that it may be difficult to achieve our goal of accepting spent fuel at an MRS facility by January, 1998, if the facility is designed and operated as a single phase "store-only" facility as analyzed in Task B of the MRS Systems Studies. The schedules developed for that type of facility indicate a 24 month NRC licensing review period followed by 26 - 30 months of construction, for a total of four to four and a half years following submittal of the license application. Therefore, to initiate spent fuel acceptance at a single phase "store-only" MRS designed as described in Task B, it would be necessary to have completed siting and the supporting Environmental Assessment, the Environmental Impact Statement, the design, the license application, and safety analysis report by mid to late 1993. Realizing that this may be a rather ambitious goal, we would like to consider other MRS facility concepts, including phased deployment.

I am requesting your support in identifying and assessing the feasibility of design alternatives to the Task B "store-only" MRS facility. The information generated will be used as input or backup to the MRS Strategy. I understand that in the system studies several alternative storage concepts were analyzed; however, I do not believe that the analysis placed significant weight on schedule considerations. Phased concepts were not considered other than a cursory analysis of impacts to a repository and MRS of receiving Transportable Storage Casks in the first phase of deployment. Therefore, I am requesting that you review earlier design studies, operational experience, and available literature regarding concepts that may be simpler and quicker to deploy then a "store-only" MRS designed with the large spent fuel receiving and handling building described in the system studies. These may include concepts such as the Foster-Wheeler design used in Great Britain and anticipated for use at Fort-Saint Vrain, or various other dry spent fuel transfer technology such as that used for clean up operations at Three Mile Island. Several of the concepts have been described in the literature (EPRI NP-6425, 1989; PNL-4795, 1983; and NUS study TTC-0736, 1987). If you believe that it would be appropriate to supplement or modify designs as previously described to better fit the program objectives and requirements, I would welcome additional preliminary conceptual drawings.

The general requirements that any design must meet are described in the draft WMSR vol. III. In addition, the facility must be able to receive, at a minimum, limited amounts of spent fuel the first two to three years (e.g. 300 - 600 MTU in the years 1998 to 2000) and then be capable of ramping up to approximately 1,500 MTU per year. It must also maintain the flexibility

ATTACHMENT 1

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to be capable of eventually (e.g. once the repository is operational) receiving up to 3,000 - 4,000 MTU per year and the design must not preclude maintaing the flexibility to perform other packaging functions, such as consolidation or encapsulating spent fuel into waste packages, at later dates if those functions are determined to be necessary and appropriate for an MRS facility.

The MRS Strategy will address several program activities that must receive attention in order to achieve our goal of accepting spent fuel into the Federal Waste Management System by the year 1998. Design alternatives that have the capability of accelerating the present schedule will be identified. In order to support the strategy paper it is important that we receive an initial evaluation in the form of a letter report, with preliminary design drawings, if necessary, by the end of January, 1990. The report should provide your assessment of the licensing, cost and schedule considerations of alternative technologies. You may direct any questions regarding this request to Jeff Williams at 586-9620.

Ronald A. Miller, Manager
MRS Management Team
Office of Facilities Siting
and Development

cc: S. Rousso, RW-1
F. Peters, RW-2
L. Barrett, RW-20
R. Stein, RW-30
T. Isaacs, RW-40
J. Bresee, RW-10
C. Head, RW-30
S. Brocoum, RW-222
W. Danker, RW-321
G. Appel, RW-331
C. Conner, RW-122
N. Del Gobbo, RW-123
J. Carlson, MRS Team
J. Williams, MRS Team
J. Daly, MRS Team
P. Coes, MRS Team
A. Leiter, WESTON
R. Jackson, WESTON
W. Wowak, WESTON
L. Snow, WESTON
M. Cline, WESTON
J. Richardson, WESTON
P. Bolton, WESTON

7 0 3 5 0 0 7 9 4

**ATTACHMENT 2**

**Activity QA category**

# Inter-Office Memorandum

WESTON
MANAGERS DESIGNERS/CONSULTANTS

TO: Mike Cline

DATE: January 23, 1990

FROM: ~~John Richardson~~, JAL

SUBJECT: QA Category for MRS Task Force Design Activity

A review has been made of the MRS Task Force Design Activity for OFSD (Jack Hale) based on the annotated outline developed in the Richardson/Leiter memo dated January 19, 1990, to determine whether this work is categorized as quality affecting. Based on discussions with QA (Gary Faust) and an examination of the relevant QAAP documents (i.e., QAAP 2.3 and associated OFSD QA control matrices) it is recommended that this work not be categorized as quality affecting. This judgement is based on the following factors:

1. QAAP 2.3 - Establishing Quality Assurance Controls - sections 5.2.1 and 5.2.2 provide general guidance for those design activities that are to be included as quality affecting and the design activity in question is considered outside this category as it is a pre-conceptual design overview.

2. From the task originating memo from DOE (Milner/Hale) dated December 20, 1989, it is stated that the task information will be used as input or back-up to the MRS Strategy Paper. It has been determined that the MRS Strategy Paper is not a quality affecting document.

cc: D. Siefken
R. Jackson
W. Wowak
A. Leiter (MRS Task Force)
G. Faust

**ATTACHMENT 3**

**CEGB letter to GEC on MVDS operational history**

**CENTRAL ELECTRICITY GENERATING BOARD**

**Generation Division**

Wylfa Power Station
Cemaes Bay
Anglesey
LL67 0DH

Telephone: 0407 710471
Telex: 61127

Mr. D. Deacon,
Engineering Director,
GEC Energy Systems Ltd.,
Cambridge Road,
Whetstone,
LEICESTER LE8 3LH

Our ref DKD/30.100 Your ref Date 31 March 1988

Dear Mr. Deacon,

Modular Vault Dry Storage

We have learned with interest that overseas electricity utilities are investigating the merits of air-cooled dry storage of irradiated nuclear fuel assemblies.

The style of dry fuel handling machinery used not only on our dry stores but also for on-load refuelling of our two reactors at Wylfa will be outside the experience of most overseas utilities.

Our experience with the air-cooled dry storage of irradiated fuel at Wylfa is set down in the attached Note Reference RSB/22.3.88. As an overall summary I can confirm that the stores and their fuel handling systems have worked safely and reliably within their design parameters throughout their sixteen years of operation.

Yours sincerely,

R. Deacon

D.K. DOO
Station Manager

**ATTACHMENT 3**

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**ATTACHMENT 4**

NRC letter confirming acceptance of Foster Wheeler topical report

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 2 2 1988

Project M-46

FW Energy Applications, Inc.
ATTN: Mr. Henry C. Pickering, Jr.
President
8 Peach Hill Road
Livingston, New Jersey 07039

Gentlemen:

SUBJECT: ACCEPTANCE AS A REFERENCE OF "TOPICAL REPORT FOR THE FOSTER WHEELER MODULAR VAULT DRY STORE (M.V.D.S.) FOR IRRADIATED NUCLEAR FUEL"

The Nuclear Regulatory Commission (NRC) staff has completed its review of Revision 1 of the FW Energy Applications, Inc., "Topical Report for the Foster Wheeler Modular Vault Dry Store (M.V.D.S.) for Irradiated Nuclear Fuel" (TR). Based on this review, NRC staff has concluded that the Modular Vault Dry Store (MVDS) design as described in the TR provides for an acceptable means to meet the requirements of 10 CFR Part 72, as defined in this letter and subject to appropriate specifications expressed in the enclosure, the NRC staff's safety evaluation report (SER), for the safe receipt, handling, and storage of spent fuel at an independent spent fuel storage installation to be located at a nuclear power plant site. This acceptability is limited to conditions and the spent fuel detailed in the TR (i.e., Revision 1), augmented by information submitted after the filing of Revision 1 and in this letter with its enclosure.

By letter dated September 11, 1986, FW Energy Applications, Inc., (FW) submitted for review a topical report entitled, "Topical Report for the Foster Wheeler Modular Vault Dry Store (M.V.D.S.) for Irradiated Nuclear Fuel" (TR) dated August 1986, (docketed under Project No. M-46). In response to NRC staff comments, a revision to the original FW report was submitted by letter dated November 12, 1987, and docketed. This was Revision 1 entitled, "Topical Report for the Foster Wheeler Modular Vault Dry Store (M.V.D.S.) for Irradiated Nuclear Fuel," dated October 1987.

The MVDS design is relatively complex when compared to other modular, passive, dry spent fuel storage designs that the NRC staff has evaluated. The MVDS design is almost a design suitable for a separate-site, stand-alone, away-from-reactor independent spent fuel storage installation. However, it provides a diversity in dry spent fuel storage options available for at-reactor-site storage in that it may be appropriate for reactors without heavy load crane capacity, capable of handling 100-ton class dry spent fuel storage casks. Also, the design, because of its compactness, may be suitable for reactor sites where there is limited space or with other storage siting location concerns. Moreover, while the NRC staff does not accept the use of

ATTACHMENT 4

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 2 3 1988

Project M-46

FW Energy Applications, Inc.
ATTN: Mr. Henry C. Pickering, Jr.
President
8 Peach Hill Road
Livingston, New Jersey 07039

Gentlemen:

SUBJECT: LIMITED PROPRIETARY REVIEW OF NUCLEAR REGULATORY COMMISSION (NRC) STAFF'S FINAL SAFETY EVALUATION REPORT (SER) FOR THE FW ENERGY APPLICATIONS, INC., TOPICAL REPORT FOR THE FOSTER WHEELER MODULAR VAULT DRY STORE (M.V.D.S.) FOR IRRADIATED NUCLEAR FUEL, REVISION 1

Enclosed is the NRC staff's letter of approval for the FW Energy Applications, Inc., (FW) Topical Report for the Foster Wheeler Modular Vault Dry Store (M.V.D.S.) for Irradiated Nuclear Fuel, Revision 1, (enclosure 1).

The letter of approval contains, as an enclosure, the NRC staff's final SER for the FW topical report. Much information and data presented in the topical report are claimed to be proprietary in nature. Of necessity there must be specificity in the NRC staff's SER in delineating the extent and limitations of our safety review of the FW topical report, and information and data in the topical report claimed to be proprietary in nature are referenced in summary form in the staff's SER. Consequently, we are providing in this letter a summary of the conclusions of the NRC staff's SER (enclosure 2). This summary and the letter of approval without its enclosed SER are being made publicly available with this letter (docketed under Project M-46) through the NRC Public Document Room. For a limited time we make available to FW the NRC staff's final SER solely for a limited proprietary review by FW to determine if there exist objections to the release of portions of the SER because of potential public release of information and/or data of a commercially damaging nature.

If the NRC staff has not received a response from FW within three weeks of the date of this letter, we will publicly release the SER. Please note that no comments on the technical nature or conclusions of the staff's SER, which is final, are either solicited or acceptable in your response.

Sincerely,

John P. Roberts

John P. Roberts
Irradiated Fuel Section
Fuel Cycle Safety Branch

Enclosures:
1) Letter of Approval
2) Summary of NRC staff's
Safety Review Conclusions

air as a storage cover gas for the MVDS at this time, we do not reject the contention that continued research in this area may subsequently result in allowance of such use.

The NRC staff believes that it is in the public interest that a broad diversity of safe passive dry spent fuel storage designs exist to ensure that storage capacity shortfalls not arise, so that sufficient storage capacity can be available at all reactor sites prior to final disposition of spent fuel generated by reactor operations.

In this SER, the staff's review examined how the submitted FW MVDS design for an ISFSI meets specific requirements of 10 CFR Part 72 with respect to design, operation, and decommissioning. The staff's review addresses normal and off-normal operating conditions and accidents. Shielding, criticality, structural, thermal, and radiological aspects of the cask design and the vendor's quality assurance program have been reviewed for compliance with applicable requirements of Subparts E, F, and G of 10 CFR Part 72.

Requirements for physical protection in 10 CFR Part 73 and for offsite transport of radioactive materials in 10 CFR Part 71 were not within the scope of the TSAR and were not addressed in the staff's review.

Operating limits established for the vault and its spent fuel content have been reviewed, and limitations and operating conditions applicable to fuel loading, storage operations, and surveillance are detailed in Chapter 12 of the SER (see enclosure). These specify the limitations under which the TR, with its described design and spent fuel, is accepted as a reference in a Safety Analysis Report in a 10 CFR Part 72 site-specific spent fuel storage license application. However, this listing is not complete; other appropriate technical specifications and limitations will apply, depending on siting or other conditions associated with a specific license application.

As a result of its evaluation, the NRC staff finds that the FW Energy Applications, Inc., "Topical Report for the Foster Wheeler Modular Vault Dry Store (M.V.D.S.) for Irradiated Nuclear Fuel" Revision 1, as augmented by additional information received and docketed after submittal of Revision 1, is acceptable as a reference, under the limitations delineated in the TR, as modified and expanded in the SER (enclosure), with the following exception:

> Chapter 10, Development and Operating Controls and Limits, of the TR is not to be cited as a reference. A site-specific license application should explicitly list its proposed technical specifications. This does not preclude a license applicant's use of Chapter 10 of the TR as guidance along with Chapter 12 of the NRC staff's SER (enclosure).

It is requested that FW Energy Applications, Inc., publish an approved version of this report, with proprietary information in a separate binder, as per Item 3, "Proprietary Information," of the Introduction of Regulatory Guide 3.48, within three (3) months of the receipt of this letter and submit copies for docketing with 20 copies to be retained by FW for future reference.

This revision is also to incorporate this letter with its enclosures including the SER, following the title page and a listing identifying with submittal dates, supporting supplemental information submitted after the TR, i.e., Revision 1, and docketed under Project M-46. The report identification of the approved report is to have an "A" suffix.

The NRC staff does not intend to repeat the review of the features important to safety described in the TR and found acceptable when it appears as a reference in a license application except to assure that the material presented is applicable to the application involved. The NRC staff's acceptance applies only to the features described in the TR, as augmented by the supplemental information submitted subsequent to the filing of the TR (i.e., Revision 1).

Should NRC criteria or regulations change, such that our conclusions as to the acceptability of the report are invalidated, FW Energy Applications, Inc. and/or the applicants referencing the Topical Report will be expected to revise and resubmit their respective documentation, or submit justification for the continued effective applicability of the Topical Report without revision of their respective documentation.

Sincerely,

John P. Roberts

John P. Roberts, Section Leader
Irradiated Fuel Section
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety

Enclosure:
Safety Evaluation Report

70358 0003