THE ADDITION OF VOLUME-REDUCTION, SOLIDIFICATION

AND INTERIM STORAGE SYSTEMS TO OPERATING LWR PLANTS

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ABSTRACT

Many Light Water Reactor (LWR) plant owners are faced with the decision of how to upgrade their plant waste solidification process and to increase their interim storage capacity. In addition, the decision to upgrade plant waste systems must consider the use of volume-reduction techniques because of the potential overall waste management cost savings. The objective of this paper is to provide a conceptual design for an integrated volume-reduction, solidification, and interim storage facility in order to assist plant owners in developing budgetary capital cost estimates for use during the decision making process. A unique feature of this conceptual design is that it is adaptable to most of the volume-reduction and packaging options shown in Fig. 1.

BACKGROUND

In situations where it is necessary to upgrade the waste solidification and on-site storage capabilities of plant, a decision of whether or not to include volume-reduction capabilities in the overall backfit project becomes a difficult task. The difficulty arises because a positive decision on volume-reduction requires the operating cost savings to justify the capital expenditure. Quantifying the capital expenditure involved is an arduous task while operating costs are easier to define. The operating cost advantage of volume-reduction systems for nuclear wastes has been reported by several independent studies.[1] For a two-unit LWR, for example, the present worth of the savings in operating costs, over a 15-year period, could vary between 5 to 32 million (1982) dollars, depending on the volume-reduction method used.[2] Volume-reduction will also result in additional capital cost savings due to reduced interim storage space requirements.

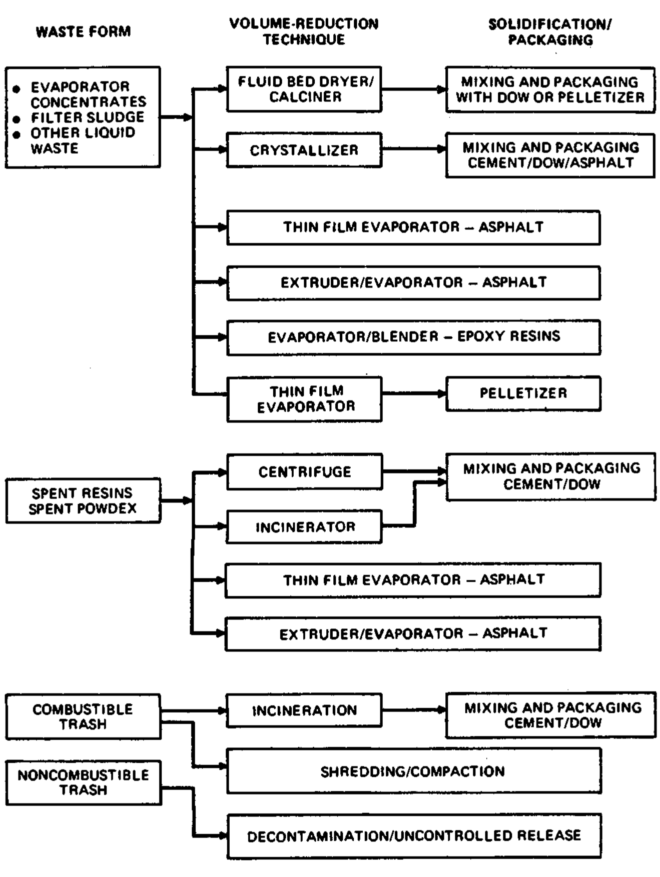


FIG. 1 LWR RADWASTE PROCESSING OPTIONS

Developing an accurate, site-specific capital cost estimate to justify a volume-reduction system is a difficult and extensive effort. To begin with, the plant owner must conduct a broad survey. The technical and commercial merits of approximately three dozen system tradeoffs must be evaluated. The evaluations must include the use of existing building space versus the construction of a new structure. Additionally, the impact on interim storage and the overall plant integration requirements must be determined. After the initial systems comparisons, the choice must be narrowed to a limited number of alternative cases. Lastly, each alternative case must be carried out to at least a conceptual design stage to allow detailed economic and technical evaluations.

This paper focuses on an alternative case that is most common during volume-reduction feasibilty studies. This case involves a plant where the existing facility has no space to accommodate either a volume-reduction or a solidification system. Therefore, a new structure outside the power block must be provided if volume-reduction and solidification systems, combined with interim storage, are to be provided. A conceptual design that is adaptable to most of the systems available in the market is presented in this paper. This facility is sized to accommodate wastes from a two-unit BWR or PWR station. This design can be used to identify the requirements for an integrated volume-reduction, solidification and storage facility and to develop budgetary cost estimates for comparison with other options as needed during the initial decision-making process.

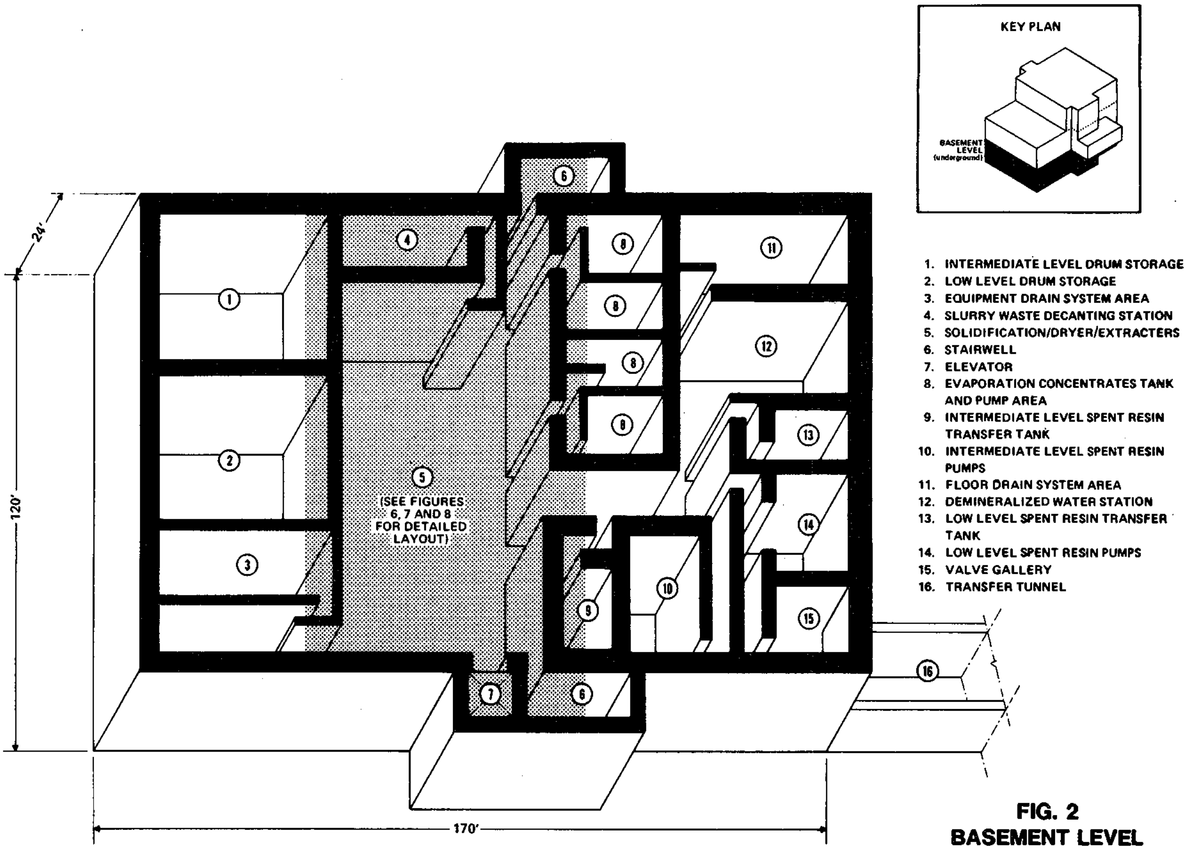


FIG. 2
BASEMENT LEVEL

Facility Description

The conceptual design consists of three sections: a volume-reduction and solidification structure, a transfer tunnel which connects the volume-reduction and solidification structure to the existing radwaste building, and a waste container storage area. The volume-reduction and solidification structure is a three-level building. The basement level contains the waste receiving and distribution systems, the first level contains equipment for the dewatering and solidification of liquids and sludges, and the second floor houses the incineration, HVAC equipment and the control room. Adjacent to the solidification equipment is the container storage and shipping area. This area runs from the foundation of the facility to the top of the first floor. This area is sized to store a minimum of 2 years' worth of waste from a typical two-unit LWR plant.

Facility Layout

The basement level (see Fig. 2) contains areas for low- and intermediate-level resin transfer systems, areas to collect floor drains and equipment drains, a demineralized water system, a chemical adjustment system, a concentrated waste transfer system, and portions of the volume-reduction and solidification system related to the drum fill and packaging functions. The bottom part of the on-site storage section is also included in the basement area. The square footage of the basement area designated to each function is shown in Table I.

The ground level (see Fig. 3) contains areas for waste storage and feed systems, a waste feed chemical adjustment system, chilled water and service air systems, an off-gas system, electrical equipment, an access control/office/Health Physics (HP) support structure, and ancillary equipment related to the volume-reduction and solidification functions. Additionally, a truck bay is included in the ground floor at the on-site storage section of the facility. The square footage of the areas designated to various function in the ground level is shown in Table II.

The second floor (see Fig. 4) contains an incineration system, a dry active waste (DAW) sorting and preparation area, a control room, the HVAC system, and the incinerator off-gas system. The square footage of the areas designated to these functions is shown in Table III.

The facility is connected to the power block (auxiliary building) via an underground tunnel. The tunnel width and height are 6 ft and 10 ft, respectively. However, the tunnel length will depend on the individual site requirement.

A perspective view of the onsite storage section of the facility is shown in Fig. 5. As shown, transfer hatches allow crane access to the basement area where the drum fill and packaging operations occur. A packaged drum is lifted from the basement area by the crane and is placed in the storage vaults.

Layout Flexibility

As mentioned previously, the conceptual design can be arranged to adapt the majority of the volume-reduction and solidification systems currently marketed in the U.S. Figs. 2, 3, and 4 show that certain areas have been designated for the volume-reduction and solidification system components. Detailed layout of these areas will vary for a given volume-reduction and solidification approach.

Layout variations for three different options have been included in this paper. The first layout,

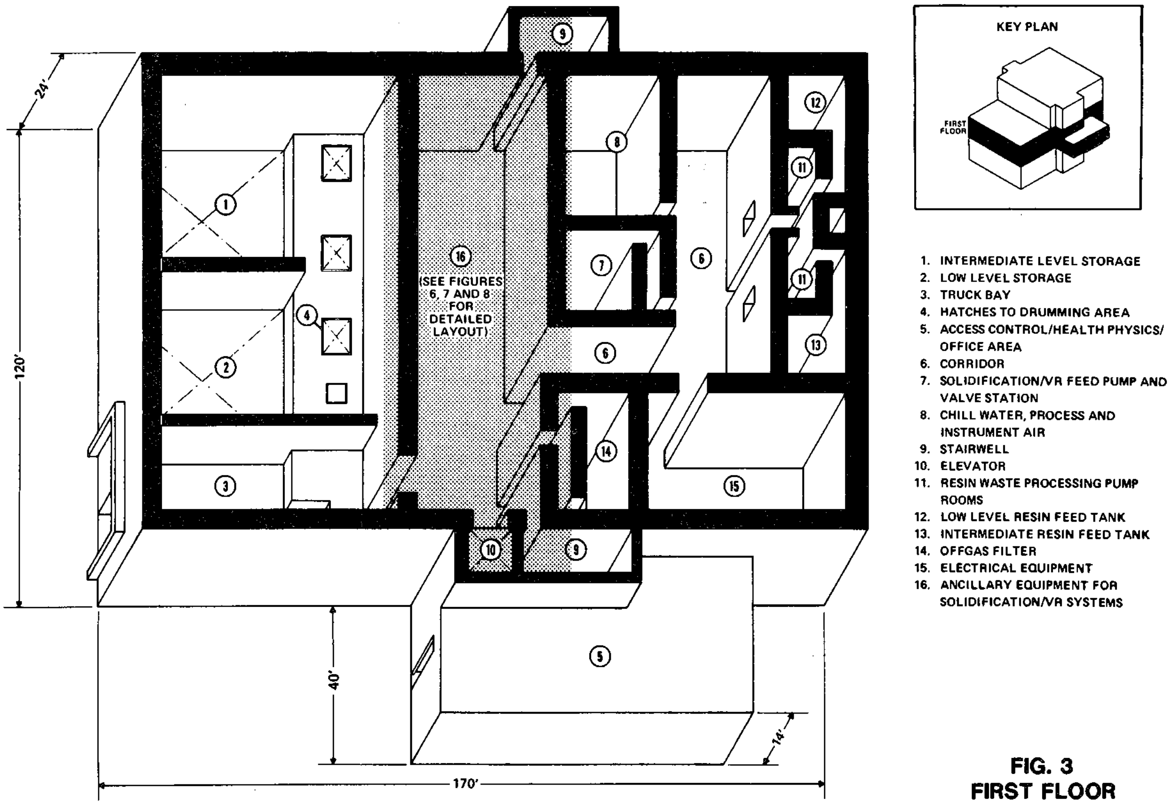


FIG. 3
FIRST FLOOR

shown in Fig. 6, includes a fluid-bed dryer and incinerator combined with a cement and polymer drumming system. The second layout (Fig. 7) is based on using a bitumen system for volume-reduction and solidification of process wastes combined with a controlled air incinerator for burning the plant DAW. The third layout (Fig. 8) demonstrates the flexibility of the facility for adoption of an evaporator/crystallizer with a cement and polymer solidification system combined with a DAW incinerator.

Table I

Area Requirements for Various Functions
Basement Level

Function	Area Requirements (ft^2)
Resin Transfer Systems	3500
Floor Drain System	1000
Equipment Drain System	1300
Demineralized Water/Chemical Adjustment Systems	1500
Concentrates Waste Transfer System	2000
Drum Fill and Packaging Stations	5500
Drum Storage	4200
Access Corridors	1400
Stairs and Elevator	850
Total Basement Area	21250

Table II

Area Requirements for Various Functions
Ground Level

Function	Area Requirements (ft^2)
Waste Feed Systems	2800
Chilled Water and Service Air	1450
Off-gas System	1000
Electrical Equipment	2000
Access Control/Office/HP	2250
VR/Solidification Ancillary Equipment	3050
Truck Bay	2100
Drum Storage	5300
Sampling Station	700
Corridors and Vestibule	2000
Stairs and Elevator	850
Total Ground Level Area	23500

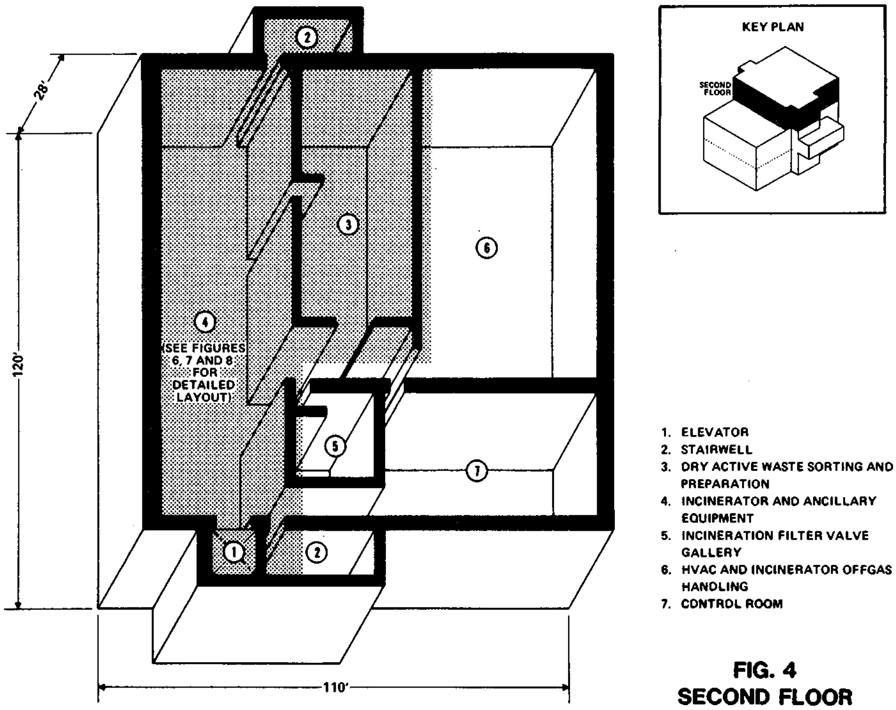


FIG. 4
SECOND FLOOR

Table III

Area Requirements for Various Functions
Second Floor

Function	Area Requirements (ft^2)
Incineration System	5500
DAW Sorting and Preparation	2000
Control Room	1500
HVAC and Incinerator Off-gas	2800
Corridors	1400
Stairs and Elevator	850
Total Second Floor Area	14050

Systems Description

Systems provided for the volume-reduction, solidification, and storage facility include:

1. Liquid and Slurry Waste Transfer Systems: These include the tanks and pumping equipment needed to collect and transfer the liquid and slurries from the power block to the volume reduction and solidification structure.

2. Waste Receiving, Storage, and Distribution Systems: These include the systems required to collect and store the wastes received from the power block as well as the systems required for collection of the volume-reduction and solidification building floor and equipment drain wastes. Also included are the systems needed for chemical treatment of the liquid and slurry wastes.

3. Volume-Reduction and Solidification Systems: The conceptual design of the facility allows any one of the following volume-reduction and solidification options to be incorporated:

   - Fluid bed dryer and incinerator with cement and polymer solidification system
   - Bitumen encapsulation process with DAW incineration
   - Crystallizer evaporator, cement solidification, and DAW incineration.

4. Miscellaneous Systems: Other utility and auxiliary systems provided for complete system integration. These include HVAC, fire protection, venting, instrument air, service air, off-gas treatment, and service water.

5. Container Handling Systems: An overhead bridge crane is included in the waste container storage and shipping cubicle. It transfers the waste containers between the solidification station, inspection station, storage area, and the truck bay. The crane is capable of being operated remotely via TV cameras and by utilizing a laydown grid indexing system.

Conclusions

The conceptual design described in this paper can be used to obtain budgetary capital cost estimates for an integrated volume-reduction and solidification and storage facility. Use of site specific requirements, coupled with the building size and ancillary systems enumerated in this paper, allows the capital cost of a volume-reduction and solidification system and storage facility to be estimated by standard cost estimating procedures. This approach will facilitate the effort required to reach a decision on an appropriate waste management plan.

References

(1) Trigillio, G., "Volume-Reduction Techniques in Low-Level Radioactive Management," Nuclear Regulatory Commission, NUREG/CR-2206, 1981.

(2) Tosetti, R., "Cost Benefit Trade-Offs for On-Site Processing Methods," presented at the Second ASME/ANS Nuclear Engineering Conference, Portland, Oregon, July 25-28, 1982.

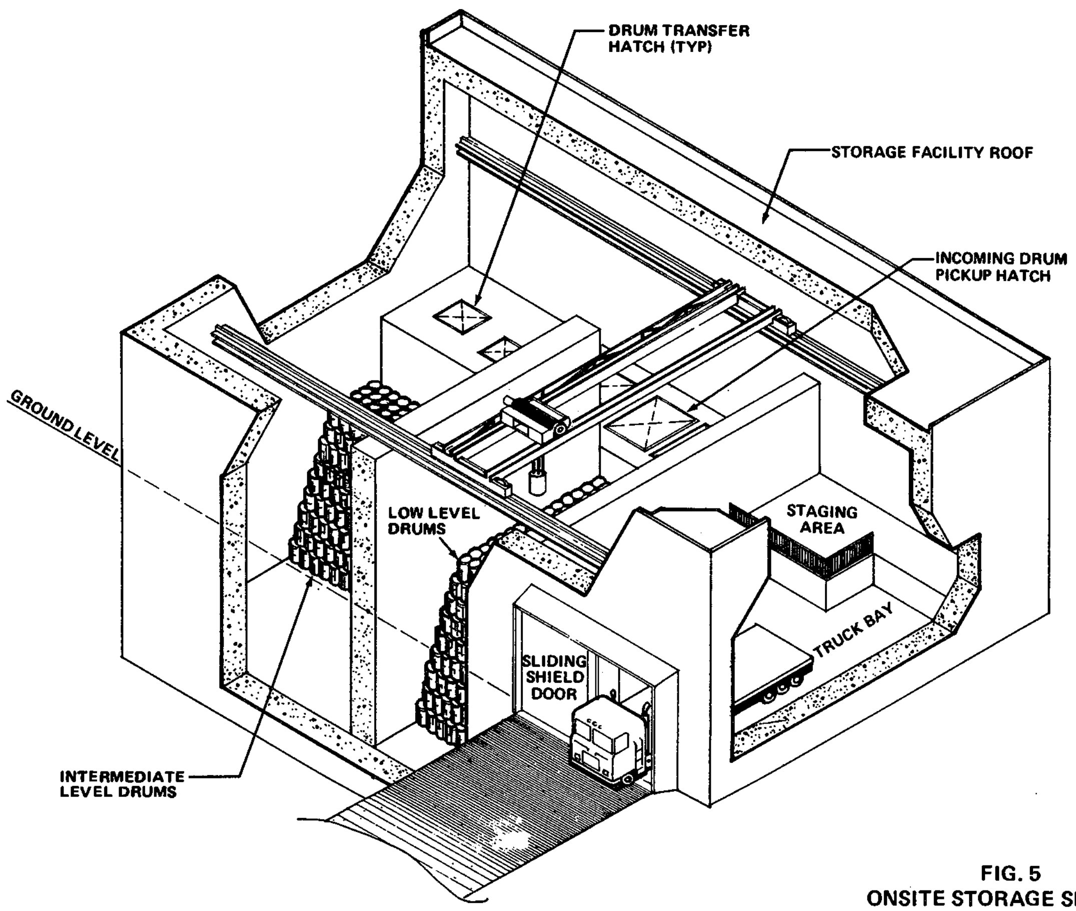
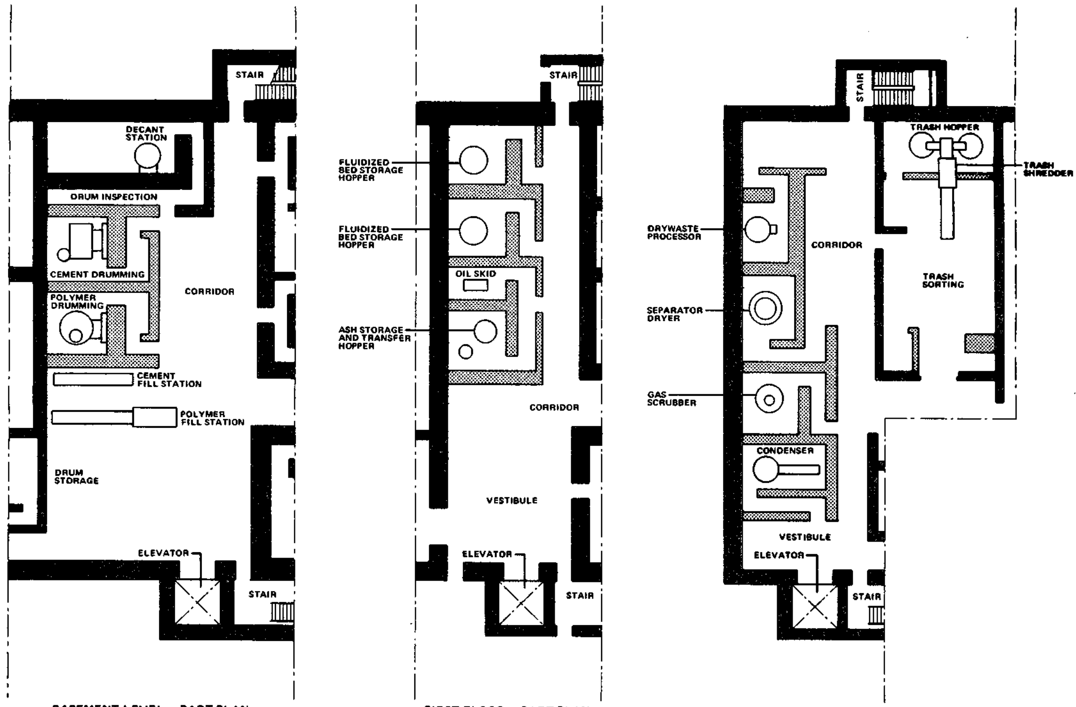


FIG. 5
ONSITE STORAGE SECTION

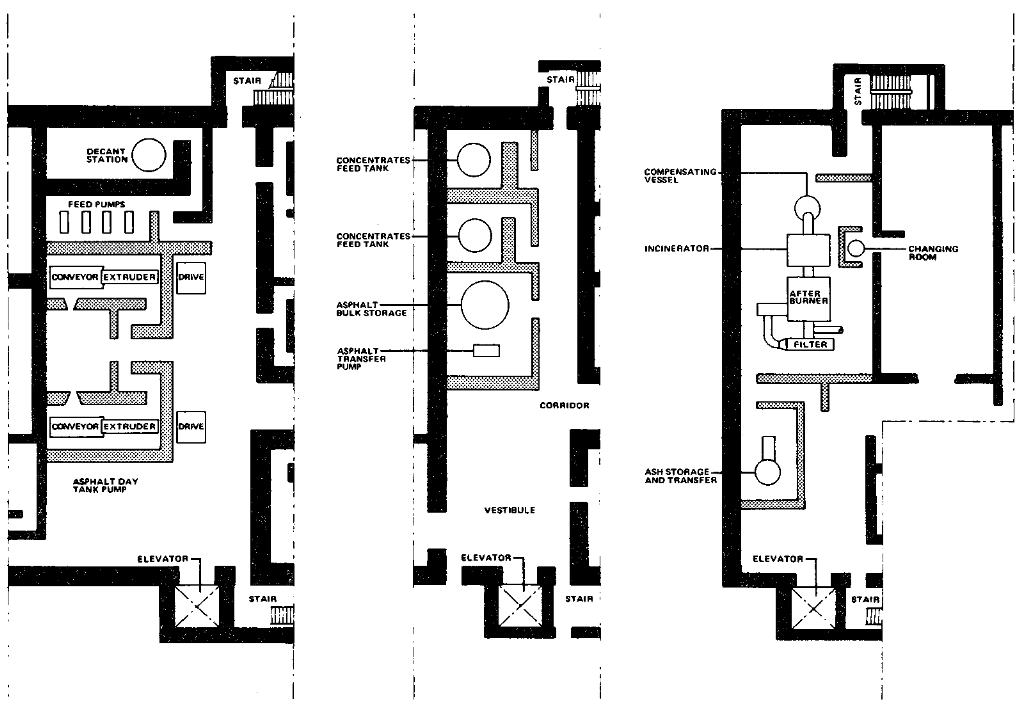


BASEMENT LEVEL – PART PLAN (AREA 5 IN FIGURE 2)

FIRST FLOOR – PART PLAN (AREA 16 IN FIGURE 3)

SECOND FLOOR – PART PLAN (AREA 4 IN FIGURE 4)

FIG. 6
ALTERNATIVE FACILITY LAYOUT FOR FLUID BED DRYER AND INCINERATION SYSTEM WITH CEMENT/POLYMER SOLIDIFICATION

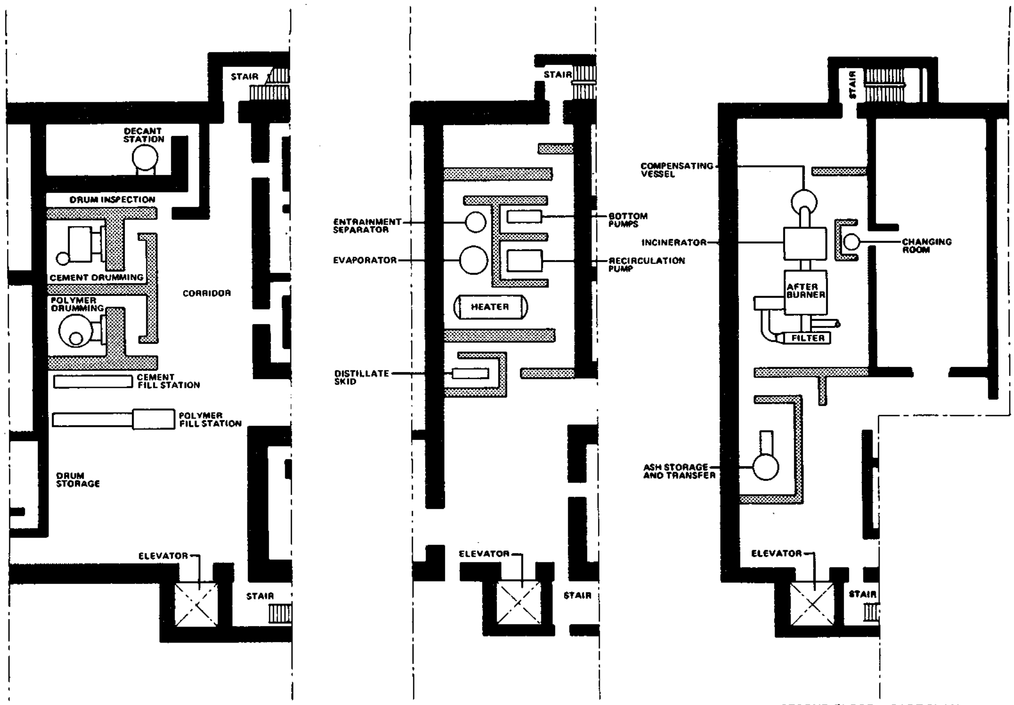


BASEMENT LEVEL – PART PLAN (AREA 5 IN FIGURE 2)

FIRST FLOOR – PART PLAN (AREA 16 IN FIGURE 3)

SECOND FLOOR – PART PLAN (AREA 4 IN FIGURE 4)

FIG. 7
ALTERNATIVE FACILITY LAYOUT FOR ASPHALT VOLUME-REDUCTION SYSTEM WITH DAW INCINERATOR



BASEMENT LEVEL – PART PLAN (AREA 5 IN FIGURE 2)

FIRST FLOOR – PART PLAN (AREA 16 IN FIGURE 3)

SECOND FLOOR – PART PLAN (AREA 4 IN FIGURE 4)

FIG. 8
ALTERNATIVE FACILITY LAYOUT FOR EVAPORATOR/CRYSTALLIZER AND CEMENT/POLYMER SOLIDIFICATION WITH DAW INCINERATOR