MODULAR INTERIM WASTE STORAGE BUILDING

FOR

LOW-LEVEL RADWASTE

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ABSTRACT

Near-term disposition of low-level radioactive waste is a significant concern in the successful start-up and continued operation of nuclear plants. In response to the perceived utility need for interim storage facilities for low-level nuclear waste, Cygna Energy Services has developed a Modular Interim Waste Storage Building (IWSB) design which emphasizes low cost, design simplicity, commercial construction techniques, rapid construction time and licensability. The IWSB is modular and easily expanded. The base module includes a truck bay, storage bay with vaults, remote-control over-head bridge crane and a separate control room. The facility design basis and features are described. Waste storage and shielding requirements are optimized through the use of a computerized inventory control system. Cost of the Cygna Modular IWSB is on the order of $4 million for a five year capacity facility and a construction period of about 12 to 14 months.

THE PROBLEM

State and federal government activities in the recent past have made the issue of near-term disposition of low-level radioactive waste a major hurdle to the successful start-up and continued operation of nuclear plants. The particular low-level waste disposition problems throughout the nuclear industry have been compounded by state regionalization strategies and the closing or restricting of existing commercial burial facilities. Utilities are now dealing with this issue to prevent it from becoming a critical path issue in the successful start-up and continued commercial operation of their nuclear plants.

Legislative and public intervening entities have either closed or severely restricted the access to current commercial burial grounds in the United States. Of the six original available facilities, only Richland, Barnwell and Beatty remain open, with the Richland and Barnwell facilities destined to become part of their respective regional compacts. Beatty may not be a viable option for long-term radwaste disposal.

The initial target schedule for having regional compact burial facilities is January, 1986, as mandated by the Low-Level Radioactive Waste Policy Act. This schedule, which is optimistic considering potential legal uncertainties and the development of state regulations, is inconsistent with the pressing radwaste needs and therefore necessitates positive action to accommodate the low-level radioactive waste generated during the period prior to operation of the regional burial facilities.

AN INTERIM SOLUTION - THE IWSB

In response to the perceived need, a number of designs of Interim Waste Storage Buildings (IWSB's) have been developed in the industry to date. Unfortunately, common characteristics of these designs has been their high cost, long construction schedule, and complicated design features that are more closely associated with traditional nuclear Categories I or II structures.

THE CYGNA MODULAR IWSB DESIGN

Cygna has developed a Modular IWSB design[a] which emphasizes low cost, design simplicity, rapid construction time, and licensability. Additionally, the design meets all federal, state, and local requirements. The Cygna Modular IWSB represents an economical and practical approach for interim waste storage. Cygna has developed specific guidelines and criteria for establishing compliance with nuclear-related regulations, such as dose limits, packaging requirements, quality assurance, and licensing; Cygna has also applied low-cost commercial construction techniques within these guidelines, such as tilt-up wall construction. Table I summarizes the key IWSB design base developed and employed in the Cygna design.

(a) Patent Pending

Table I. CYGNA MODULAR IWSB DESIGN BASIS SUMMARY

- Waste containers are assumed to be a mix of 55 gal drum or 100 cubic foot metal Dry Active Waste boxes and radwaste liners. Higher activity waste forms are vaulted and lower activity waste forms are stored above-ground in the storage bay area.
- Design Life - The facility is designed for a 40-year lifetime. Since the NRC storage limit is five years for any individual container, the building can be used to store additional loadings of waste upon removal of the previous loadings. In addition, once regional burial grounds become operational, the facility can act as a waste buffer, or be reactivated in later years.
- Optimum Sizing and Layout - The facility is designed with one truck bay and two storage bays located on each side of the truck bay. A single crane has access to both storage bays. Five years storage capacity is provided consistent with current NRC guidelines. The facility will be located above-ground.
- Shielding - Sufficient shielding is provided by the walls and roof to meet NRC and EPA dose rate guidelines for both operational personnel and the general public. The shield thicknesses are based on average LWR curie contents and waste volumes.
- ALARA - The truck bay is separated from the storage bays by shield walls, one on each side of the truck bay. The control room also has additional shielding at the common wall with the truck bay. An overhead bridge crane is remotely controlled from the control room using CCTV camera systems for indexing and operations.
- Waste packing is assumed to meet all NRC and DOT shipping and burial requirements.
- The facility is assumed to be located inside the fenced security perimeter on the plant site in a controlled access area.
- Expandable - The Cygna Modular IWSB is readily expandable in two and one-half-year waste volume increments.

The resulting structure has the following primary features:

1. The building is designed as an assembly of 2½ year capacity modules. Initially, one or two of these modules could be assembled (i.e., 2½ or 5-year total capacity). New modules could be readily added at a later date without impacting operability in the existing module(s).

2. An above-ground vault system is provided in each module to store the higher curie content wastes (typically a large percentage of the waste curie content is contained in a relatively small percentage of the total volume). The use of vaults allows substantial reductions in concrete wall and roof thicknesses.

3. An overhead bridge crane is employed and will be remotely operated to minimize personnel operational exposure, thereby enhancing ALARA.

4. A single-story layout with commerical construction features. This design results in a very low cost structure.

5. Construction time is also reduced significantly due to the use of well-established commercial construction techniques.

6. The IWSB building is designed for a 40-year lifetime. Since the NRC storage limit (using the 10CFR50.59) licensing approach is five years for any individual container, the building can be used to store additional loadings of waste upon removal of the previous loadings. In addition, once regional burial grounds become operational, the facility can act as a waste buffer, or be reactivated in later years.

MODULAR IWSB FACILITY DESCRIPTION - MAJOR FEATURES

The base module includes a truck bay, storage bay with vaults, remote-control overhead bridge crane, and a separate control room. The truck bay accommodates a full-size tractor-trailer rig and is equipped with decontamination and washdown facilities. A biological shield wall separates the storage bay from the truck bay. The remote-controlled overhead bridge crane has total facility access, and is typically controlled using closed-circuit TV via cameras mounted on the bridge, trolley and hoist. The IWSB is modular in design with the reference design utilizing twin-modules for storage. Expansion is flexible with new modules either being added to the end of the existing building, or on the side. Should an additional module be needed later, the crane runway is extendable, thereby allowing one crane to have access to both modules. For multiple unit sites, additional modules can readily be constructed on an as-needed basis, and can be serviced by a single crane.

Bay Storage

Waste is stored in the storage bay on a segmented first-in, first-out basis in order to optimize disposal of the "oldest" waste as rapidly as possible, when burial ground allocation space becomes available. Liners with nominal contact dose-rate below 100 mr/hr are stored at the perimeter of the storage bay, and higher level wastes are stored in the interior of the storage bay array, or in the vault. This maximizes self-shielding potential and minimizes direct transmission radiation shielding requirements at the walls. The liners are stored in a nested array (rather than by row/column) in order to conserve floor space area and enhance self-shielding effects. Dry active wastes compacted in either 55-gallon drums or 4'x4'x6' steel boxes are stacked in a high-density array near the biological shield wall in the storage bay, thereby minimizing handling logistics.

Vault System

The majority of low-level wastes assigned to the facility have low specific activity and presents minimum shielding problems. By storing the high-curie content waste in above-ground concrete vaults, general building shielding requirements are significantly reduced, enabling thinner walls and roof. Additionally, personnel access to the storage bay is enhanced for performing non-routine maintenance and surveillance operations while still meeting ALARA requirements.

The vault silo shield covers are 2½ feet thick, and are flush to the top surface of the vaults. Lifting lugs are provided for removal using the remotely-controlled overhead bridge crane.

Superstructure

Exterior shield walls for the storage bay are conventionally constructed tilt-up panels. Each panel is formed and poured on-site, near the IWSB base mat, and then erected using a motorized crane. The wall panels have field joints which are poured-in-place. Pilasters (support columns) are placed between panel sections using poured-in-place forming. Tilt-up walls incorporate rebar vertically and horizontally.

The roof is a poured-in-place concrete slab on metal decking which is supported by steel girders. Thus, overall building height and facility cost is mimimized.

Truck Bay

The truck bay services both storage bays. A dock is located at the end of the truck bay for facilitating truck loading. A liquid collection sump is located in the truck bay floor area for collection of cask/truck wash-down liquids. Truck entrance to the bay is through a large roll-up door, which is open only during truck movements.

Bridge Crane

The crane is an electric over-head single trolley bridge crane with CCTV remote-control. The crane is operated from a control console in the control room.

The crane end-trucks run on rails and runway girders running the length of the facility, and the crane has access to both storage bays. A power rotate block/hook is provided for ease of load control. A CCTV system is used for visual control and a multi-position light panel acts as backup for remote indexing. Three TV cameras are used for positioning the crane and hoist operations.

Features are included in the design to enhance operability in a radwaste facility and the crane is designed to be maintained while in the truck bay.

Remote-Handling Equipment

Storage and removal operations are performed using remotely-controlled grappling hardware. The grapples are readily installed by removal of the lock-pin on the block and replacing the hook with the grapple assembly.

Two grapples are provided for normal operations. The Dry Active Waste (DAW) boxes can be handled with a forklift or a remote pick-up grapple (electro-mechanical remote actuation). The liners and vault shield covers use a three-point pick-up grapple with electro-mechanical remote actuation.

Control Room and Equipment Room

The control room is located outside of the building. An equipment room is also provided adjacent to the control room.

The control console for the crane, including closed circuit TV (CCTV) monitors is located in the control room as well as all electrical, fire protection, radiological monitor readout/annunciation, and HVAC panels and alarms. The control room has full HVAC, since operations personnel will inhabit the room on a routine basis.

Decontamination

All IWSB interior surfaces subject to possible radionuclide contamination are specified to be sealed with a protective coating permitting effective decontamination of the surfaces, if necessary.

INVENTORY CONTROL

The Cygna tracking and inventory control program (CYTRAC) provides the basis for integrating all low-level radwaste storage and disposal operations. This computer program provides inventory control and tracking of each individual waste form from production, to storage, and finally disposal at the licensed burial ground when available. The program is structured to readily prepare the several types of radwaste and transportation reports that are currently being manually prepared by many utilities. A Program Logic Representation of the key features of the CYTRAC program is provided in Fig. 1. The program is interactive and user friendly, being menu driven and therefore easily used by site personnel. Site wide access thru modern communication packages permits site wide interrogation of the CYTRAC modules for data entry, modification and report generation.

LICENSABILITY

The Cygna IWSB meets all Federal, EPA, and industry design requirements and guidelines. The facility has been designed to meet criteria and regulations 1) limiting the radiation dose on and off-site, 2) controlling the release of radioactive material to the environment, and 3) the design interfaces important to the safety design basis of the power plant.

Shielding Assessment

The radiation exposure interior to the facility, as well as at the fence boundary, is a combination of (1) a direct transmission radiation component through the facility structures, biological shields and the waste containers themselves, and (2) a scattered radiation component through the walls and roof of the facility and the air surrounding it. A detailed generic assessment of the shielding and ALARA adequacy of the facility has been made.

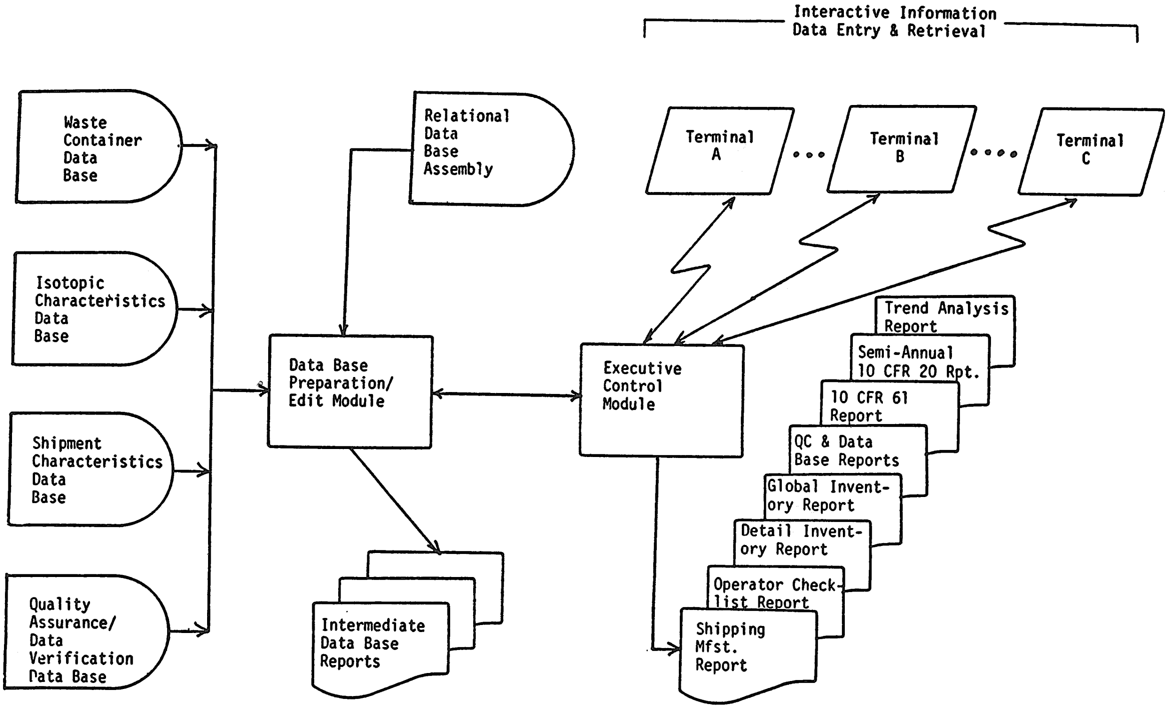

Fig. 1. CYTRAC- Program Logic.

The QAD-CG[1] point kernal gamma penetration program has been utilizied to evaluate direct transmission radiation dosage for the Modular IWSB design. Detailed site/waste specific evaluations utilize the QAD-CG computer analysis, benchmarked with COHORT-II[2] analysis.

The COHORT-II computer code employs the conventional Monte Carlo shielding algorithm and is able to track and consider complex scattered radiation contributions through facility, walls, waste packages, roof and surrounding air. COHORT-II is used to assess the contribution of skyshine (air scattered radiation) to site boundary dose receptor locations.

Operations and Maintenance - ALARA

The Cygna Modular IWSB Design has been carefully developed with respect to the radiation control features in-place to protect occupationally exposed workers as well as the off-site public during facility loading and unloading maintenance, repair and surveillance. Facility design features conform to Regulatory Guides 8.8 and 8.10 guidance. The accessibility of compartment modules, the flexibility of the design with regard to surveillance capabilities to detect containers' loss of integrity, airborne contamination mitigation and control as well as subsequent decontamination or decommissioning features are significant ALARA aspects of the Cygna design.

Routine storage bay survey requirements are accomplished remotely (i.e., mini-cam visual surveys), and minimize occupational dose accumulation to meet the intent of ALARA. Controlled access to storage bay locations will be possible with proper health physics control, should the need arise.

Monitoring Facility Environment and Ventilation Exhaust

Process and effluent radiological monitoring systems will be provided to provide information to operations personnel on the radiation levels within the facility, as well as monitoring of ambient work space and exhausted air from ventilation systems. Liquid discharges are not anticipated; however, the liquid control sump system is designed to contain facility liquids until proper sampling, monitoring and control can be accomplished. Standard facility radiation monitors consist of annunciated gamma monitors, continuous work space air monitors, fixed-filter personnel breathing zone samplers and continuous stack monitors.

Surveillance Features

US NRC Generic Letter 81-38,"Storage of Low-Level Radioactive Wastes at Power Reactor Sites", recommends that a periodic (quarterly) visual inspection of container integrity (swelling, corrosion, breach, etc.) be performed. This inspection can best be accomplished by TV monitors located in the storage area or on the bridge crane assembly. The use of remote TV monitors and mini-cams is a very effective method to reduce personnel exposure and maintain ALARA.

All stored radwaste will be uniquely identified, located in the IWSB and inventory records will be maintained. The CYTRAC Inventory Control Program will provide surveillance logic to provide inventory control and tracking of each individual waste package and thereby greatly enhance an effective radiation control and surveillance program.

Environmental Impacts

Operations within the IWSB are expected to produce negligible impact to the off-site environs.

All radioactive liquids which may be captured in IWSB drains and sumps are collected, monitored and, if necessary, returned to the plant's radwaste processing system, i.e., liquids will not be discharged from the facility to the environment.

IWSB airborne exhaust streams are filtered and monitored prior to discharge. Additionally, radiation control and surveillance programs will ensure that routine IWSB ventilation exhausts conform to regulatory guidance, in particular, ALARA limits for off-site dose levels.

Facility shielding design requirements limit off-site (site boundary) dose levels to small fractions of 10CFR50, Appendix I, guidance. To allow for the dose contribution of other plant radiation sources, the IWSB dose contribution is held to less than about 20 percent of the Appendix I limit, or 5 mr/year.

FACILITY COST AND SCHEDULE

Cost of the Cygna Modular IWSB is on the order of $4 million for a five year facility, assuming average LWR waste characteristics and site conditions. This cost includes engineering, construction, hardware, operational checkout and turnover, taxes, and fees.

As a result of the advanced state of design, and the use of commercial construction techniques, Cygna, in concert with a national nuclear construction company partner, is able to offer a firm-price "turn-key" approach for implementing the design. Engineering, construction, and facility checkout and turnover can be accomplihsed within a 12 to 14 month time schedule.

SUMMARY AND CONCLUSIONS

In response to the perceived need for interim storage facilities for low-level nuclear waste, Cygna has developed an innovative Modular IWSB design which emphasizes low cost, design simplicity, commercial construction techniques, rapid construction time, and licensability.

REFERENCES

1. "QAD-CG, A Combinatorial Geometry Version of QAD-P5A, A Point Kernel Code for Neutron and Gamma - Ray Shielding Calculations", Radiation Shielding Information Center, CCC-307, 5/14/79.

2. "COHORT II, General Purpose Monte Carlo Radiation Transport Code", ORNL Radiation Shielding Information Center, CCC-198, 12/21/78.