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DECOMMISSIONING CONCEPTUAL STUDY

IN SITU DECOMMISSIONING OF EIGHT

105 REACTOR BUILDINGS IN THE 100 AREAS

Prepared for

UNC NUCLEAR INDUSTRIES

March 1987

For the U.S. Department of Energy
Contract DE-AC06-87RL10900

Prepared by

KAISER ENGINEERS HANFORD COMPANY
Richland, Washington

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UNC NUCLEAR INDUSTRIES

Operations Division

for the

U. S. DEPARTMENT OF ENERGY

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IN SITU DECOMMISSIONING OF EIGHT 105 REACTOR BUILDINGS IN THE 100 AREAS

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DECOMMISSIONING CONCEPTUAL STUDY
IN SITU DECOMMISSIONING OF EIGHT
105 REACTOR BUILDINGS IN THE 100 AREAS

I. INTRODUCTION

Hanford was commissioned as a site for the production of plutonium by the Manhattan Engineer District of the Army Corps of Engineers in 1942. Eight graphite-moderated reactors and associated support facilities were constructed in the Hanford 100 Area between 1942 and 1955 to support the plutonium production effort: reactors 100-B, -C, -D, -DR, -F, -H, -KE, and -KW. These facilities have now been declared surplus and require decommissioning. (A ninth production reactor, N Reactor, started operation in 1963 and is still in operation. The decommissioning of N Reactor is not within the scope of this report.) The reactor buildings are all designated as "105 Buildings".

The original eight production reactors and most of their support facilities were deactivated during the period from 1964 to 1971, and have since been maintained in a safe storage condition. Maintenance activities for these reactors have consisted of short-term measures adequate to protect the workers and the environment for the present, and are not adequate to assure stabilized, long-term control. This report presents the in situ approach as a viable, permanent decommissioning alternative, and it has been prepared to better define costs and schedules for long-range planning purposes.

Kaiser Engineers Hanford Company (KEH) performed the decommissioning conceptual study based on Appendix F, DCS Work Scope Statement of Instructions, for UNC Nuclear Industries (UNC), Richland, Washington, under the authority of work order B32208.

II. SUMMARY

Eight deactivated reactors on the Hanford Site (100-B, -C, -D, -DR, -F, -H, -KE, and -KW) will be decommissioned by this project. This decommissioning conceptual study report is based on performing the decommissioning with the recommended preferred method (in situ). Final selection of the method of decommissioning is dependent upon the completion of the National Environmental Policy Act (NEPA) process. For the purpose of estimating this effort, it is assumed that the work will be done as follows.

The work will be divided among three parties. UNC Nuclear Industries Decommissioning Operations will do the radiological characterization, all Decontamination and Decommissioning (D&D) nonexplosive destruction, fixing of contaminants, and void filling. An offsite explosives contractor will assist in destruction of some concrete walls. A large scale earth-moving contractor will construct the burial mound.

Before demolition, loose contamination will be stabilized. Building walls and ceilings will be safely and cost effectively demolished using a wrecking ball and/or explosives. Most of the reinforced concrete walls that will reside within the berm envelope will be retained. The rubble will be spread and left as fill. The tunnels directly under the reactor block will not be filled because calculations show that the structure is satisfactory for construction loads and long term soil loads. This will save approximately $1 million. All other void spaces in the building will be filled using either slurry or gravel. Structures that require asbestos removal to facilitate other work, e.g., transite (asbestos) panels in the K and C Areas, will be individually removed, placed at the bottom of the storage basins, and covered with fill.

After demolition and void filling is completed, an offsite contractor will mound over the entire building with earth and gravel to extend a minimum of 16 ft above the reactor block. The mound will be seeded to establish plant growth which will minimize run-off erosion, and promote transpiration of precipitation. The depth of the mound will be sufficient so that precipitation penetration will be negligible, thereby reducing the potential for

radionuclide transport down into the water table. In Hanford's semi-arid climate, precipitation generally evaporates and returns to the atmosphere before penetrating 16 ft of earth.

Infrastructure linkages (piping, ducts, etc.) that lead from outside the burial mound to the building will be removed or filled with either slurry or gravel for a distance of at least 16 ft from the perimeter of the mound.

The earthen mound, once completed, will extend 16 ft over the reactor top, and is designed to last a minimum of 500 years, thus providing the equivalent inadvertent intruder protection barrier presented in the Nuclear Regulatory Commission (NRC) regulation 10 CFR 61. In situ decommissioning of the Hanford production reactors would yield results that are well within current Department of Energy (DOE) dose limits. Over the design life of the mound, it is anticipated that settlement of up to 4.5 ft may occur, with no significant decrease in the mound's design life. If, during the post-decommissioning period, differential settlement due to seasoning densification should create unsatisfactory conditions, they can easily be corrected by the addition of more backfill.

All eight reactor buildings will be decommissioned under one project. Work crews performing specific tasks will be sequenced (upon completion of the task at one facility, the crew will move to the next until all eight buildings are decommissioned).

The total estimated cost of this project, including escalation, contingency, and engineering, is $42,760,000, and is estimated to take 5 years to complete. The project funding is scheduled to commence with capital equipment procurement and design in the first quarter of FY 1987, and involves both AR (Defense Waste and Transportation Management Program) and GE (Material Production Program) funding sources until decommissioning completion in the last quarter of FY 1991.

III. JUSTIFICATION

"The Surplus Facilities Management Program Plan" (UNI-3560) requires program participants (UNC, etc.) to implement a structured long-range decommissioning program to accomplish disposition of all contaminated surplus facilities owned by the Department of Energy (DOE) under the responsibility of the DOE Division of Remedial Action Projects (DRAP) and Office of Defense Waste and Transportation Management (DWTM). The eight shut-down production reactors in the Hanford 100 Areas are a major part of the long-range plan. The "Assessment of Decommissioning Alternatives for the Shut-Down Hanford 100 Area Reactors," UNI-2619, identified several candidate decommissioning alternatives. Of these alternatives, the Department of Energy (DOE) identified the in situ method as the recommended preferred decommissioning alternative pending completion of the NEPA process.

It is estimated that under the current maintenance routines, within 20 years the buildings used to house the reactors will begin to develop serious safety hazards and structural weakening, unless a long-term upgrade program is implemented. An immediate decommissioning approach is the most cost-effective way to ultimately take care of the shutdown reactor facilities. By ultimately decommissioning the reactors, the current routine maintenance and surveillance cost for the reactor buildings will be essentially eliminated following the in situ post-decommissioning stabilization period of 10 years. The decommissioning will also realize a major savings by not requiring the implementation of the long-term maintenance initial upgrade of the structures. The structure upgrade is estimated to be about $6 million (1983 dollars) for preparing the reactor buildings for a long-term safe storage program.

Preliminary engineering and cost evaluations were made of three candidate decommissioning alternatives for the eight reactors: safe storage/deferred dismantlement; immediate dismantlement; and in situ. Detailed descriptions and assessments of these decommissioning alternatives may be found in UNI-2619. (See Section XI., References A.1.) For the eight reactor facilities, the in situ alternative is dramatically superior to the other alternatives in terms of cost, occupational exposure, manpower, completion

time, and waste volume, and thus has been determined by DOE to be the recommended preferred decommissioning alternative. It should be noted that the completion of the NEPA process Environmental Impact Statement (EIS) will assess all alternatives for environmental impacts prior to selecting the final alternative to be used for ultimate decommissioning.

This in situ decommissioning provides a degree of environmental isolation superior to that achievable by dismantling the reactor block and shielding and then burying the disturbed radioactive material. The 9000-ton reactor block, left intact, serves as its own high-integrity, long-term radiological burial container. A typical reactor block consists of a .25 to .38 in. steelplate outer shell, a 40- to 80-in. thick biological shield comprised of alternating layers of steel and Masonite, and an 8- to 10-in. thick cast iron thermal shield, all encasing the stable stack of graphite blocks. Once covered with earth, this structure can reasonably be expected to provide long-term containment capability under environmental conditions far harsher than any that may be encountered in the dry Hanford soil. Should the reactor block be inadvertently exposed, the majority of radionuclides still remaining within it would be chemically "bound" in the physical matrix of cast iron and graphite and would not readily migrate to the environment or contaminate the human food chain.

The 42-ft to 56-ft high, 3-ft to 5-ft-thick reinforced concrete shielding walls provide an additional strong extra barrier around the reactor block and assist in retaining the buried materials in one place. The 16 ft earthen barrier over the top of the razed reactor (refer to sketches, appendix J) is designed to isolate the in situ radioactive material from people and the environment for at least 500 years.

In addition to meeting the technical requirements for decommissioning, the in situ decommissioning mode, as described in this report, yields very favorable cost and schedule figures. The materials and equipment required for this mode are all simple, relatively inexpensive, and available on the Hanford Site. The concrete rubble for the backfill and mound will come from the demolished reactor building superstructure. The gravel for forming erosion-resistant earth barriers is abundantly available near the reactor sites, and

can be transported to the work sites using ordinary earthmoving equipment and procedures. Once installed, the mounds will require minimal maintenance.

The in situ decommissioning of the reactor block by direct earthen entombment and mounding with earth/gravel meets the DOE requirements for disposal and long-term control of low-level radioactive waste and also meets the inadvertent intruder protection (refer to References, Section XI.B.) objectives of Nuclear Regulatory Commission (NRC) 10 CFR 61.

Engineering estimates indicate that the earth mound will last well beyond 500 years with little or no maintenance. Erosion rates have been calculated for the mound based on erosion data for natural soils in similar areas (Section XI. References, A.1). Based on these calculations, very little erosion of the mounds is anticipated. Natural mounds of roughly the same size, shape, and composition have existed in the Hanford Site for over 13,000 years.

The 16-ft earth/gravel barrier would protect inadvertent intruders and isolate the radioactive materials from pathways to man and the environment for over 500 years. The 16-ft depth of the earthen cover will be sufficient so that rainwater penetration would be negligible into the site. The potential of radionuclide migration down into the water table would be thereby reduced. In Hanford's semi-arid climate, precipitation generally evaporates and returns to the atmosphere before penetrating 16 ft of earth.

Further confidence in the integrity of the in situ mode is provided by the nature of the buried material itself. An estimated 99% of the radionuclides of concern in the reactor block are "part of the matrix" in the solid metallic and graphite components of the reactor and cannot readily migrate to the environment. Lesser amounts are expected to be in the piping and other components that would be buried with the reactor block. The integrity of the earth cover, the imperviousness of the reactor block structure, the massive foundation upon which the reactor rests, and the chemical and physical stability of the graphite matrix all provide assurance that the in situ

decommissioning mode will meet present and anticipated requirements for the isolation of radionuclides from pathways that could significantly impact man and the environment.

IV. PROJECT SCOPE

A. Improvements to Land

The in situ disposal of the 100 Area reactor buildings will return the area to a near natural-looking condition similar to the rolling Quaternary glacio-fluvial sand and gravel hills deposited in the river basin area. The immediate land surrounding the reactors is relatively flat with sparse vegetation, much the same as it has been for several hundred years. This project will restore the land to a near natural-looking state with an earth mound used to cover the reactor block at each of the eight reactor locations.

Institutional control up to 100 years may include access control, minor maintenance and surveillance, and site use restrictions. The institutional control effort is not included as a part of this report.

B. Modification of Existing Facilities and Systems

The main scope of this project is modifying (decommissioning) the eight graphite moderated nuclear reactor facilities. The significant aspects investigated concerning the facilities are: in situ decommissioning of all eight facilities, site-specific procedural planning for individual facility decommissioning, and estimating costs associated with the processes.

All reactor buildings have subgrade infrastructure linkages to other facilities. The majority of the support facilities will be decommissioned prior to the reactor facilities. The scope of this report ends at the perimeter of the mound. However, infrastructure linkages from the reactor core to beyond the perimeter of the mound will be sealed off.

The overall project planning consists of two parts: a decommissioning conceptual study report and action required by the National Environmental Policy Act (NEPA). The NEPA process will be a separate document from this report, and will address the environmental issues and alternatives relating to this project.

C. Standard Equipment

Standard equipment will include:

- Concrete pump and discharge hoses
- Batch concrete plant
- Conveyors

D. Decommissioning Approaches

The existing eight reactor facilities are in a "safe storage" status. In situ decommissioning will demolish extensive perimeter portions of the building in place as well as raze all structures which would extend above the finished mound contours. Voids will be filled with either local natural gravel fill material or a cement slurry mix (very lean concrete). Some voids will be satisfactory with little or no fill. With considerable portions of the building reduced to rubble, except for reinforced concrete walls, earth will be hauled from local borrow pits and placed in, around, and over the building.

Two decommissioning approaches were studied in this report: decommissioning the buildings one at a time (with each being an individual project), or decommissioning all buildings under one project. These two alternatives have been part of the basis for comparison in the cost estimates.

1. Decommissioning All Reactor Buildings Under One Project

The UNC D&D crew will fix contaminated surfaces, perform most of the physical destruction, and fill voids. Decontamination and Decommissioning work crews will systematically perform one task in all structures before proceeding to the next task. At the point when the

demolition and void filling of the first reactor building is complete, an offsite contractor will handle the major portions of earthwork to complete the mound. An explosives expert will also assist in razing portions of the structure. Interface turnover points will need to be clearly established for safe operations considering the many diverse work crews and the potential for interferences.

2. Decommissioning Each Reactor Building Separately

Completely decommissioning each building as a separate project means all decommissioning would be completed one reactor at a time before work is started on the next reactor. Offsite contractors (earth-movers) would come to one site, finish a task (the mound) and leave the site. The main advantages of individual decommissioning are discrete budgeting and project work closeout. The disadvantages of separate decommissioning are that it would cost 33% more and require nine additional years to complete.

3. Alternative Plans

The following four alternative plans were selected for analysis and cost estimation.

a. Plan 1

Plan 1 consists of demolishing the reactor buildings, except for the shielding walls, and mounding earth over the reactor blocks. Each reactor building would be demolished and buried before beginning work on the next reactor, in the following order: F, H, D, DR, C, KE, KW, and B.

b. Plan 2

This plan would demolish most of the building structure except for leaving most of the reinforced concrete walls. A minimum of 3 ft of earth fill will be established over all clean demolished sections of the buried structure. The objectives of 16 ft inadvertent protection earthen barrier for the radioactive portion of the reactor facilities will also be met. (See appendix J.)

Plan 2 would decommission each reactor separately as explained in Plan 1.

c. Plan 3

Plan 3 is the same as Plan 1 (leaving up the shielding walls only), but with the work on all the reactor buildings being performed concurrently.

The decommissioning would be divided into tasks such as fixing contamination, demolition, and burial. Each task would be accomplished for each reactor building in sequence. For example, fixing of contamination would begin on F Reactor. After the fixing of contamination was completed on F, fixing of contamination would begin on H Reactor and demolition would begin on F Reactor Building. After demolition of F Reactor Building, its burial would begin while demolition would begin on H Reactor Building, and fixing of contamination would begin on D Reactor. This concurrent sequencing of work would continue until all work was completed on all the reactors.

d. Plan 4

Plan 4 is the same as Plan 2 but with the work done concurrently on all the reactors, as explained in Plan 3.

Of the four plans described above, Plan 4 (all reactors decommissioned concurrently, leaving all reinforced concrete walls) was chosen as the most cost effective (refer to Section IX.G., Economic Analysis). Section V of this report, Performance Requirements, describes the decommissioning effort in detail.

E. Hazardous Material Disposition and Alternatives

The disposition of nonradioactive, hazardous wastes and/or materials, including asbestos, mercury, polychlorinated biphenyl (PCB) oil, and possibly other materials, will be addressed in the Safety Hazards Assessment issued by UNC, in accordance with DOE directives, before any actual decommissioning work begins on a facility. The applicable

Decommissioning Work Procedures will provide explicit instructions to control the release of any hazardous material during decommissioning work. Table 1 lists the known significant, nonradioactive hazardous materials present in the eight shutdown Hanford reactors. Should other hazardous materials be identified, they will be addressed at definitive design.

Research into the local, state, federal, and DOE contractural requirements provided possible alternatives. The items of importance are: 1) asbestos demolition and removal work practices; including, personal protective equipment, monitoring, housekeeping, recordkeeping, and training; 2) asbestos waste methods of disposal; that is, removal to another area or burial in its original position; 3) PCB disposal; and 4) mercury disposal; 5) lead disposal; and 6) cadmium disposal.

The Environmental Protection Agency (EPA) has ruled that asbestos removed during demolition be kept wet until it is collected for disposal. In addition, it is required that asbestos not be dropped or thrown to the ground or a lower floor, and that asbestos removed from more than 50 ft above ground level be transported to the ground in dusttight chutes or containers (unless it is removed in units or sections). Work on the reactor buildings will be in compliance with the applicable UNC industrial safety manual and procedures which require additional control methods. It is recommended to leave the asbestos in its original location and bury it with the facility. In situ burial of asbestos is cost effective and can meet safety and environmental requirements, as long as proper approvals are obtained and approval terms are complied with. Additionally, the exposure to workers is greatly reduced.

Potential problems arise when consideration is given to burying the asbestos in situ. The overall concern of any governing agency pertaining to asbestos is that of airborne emissions above allowable limits. The burial condition and placement procedures are aspects that need to be addressed. To bury the asbestos in situ, it would be necessary to obtain

Table 1

Nonradioactive Hazardous Materials Present in the Eight Shutdown Hanford Reactors

Material	Quantity	Location	Preferred Disposition
Asbestos	2,100 yd^3	Friable - pipes and equipment in 105 buildings. Nonfriable - siding material on 105 buildings.	For facilities demolished in place, nonfriable asbestos may be placed belowgrade. Friable asbestos will be removed from buildings and disposed of prior to final decommissioning.
Lead	320 ton	Removable - external shielding, such as doors, caves, sample trays, shield sheets.	Will be removed and disposed of in accordance with applicable requirements.
	480 ton	Nonremovable - tube caulking inside reactor thermal shield (105-B, -C, -D, -DR, -F, and -H).	Will be disposed of in connection with final reactor decommissioning option.
	200 ton	Nonremovable - tube caulking inside reactor thermal shield (105-KE and KW).	Will be disposed of in connection with final reactor decommissioning option.
Cadmium	640 lb	Neutron detector bonnets, monitoring tubes, sheets.	Material outside the reactor block will be disposed of in accordance with applicable regulations.
Mercury	1,000 lb	Panel gauges for control equipment	All mercury will be removed prior to decommissioning.
PCB Oil	Unknown	In transformers.	All PCB remaining in 100 Area shutdown facilities will be removed prior to decommissioning. A sampling program is currently being conducted to determine PCB inventories.

an approval from EPA or its authorized representative agency. Preliminary discussions initiated by KEH with DOE have led to an understanding that UNC would need to request DOE to obtain an approval to designate the site as an asbestos waste disposal area.

The EPA rulings require PCB's to be incinerated at an approved facility. Rockwell is the onsite contractor responsible for transporting PCB's to an approved facility for final dispositioning.

Mercury is present in some of the instrumentation that was used at shutdown reactors. Procedures will be in place to identify, collect, and then either reclaim or dispose of the mercury as required.

Lead is present in the reactors in both nonremovable and removable forms. Nonremovable lead is integral to the reactor block in the caulking for cooling tubes which penetrate the reactor thermal shield. The EIS will assess the impact of nonremovable, radioactively contaminated lead. The removable lead (external to the reactor blocks) is present in shielding material such as doors, caves, sample trays, viewers, and equipment.

Cadmium was used in the neutron detector bonnets, monitoring tubes, sheets for experiments, and other equipment. These hazardous materials will be disposed of in accordance with applicable regulations at the time of decommissioning and will be addressed in a Safety Hazards Assessment before actual decommissioning work begins. In addition, decommissioning and radiation work procedures and definitive engineering will provide explicit instructions for control and disposal of all hazardous materials during the actual decommissioning work.

F. Other Considerations

The following design elements have been considered and are not part of the scope of this project.

- Buildings (New)
- Other structures
- Utilities
- Special facilities and equipment
- Transferred capital property or equipment
- Research and development

V. PERFORMANCE REQUIREMENTS

The eight graphite moderated nuclear reactors in the 100 Areas will be decommissioned by initially fixing loose contaminants and then proceeding to filling subgrade and abovegrade volumes. A batch plant will be brought onsite to mix and pump slurry. Most of the peripheral structures of the reactor buildings will be demolished using standard heavy-duty equipment. Most of the reinforced concrete walls will be left standing. Demolition will remove portions of the building that would extend above the finished mound contours. After rearrangement of portions of the demolished building and completion of void filling, an offsite earthmoving contractor will construct the mound, which acts as a protective barrier over the reactor and demolished structure. The mound is designed to endure for at least 500 years. The design life of the protective barrier will be based on the length of time it takes for the radionuclides in the reactor to decay to a level that prevents significant radiation exposure to an inadvertent intruder into the mound.

This conceptual design effort presents a feasible concept for reactor decommissioning. The design assumes a 10-year post-closure maintenance period and up to a 100-year institutional control period once the mounds are completed. The post-closure maintenance period will be required to repair any adverse settlements of the mound, and assure that the site is stable. Preliminary calculations show that the majority of settlement will occur within the first

10 years after mound construction. The ability of the topsoil to remain in place is partially dependent on the growth of vegetation. The barrier can also be observed during the institutional control period to verify that it performs as designed.

A. Demolition Process for Each 105 Reactor Building

The mounds covering the reactor building will have minor differences in size and shape, reflecting the different geometry and size of each facility (refer to sketches in appendix J). Section 1, which follows, describes the decommissioning of a "generic" reactor. The next five sections (2 through 6) describe decommissioning differences for individual reactors.

1. Demolishing a Typical 105 Reactor Building

The construction materials and arrangement of rooms vary in the different reactor buildings; basic areas of the reactor buildings are similar. Comparable areas of each 105 reactor building can be demolished or buried in situ using similar procedures. The reactor areas to be decommissioned, as shown in the sketches in appendix J, are:

- Process area (reactor block)
- Work area
- Storage basins
- Inner rod room
- Outer rod room
- Fan rooms
- Valve pit
- "D" elevator
- Laboratory areas
- Miscellaneous abovegrade support rooms
- Miscellaneous belowgrade rooms and tunnels
- Mechanical equipment rooms above the reactors

The following sections describe how each of these areas will be demolished and/or filled.

a. Process Area

The process area in this report refers to the reactor block, which includes a graphite core, cast iron thermal shield, and alternating layers of steel and Masonite. The process area is considered solid and incompressible. Any major openings into the reactor will be sealed before backfilling begins. Care must be taken when filling around the process area to prevent breaking the nozzles on the front and back faces of the reactor or breaking the ball hoppers on the top of the reactor. This will maintain the reactor's containment integrity during mound construction.

b. Work Area

The work area is adjacent to the front face of the reactor. The work area is constructed of three 3-ft-thick shielding walls surrounding the front face of the reactor. The roof deck is a 6-in. concrete slab. The roof will be demolished using a wrecking ball. Methods considered for filling the area included: 1) filling with gravel using heavy equipment passing through a slot in the wall formed by demolition, or 2) pumping slurry into the area. The slurry method was used in the cost estimate for this conceptual design. The methods have fairly comparable costs for filling this area.

c. Storage Basin Area

The storage basin area is located behind the reactor and consists of the fuel transfer areas, wash pad area, and the fuel storage basin. The storage basin area abovegrade structure is constructed of concrete block walls and precast concrete (panel) tile roof, 10 ft to 40 ft in height. The belowgrade area is 20-ft deep with reinforced concrete columns and walls. The

abovegrade structure will be demolished to grade elevation. The belowgrade areas will be filled with rubble from the abovegrade demolition and gravel backfill using earthmoving equipment.

d. Inner Rod Room

The inner rod room and the control rods are on the left side of the reactor when looking toward the front face. The room is enclosed by 3-ft to 4-ft-thick concrete shielding walls on three sides with the reactor forming the fourth wall. The roof is a 1-ft to 2-ft-thick reinforced concrete slab. Entry into the room is a labyrinth with 3-ft to 4-ft-wide passageways. These rooms are contaminated and contain structural steel beams and columns supporting three platform levels of steel grating floors. Slurry will be used to fill this room.

e. Outer Rod Room

The outer rod room is adjacent to the inner rod room directly opposite the process area. The walls are constructed of concrete block and the roof is precast concrete (panel) tile. Inside the room are three operating platforms supported by structural steel columns and beams. The structural steel will be demolished and arranged to reduce voids when the room is backfilled. The block walls and roof will be demolished using a wrecking ball. The area will then be filled with gravel backfill.

f. Fan Rooms

The fan rooms are divided into two areas: the exhaust fan area and the supply fan area. The exhaust fan area is constructed of 1-ft-thick reinforced concrete walls and roof. The supply fan area is constructed of concrete block walls with a precast concrete tile (panel) roof. The exhaust fan area is divided into several smaller rooms by additional reinforced concrete walls. The exhaust fan area will be filled with slurry because of the effort required to demolish the reinforced concrete and to retain

the contamination. The supply fan area can be easily demolished using a wrecking ball. After the area is demolished, it will be filled with gravel backfill.

g. Valve Pit

The valve pit is located adjacent to the work area on the wall opposite the process area. The valve pit consists of an abovegrade and a belowgrade structure. The belowgrade portion is a 16-ft-deep pit with reinforced concrete walls. The abovegrade portion is 12-ft-high concrete block walls with a precast concrete tile roof. The platforms in the abovegrade and belowgrade areas are steel grating supported on structural steel framing. The pit is also filled with contaminated pipes and valves. The abovegrade structure will be demolished and covered with gravel and the belowgrade part of the pit filled with slurry.

Filling the belowgrade part with gravel would require demolition of the pipes, valves, structural steel, and platforms before demolition of the abovegrade part to minimize bridging of the fill material as it is dumped from above into the pit. In contrast, filling with slurry will not require demolition of the structures in the pit area. When the belowgrade area is filled with slurry, the abovegrade structure is easily accessible to the heavy equipment used for demolition and the resulting abovegrade rubble can be easily rearranged to minimize bridging.

h. D Elevator

The D elevator area is adjacent to the process area between the process area and the storage basin. The D elevator area includes the D elevator work platform, the downcomers, the tool dolly room, and the fuel discharge chute. The walls and roof in this area are constructed of reinforced concrete 4 ft to 5 ft thick. These areas are contaminated and the roofs of these areas extend over the reactor core. Demolishing these areas would require additional procedures to prevent the release of contamination to

the atmosphere or damage to the reactor core. A relatively small area of the downcomers (baffles through which cooling water from the reactor passes) extends above the profile of the covering mound. The downcomers are located away from the reactor and could be safely removed to an elevation below the mound contours. The downcomer height reduction is most cost effectively performed by explosives due to the heavy wall construction and difficult work location within the structure. Difficulty in providing access to fill the areas with gravel, and to fix the contamination makes it more cost effective to fill the areas with slurry. Contamination on the downcomer walls will be fixed prior to demolition.

i. Laboratory Areas/Tool Rooms

The laboratories/tool rooms are within the shielding walls adjacent to the process area on the opposite side of the reactor from the inner rod room. The laboratories/tool rooms are three rooms at three different levels serviced by the F elevator. The walls around the laboratory area on three sides are 3 ft thick and the reactor forms the fourth wall. The floors and roof are 6-in. to 8-in.-thick reinforced concrete. The rooms are approximately 12 ft to 14 ft high. They will be filled with slurry, which is more cost effective and supports a more timely sequencing of work in this case than demolishing the reinforced concrete roof and floor (refer to subsection D.3, Comparison of Slurry Method and Gravel Method.)

j. Miscellaneous Abovegrade Support Rooms

Abovegrade are various other offices, maintenance areas, change rooms, storage areas, etc. These areas are outside of the reactor shielding walls and are constructed of concrete block with precast concrete tile (panel) roofs. A wrecking ball will be used to collapse these areas before they are covered with gravel backfill. The concrete debris will be left as fill.

k. Miscellaneous Belowgrade Rooms

Under the reactor buildings are several tunnels and rooms for piping, ventilation, and other types of support for the reactor operation. These areas are generally less than 14 ft high with 1-ft to 3-ft-thick reinforced concrete ceilings. These areas will be filled with slurry for industrial safety precautions to prevent the ceiling from collapsing which could result in unpredictable subsidence during the backfilling operations of the areas above them. Their locations make them inaccessible to be cost effectively filled with gravel by conveyor or direct placement methods.

l. Mechanical Equipment Rooms

The mechanical equipment rooms above the reactor are constructed of concrete block walls and precast concrete tile (panel) roofs. These rooms contain the mechanical equipment required to operate and maintain the C, D, and F elevators and the vertical control rods. This area also provides a roof over the process area. The vertical control rods are inserted in the reactor and will be left in the reactor. The winches, motors, cables, and machinery in the upper rooms will be lowered onto the top of the reactors or into the work area. Special care must be taken here to protect the top of the reactor during demolition and until it is adequately covered with soil. These areas are beyond the reach of the wrecking ball and will be demolished using jackhammers and other manual equipment.

2. Demolishing the 105 B, D, and F Reactor Buildings

The 105-B, -D, and -F Reactors were the first of the eight reactors to be built, constructed in August 1943, November 1943, and December 1943, respectively. These three 105 Buildings were constructed from the same drawings. These buildings will be demolished and backfilled as described previously for the typical 105 Building, except for the control room area and the laboratory area. These two areas are discussed in the following paragraphs.

a. Control Room

The control room is located below the inner rod room floor slab, which is 3 ft thick. There are two other rooms between the control room and the reactor block, which are also beneath the inner rod room. These rooms together with the control room will be filled with slurry. Their location beneath the inner rod room makes them inaccessible to be cost effectively filled with gravel.

b. Laboratory Area/Experimental (X) Levels

The laboratory area adjacent to the reactor consists of a below-grade room, a concrete slab floor at ground level, and two above-grade rooms separated by a metal grating floor. A metal stairway leads up to the top of the reactor. The laboratory area is very narrow, with approximately 20 ft between the shielding wall and the reactor block. Care must be taken during demolition and filling to avoid damage to the reactor block. It would be difficult to use a wrecking ball in this location. The belowgrade room will be filled with slurry. The abovegrade areas may be filled either with gravel or slurry. Slurry fill was chosen as the method used in the cost estimate because of space restrictions and proximity to the reactor block.

3. Demolishing the 105 DR Reactor Building

The DR Reactor was constructed in December 1947. The control room and surrounding offices and rooms are located below the 4-ft-thick concrete slab floor of the inner and outer rod rooms. A 17-ft-wide tunnel runs underneath the control room area from the process area to outside the 105 Building. Areas under the rod room floors will all be more cost effectively filled with slurry.

The rooms directly below the contaminated inner rod room are not accessible for soil filling. For the tunnel and the rooms below the outer rod room, it is more cost effective to fill with slurry than to demolish the 4-ft concrete floor to fill with gravel. All other

areas in the 105-DR Reactor Building will be demolished and back-filled as described for the typical 105 Building (previous section 1).

4. Demolishing the 105-C and 105-H Reactor Buildings

The 105-C and 105-H Reactor Buildings were constructed in June 1951 and March 1948, respectively, and contain some differences in arrangement and materials of construction, as follows:

- Both buildings were constructed without valve pits. (More extensive tunnel networks served the same purpose.)

- The 105-C Reactor block foundation contains narrow short tunnels in their mass foundations for retrieving balls (3X) used as a third reactor shutdown method. These tunnels are inaccessible from above and will withstand the overburden pressures of the 70-ft high mound; therefore, they will be left void.

- The wall area and storage basin areas of the 105-C and 105-H Buildings have gypsum roofs instead of concrete tile. In addition, the 105-C Building has transite (asbestos) siding on the abovegrade storage basin areas. (Refer to the following section 5.a. for a description of the procedure for removing the panels.)

- In 105-C, numerous rooms in the upper part of the building have transite siding on the walls instead of concrete block.

- The outer rod room at 105-H has concrete walls instead of the concrete block walls in the typical reactor. These walls need not be demolished any more than required to permit access for filling of the voids.

- The storage basin for 105-C includes a Metal Examination Facility, a belowground and aboveground building about 26 ft by 60 ft with transite siding abovegrade. The abovegrade portion (except

the transite panels) will be easily demolished, allowed to fall into the pit, and be covered with gravel. The transite panels will be removed by special procedures and placed in the bottom of the pit.

- Although the fan rooms are similar to the typical reactor buildings, there are significant differences in 105-C and 105-H. The tunnel and underground plenums are larger, especially on 105-H. The 105-H tunnel extends far to the east under the fan room and contains numerous heavy partitions and spaces all covered with a 3-ft-thick slab. This area is difficult to access for cost effective placement of earth fill; therefore, this area will be filled with slurry.

5. Demolishing the 105 KE/KW Reactor Buildings

The 105-KW and 105-KE Reactors were constructed in November 1952 and January 1953, respectively. The reactor buildings were constructed using the same drawings and are therefore very similar. The minor differences in buildings do not justify a separate description of the demolition procedures to be used for each reactor. The KE and KW Reactors do, however, have several deviations from the "typical reactor" (described in section V.A.1 of this report) in the following areas: the storage basin, the outer rod room, the fan rooms, the valve pit, the mechanical equipment rooms, and the miscellaneous abovegrade support rooms. Descriptions of the demolition of each of these areas follow.

a. Storage Basin

The 105-K Area Reactor storage basins were constructed without the concrete columns in the basins, and the abovegrade walls are constructed of transite panels instead of concrete block. The roofs of the basins are reinforced concrete slabs above a heavy steel support structure. Demolition of the basins can be basically the same as the typical reactor, except additional procedures will be required to remove and dispose of the transite

panels. Each sheet will be released individually, lifted down by crane, placed on the floor of the basin, and covered with gravel. Handling procedures will meet the health and safety requirements of OSHA and EPA.

b. Outer Rod Room

The outer rod rooms of the 105-K Area Reactors are constructed of 2-ft to 3-ft-thick reinforced concrete walls instead of the concrete block described for the typical reactor. The K Reactors' outer rod rooms are similar in construction and size to the work areas. The rod rooms will be demolished and filled in the same manner as the typical reactor work area.

c. Fan Rooms

The fan rooms for the K Reactors are located on opposite ends of the building. The supply fan rooms are abovegrade and the exhaust fan rooms are belowgrade. The supply fan rooms have transite walls and a reinforced concrete roof and can be totally demolished, taking special precautions with the transite siding. The exhaust fan rooms are located below a reinforced concrete slab and will be more cost effectively filled with slurry.

d. Valve Pit

The K Area valve pits are belowgrade, directly under the work areas. The valve pit areas are two large rooms called piping rooms No. 1 and No. 2. These valve pits are similar to the typical reactor but located below the work area floor slab. The valve pit rooms will be slurried in the same manner as the valve pits for the typical reactor.

e. Mechanical Equipment Rooms and Miscellaneous Abovegrade Support Rooms

The mechanical rooms and the miscellaneous abovegrade support rooms were built with the transite wall panels and reinforced concrete roofs or ceilings. These rooms will be demolished in

the same manner as the other transite areas in the K Reactor buildings (see section V.A.5.a above for details).

6. Removal of Soil From 105-F and -H Fuel Storage Basins

The 105-F and 105-H fuel storage basins were backfilled with 20 ft of earth after being deactivated to stabilize the contamination in the basins. No decontamination was performed in them before they were filled. In developing cost information it was planned to remove and screen the backfill from the basins to assure that only material suitable for in situ disposal remains. Actual backfill removal and screening determination will be made prior to definitive design.

The cost estimate for this project assumed that the first 18 ft of backfill were noncontaminated because most of the water had been drained before the fuel storage basins were backfilled. The remainder of the backfill was assumed contaminated and would require special radiological work procedures for the removal and screening process.

The 105-F and 105-H Reactors will be demolished and filled in the same manner as the typical 105 Reactor Building.

B. Use of Wrecking Ball and Explosives for Demolition

A 5-ton wrecking ball is currently used for most of the demolition work in the 100 Areas, and will be the primary equipment used for the building decommissioning. The wrecking ball is attached to a crane with a 100-ft boom, and can be used for heights of up to 60 ft. This ball can be used to effectively demolish masonry and reinforced concrete up to 2 ft thick.

For concrete walls and slabs with a thickness greater than 2 ft (in some areas up to 5 ft thick), it is more cost effective to either leave the concrete in place or use explosives to demolish it.

Both the wrecking ball and the explosives break the concrete into rubble. The rubble will be spread evenly or moved to other areas of the

105 facility with bulldozers and left as fill. The rubble left from explosives is more hazardous to work with than that from the wrecking ball because the reinforcing steel becomes twisted and tangled up with the concrete during the explosion. Conventional metal cutting methods will be used to cut the reinforcing steel in the rubble left from explosives.

The use of blasting in the demolition effort requires the services of explosives experts to determine types of explosives and placement methods to be used. Blasting will only be used where the wrecking ball is impractical or ineffective, and where the integrity of the exterior of the reactor will not be compromised.

Definitive design for this project will determine the acceptable form of demolition for specific location within the reactor buildings.

C. Reducing Voids Caused by Demolition Rubble

Rubble from the demolished structures will be left as fill inside the reactor facilities. The rubble as it first falls will be in large pieces which can bridge between each other creating large voids and pockets. To eliminate these voids as much as feasible and minimize settlements of the mound, the rubble on the ground will require additional breakage, cutting, and rearrangement. Small pipes and equipment may be left in place. Large pipes (greater than 3-ft diameter), ductwork, and tanks will be flattened as much as possible. Concrete and masonry will be broken into pieces no greater than 18 in. for the longest dimension to minimize voids where rubble bridging occurs. Metal decking, grating, and structural steel will be left in a manner that eliminates bridging and reduces backfilling voids.

Rubble may be moved from one area of the facility to another to maintain a maximum 4-ft layer depth. A layer of gravel or slurry will be placed over the rubble. Grading equipment or a vibratory compactor will be used on this initial layer to make the gravel or slurry sift into as many

rubble voids as possible. The initial layer stabilization cost is approximately the same for either method. A slurry layer was assumed to be used for estimating purposes.

During definitive design, individual rooms and spaces will be investigated to determine critical areas of void reduction. An additional effort to reduce voids may have to be made in an area such as the valve pit, which has a great deal of large pipe, grating, and equipment. In other open areas (such as the work area), an isolated large void would result in only negligible settlement of the finished mound.

D. Slurry Backfilling Versus Gravel Backfilling

Two methods of filling the void spaces inside the reactor buildings after demolition have been examined: the use of slurry and the use of gravel. Each of these methods would require different equipment and procedures, and each method has different engineering, schedule, and cost advantages and disadvantages. Both methods are described and analyzed in the following sections.

1. Slurry Backfill

In slurry backfill the roof is not destroyed, as in the case of gravel fill; rather, some holes are added to the roof for pumping in the slurry. The overall structure is stronger because of the roof support in this fill method.

The slurry consists of 3/4-in. minus gravel, soil, Portland cement, fly ash, air entrainment, and plasticizer. These ingredients are mixed using standard concrete mixing techniques, and placed using a concrete pumper. As soon as the cement and water in the slurry are mixed, the slurry will begin to set up. The slurry will be placed while it is still in a fluid or pliable state, and will exert an outward pressure on the walls until it hardens. As the slurry fills the room, the lower layers gain strength and limit the lateral pressure exerted against the wall. For larger rooms where the room is filled at a slower rate, the total pressure of slurry against the

wall is less than the lateral pressure would be if the rooms were filled with gravel. The walls of larger rooms will not withstand the lateral pressures of gravel fill. For smaller rooms, the strength of the walls is sufficient to withstand the lateral pressures of the slurry even though the room is filled at a faster rate. The slurry will eventually harden into a solid mass with a compressive strength of approximately 300 psi. After holes are made in the ceiling, the hose from the concrete pumper is placed in one of the holes and the slurry is pumped into the room. Varying the ingredients in the slurry mixture will allow variation in the consistency of the slurry, and the room can be filled leaving minimum voids.

The slurry can be pumped into many of the inaccessible areas of the reactor with minimal demolition required. Contaminated areas can be filled without requiring additional cost for fixing procedures. Structural steel platforms, gratings, stairways, equipment, and other obstructions can be slurried with minimal demolition. Lateral pressures on walls can be reduced to allow filling on only one side without causing structural instability of the walls.

2. Gravel Backfill

The gravel backfill consists of material generally less than the 4-in. sieve size with less than 15% of the material passing the #50 sieve.* This material is generally available from the borrow pits designated for use at Hanford, within 1 to 2 miles of the reactor sites, or may be obtained from land adjacent to the reactor buildings with prior approval. The designated pit material can most generally be obtained with only operators' visual acceptance of size, minimizing the need for a sieving operation.

To fill an area economically with a soil backfill requires the use of large equipment such as scrapers, bulldozers, or loaders. The ability

*The #50 sieve has 50 openings per square inch.

of these large machines to work in confined spaces within the reactor building is greatly limited. To make these areas accessible to this equipment, additional demolition work is necessary.

Use of conveyor belts is one way of moving large volumes of soil short distances into inaccessible areas. Conveyors require large equipment to load the belts and equipment to spread the soil as it comes off the conveyor belts. Thus, the equipment and associated personnel required for conveyors make this option more expensive, and it was not included as part of the cost estimate. Costs incurred with conveyors are:

- Rental
- Movement setups
- Fuel or electricity
- Operating personnel (at least four men per belt)

The minimum demolition required to fill a room with gravel backfill is the removal of the ceiling. The reason for the ceiling removal is the equipment needed to move the dirt around inside the room needs 4 ft to 5 ft of headspace in which to work. If the ceiling was left intact, the space left between the backfill and the ceiling would be a safety hazard. When backfilling operations begin on top of the ceiling, the ceiling could collapse, injuring personnel or damaging equipment. With the ceiling removed, the backfill can completely fill the room and backfilling operation can continue to safely mound to provide the required cover.

3. Comparison of Slurry Method and Gravel Method

Slurry is more expensive per cubic yard than gravel backfill material. Therefore, where great quantities of fill are necessary, earth fill is substantially less expensive than slurry. However, unit cost of the material is not the only consideration when selecting the

backfill method. Costs associated with preparing an area for filling, transporting the material, and placing the material also must be considered.

An example where both methods have comparable cost is presented below. A 20-ft by 40-ft room with a 14-ft ceiling must be filled. The ceiling is a 6-in. reinforced concrete slab with supporting beams. The estimated costs for the two methods of filling this room are:

Slurry	
Slurry to fill room ($17.24/yd^3)	$7151
Core drills through ceiling slab	126
($9/hole, 14 holes)	$7277
Gravel	
Gravel to fill room ($1.80/yd^3)	$ 747
Demolition of ceiling slab ($8.50/ft^2)	6800
	$7547

These costs were based on the following:

a. In this comparison, the cost of the batch plant/pumping equipment is considered to be absorbed by voids already designated to be filled with slurry. The $17.24/yd^3 cost will allow for an evaluation of any additional spaces that may need to be filled.

b. The cost of the gravel includes only the cost to excavate the gravel from the borrow pit and transport it to the site.

c. Demolition of the ceiling slab includes operator and wrecking ball equipment usage.

As the room height varies, the cost of slurry changes at a faster rate than the cost of gravel. However, the cost for the core drilling and slab demolition remains constant. As the room height

increases, the slurry method cost will quickly exceed the cost of the gravel method. Conversely, as the height decreases, the costs decrease faster for the slurry method than for the gravel method. In summary, rooms 14 ft or less in height will be more cost effectively filled using the slurry method. However, rooms 14 ft or higher may also be more cost effectively filled with slurry based on other variables.

The time factor of labor must be considered. Material for slurry is at the jobsite and included in the unit cost per cubic yards of slurry. This can be placed at a rate of 800 yd^3 per day. The cost of the gravel must include the transport plus the clamshell operator and rental. Based upon the standard operating procedures for operating engineers, the 3 yd^3 clamshell will place about 240 yd^3 per day.

Another factor to consider is that the batch plant, the pumper and associated procured equipment will be standing idle if slurry is not used as much as possible. Startup and cleanup time between operations also adds additional cost. Therefore, a slurry operation requires tighter management to be an effective alternative.

Another consideration in choosing slurry or soil backfill is the scheduling for backfilling inside and outside the building. Backfilling with soil makes it necessary to stagger filling in the inside with filling on the outside to protect walls from unexpected collapse, which may be hazardous to workers and equipment. This is necessary to maintain a minimum difference in fill height on each side of the wall, so the design stresses of the wall will not be exceeded by an uneven soil load on one side. In contrast, slurry exerts a pressure within the design limits against the wall, so the building could be completely filled with slurry before backfilling outside the building begins. Slurry costs more than soil, but the

ability to use it inside the building without the need for concurrent backfilling outside would minimize scheduling and coordination impact between demolition and backfilling work outside the building.

E. Ability of Building to Withstand Backfill and Mound Weights

1. Filling Against Standing Walls

Building a ramp against reinforced concrete shielding walls to provide access for dumping fill in such spaces as the work areas is economically more advantageous than using the clamshell for dumping fill. To do so, however, requires that the wall have the flexural strength to withstand the substantial loading due to the pressure of the soil and the surcharge of the equipment.

Preliminary calculation (appendix E), based on appropriate dimensions of a typical work area enclosure wall, indicate that the wall would be highly overstressed by the equipment on the ramp. Although the walls are thick and quite rigid, they were typically reinforced only to the minimum the code required for temperature reinforcement. In addition, more detailed calculations would not likely produce acceptable stress levels.

Two other alternatives were investigated:

a. A notch may be cut in the top of the wall down to a point where lateral pressures are low enough to produce acceptable stresses. Approximately one-half to two-thirds the way up the wall, fill could be placed on one side of the wall. The resulting ramp could then be used to bring fill up in the inside of the wall, thus equalizing the pressures in the wall.

b. Another alternative is for fill to be placed against the inside face of the wall by clamshell and/or conveyor until fill against both sides was about one-half to two-thirds the wall height, thus equalizing the pressure on the lower portion. Then the ramp could be built over the top of the wall.

During definitive design, further investigation of each building and wall will indicate the best and most economical method for each case. Wall length, heights, and the number and sizes of openings in the walls will affect the results.

2. Mounding Over Pipes and Tunnels

During the decommissioning of the reactor facilities, belowgrade piping and tunnels will be subject to loadings much greater than those designed for originally. Calculations were done (appendix E) to determine what structural effects the total 70-ft-high mound and the equipment used to build it will have on the various sizes and types of underground piping and tunnels. Heavy equipment might cause piping or tunnels to collapse, thus damaging the equipment or injuring the operator. (Piping will eventually fail due to fatigue or corrosion. The failure was assumed to happen during the 500-year design life of the mound.) Types of underground piping found in the facilities include vitrified clay, asbestos cement, reinforced concrete, cast iron, and carbon steel. Approximately 70% of this piping is 24-in. diameter or less. If pipe of this size failed, it would neither create large areas of subsidence nor damage construction equipment. Therefore, equipment loadings and overburden pressures on these smaller pipes were disregarded.

Pipes larger than 24-in. diameter were analyzed (appendix E) to determine if they would fail under the equipment loads or soil overburden loads. Maximum equipment wheel loads were based on the largest equipment assumed to be used, a truck with two 50 yd^3 bottom dumping trailers. None of the pipes were found to fail under soil loads alone and most of the piping will withstand the maximum wheel load without failure if it has a 2-ft 6-in. soil cover. Concrete pipe in the 30-in. to 66-in. diameter range will require a 5-ft minimum soil cover to withstand the maximum wheel load. Existing depths of these pipes must be determined during definitive design. Lighter vehicles could be used to add the soil cover to reach the 5-ft cover height.

3. Mounding Over Floors/Roofs

There are several factors to be considered as to whether or not all floors in the reactor buildings must be demolished prior to earth fill, or if some floors may be left in place creating voids in the mound. Maximizing the number of voids in the earth mound could produce cost savings for the total decommissioning effort. However, the remaining voids could allow long-term settlement of the soil mass if the voids collapse. In addition, the void areas might require special techniques and safety precautions during mound construction to avoid collapse. Imposing equipment weight limitations and stringent safety precautions on a contractor would escalate costs. Therefore, all pertinent factors need to be included for a final decision as to whether or not a certain void is acceptable.

Various floor construction systems were structurally evaluated as to their capabilities to support construction loads and the final long-term soil loads. The evaluation was done specifically on the 100 KE/KW Reactor complex. This complex was assumed representative of the other eight reactors with respect to floor construction systems.

Two specific floor systems that appeared to be good candidates for voids were evaluated: the reactor block foundation system and the (reactor shutdown) ball (3X) room. The following sections discuss both floor systems.

a. Reactor Block Foundation System

A typical reactor block rests on a massive concrete mat foundation. The KE/KW mat is 20 ft 6 in. thick. The concrete (except -B, -D, -F, -H, -DR) mat contains tunnels for the retrieval of the boron balls used for the reactor's third shutdown safety system. To determine whether the tunnels should be filled during decommissioning, structural calculations were performed on the KE/KW mat. The calculations (appendix E) indicate that the additional soil load on the reactor block would not overstress the reinforced concrete surrounding the tunnels, i.e., the

tunnels would not collapse. Calculations were also performed (appendix E) to determine if the concrete would support the load if the reinforcement was lost due to corrosion. Even without reinforcement, the stresses in the concrete are below the allowable.* In conclusion, these tunnels need not be filled because the surrounding structure is easily capable of supporting foreseeable construction loads and long-term soil loads. Not filling these tunnels would result in cost savings of approximately $964,000.00.

b. Ball 3X Room

The ball 3X room is beneath the inner rod room at elevation (-)17'-6". Its approximate size is 30 ft by 40 ft. The inner rod room floor slab above the ball 3X room is 4-ft thick reinforced concrete. A structural analysis was performed on the floor slab (appendix E) using a uniform load equivalent to 65 ft of soil. The slab was analyzed using the working stress design method and found to be overstressed by a factor of 7.6. An ultimate strength analysis was then performed on the slab, indicating that the slab was overstressed by a smaller factor of 6.9.

Using the ultimate strength analysis, the allowable soil height placed on the slab prior to yield was 4.9 ft. This amount may seem small when compared to the thickness of the slab. However, thick slabs and walls in a reactor structure are usually for radiation shielding and contain minimum steel reinforcement. As shown on the allowable floor loading plan (drawing H-1-21052, References, Section XI, C.), the inner rod room allowable live load is 250 psf. This is equivalent to 2.3 ft of soil. Therefore, the 4.9 ultimate soil load prior to yielding does not appear

*As defined in ACI 318-83, "Building Code Requirements for Reinforced Concrete," 1983.

unreasonable. Since the final soil height of 65 ft overstresse the slab by such a large factor, it is recommended that the ball 3X room be filled during final decommissioning.

c. Other Rooms

A review of the allowable floor loading drawing H-1-21052 will answer questions on most other rooms which might be considered being left as voids in the final soil mound. Most of the floor systems for these rooms are concrete monolithic beam-slab structures. They are designed for uniform floor loads varying from 50 psf to 2,000 psf. The equivalent maximum load for a mound over the reactor floor area created by 65 ft of soil height is 7,150 psf. As can be seen from the structural analysis performed on the ball 3X room, the ultimate capacity of a floor system beyond its allowable live load usually is less than a factor of 2. Therefore, for conceptual design cost estimating purposes, all rooms were considered filled during the decommissioning effort.

F. Constructing the Mound

1. Equipment and Method

The material to fill the outside of the reactor building will be the same gravel backfill material used inside the building. The area outside the building is accessible to large earthmoving equipment, which is the most economical method for handling the backfill material. The equipment will include scrapers, bottom dump trucks, front end loaders, and bulldozers. The mound slopes and access were designed to accommodate the grades and turning radius limitations of this equipment (refer to sketches in appendix J).

The mound will be built to use the minimum amount of backfill required to allow equipment access, assure stable slopes, and provide the minimum required cover.

After the demolition and backfilling within the reactor building is complete, the backfilling outside of the building will begin. Selected backfill from borrow pits located near the reactor will be self-loaded into scrapers or loaded into bottom dump trucks with front end loaders. The loads will be hauled to the reactor site and dumped in 12-in. to 18-in. lifts. The bulldozers will spread the material, and assist in leveling the fill and shaping the mound as required.

2. Seeding the Mound Versus Leaving a Rocky Surface

The resulting earthmound will be approximately 70 ft high. Two options for surface stabilization to minimize wind and water erosion were studied: seeding and leaving a rocky surface. For this conceptual design report the seeding method was used as a basis of the cost estimate. Seeding a soil layer with grass prevents erosion of the mound surface, provides surface moisture removal by plant transpiration, and deters the growth of deep-rooted plants. Discussion of both methods follows. Further analysis of alternatives may be done in definitive design.

The mound will be covered with a 2-ft layer of topsoil and seeded with shallow-rooted indigenous plants. The seeded topsoil will require maintenance during the 2-month germination period to ensure that seed and soil are not blown away before the plants take root. Indigenous plants provide a natural-looking mound which blends into the surrounding terrain. The topsoil and plant growth absorb water and reduce water seepage into the mound. The mound will require a flatter slope than the rocky surface to prevent erosion of the topsoil.

The alternative method of stabilization is to provide a rocky surface, either by leaving the gravel exposed or by adding a layer of broken basalt rock. This surface minimizes deterioration while remaining permeable and preventing ponding of water and excessive runoff. The mound may be built at a steeper slope requiring less material.

3. Volume of Fill

The estimated volume of fill required for each reactor is shown in Table 2. These volumes were based on mounds designed with a 5:1 slope as used for the cost estimate basis.

TABLE 2. Estimated Fill Volumes for 100-Area Reactors

Reactor	Slurry (yd^3)*	Gravel (yd^3)
105-F	15,000	470,000
105-H	21,000	365,000
105-D	15,000	470,000
105-DR	17,900	328,000
105-C	19,500	470,000
105-KE	21,500	989,800
105-KW	21,500	989,800
105-B	15,000	470,000

*The total slurry volume in this table differs from the total slurry volume in appendix D. The difference in volume of slurry used is 1% of total project cost.

G. Settlements

1. Rubble Settlement

Rubble from demolished structures is to be left in place as fill around the central reactor facilities. It is estimated that this rubble will be a maximum of 3 ft to 4 ft deep, and comprised of demolished concrete, masonry, structural steel, piping, equipment, and miscellaneous metal work.

The rubble itself will contain open areas due to pipes, equipment, and grating, and pieces of rubble will bridge between each other creating void areas. Steel materials will deteriorate over time (due to corrosion), creating further voids. The more void space there is, the more settlement will occur.

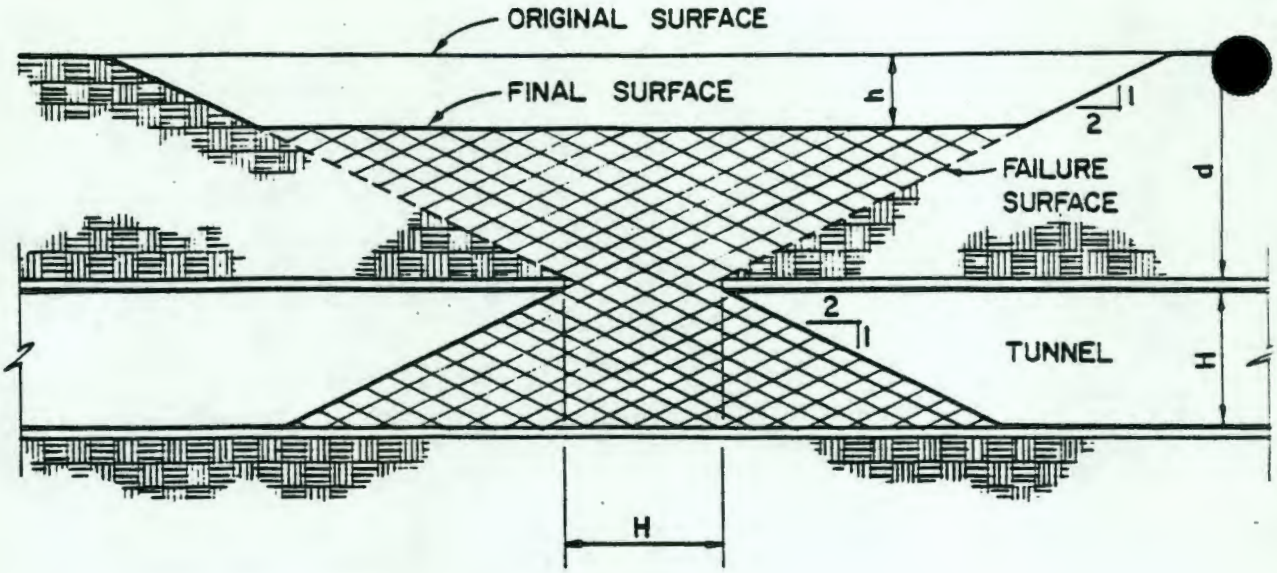
The final makeup of the rubble (the percentages of various materials, sizes, amounts, and demolished condition of rubble) is difficult to determine. Because of this, settlements of the mound due to the rubble cannot be estimated as accurately as settlements due to the soil. If grading equipment or a vibratory compactor is well-routed over the rubble area, it is estimated that 4 ft of rubble will not settle more than 6 in.

2. Voids

Settlements resulting from voids can appear in the mound both during and after mound construction. Small voids in the mound backfill and rubble will result in uniform settlements which will have a minimum adverse effect on the mound. Large voids may result in large localized settlements after the mound is completed. Localized settlements during construction of the mound could result in injuries to personnel, damage to equipment, or delays in construction. To prevent large localized settlements, large voids will be filled before mound construction.

To determine which large voids require filling, a comparison of tunnel size to depth of expected settlement was made as shown in figure 1. As an example to show how to use this graph, a square tunnel, with cross section dimensions H (feet) by H (feet), is buried a depth of d (feet) below the surface of the ground. An opening with the same cross-section dimensions as the tunnel is made in the top of the tunnel and the soil is allowed to flow into the tunnel until a stable slope is obtained in the tunnel. The settled soil above the tunnel would be in the shape of an inverted frustum of a cone that has the same volume as the soil in the tunnel. The graph in figure 1 shows the relationship between the size of the tunnel, depth of cover, and the expected settlement resulting from the filling of the tunnel.

For example, an 8-ft-square tunnel with less than 5 ft of cover would result in the total soil cover over the opening settling into the tunnel. By placing another foot of cover over the tunnel (total



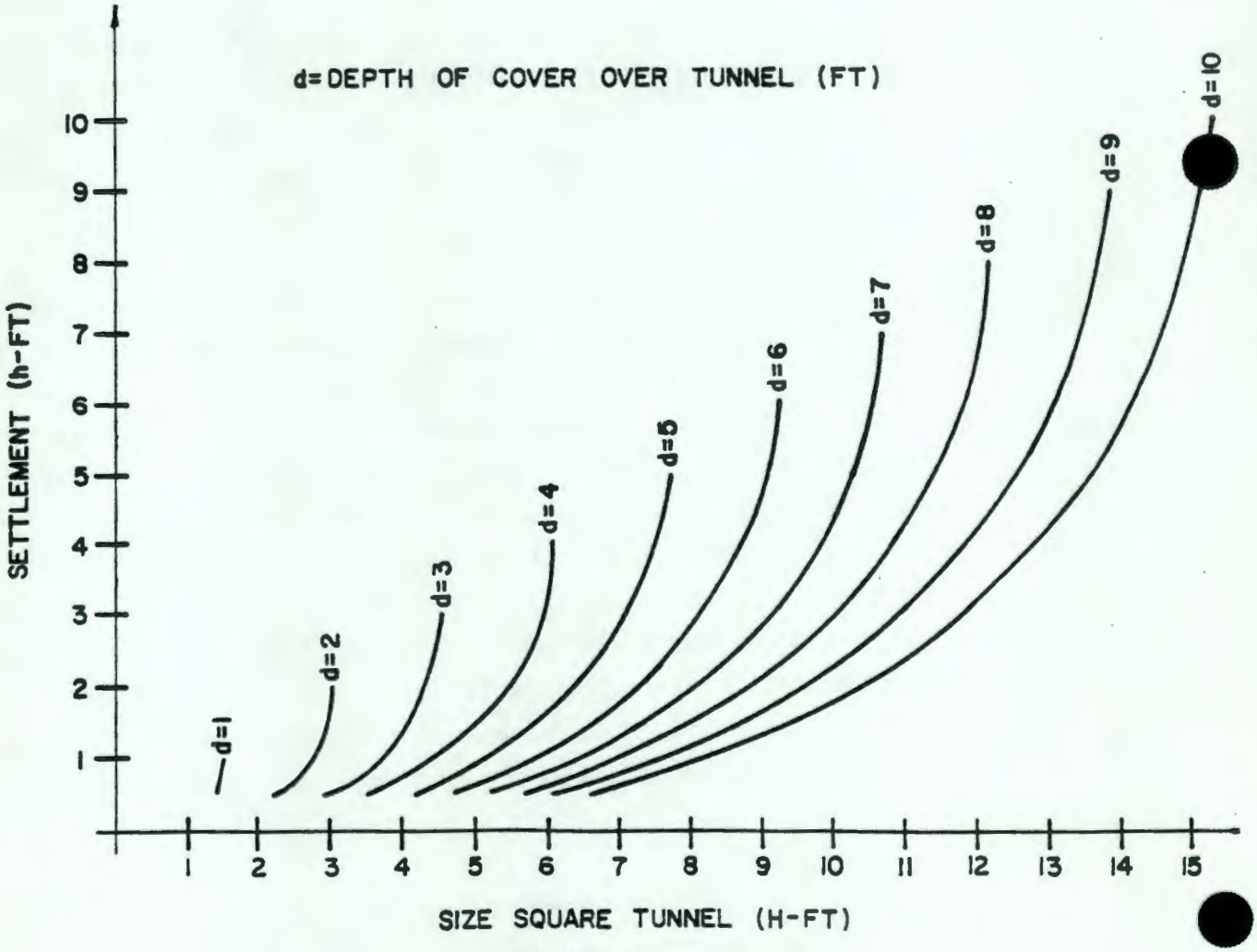


FIGURE I

Relationship Between Tunnel Size, Depth of Cover, and Depth of Expected Settlement

cover 6 ft), a settlement of approximately 3 ft would occur. This would assure 3 ft of cover over the tunnel and minor settlement which would not result in personal injury, equipment damage, or construction delays.

3. Soil Settlement

As the soil is excavated, the density will reduce and, depending on the way the soil is backfilled, part of the density will be regained. During the post mound construction period, the density will continue to increase but at a relatively rapidly decreasing rate. The post construction increases in density will result in settlements within the mound.

Relative density is one method of determining the expected settlements. Table 3 shows the expected settlements associated with a gravelly soil with a maximum dry density of 109 lb/ft^3 and a minimum dry density of 81 lb/ft^3. The settlement due to increased soil density is shown in table 3 as a percentage of the height of the backfill material.

A gravelly soil backfilled using heavy equipment, which has been conscientiously routed over the fill, will compact to a placed relative density of the placed soil of about 65%. As the backfill ages, the relative density of the placed soil will increase and the mound will settle. The soil settlements will occur continuously at a decreasing rate with most of the measurable settlements happening in the first 10 years. The post-construction relative density at this time will be 75% and result in a 3.2% or 2-1/4 ft of settlement for a total fill depth of 70 ft. When a clamshell is used to place the gravel soil, the placed relative density will be about 55%. The resulting settlement will be 6.4% for a post-construction relative density of 75% or 4.5 ft for a 70-ft fill height.

TABLE 3. Soil Settlement (% of Fill Height)*

Dry Density (lbs/ft^3)	Post-Construction Relative Density(%)	Placed Relative Density (%)						
		50%	55%	60%	65%	70%	75%	80%
92.9	50	0						
94.3	55	1.5	0					
95.8	60	2.8	1.6	0				
97.2	65	4.6	3.1	1.5	0			
98.8	70	6.4	4.8	3.1	1.6	0		
100.3	75	8.0	6.4	4.7	3.2	1.5	0	
102.0	80	9.8	8.2	6.5	4.9	3.2	1.7	0

*This table is based on a maximum dry density of 109 lb/ft^3 and a minimum dry density of 81 lb/ft^3. See letter in appendix E-29.

The maximum expected settlement in the mound is 4.5 ft due to the increase in density of the soil. With a 4.5 ft settlement, the 16 ft soil cover will be maintained. The soil settlement should be fairly uniform and occur at a relatively slow rate with no detrimental effects on the mound. If, during the 10-year postconstruction maintenance period, differential settlement creates deleterious conditions, they can be corrected.

4. Compaction

Compaction was considered as a means of reducing the settlements of the backfill areas. Compaction used on the designated backfill material would result in placed relative densities of 70% versus the 55% and 65% relative densities discussed previously in Section V.G.3, Soil Settlement. Compaction of original volumes would reduce the overall height of the mound from 70 ft to 66 ft, but would not reduce the volume of selected backfill materials to be hauled. Since

deliberate compaction would not increase the integrity of the mound and would result in additional cost, compaction operations were not included as part of this project.

H. Design Life Considerations of the Mound

1. Infrastructure Linkages

Openings such as pipe, ducts, or conduits that lead from outside the burial mound to within the shielding walls are defined as infrastructure linkages. All such linkages that could be used as access (by man, rodents, reptiles, insects, etc.), or provide a means of unobstructed flow for water or air will be removed or filled with slurry or gravel for a distance of at least 16 ft (see appendix F).

All of the reactor buildings have numerous pipes and conduits leading into and out of the building. The most critical are those that connect the reactor block with the outside, such as cooling water supply and effluent lines. In order to provide a barrier of maximum reliability, lines that penetrate the reactor block will be filled with slurry for 16 ft between the reactor and the point at which they enter the building. They may be severed and sealed off with fill at the most accessible location within the building.

Other lines, such as water and process sewer lines that enter basement areas belowgrade, will be severed at the point of penetration, or as required to terminate the linkage, providing a 16-ft barrier.

Lines such as sanitary sewer and service water lines under floor slabs will be left undisturbed unless they connect to linkages into the critical areas of the building.

Tunnels that connect the basement area of the building with the outside will be breached and filled.

2. Slope Stability

For the mound slopes to maintain their stability, they must be less than the natural angle of repose of the material used. Both gravel and topsoil were considered as the outer cover layer of material for the mound, and topsoil was chosen.

Gravel has a natural angle of repose of approximately 1-1/2 horizontal to 1 vertical. If undisturbed by outside forces, the gravel would remain at this slope. However, melting snow, animals, plant growth, wind and other natural forces will cause raveling and sloughing of the gravel. Therefore, a slope of 2 horizontal to 1 vertical will be used to reduce the erosive effects on the mound and increase the endurance of the mound slope.

The natural angle of repose of topsoil is about 2 horizontal to 1 vertical. When topsoil is used to provide a 2-ft cover layer over the mound, a slope of 3 horizontal to 1 vertical is considered adequate. This slope would minimize the erosion of the topsoil during the planting and watering required to establish a cover of vegetation. The sketches in appendix J show mounds designed with a 3:1 slope.

Topsoil mound slopes of 5:1 were used for the cost estimate because heavy equipment can get up to the top of a mound of this grade from any direction. The optimum slope will be determined during definitive design.

3. Probable Maximum Flood

The probable maximum flood (PMF) for the Columbia River as defined in Hanford Standard Design Criteria SDC-4.1 will result in a flow through Hanford of 1,440,000 ft^3/sec. The Corps of Engineers has defined this flood as one "representing flood discharge that may be expected from the most severe combination of meteorological and hydrological conditions that are reasonably possible in the

region."* The maximum flood in recorded history was in 1894 when the calculated flow at Hanford was 800,000 ft^3/sec.

The floor elevations at the reactor buildings and water elevations at PMF are in table 4.

The PMF is lower than the first floor elevation of every reactor building. The calculated flood levels are not expected to cause significant erosion of the mound surface nor cause release into the groundwater of contaminants from within the mound. In the event of recurring, catastrophic long-term flooding (due to watershed and/or changes in climate that would cause removal of the mound), the massive reactor block would be exposed. Even then, the majority of radionuclides within the block would still remain in the matrix.

4. Survey and Mapping

The location of the centerlines of each process area and its shielding walls will be mapped during definitive design, enabling future location of the buried reactors if ever required.

The location of the -B, -C, -D, -DR, -F and -H reactor facilities are given on existing drawings using the Hanford Plant Grid system. The -KE and -KW facilities can be located by the K Area Grid. Both of these grid systems are common only to the Hanford Site.

During definitive design, coordinates for locating the decommissioned facilities will be converted to the Washington Coordinate System (Lambert grid system). Use of the Lambert coordinates will enable these areas to be readily referenced to United States Geological Survey (USGS) or National Geodetic Survey (NGS) control stations. The Lambert coordinates will facilitate location of the decommissioned facilities some time in the future when the Hanford and K Area grids are no longer in use.

*"Evaluation of Impact Potential Flooding Criteria on the Hanford Project" DOE-RL, 1976.

TABLE 4. Reactor Floor Elevations and Corresponding Water Elevations at Probable Maximum Flood

Reactor	First Floor Elevation (Ft)	*PMF Level (Ft)
105-C	494.0	434
105-D	466.5	419
105-DR	466	419
105-KE & W	465	431
105-B	468.5	434
105-H	423	416
105-F	412.5	412

* From SDC 4.1

Three permanent survey marker control points will be established at each reactor site to facilitate future survey work. Two control points are needed, at each reactor, and the third one serves as a checkpoint. The survey markers must be set on undisturbed earth outside the boundaries of the mound. The control points will be referenced to USGS or NGS control stations and will provide both horizontal and vertical controls.

VI. APPLICABLE CODES AND STANDARDS

A. National

1. American Society for Testing and Materials

C136-82	Standard Method for Sieve Analysis of Fine and Coarse Aggregates

2. American Concrete Institute*

ACI-318-83	Building Code Requirements for Reinforced Concrete

* Dates will be assigned at definitive design.

3. Code of Federal Regulations*

10 CFR 61**	Title 10, Chapter 1, Energy Part 61, December 30, 1982
40 CFR 61 Subpart M	National Emission Standard for Asbestos
40 CFR 761	Polychlorinated Biphenyl (PCBs) Manufacture, Processing, Distribution in Commerce, and Use Prohibition
40 CFR 1500-1508	Council on Environmental Quality Regulations
45 CFR 20694	Compliance with the National Environmental Policy Act; Final Guidelines, March 1980

4. Occupational Safety and Health Standards

OSHA 1910	General Industry Standards
OSHA 1926	Construction Industry Standards

B. Federal Government

1. Department of Energy

Headquarters

DOE-EV/10128-1	Decommissioning Handbook
DOE Order 5440.1B	Implementation of the National Environmental Policy Act
DOE Order 5480.1A	Environmental Protection, Safety, and Health Protection Program for DOE Operations
DOE Order 5480.2	Hazardous and Radioactive Mixed Waste Management

* Dates will be assigned at definitive design.
** Guidelines for technical design for inadvertent intruder protection.

DOE Order 5481.1A	Safety Analysis and Review System
DOE Order 5820.2	Radioactive Waste Management

Richland Operations

DOE-RL Order 5480.1 Chg. 1 Chapt. 9, Part A	Environmental Protection, Safety and Health Protection Program for Richland Operations - Part A, Explosives Safety, June 24, 1982.
DOE-RL Order 5481.1A	Safety Analysis and Review System
DOE-RL Order 5700.2	Project Management System (adapted as guidelines for decommissioning projects)

2. U.S. Nuclear Regulatory Commission

U.S. NRC Regulatory Guide 1.86	Termination of Operating Licenses for Nuclear Power Plants

C. UNC Nuclear Industries

The project incorporates the standards from appropriate UNC documents for the following activities:

- Radioactive and other hazardous materials shipment
- Radiation and environmental control
- Industrial safety
- Quality assurance

UNI-M-10 REV2	ALARA Program and Radiation Exposure Reduction Guide
PNL-4722/UNI-2522	Allowable Residual Contamination Levels for Decommissioning Facilities in the 100 Area of the Hanford Site.
UNI-3560	Surplus Facilities Management Program Plan

VII. SCHEDULE

The project master schedule is contained in appendix B.

VIII. METHODS OF PERFORMANCE

A. Work Planned for the Operating Contractor

The operating contractor will perform the mechanical (nonexplosive) demolition and void filling, and provide overall project management during design, procurement, construction, and inspection on this project.

B. Fixed Price Construction

A fixed price construction contractor will build the earth mound, and another fixed price contractor will perform the explosives work during demolition.

C. Onsite Architect-Engineer Work

The onsite architect-engineer will perform the definitive design for this project.

D. Procurement Strategy

The batch plant and pumping equipment will be a competitive procurement.

Rental of comparable pumping equipment for eight reactor buildings would cost: $1,360,000 versus $336,000 for a new pumper.

IX. REQUIREMENTS AND ASSESSMENTS

A. Safeguards and Security

The special decommissioning procedures for use of explosive demolition will be reviewed and approved by Safeguards and Security. No other additional safeguards or security measures are required by this project.

This project will remove the vacated buildings that require stringen routine monitoring and surveillance of the multi-portaled structures. The mound barrier will significantly simplify the area surveillance for the institutional control period.

B. Safety

Hazards associated with this project will be mitigated by strict compliance with DOE-RL 5481.1A, Hazard Analysis.

A Decommissioning Project Readiness Review (DPRR) is required prior to the start of any project. The hazard analysis will be performed as required by DOE-RL 5481.1A. A detailed Project Safety Plan will be prepared prior to the start of this project according to the applicable industrial safety manual. The project safety plan will address, as a minimum, the following items:

- A demolition plan to delineate measures to assure that mechanical demolition of such areas as roof, floor, interior partitions, etc. can be performed safely.

- An engineering survey to assess stability, floor loading, etc. during demolition.

- Access, egress during demolition.

- Storage and handling of materials and debris.

- Explosive safety

  - Blasters' qualifications
  - Transportation
  - Storage
  - Controls and warnings during explosive demolition
  - Posting of restricted area
  - Control of radio frequency energy during explosive demolition

. Fire protection during demolition.

This project will occur in a controlled area. Decontamination and exposure reduction techniques will conform with the applicable radiation practice manual, prior to and during the project. The fundamentals of the as low as reasonably achievable (ALARA) objective shall be applied, as required by UNI-M-10. The Allowable Residual Contamination Levels (ARCL) method (reference XI.A.3) will be used to determine allowable residual contamination levels for decommissioned facilities.

Most of the estimated 40 man-rem (UNI-2619, References, Section XI.A.1) of occupational exposure is expected to be used during the removal and/or fixing of loose contamination in the buildings prior to the superstructure demolition work. This preparatory work will, for the most part, be conducted in a low-radiation (2 to 3 mrem/hr) area.

Implementation of this project will require the removal, movement, transport and disposal of asbestos, PCB's, mercury and other hazardous materials. The requirements of OSHA 1910 and EPA regulations will apply, respectively. Section IV.E. of this report, "Hazardous Material Disposition and Alternatives," discusses hazardous materials disposition.

Contractors will be required to take all reasonable precautions in the performance of their work to protect the health and safety of their employees, subcontractors, operating contractors, and DOE personnel.

At all times, the project area will remain accessible to emergency vehicles or personnel, and emergency evacuation of personnel must not be obstructed.

The construction support facilities will utilize the accommodations that have already been established for decommissioning the ancillary structures. The utility services have been restored in the support facilities. The decommissioning operations office may use either the refurbished 108-F and/or 105-B Building, depending on work locality.

C. Environmental Evaluation

In support of the ultimate disposition for the decommissioning of the surplus 100 Areas at the Hanford Site, an Action Description Memorandum (ADM), "Decommissioning of the Shut-Down Hanford 100 Area Reactors (UNI-2983, dated September 1, 1984)," was issued as part of the NEPA process. The action required by the NEPA regulations, DOE Order 5440.1B, the Council on Environmental Quality Regulations (40 CFR Parts 1500-1508), the DOE NEPA Guidelines (45 FR 20694), and other environmental statutes will be complied to within the implementation of the project. No decommissioning alternative will be implemented until the NEPA process is completed.

D. Decontamination and Decommissioning

Decontamination of the reactor buildings (i.e., removal of contaminants) will be held to a minimum. The main areas of concern are those which lie above the top of the reactor block or at grade level, and which will be demolished during the process.

Areas or voids below the top of the reactor block and/or at grade level where personnel entry is anticipated will require study during definitive design to determine the extent and nature of the contamination.

The type of contamination of greatest concern in this project is the loose particulate type (dust or small particles) which tends to migrate to other areas when disturbed.

Another type of contamination, deposited contamination, is attached to surfaces by direct adhesion, physical, and/or chemical attraction, or is imbedded into a surface.

Fixation of the contamination to reduce its potential for migration can be achieved by multiple methods. For some areas belowgrade, this can be accomplished during the filling of the void with slurry, rubble and/or soil. In some rooms, openings could be made in the ceilings and portable

high efficiency particulate air (HEPA) filters mounted over several of the openings. As the grout fills the void, displaced air would exhaust through the filters which would trap the loose particulates.

Drains in laboratories, wash stations, and other areas could be filled and fixed at the same time by the addition of a foaming material such as a polyurethane or similar material. The material would fill and trap the contaminant in the drain. Another method would be to use leftover slurry (very thin) to fill the drains.

Loose contamination can be removed by dry vacuuming. Walls, ceilings and floors can be dry vacuumed using portable equipment and then immediately demolished, creating minimal dispersion of loose contamination.

In areas where vacuuming is not practical, coatings may be applied to cover and retain the contamination on the surface. Two types of coatings can be applied to fix the contamination: a strippable coating (i.e., ALARA coating or equal), or a sodium silicate coating.

The strippable coating is basically a latex-based film 1 to 3 mils in thickness that dries rapidly and adheres to the surface in a continuous film. The film will contain the contaminants during demolition, permitting only minimal dispersion into the air at the shear planes.

The sodium silicate solution produces a glass-like brittle coating which adheres tightly to surfaces. The coating is not strippable in a continuous film.

Application of either coating would be by an airless multi-nozzled spray system. The spray system and associated piping should be designed to provide adequate surface wetting of all areas to be coated and to operate semi-remotely.

A column in the tables in appendix D tells whether contamination is suspected in each area to be filled.

E. Quality Assurance

The overall impact level of this project for cost estimating is Level III as described by UNC's Quality Assurance policy. The project work will involve minimal radiological exposure for the in situ decommissioning of the structures and it is not envisaged that conditions will warrant Impact Levels I or II. The overall long-term effect of the project will be assessed at definitive design.

A different overall impact level designation may be applied during definitive design. If a higher overall impact level is assigned to the project, a lower impact level may be applied to subtier items, components, systems, etc., provided the consequences of failure satisfy the criteria for the impact level classification as defined in QAI 1.0. The impact level designations of the subtier items, components, systems, etc., will be assigned and documented as a part of definitive design.

The overall quality assurance requirements will be in compliance with UNC's Quality Assurance policy. Additional project requirements may be added by letters of instructions, project management plans, or other contractural documents.

The specific quality assurance requirements for decommissioning construction will be established by the architect-engineer and included in the definitive design documents.

F. Maintenance Requirements

The mound will be stabilized by covering it with a 2-ft layer of topsoil and seeded with shallow-rooted indigenous plants. The seeded topsoil will require maintenance during the 2-month germination period to ensure that seed and soil are not blown away before the plants take root.

The maximum expected soil settlement is 4.5 ft. A postclosure observation and maintenance period of at least 10 years will ensure adequate stabilization. Any surface slumping that develops from fill material

settling will be filled as required by the landlord. The mound will continue to be under institutional control for up to 100 years beyond the postclosure stabilization period.

Engineering estimates indicate that the earth mound will last a minimum of 500 years with little or no maintenance, given typical uniform climatic and geologic conditions. Erosion rates for the mound are based on erosion data for natural soil in similar areas; very little erosion of the mounds is anticipated during the 500-year period. Natural mounds roughly the same size, shape, and composition have existed on the Hanford Site for thousands of years.

G. Economic Analysis

Cost estimates were done for the four alternative plans for this project. (The four plans are described in Decommissioning Approaches, Section IV.D.)

Plan 4 (all reactors decommissioned concurrently, leaving reinforced concrete walls) was chosen as the most cost effective. The cost estimate for Plan 4 is in appendix A.

The overwhelming cost factor in favor of Plan 4 is the decommissioning of all eight reactors under one project. The cost escalation factor is only 39.6%, as compared to the percentages for decommissioning each reactor under a separate project: 105-F, 29.07%; 105-H, 44.83%; 105-DR, 60%; 105-D, 78.97%; 105-C, 98.88%; 105-KE, 122%; 105-KW, 146%, and 105-B, 174%.

Another contributing cost factor in favor of Plan 4 is leaving the reinforced concrete walls. This decreases demolition time and results in a cost savings of approximately 30%.

A cost comparison of slurry versus gravel methods for filling void spaces is discussed in Comparison of Slurry Method and Gravel Method, Section V.D.3.

H. Other Considerations

The following items have been considered and are not applicable:

- Energy Conservation
- Communications Requirements
- Provisions for Fallout Shelters

X. REQUIRED CHANGES AT PROJECT COMPLETION

UNC Nuclear Industries will change the following documents and drawings, as required, upon completion and final acceptance. Other applicable 100 Area documents will be designated at definitive design.

A. Documents

UNI-3560, "Surplus Facilities Management Program, PROGRAM PLAN," November 18, 1985.

B. Drawings

H-1-15855 Drawing List (15 Drawings), "Contaminated Zone Markers 100-B/C, D/DR, F, H, & K Areas," March 1983, Kaiser Engineers Hanford.

XI. REFERENCES

A. Reports

1. UNI-2619, "Assessment of Decommissioning Alternatives for the Shut-Down Hanford 100 Area Reactors," May 15, 1984, UNC Nuclear Industries.

2. UNI-2983, "Action Description Memorandum Decommissioning of the Shut-Down Hanford 100 Area Reactors," September 1, 1984, UNC Nuclear Industries.

3. Preliminary Engineering Study R-83-14, REV1, "Cocooning of 105-F Reactor," September 12, 1984, Kaiser Engineers Hanford (revised November 1986).

4. PNL-4722, UNI-2522, UC-70A, "Allowable Residual Contamination Levels for Decommissioning Facilities in the 100 Areas of the Hanford Site," W. E. Kennedy, Jr., and B. A. Napier, July 1983, Pacific Northwest Laboratory, Richland, Washington.

B. Guidelines

Code of Federal Regulations

10 CFR 61, "Licensing Requirements for Local Disposal of Radioactive Waste," U.S. Nuclear Regulatory Commission, Washington, D.C., 1981.

C. Drawing

H-1-21052, "Structural Plans Allowable Floor Loading, 105-KW, Rev. 2," March 26, 1955, UNC Nuclear Industries.

XII. ATTACHMENTS

Appendix A. Cost Estimate
Appendix B. Schedules
Appendix C. Work Breakdown Structure
Appendix D. Void Filling Plans
Appendix E. Calculations
Appendix F. DCS Work Scope Statement of Instructions
Appendix G. Physically Handicapped Assessment
Appendix H. Plant Forces Work Review
Appendix I. Outline Specifications
Appendix J. Sketches

APPENDIX A

Cost Estimate

Total Pages: 14
Date: 3-2-87

KAISER ENGINEERS
HANFORD

PROJECT COST ESTIMATE SUMMARY U290A0

Title	Prepared For	Prepared By	Checked By	Project No.	Date
In-Situ - Decommissioning of Eight 105 Facilities	UNC	C. Elliott	A. Dove	B32207	11/1/84

	DEFINITIVE DESIGN	CONSTRUCTION ENGR/INSP	DEFINITIVE DESIGN	CONSTRUCTION ENGR/INSP	$ TOTAL
A. ENGINEERING					
Architect - Engineer			973,000	308,000	1,281,000
Escalation	25.95 %	39.60 %	252,500	122,000	374,500
Contingency	15 %	25 %	183,800	107,500	291,300
Subtotal			1,409,300	537,500	1,946,800
Other (specify)					
Escalation	%	%			
Contingency	%	%			
Subtotal					
Operating Contractor					
Total A					1,946,800
B. CONSTRUCTION					
(1) Improvements To Land					(1)
(2) Buildings					(2)
Building No. ____ ____ sq. ft.					
Building No. ____ ____ sq. ft.			Construction		24,281,900
(3) Other (Detached Structures)					(3)
(4) Special Construction (Facilities & Installation)					(4)
(5) Utilities					(5)
(6) Procurement					(6)
(7) Operating Expense Charges					(7)
(8) Other (Specify)					(8)
(9) Contract Administration					(9)
(10) Bid Package					(10)
(11) Reconciliation Adjustment					(11)
Subtotal					24,281,900
Escalation	39.6 %				9,615,300
Contingency	20 %				6,916,000
Total B					40,813,200
C. STANDARD EQUIPMENT					
TOTAL PROJECT ESTIMATE					$ 42,760,000

PROPOSED FUNDS ALLOCATION

FUNDS PURPOSE	OPER. CONTR.	DOE-RL
Engineering	1,281,000	
Procurement		
Construction	24,281,900	
Escalation	9,989,800	
Contingency	7,207,300	
Total	42,760,000	

Type of Estimate: ~~Conceptual~~ Study

Approvals	Date
Architect-Engineer	11-2-84
Operating Contractor	11-30-84
	11-30-84

REMARKS:

Estimate Sheet 1 of 13

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UNI-2898 REV0

IN SITU D&D 105 BUILDINGS

10-30-84

	Bldg No	1.2	1.3.1.1	1.3.2.1	1.3.2.2	1.3.2.3	1.3.2.4	1.3.3.1	1.3.3.2	1.3.4	1.3.5	TOTAL
	Plan No 4											
	105 F	$ 527,500	$ 503,900	$ 13,000	$ 170,000	$ 144,800	$ -0-	$ 91,100	$ 183,700	$ 1,138,200	$ 262,000	$ 3,034,200
	Sales Tax	37,500	$ 1,200	400	6,000	3,500		4,300	7,300	38,700	9,700	108,600
	Subtotal	565,000	505,100	13,400	176,000	148,300		95,400	191,000	1,176,900	271,700	3,142,800
39.6	Escalation	223,700	200,000	5,300	69,700	58,700		37,800	75,600	466,100	107,600	1,244,500
31%	Contingency	* 92,600	* 105,900	5,800	21,600	64,200		41,300	82,600	* 164,300	117,600	695,900
	TOTAL	881,300	811,000	24,500	267,300	271,200		174,500	349,200	1,807,300	496,900	5,083,200
	105 H	$ -0-	$ 505,200	$ 10,000	$ 671,400	$ 190,000	$ 1,600	$ 162,400	$ 213,100	$ 909,000	$ 341,700	$ 3,004,400
	Sales Tax		1,200	300	11,200	4,600	-0-	7,100	8,500	30,800	12,700	76,400
	Subtotal		506,400	10,300	682,600	194,600	1,600	169,500	221,600	939,800	354,400	3,080,800
39.6	Escalation		200,500	4,100	270,300	77,100	600	67,100	87,800	372,200	140,300	1,220,000
31%	Contingency		219,100	1,400	295,400	84,200	700	73,300	95,900	* 131,200	153,400	1,054,600
	TOTAL		926,000	15,800	1,248,300	355,900	2,900	309,900	405,300	1,443,200	648,100	5,355,400
	105 D	$ -0-	$ 503,700	$ 13,000	$ 62,000	$ 135,600	$ -0-	$ 106,500	$ 172,200	$ 1,144,100	$ -0-	$ 2,137,100
	Sales Tax		1,300	400	1,000	3,500		4,500	6,800	38,800		56,300
	Subtotal		505,000	13,400	63,000	139,100		111,000	179,000	1,182,900		2,193,400
39.6	Escalation		200,000	5,300	24,900	55,100		44,000	70,900	468,400		868,600
31%	Contingency		218,600	5,800	27,200	60,200		48,100	77,500	* 165,100		602,500
	TOTAL		923,600	24,500	115,100	254,400		203,100	327,400	1,816,400		3,664,500
	105 DR	$ -0-	$ 496,000	$ -0-	$1,139,600	$ 169,800	$ -0-	$ 130,800	$ 148,200	$ 885,500	$ -0-	$ 2,969,900
	Tax		1,200		18,000	4,700		7,900	5,600	29,900		67,300
	Subtotal		497,200		1,157,600	174,500		138,700	153,800	915,400		3,037,200
39.6	Escalation		196,900		458,400	69,100		54,900	60,900	362,500		1,202,700
31%	Contingency		215,200		501,000	75,500		60,000	66,600	* 127,800		1,046,100
	TOTAL		909,300		2,117,000	319,100		253,600	281,300	1,405,700		5,286,000
	TOTAL	$ 881,300	$3,569,900	$ 64,800	$3,747,700	$1,200,600	$ 2,900	$ 941,100	$1,363,200	$ 6,472,600	$1,145,000	$19,389,100

A-3

UNI-2898 REVO

IN SITU D&D 105 BUILDINGS (contined)

10-30-84

	Bldg No	1.2	1.3.1.1	1.3.2.1	1.3.2.2	1.3.2.3	1.3.2.4	1.3.3.1	1.3.3.2	1.3.4	1.3.5	TOTAL
	Plan No 4											
	105 C		$ 514,400	$ 11,800	$ 674,400	$ 37,600	$ 142,600	$ 199,100	$ 172,300	$ 1,095,900	$ -0-	$ 2,848,100
	Tax		1,300	400	12,600	800	900	8,600	6,300	37,400		68,300
	Subtotal		515,700	12,200	687,000	38,400	143,500	207,700	178,600	1,133,300		2,916,400
39.6	Escalation		204,200	4,800	272,000	15,200	56,800	82,200	70,700	448,800		1,154,700
31%	Contingency		223,200	5,300	297,300	16,600	62,100	89,900	77,300 *	158,200		929,900
	TOTAL		943,100	22,300	1,256,300	70,200	262,400	379,800	326,600	1,740,300		5,001,000
	105 KE		$ 496,000	$ 16,000	$ 288,000	$ 41,300	$ 27,500	$ 219,800	$ 203,900	$ 2,235,300	$ -0-	$ 3,527,800
	Tax		1,200	500	4,800	1,000	500	9,100	7,500	75,500		100,100
	Subtotal		497,200	16,500	292,800	42,300	28,000	228,900	211,400	2,310,800		3,627,900
39.6	Escalation		196,900	6,500	115,900	16,800	11,100	90,600	83,700	915,100		1,436,600
31%	Contingency		215,200	7,100	126,700	18,300	12,100	99,000	91,500 *	322,600		892,500
	TOTAL		909,300	30,100	535,400	77,400	51,200	418,500	386,600	3,548,500		5,957,000
	105 KW		$ 496,000	$ 16,000	$ 288,000	$ 41,300	$ 27,500	$ 219,800	$ 203,900	$ 2,235,300	$ -0-	$ 3,527,800
	Tax		1,200	500	4,800	1,000	500	9,100	7,500	75,500		100,100
	Subtotal		497,200	16,500	292,800	42,300	28,000	228,900	211,400	2,310,800		3,627,900
39.6	Escalation		196,900	6,500	115,900	16,800	11,100	90,600	83,700	915,100		1,436,600
31%	Contingency		215,200	7,100	126,700	18,300	12,100	99,000	91,500 *	322,600		892,500
	TOTAL		909,300	30,100	535,400	77,400	51,200	418,500	386,600	3,548,500		5,957,000
	105 B		$ 503,700	$ 13,000	$ 503,200	$ 143,500	$ -0-	$ 106,500	$ 172,200	$ 1,150,600	$ -0-	$ 2,592,700
	Tax		1,300	400	7,500	3,500		4,500	6,800	38,800		62,800
	Subtotal		505,000	13,400	510,700	147,000		111,000	179,000	1,189,400		2,655,500
39.6	Escalation		200,000	5,300	202,200	58,200		44,000	70,900	471,000		1,051,600
31%	Contingency		218,600	5,800	221,000	63,600		48,100	77,500 *	167,400		802,000
	TOTAL		923,600	24,500	933,900	268,800		203,100	327,400	1,827,800		4,509,100
	TOTAL	$ 881,300	$7,255,200	$ 171,800	$7,008,700	$1,694,400	$ 367,700	$2,361,000	$2,790,400	$17,137,700	$1,145,000	$40,813,200

*(Note contingency adjusted per estimators judgement)

Construction	$ 24,281,900	39.6%
Escalation	9,615,300	
	33,897,200	
Contingency	6,916,000	20.0%
	40,813,200	

KAISER ENGINEERS HANFORD

ENGINEERING COST ESTIMATE SUMMARY

Job Description	Job No.	Client No.
Decommissioning of the Eight 105 Facilities	U290A0	B33207

KEH Project Engineer	Client	Client Engineer	Prepared By	Issue Date	Checked By	KEH Approval
EF Riedel	UNC	PW Griffin	EF Riedel	7/17/84	CHL	Orig Signed by

DISCIPLINE				DEFINITIVE DESIGN		Construction Engr/Insp	DISTRIBUTION
		No. Drawings	Manhours	No. Drawings	Manhours	Manhours	
Civil	(01)			138	12,690	1,270	
Architectural	(02)			133	6,150	615	
Structural	(03)						
Nuclear Equipment	(04)						
Fire Protection	(05)						
Piping & Vessels	(06)						
HVAC	(07)						
Instrumentation	(08)						
Security/Safeguards	(09)						
Electrical	(10)						
Specifications	(11)				308		
Specialty Engineering	(12)						
CADD	(13)			16	144		
Design Administration	(14)				880		
SUBTOTAL DESIGN ENGRG				287	20,172	1,885	
Scheduling	(51)				1,018		
Cost Estimating	(52)				850		
Safety Review	(53)				350	24	
QA Review	(54)				350	24	
QA Audit	(55)				32	24	
Survey & Layout	(56)				33	1,336	
Field Engineering	(57)				152	3,974	
Project Management	(58)				1,430	1,326	
TOTAL ENGINEERING					24,387	8,593	
Graphics	(61)						
Publications	(62)						
Data Control	(63)				8	160	
Administration/Reports	(64)				260		
TOTAL ENGRG & SUPPORT					24,655	8,753	
Rate	$/Hr.				$39.00	$35.00	
Hours					24,655	8,753	
TOTAL	$				961,500	306,400	
Reproduction	$				10,000	1,600	
Data Processing	$				1,500		
Work Order	$						
Consultants	$						
Travel/Other	$						
SUBTOTAL	$				973,000	308,000	
Escalation	$	25.95%/39.60%			252,500	122,000	
SUBTOTAL	$				1,225,500	430,000	
Contingency	$	15%/25%			183,800	107,500	
TOTAL COST	$				1,409,300	537,500	

Remarks: Per Engineering Statement of Work

Page 4 of 13

KEH-81.2 (1C

KAISER ENGINEERS
HANFORD

ESTIMATE BASIS

TITLE In-Situ - Decommissioning of 105 Facilities DATE 11/1/84

KEH JOB # U290A0

CLIENT PROJECT/WORK ORDER # B32207

1 DOCUMENTS AND DRAWINGS

DOCUMENTS DCS - Incomplete

DRAWINGS Various microfische of the 105 Buildings

2 MATERIAL PRICES

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL. VENDOR QUOTES WERE OBTAINED FOR batch plant, concrete pump, cement, fly ash, explosive techniques and earth movement.

3 LABOR RATES

CURRENT BASE RATES AS ISSUED BY KEH (ISSUE # *, DATED *)INCLUDE FRINGE BENEFITS, LABOR INSURANCES AND TAXES, AND TRAVEL WHERE APPLICABLE.
*UNC plant forces - Appendix F.

4 ESCALATION

ESCALATION IS CALCULATED AT 39.6 % ON THE ACCRUAL BASED PROJECTED FROM THE ATTACHED SCHEDULE NOTING THE MID-POINT OF CONSTRUCTION. PROCUREMENT IS CALCULATED AT 39.6 % PER THE ATTACHED SCHEDULE.

5 CONTINGENCY

CALCULATED AT 20 % OF THE ESTIMATED CONSTRUCTION PER THE ATTACHED CONTINGENCY ANALYSIS.

6 REMARKS

Reference estimate backup.

CRE:ad

STATEMENT OF WORK
B32207/U290A0
In-Situ Decommissioning of the
Eight Shut-Down Reactor
105 Buildings In The 100 Areas

I OBJECTIVE

Perform definitive design on in-situ decommissioning of the eight shut-down reactor 105 buildings in the 100 areas. Provide engineering support and inspection during the demolition.

II BASIS

A. DCS: In-Situ decommissioning of the eight shut-down 105 buildings in the 100 areas.

B. Kaiser Engineers Hanford Co., Engineering Study KEH R-84-9.

C. J. A. Adams, J. C. Chattin, P. W. Griffin, M. C. Hughes, Assessment of Decommissioning Alternates for the Shut-Down Hanford 100 Area Reactors, UNI-2619, UNC Nuclear Industries, Richland, WA, 1984.

III TASKS

A. Architectural

1. Prepare demolition drawings in conjunction with Civil/Structural.

2. Interface with Civil/Structural and Safety as required.

3. Prepare input to specifications as required.

B. Civil/Structural

1. Assist Architectural on the preparation of demolition drawings.

2. Prepare a site plan for each reactor.

3. Prepare input to specifications as required.

C. Specifications

Review and edit the construction specifications.

D. Estimating

1. Prepare the final project cost estimate.

2. Prepare a fair cost estimate.

III TASKS (cont.)

E. Safety

Support the project as needed.

F. Quality Assurance

Support the project as needed.

G. Field Engineering

1. Provide field engineering services during the project.

2. As-built drawings as required.

3. Provide survey and survey markers as required.

H. Data Control

Prepare a master submittal list and process submittals as required.

I. Project Management

The KEH Project Engineer will have overall responsibility for the definitive design and will ensure the generation of an integrated package meeting the established criteria and cost estimate.

EFR:lms

KAISER ENGINEERS HANFORD

ESCALATION ANALYSIS SCHEDULE

PROJECT NO/WORK ORDER NO. U290AQ PLAN 344

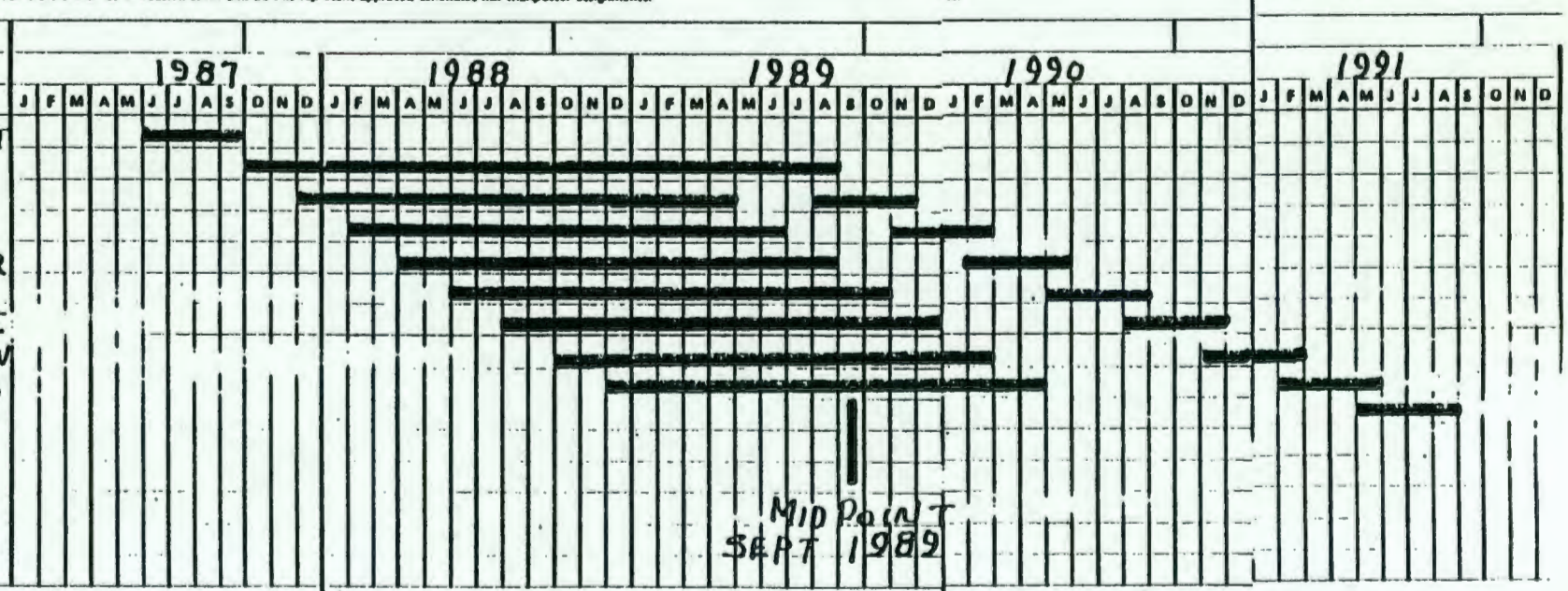
TITLE IN-SITU D&D 105 BLDGS

REQUESTED BY UNC

PREPARED BY BWJ DATE 7-10-84

APPROVED BY _____ DATE _____

Tasks are shown as forecasted work and do not represent approved schedules nor manpower assignments.



ENGINEERING ESCALATION

TITLE I - Mos. At ___ %/Month -
TITLE II - Mos. At ___ %/Month -
TITLE III - Mos. At ___ %/Month -

(1) CONSTRUCTION AND PROCUREMENT ESCALATION

ESCALATION ACCRUAL 39.6

(1) To be provided by Estimating Department

(2) May/May Not be required to be broken out separately

KEH-281 (3-82)

UNI-2898 REVO

MONTH	10-1	11-1	12-1	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1	10-1	
YEAR						USE FOR JUNE								
	FILE JUNE													
1984	1.0000									0.0047	0.0047	0.0047	0.0047	0.0047
MLTPLR	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0047	1.0094	1.0142	1.0190	
1985	1.0000	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
MLTPLR	1.0000	1.0247	1.0304	1.0361	1.0419	1.0477	1.0535	1.0594	1.0653	1.0713	1.0772	1.0832	1.0893	
1986	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.0950	1.1008	1.1066	1.1124	1.1182	1.1241	1.1300	1.1360	1.1420	1.1480	1.1540	1.1601	
1987	1.0000	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
MLTPLR	1.0000	1.1659	1.1718	1.1777	1.1836	1.1895	1.1955	1.2015	1.2076	1.2136	1.2197	1.2258	1.2320	
1988	1.0000	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
MLTPLR	1.0000	1.2384	1.2448	1.2513	1.2578	1.2643	1.2708	1.2774	1.2840	1.2907	1.2974	1.3041	1.3109	
1989	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.3178	1.3247	1.3317	1.3387	1.3457	1.3528	1.3599	1.3671	1.3743	1.3815	1.3888	1.3961	
1990	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.4034	1.4108	1.4182	1.4257	1.4332	1.4407	1.4483	1.4559	1.4636	1.4713	1.4790	1.4868	
1991	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.4946	1.5025	1.5104	1.5184	1.5263	1.5344	1.5424	1.5506	1.5587	1.5669	1.5752	1.5835	
1992	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.5918	1.6002	1.6086	1.6170	1.6256	1.6341	1.6427	1.6513	1.6600	1.6688	1.6776	1.6864	
1993	1.0000	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
MLTPLR	1.0000	1.6955	1.7047	1.7139	1.7232	1.7326	1.7420	1.7514	1.7609	1.7704	1.7800	1.7897	1.7994	
1994	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	1.8090	1.8186	1.8283	1.8381	1.8479	1.8578	1.8677	1.8777	1.8877	1.8978	1.9079	1.9181	
1995	1.0000	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
MLTPLR	1.0000	1.9281	1.9381	1.9481	1.9582	1.9684	1.9786	1.9888	1.9991	2.0095	2.0199	2.0304	2.0409	
1996	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	2.0516	2.0624	2.0733	2.0842	2.0951	2.1062	2.1173	2.1284	2.1396	2.1509	2.1622	2.1735	
1997	1.0000	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
MLTPLR	1.0000	2.1850	2.1965	2.2080	2.2197	2.2313	2.2431	2.2549	2.2667	2.2787	2.2907	2.3027	2.3148	

KAISER ENGINEERS
HANFORD

VENDOR QUOTE

DATE 3/23/84

VENDOR: Oregon Portland Concrete

PROJ. OR W.O. B32207

PHONE: 586-9324

BY: Bruce Jones

PERSON: Bill Mahorny
Steve Clements 586-9324 (local)

MATERIAL TO BE USED FOR:

F.O.B.

REF. DWGS. AND SPECS.

ITEM	QUANTITY	DESCRIPTION	UNIT PR	TOTAL PR
	1,610	Ton Cement for each	77.20T	
		12,900 for 8 each		124,300
		6,800T Fly Ash 400 CY	31.00	210,800
		3,187 Gallon Plasticizer @ 12 oz/cy	4.60	14,700
		126 Gallon Air Entrainment 1/2 oz/100# cement	3.175	400

KEH-218 (6-

KAISER ENGINEERS
HANFORD

VENDOR QUOTE

DATE 3/27/84

VENDOR: Schwartz N. W.
Seattle, WA

PROJ. OR W.O. B32207

PHONE: (206) 329-5852

BY: Bruce Jones

PERSON: Skip

MATERIAL TO BE USED FOR:

F.O.B.

REF. DWGS. AND SPECS.

ITEM	QUANTITY	DESCRIPTION	UNIT PR	TOTAL PR
	1	Concrete pump w/800 CY per day capacity	180,000	
		Lift 70'-0 and discharge hose 60' Setup	20,000	
			200,000	

KAISER ENGINEERS HANFORD

VENDOR QUOTE

DATE 3/19/84

VENDOR: Eric Strayer Company
Seattle, WA

PROJ. OR W.O. B32207

PHONE:

BY: Bruce Jones

PERSON: Les Pearson

MATERIAL TO BE USED FOR:

F.O.B.

REF. DWGS. AND SPECS.

ITEM	QUANTITY	DESCRIPTION	UNIT PR	TOTAL PR
	1	4-1/2CY Batch Plant 800 CY daily capacity 100 per Hr Manual Control	162,800	
	1	Fly Ash Chamber	25,800	
			188,600	

[illegible] W. Marginal Way South / Seattle, Washington 98108 / Area Code 206.763-2004

Date March 20, 1984

Process No. SW-631

QUANTITY	DESCRIPTION	AMOUNT
	36KS filter vent (250 sq. ft. cloth area) with 1/4 HP bag shaker Pressure safety valve Solenoid valve controlled air diffuser aeration system Discharge adapter 9" safety gate 9" manual discharge valve Air kit consisting of filter, lubricator and regulators with gauges Air hose and fittings for air to aeration system	
	Item 5	
	Inclined Screw Feeder	
	10" dia. x 24' inclined screw feeder for charging Pozzolan from the auxiliary silo to the plant cement batcher. 15 HP electric motor and drive Steel casing Helicoid flighting mounted on steel pipe Inlet flange for Pozzolan from auxiliary storage silo Discharge flange Discharge chute to plant batcher Supports	
	Total Price F.O.B. Erie, PA.	$188,585.
	ALTERNATES:	
	AA. - For 30" Batch Transfer Conveyor with 20 HP motor in place of 24" Conveyor with 15 HP motor. ADD	$ 4,390.
	AB. - For Cement Bin Extension for a total of 400 Barrels storage.	$ 3,350.
	AC. - For 6 Yd. Tilt Mixer in place of the 4-1/2 Yd. Mixer.	$ 5,400.
	For [illegible]	= [illegible]

APPENDIX B

Schedules

Total Pages: 4
Date: 3-2-87

UNI-2898 REV0

WBS	Description	Total Cost	FY80/Year 1 (J A S)	FY81/Year 2 (O N D J F M A M J J A S)	FY82/Year 3 (O N D J F M A M J J A S)	FY83/Year 4 (O N D J F M A M J J A S)	FY84/Year 5 (O N D J F M A M J J A S)	FY85/Year 6 (O N D J F M A M J J A S)	FY86/Year 7 (O N D J)
F1.1	Engineering	234,100	200,000/0	184,100/207,100	0/27,000				
F1.1.1	Definitive Dsgn			8000/0	31,900/31,800	19,800/27,900			
F1.1.2	Engrg/Inspectn	57,600							
F1.2	Procurement	881,300		881,300/881,300					
F1.3	Construction			618,300/0	1,751,000/1,854,900	0/815,500			
	DPF	2,379,100			1,082,900/832,600	948,400/999,200			
	FUPC/FPC	1,881,800							
H1.1	Engineering	234,100	200,000/0	184,100/207,100	0/27,000				
H1.1.1	Definitive Dsgn				31,900/27,100	31,900/31,800	0/6400		
H1.1.2	Engrg/Inspectn	63,800							
H1.3	Construction			153,800/0	2,826,700/2,963,500	910,600/993,800			
	DPF	2,894,400			848,900/81,000	520,600/1,379,600			
	FUPC/FPC	1,459,000							
D1.1	Engineering			99,100/46,800	49,500/108,600				
D1.1.1	Definitive Dsgn	148,600			26,400/18,500	31,800/31,800	8000/12,900		
D1.1.2	Engrg/Inspectn	66,300							
D1.3	Construction				1,806,600/911,800	821,000/911,800			
	DPF	1,838,600				1,040,900/1,791,500	0/649,700		
	FUPC/FPC	1,800,900							
DR1.1	Engineering			99,100/46,800	49,500/108,600				
DR1.1.1	Definitive Dsgn	148,600			19,900/11,900	31,800/31,800	17,100/33,100		
DR1.1.2	Engrg/Inspectn	68,800							
DR1.3	Construction				1,908,800/1,145,000	1,772,000/2,353,600	0/351,700		
	DPF	3,880,300				834,900/578,800	578,200/834,900		
	FUPC/FPC	1,402,700							
G1.1	Engineering				148,600/148,600				
G1.1.1	Definitive Dsgn	148,600			18,600/3600	31,800/31,800	57,800/81,800	0/4000	
G1.1.2	Engrg/Inspectn	70,300							
G1.3	Construction				835,700/348,900	1,880,400/2,402,700	522,300/686,800		
	DPF	2,338,400				783,400/272,800	979,800/1,468,800		
	FUPC/FPC	1,762,600							
KE1.1	Engineering				261,100/153,100	27,000/81,000			
KE1.1.1	Definitive Dsgn	234,100				51,700/23,900	31,800/31,800	6700/19,600	
KE1.1.2	Engrg/Inspectn	70,300							
KE1.3	Construction					1,871,600/1,003,600	804,900/999,800		
	DPF	2,378,400					3,818,600/2,604,800	0/996,100	
	FUPC/FPC	3,578,600							
KW1.1	Engineering				48,800/0	103,600/148,600			
KW1.1.1	Definitive Dsgn	148,600				18,800/19,600	31,800/31,800	18,700/33,900	
KW1.1.2	Engrg/Inspectn	66,300							
KW1.3	Construction					1,187,300/677,800	1,187,300/1,829,000	0/169,900	
	DPF	2,378,400					2,845,800/1,973,600	1,345,100/2,105,100	
	FUPC/FPC	3,578,600							
B1.1	Engineering				112,600/66,800	0/63,600			
B1.1.1	Definitive Dsgn	112,600				11,900/6000	31,700/31,700	39,500/31,700	0/5900
B1.1.2	Engrg/Inspectn	72,800							
B1.3	Construction					782,900/261,300	1,872,900/1,872,800	0/532,900	
	DPF	2,654,800					648,300/370,600	1,294,000/1,481,500	
	FUPC/FPC	1,852,300							
	Totals BA/BO *	42,760,000	400,000/0	2,338,900/1,372,000	11,970,000/8,690,000	14,480,800/14,420,800	12,390,800/12,930,800	2,830,000/2,850,000	0/0

LEGEND
- ACTIVITY
- CRITICAL PATH
- DPF DEMONSTRATIONAL PLANT FORCES
- FUPC FIXED UNIT PRICE CONTRACT
- FPC FIXED PRICE CONTRACT

* – BA/BO Totals By Fiscal Year Have Been Rounded Off To 10,000

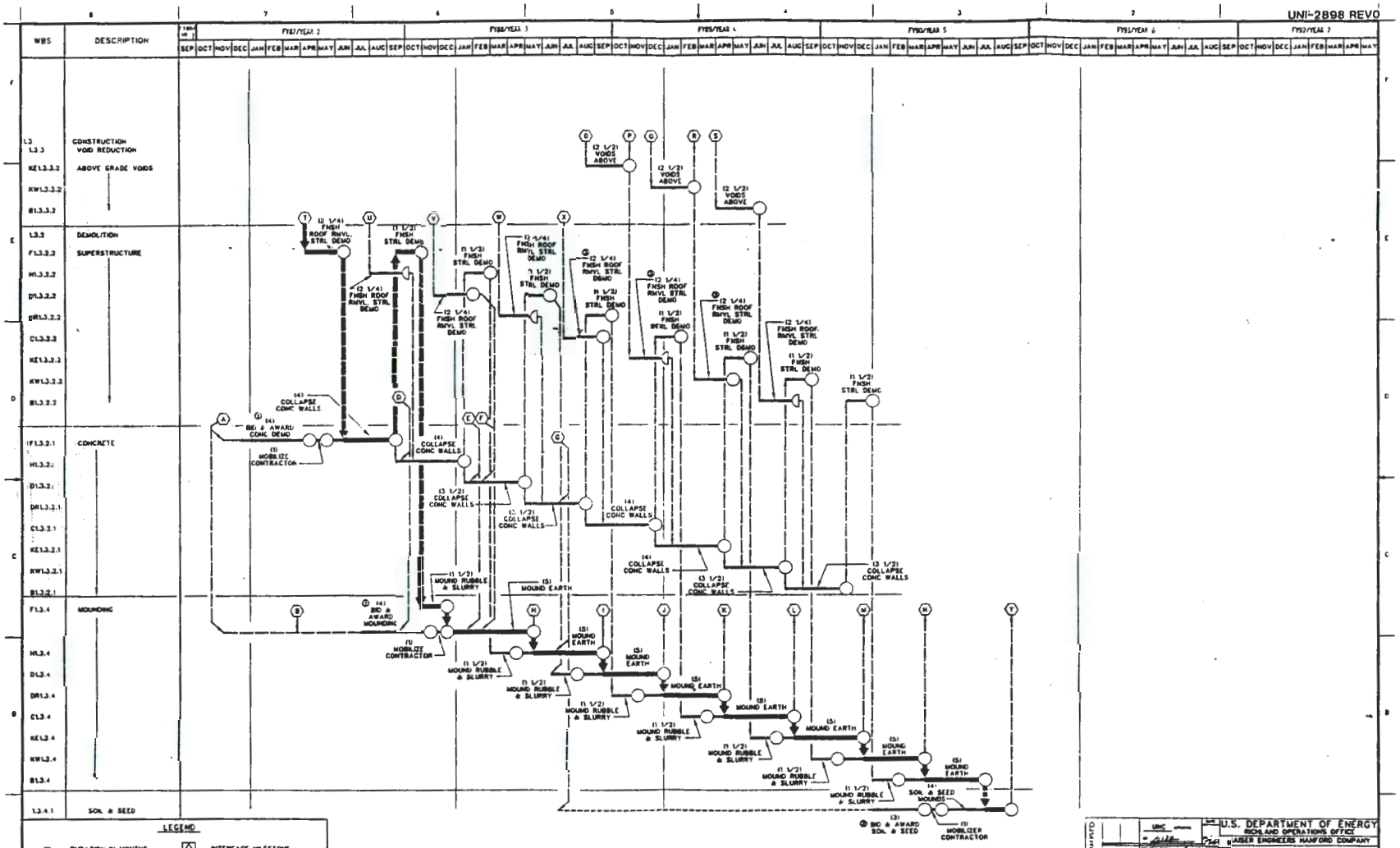
U. S. DEPARTMENT OF ENERGY
Richland Operations Office
KAISER ENGINEERS HANFORD COMPANY

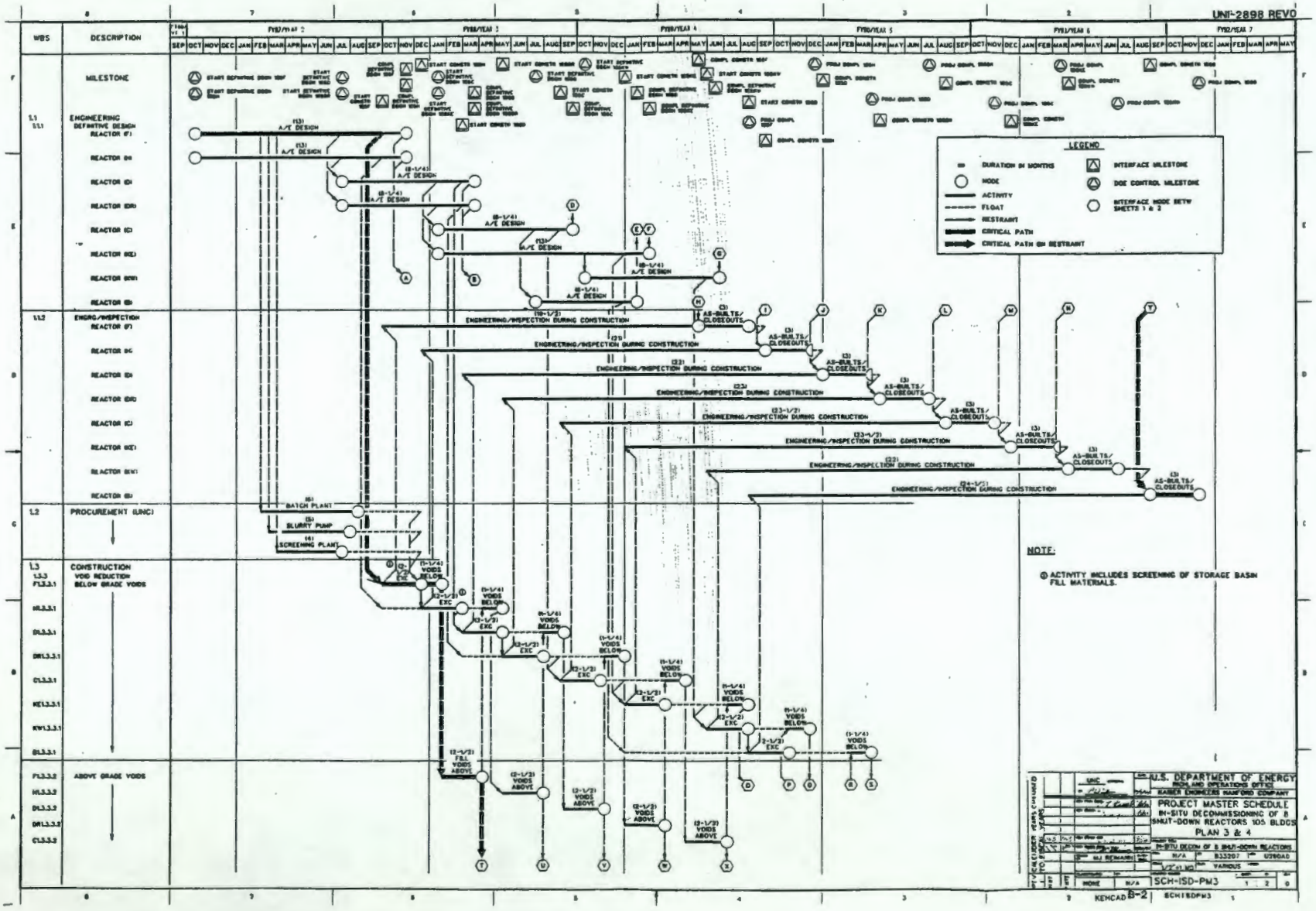
BA/BO SCHEDULE
In-Situ Solidification Of The 8 Short-Lived Radiation 105 Blocks
PLAN 2

N/A	833207	U290AC	
	VARIOUS		
SCH-130-BA6	1	1	0

B-2

UNI-2898 REVO




UNF-2898 REV0
WBS
DESCRIPTION
FY87/YEAR 2
FY88/YEAR 3
FY89/YEAR 4
FY90/YEAR 5
FY91/YEAR 6
FY92/YEAR 7
SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
MILESTONE
1.1 ENGINEERING DEFINITIVE DESIGN
1.1.1
REACTOR (F)
REACTOR (H)
REACTOR (D)
REACTOR (DR)
REACTOR (C)
REACTOR (KE)
REACTOR (KW)
REACTOR (B)
(13) A/E DESIGN
(8-1/4) A/E DESIGN
(10-1/2) ENGINEERING/INSPECTION DURING CONSTRUCTION
(3) AS-BUILTS/ CLOSEOUTS
1.1.2 ENGRG/INSPECTION
1.2 PROCUREMENT (UNC)
(6) BATCH PLANT
(5) SLURRY PUMP
(4) SCREENING PLANT
1.3 CONSTRUCTION VOID REDUCTION BELOW GRADE VOIDS
1.3.3 F1.3.3.1
H1.3.3.1
D1.3.3.1
DR1.3.3.1
C1.3.3.1
KE1.3.3.1
KW1.3.3.1
B1.3.3.1
(1-1/4) VOIDS BELOW
(2-1/2) EXC
(2-1/2) FILL VOIDS ABOVE
(2-1/2) VOIDS ABOVE
F1.3.3.2
H1.3.3.2
D1.3.3.2
DR1.3.3.2
C1.3.3.2
ABOVE GRADE VOIDS
LEGEND
DURATION IN MONTHS
NODE
ACTIVITY
FLOAT
RESTRAINT
CRITICAL PATH
CRITICAL PATH ON RESTRAINT
INTERFACE MILESTONE
DOE CONTROL MILESTONE
INTERFACE NODE BETW SHEETS 1 & 2
NOTE:
① ACTIVITY INCLUDES SCREENING OF STORAGE BASIN FILL MATERIALS.
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY
PROJECT MASTER SCHEDULE
IN-SITU DECOMMISSIONING OF 8 SHUT-DOWN REACTORS 105 BLDGS
PLAN 3 & 4
IN-SITU DECOM OF 8 SHUT-DOWN REACTORS
N/A
B33207
U290AD
VARIOUS
NONE
N/A
SCH-ISD-PM3
KENCAD B-2
SCHTSDPM3

APPENDIX C

Work Breakdown Structure

Total Pages: 3
Date: 3-2-87

WORK BREAKDOWN STRUCTURE

1.0 REACTOR DECOMMISSIONING

1.1 Engineering

1.1.1 Definitive Design
1.1.2 Engineering and Inspection

1.2 Procurement (UNC)

1.3 Construction

1.3.1 Decontamination

F	1.3.1.1	Contaminated Structures
H	1.3.1.1	Contaminated Structures
D	1.3.1.1	Contaminated Structures
DR	1.3.1.1	Contaminated Structures
C	1.3.1.1	Contaminated Structures
KE	1.3.1.1	Contaminated Structures
KW	1.3.1.1	Contaminated Structures
B	1.3.1.1	Contaminated Structures

1.3.2 Demolition

F	1.3.2.1	Concrete
H	1.3.2.1	Concrete
D	1.3.2.1	Concrete
DR	1.3.2.1	Concrete
C	1.3.2.1	Concrete
KE	1.3.2.1	Concrete
KW	1.3.2.1	Concrete
B	1.3.2.1	Concrete
F	1.3.2.2	Superstructure
H	1.3.2.2	Superstructure
D	1.3.2.2	Superstructure
DR	1.3.2.2	Superstructure
C	1.3.2.2	Superstructure
KE	1.3.2.2	Superstructure
KW	1.3.2.2	Superstructure
B	1.3.2.2	Superstructure
F	1.3.2.3	Concrete Blocks
H	1.3.2.3	Concrete Blocks
D	1.3.2.3	Concrete Blocks
DR	1.3.2.3	Concrete Blocks
C	1.3.2.3	Concrete Blocks
KE	1.3.2.3	Concrete Blocks
KW	1.3.2.3	Concrete Blocks

APPENDIX D

Void Filling Plans

Total Pages: 28
Date: 3-2-87

105 B, D, and F Void Filling Plan

Belowgrade Fill with Gravel	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Storage Basin	4200	Y	-20'-9"	HW-70481
Transfer Area	603	Y	-20'-9"	HW-70481
Flow Lab	174	N	-10'-0"	HW-76121
Neutralizing Pit	17	N	-7'-6"	HW-70463

Belowgrade Fill with Slurry	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Pipe Tunnel and Vent Duct	220	Y	-16'-8"	HW-70502
"C" Elevator Pit	74	Y	-6'-0"	HW-70502
**North Side of Process Area	256	N	-12'-6"	HW-70502
**South Side of Process Area (Laboratory Area)	325	N	-12'-6"	HW-70502
Tunnel Under Discharge Ramp	164	Y	-14'-6"	W-71349
Outflow Area B&D	198	Y	-20'-0"	HW-70502
Outflow Area F	152	Y	-14'-0"	W-73335
Exhaust Fan Room (Below Grade)	444	Y	-16'-6"	W-72036

105 B, D, and F Void Filling Plan

Abovegrade Fill with Slurry	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Control Room	276	N	0'-0"	HW-70830
Right Sample Rooms	82	N	0'-0"	HW-70842
	82		10'-9"	HW-70647
	76		20'-9"	HW-_____
Left Sample Rooms	87	N	0'-0"	W-71485
	80	N	10'-9"	W-71485
	80	N	20'-9"	W-71485
Northside Downcomers	183	Y	0'-0"	HW-70842
Southside Downcomers	238	Y	0'-0"	HW-70842
"D" Elevator	1600	Y	0'-0"	HW-70830
Valve Pit Extension	612	N	-11'-0"	HW-74620
Valve Pit	1671	N	-15'-9"	W-71338
Laboratory Areas	3612	N	0'-0"/4	HW-70830
*Inner Apparatus (Rod) Room	538	Y	13'-0"	HW-70831

Abovegrade Demolish (All above El 56'-4")	Contamination Suspected	EL	Drawing No.
Machinery Room	N	56'-4"	HW-70832
Grating Floor	N	80'-5-1/4"	HW-70832
Machinery Platform	N	59'-4"	HW-70832

* Portions of this area may require slurry.
** Areas noted as north or south are for "B" and "D" reactor. For "F" reactor north corresponds to east, and south corresponds to west.
***Volumes not calculated for this area are accounted for in the quantity of fill for the mound.

105-H Void Filling Plan

Belowgrade Fill with Slurry	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Room East/West Sides Discharge Shut	626	N	-17'-6"	P-1756
Room East of Reactor	211	N	-12'-0"	P-1756
Effluent Pipe Elbow Room	44	Y	-10'-6"	P-1756

Abovegrade Demolish Totally Cover with Gravel*	Contamination Suspected	EL	Drawing No.
Misc Storage Area	N	0'-0"	P-1758
Corridor #6	N	0'-0"	P-1758
Corridor #7	N	0'-0"	P-1758
Corridor #11	N	0'-0"	P-1758
Corridor #13	N	0'-0"	P-1758
Electrical Equip Room	N	0'-0"	P-1758
Battery Room	N	0'-0"	P-1758
Toilet #2	N	0'-0"	P-1758
Office #1	N	0'-0"	P-1758
Office #2	N	0'-0"	P-1758
Instrument Repair Room	N	0'-0"	P-1758
Lunch Room	N	0'-0"	P-1758
Locker Room	N	0'-0"	P-1758
Toilet #1	N	0'-0"	P-1758
Office #3	N	0'-0"	P-1758
Compressor Room #1	N	0'-0"	P-1758

105-H Void Filling Plan

Abovegrade Demolish Totally Cover with Gravel* (Continued)	Contamination Suspected	EL	Drawing No.
Stair #4	N	12'-0"	P-1758
Stair #1	N	0'-0"	P-1758
Metal Storage	N	0'-0"	P-1758
Counting Room	Y	12'-0"	P-1762
Electrical Equip Room #2	N	12'-0"	P-1762
A. C. Room	N	12'-0"	P-1762
Ready Room	N	20'-9"	P-1763
Stair #2	N	0'-0"	P-1758
Ready Room	N	20'-9"	P-1763
Ready Room #2		30'-9"	P-1763

Abovegrade Demolish Partially Cover with Gravel	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Work Area	5606	Y	0'-0"	P-1758
Outer Rod Room	3615	Y	0'-0"	P-1758
Transfer Area	41	Y	0'-0"	P-1758
Control Room	733	N	0'-0"	P-1758
Corridor #3	207	N	0'-0"	P-1758
Corridor #5	320	N	0'-0"	P-1758
Corridor #12	124	N	0'-0"	P-1758
Corridor #9	148	N	0'-0"	P-1758
Elevator "C"	759	Y	0'-0"	P-1758

105-H Void Filling Plan

Abovegrade Demolish	Contamination Suspected	EL	Drawing No.
Machine Room	Y	59'-4"	P-1764
Machine Room	N	80'-5"	P-1764
Machine Room	N	97'-0"	P-1768

*Volumes not calculated for this area are accounted for in the quantity of fill for the mound.

105-DR Void Filling Plan

Abovegrade Demolish Totally Cover with Gravel*	Contamination Suspected	EL	Drawing No.
Toilet Room #3	N	0'-0"	HW-70825DR
Toilet Room #2	N	0'-0"	HW-70825DR
Lunchroom	N	0'-0"	HW-70825DR
Corridor #4	N	0'-0"	HW-70825DR
Corridor #3	N	0'-0"	HW-70825DR
Misc. Storage Room	N	0'-0"	HW-70825DR
Clean Clothing Storage	N	0'-0"	HW-70825DR
Office #1	N	0'-0"	HW-70830DR
Office #2	N	0'-0"	HW-70830DR
Laboratory	N	0'-0"	HW-70830DR
Main Electrical Dist. Room	N	0'-0"	HW-70825DR
Battery Room	N	0'-0"	HW-70825DR
Storage Room No. 1	N	0'-0"	HW-70825DR
Corridor #5	N	0'-0"	HW-70825DR
Instrument Repair Room	N	0'-0"	HW-70825DR
Wash Pad	N	0'-0"	HW-70836DR
Tool Room	N	0'-0"	HW-70825DR

Abovegrade Demolish Partially Cover with Gravel	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Outer Apparatus (Rod) Room	1296	Y	15'-0"	HW-70831DR

105-DR Void Filling Plan

Abovegrade Slurry Fill	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Control Room	456	N	0'-0"	HW-70830DR
Office #4	73	N	0'-0"	HW-70830DR
Office #3	100	N	0'-0"	HW-70830DR
Air Conditioning Equipment Room	74	N	0'-0"	WH-70830DR
Corridor #2	159	N	0'-0"	HW-70830DR
Counting Room	48	N	0'-0"	HW-70830DR
Inner Apparatus (Rod) Room	485	Y	15'-0"	HW-70831DR
Laboratory Area	2473	N	0'-0"	H-1-8466DR
Observation Room	45	N	28'-4"	HW-70831DR
North Downcomer	100	Y	0'-0"	H-1-8467DR
South Downcomer	100	Y	0'-0"	H-1-8467DR
***Valve Pit	2249	Y	-15'-9"	HW-71338DR

Abovegrade Demolish	Contamination Suspected	EL	Drawing No.
Machine Room	Y	42'-6"	H-1-8462DR
Machine Room	N	56'-4"	H-1-8466DR
Machine Room	N	80'-0"	H-1-8466DR
Machine Room	N	97'-0"	H-1-8466DR

*Volumes not calculated for this area are accounted for in the quantity of fill for the mound.
**Above-grade portions of these areas may require gravel fill.
***Portions of above-grade walls may be reduced.

105 C Void Filling Plan

Belowgrade Fill with Slurry	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Pipe Installation Tunnel	268	Y	-9'-2"	P-6007
Exhaust Air Plenum Chamber	470	Y	-15'-0"	P-6007
Exhaust Air Intakes	111	Y	-15'-2"	P-6007
Tunnel	509	Y	-16'-8"	P-6007
Cylinder Storage	217	Y	-15'-2"	P-6007
Sewage Pump Chambers	548	N	-37'-3"	P-6007
Collection Sump	324	N	-30'-3"	P-6007
VSR Compressor Room	155	N	-17'-6"	P-6007
Vacuum Cleaner Equip Room	146	N	-17'-6"	P-6007
Stair No. 3	46	N	-15'-2"	P-6007
"F" Elevator	39	N	-17'-6"	P-6007
North Tunnel	196	N	-12'-0"	P-6006
Instrument Tunnel	55	N	-9'-6"	P-6006
West Pipe Tunnels	880	N	-14'-6"	P-6006
Ball 3X Room	238	Y	-17'-6"	P-6006
"D" Machine Door Operating Room	92	Y	-16'-2"	P-6006
"D" Machine Pit	78	Y	-7'-0"	P-6006
Ball 3X Equipment Room	56	Y	-12'-0"	P-6006
Stair No. 4	57	N	-12'-0"	P-6006
Equipment Room No. 3	190	N	-12'-0"	P-6006

105 C Void Filling Plan

Abovegrade Demolish Totally Cover with Gravel* (Continued)	Contamination Suspected	EL	Drawing No.
Corridor No. 6	N	0'-0"	P-6009
Corridor No. 7	N	0'-0"	P-6009
A.C. Room	N	12'-0"	P-6012
Counting Room	N	12'-0"	P-6012
Stair No. 5	N		P-6009
Stair No. 1	N		P-6009
Stair No. 2	N		P-6009
Ready Room	N	30'-9"	P-6013
Corridor No. 13	N	0'-0"	P-6009
Dummy Storage	N	0'-0"	P-6003
Metal Storage	N	0'-0"	P-6009
Electrical Equip. Room	N	0'-0"	P-6009
Battery Room	N	0'-0"	P-6009
Corridor No. 14	N	0'-0"	P-6009
Electrical Shop	N	0'-0"	P-6003
Maintenance Shop	N	0'-0"	P-6003
Janitor's Closet	N	0'-0"	P-6003
Toilet No. 2	N	0'-0"	P-6003
Corridor No. 8	N	0'-0"	P-6003
Office No. 1	N	0'-0"	P-6003
Office No. 2	N	0'-0"	P-6003

105 C Void Filling Plan

Abovegrade Demolish Totally Cover with Gravel* (Continued)	Contamination Suspected	EL	Drawing No.
Passage	N	12'-0"	P-6010
Soiled Clothes Storage Room	N	0'-0"	P-6009
Decontamination Station	N	0'-0"	P-6009
Change Room	N	0'-0"	P-6009
Blue Tool Room	N	0'-0"	P-6009
Permanent Hot Storage	N	0'-0"	P-6009
Corridor No. 3	N	0'-0"	P-6003
Corridor No. 1	N	0'-0"	P-6003
Electrical Equip. Room	N	12'-0"	P-6012
Office No. 11	N	0'-0"	P-6012
Office No. 10	N	0'-0"	P-6012
Office No. 9	N	0'-0"	P-6012
Office No. 8	N	0'-0"	P-6012
Stair No. 11	Y	0'-0"	P-6014

Abovegrade Demolish Partially Cover with Gravel	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Outer Rod Room	2670	Y	0'-0"	P-6009
Corridor No. 5	234	N	0'-0"	P-6009
Work Area	4085	Y	0'-0"	P-6009
"C" Elevator	--	Y	0'-0"	P-6009
Observation Room	43	N	23'-4"	P-6013

105 C Void Filling Plan

Abovegrade Fill with Slurry (Continued)	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Stair No. 3	--	N	24'-9"	P-6013
"F" Elevator	327	N	0'-0"	P-6013
Tool Dolly Room	105	Y	0'-0"	P-6009
Corridor No. 10	111	N	0'-0"	P-6003
Laboratory No. 2	374	N	0'-0"	P-6009
"D" Machine Maintenance Room 1	122	Y	2'-6"	P-6009
"D" Elevator	1903	Y	0'-0"	P-6012
X-1 Level	739	N	15'-0"	P-6012
Upper Viewing Room	120	Y	18'-4"	P-6016

Abovegrade Demolish	Contamination Suspected	EL	Drawing No.
Elevator "C" Machine Room	N	59'-5"	P-6014
Switchgear Room No. 1	N	59'-5"	P-6014
Switchgear Room No. 2	N	59'-4"	P-6014
Elevator "D" Machine Room	N	59'-4"	P-6014
Switchgear Room No. 3	N	59'-4"	P-6014
Switchgear Room No. 4	N	59'-4"	P-6014
"F" Elevator Lobby	N	59'-4"	P-6014
Balcony No. 1	N	59'-4"	P-6014
Balcony No. 2	N	59'-4"	P-6014
"F" Elevator Lobby	N	80'-5"	P-6014

*Volumes not calculated for this area are accounted for in the quantity of fill for the mound.

--Denotes that the volume for this space has been accounted for in the volume of another area.

105 KE and KW Void Filling Plan

Belowgrade Fill with Slurry (Continued)	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Storage	407	Y	-17'-0"	H-1-21002
Piping Room No. 1	2023	N	-14'-6"	H-1-21002
Piping Room No. 2	322	N	-14'-6"	H-1-21002
Corridor No. B-1	75	N	-12'-0"	H-1-21002
Gas Instrument	102	N	-8'-2"	H-1-21002
SK Carriage Room	149	N	-8'-2"	H-1-21002
Machine Room	100	Y	-3'-0"	H-1-21002
Exhaust Fan Room	2175	Y	-12'-0"	H-1-21002
Fan Room Access	4	N	-12'-0"	H-1-21002
"F" Elev Stairwell	516	N	-8'-0"	H-1-21002

Abovegrade Demolish Totally Cover with Gravel*	Contamination Suspected	EL	Drawing No.
Instrument Storage	N	0'-0"	H-1-21004
Office #3	N	0'-0"	H-1-21004
RMU Lab	N	0'-0"	H-1-21004
Personnel Decon	N	0'-0"	H-1-21004
Storage Room	N	0'-0"	H-1-21004
Janitor Room	N	0'-0"	H-1-21004
Corridor #2	N	0'-0"	H-1-21004
Change Room	N	0'-0"	H-1-21004
Corridor #3	N	0'-0"	H-1-21004

105 KE and KW Void Filling Plan

Abovegrade Demolish Partially Cover with Gravel (Continued)	Vol. (CY)	Contamination Suspected	EL	Drawing No.
Storage Room #3	364	N	28'-0"	H-1-21009
Ready Room	328	N	38'-0"	H-1-21010
Blue Tool Room	98	N	0'-0"	H-1-21004
Clean Clothes	89	N	0'-0"	H-1-21004
Locker Room	92	N	0'-0"	H-1-21004
Office #1	128	N	0'-0"	H-1-21004
WO Room	43	N	0'-0"	H-1-21004
Monitor Room	124	N	0'-0"	H-1-21004
Corridor #1	142	N	0'-0"	H-1-21004
Counting Room	87	N	0'-0"	H-1-21004
Men's Toilet Room	62	N	0'-0"	H-1-21004
Air Conditioning	142	N	0'-0"	H-1-21004
Corridor #5	121	N	0'-0"	H-1-21004
Corridor #7	173	N	0'-0"	H-1-21004
Electrical Equipment Room #5	--	N	15'-0"	H-1-21005
Electrical Equipment Room #4	--	N	15'-0"	H-1-21005
Compressor Room	432	N	10'-0"	H-1-21005
Storage Room #2	373	N	15'-0"	H-1-21005
Electrical Equipment Room #6	--	N	28'-0"	H-1-21006
Equipment Room	--	N	28'-0"	H-1-21006

105 KE and KW Void Filling Plan

Abovegrade Slurry Fill	Vol. (CY)	Contamination Suspected	EL	Drawing No.
"F" Elevator Lobby	205	N	28'-0"	H-1-21006
Laboratory (X-2)	1065	N	28'-0"	H-1-21006
Electrical Equipment Room #1	664	N	0'-0"	H-1-21004

Abovegrade Demolish	Contamination Suspected	EL	Drawing No.
Vertical Rod Room	Y	51'-7"	H-1-21011
Machinery Room	N	66'-0"	H-1-21012
Upper Machine Room	N	70'-0"	H-1-21012
Upper Equivalent Room	N	90'-2"	H-1-21012

*Volumes not calculated for this area are accounted for in the quantity of fill for the mound.

--Denotes that the volume for this space has been accounted for in the volume of another area.

APPENDIX E

Calculations

Total Pages: 41
Date: 3-2-87

CALCULATIONS SUMMARY

1. Wall stability (p. E-3): Work area wall checked to support backfill for ramp. Horizontal reinforcing in walls is insufficient to support load.

2. Mound and wheel load on pipes (p. E-6): Concrete and steel pipes over 24 in. in diameter checked to support wheel and additional soil loads. Concrete pipe greater than 30 in. in diameter will require minimum of 5 ft of cover to support wheel load. All other pipe will support the soil and wheel loads.

3. Mound and wheel loads on tunnels (p. E-16): Concrete tunnel 12 ft wide by 6 ft 6 in. deep with 3-ft thick slab and 1-ft thick walls checked for 1) wheel load with 6 in. of soil, 2) wheel load with 8 ft of soil and 3) 65 ft of soil. Cases 1 and 3: tunnel failed; case 2 is close to failure.

4. Mound load on existing slabs (p. E-21): KE and KW reactor base, and inner rod room floor slabs checked for addition soil loadings. Reactor base will support additional loading. Inner rod room floor overstressed, maximum additional soil before overstressing occurs 3 ft.

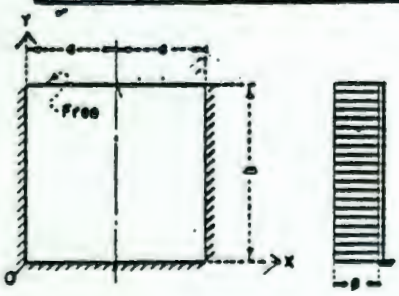
5. Letter from E. Becker to J. Egger (p. E-29): Discussion of mound stability, compaction and settlement.

6. Expected surface settlement due to filling of belowgrade tunnels (p. E-34): Calculation to determine settlement resulting from tunnel collapse. See graphs.

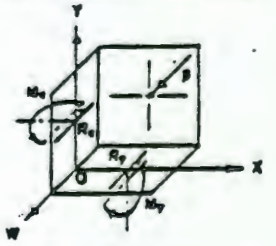
7
P, 1 A

RESULTS

			M_x						M_y					
	l/b	R_x \ x/a	0	0.2	0.4	0.6	0.8	1.0	0	0.2	0.4	0.6	0.8	1.0
$a/b = 1/8$	1.0	+.1249	+.0052	+.0024	+.0002	−.0014	−.0024	−.0027	0	0	0	0	0	0
	0.8	+.1248	+.0051	+.0023	+.0002	−.0014	−.0023	−.0026	+.0010	+.0005	+.0000	−.0003	−.0005	−.0005
	0.6	+.1247	+.0052	+.0023	+.0002	−.0014	−.0023	−.0027	+.0010	+.0005	+.0000	−.0003	−.0005	−.0005
	0.4	+.1250	+.0051	+.0023	+.0001	−.0014	−.0023	−.0027	+.0010	+.0005	+.0000	−.0003	−.0005	−.0006
	0.2	+.1185	+.0048	+.0021	+.0001	−.0013	−.0021	−.0024	+.0010	+.0004	−.0001	−.0004	−.0006	−.0007
	0	+.0504	0	+.0001	+.0003	+.0005	+.0006	+.0007	0	+.0006	+.0016	+.0025	+.0031	+.0033
		R_y \ x/a	+.0504	+.0116	+.0568	+.0893	+.1084	+.1141						
$a/b = 1/4$	1.0	+.2483	+.0209	+.0096	+.0007	−.0057	−.0096	−.0109	0	0	0	0	0	0
	0.8	+.2523	+.0206	+.0093	+.0006	−.0056	−.0093	−.0105	+.0041	+.0019	+.0002	−.0009	−.0016	−.0019
	0.6	+.2513	+.0205	+.0093	+.0006	−.0056	−.0093	−.0105	+.0041	+.0018	+.0000	−.0013	−.0021	−.0023
	0.4	+.2512	+.0196	+.0089	+.0003	−.0054	−.0088	−.0099	+.0039	+.0016	−.0004	−.0018	−.0027	−.0030
	0.2	+.1905	+.0137	+.0053	−.0003	−.0039	−.0059	−.0065	+.0027	+.0007	−.0011	−.0024	−.0032	−.0034
	0	+.0295	0	+.0005	+.0013	+.0020	+.0025	+.0027	0	+.0023	+.0063	+.0101	+.0128	+.0135
		R_y \ x/a	+.0295	+.0236	+.1131	+.1786	+.2174	+.2301						
$a/b = 3/8$	1.0	+.3711	+.0476	+.0219	+.0016	−.0130	−.0218	−.0247	0	0	0	0	0	0
	0.8	+.3896	+.0466	+.0208	+.0012	−.0126	−.0208	−.0235	+.0093	+.0042	+.0004	−.0022	−.0038	−.0043
	0.6	+.3757	+.0442	+.0193	+.0007	−.0122	−.0198	−.0223	+.0088	+.0036	−.0007	−.0039	−.0059	−.0065
	0.4	+.3541	+.0379	+.0155	−.0003	−.0107	−.0167	−.0186	+.0076	+.0024	−.0021	−.0054	−.0075	−.0082
	0.2	+.2133	+.0210	+.0075	−.0009	−.0059	−.0085	−.0093	+.0042	+.0009	−.0017	−.0034	−.0044	−.0047
	0	−.0019	0	+.0010	+.0027	+.0043	+.0054	+.0058	0	+.0050	+.0135	+.0215	+.0269	+.0288
		R_y \ x/a	−.0019	+.0303	+.1666	+.2644	+.3220	+.3410						
$a/b = 1/2$	1.0	+.5101	+.0852	+.0384	+.0022	−.0233	−.0383	−.0432	0	0	0	0	0	0
	0.8	+.5331	+.0807	+.0349	+.0013	−.0218	−.0353	−.0397	+.0161	+.0068	−.0001	−.0049	−.0077	−.0086
	0.6	+.4805	+.0712	+.0298	−.0000	−.0199	−.0313	−.0350	+.0142	+.0051	−.0026	−.0084	−.0120	−.0132
	0.4	+.4148	+.0549	+.0209	−.0014	−.0156	−.0233	−.0258	+.0109	+.0026	−.0043	−.0094	−.0125	−.0135
	0.2	+.1928	+.0250	+.0087	−.0009	−.0063	−.0089	−.0096	+.0050	+.0015	−.0003	−.0008	−.0008	−.0007
	0	−.0294	0	+.0019	+.0050	+.0080	+.0100	+.0107	0	+.0094	+.0252	+.0399	+.0499	+.0534
		R_y \ x/a	−.0294	+.0482	+.2263	+.3559	+.4322	+.4572						
$a/b = 3/4$	1.0	+.8592	+.1788	+.0716	−.0010	−.0471	−.0726	−.0807	0	0	0	0	0	0
	0.8	+.7864	+.1552	+.0607	−.0020	−.0414	−.0630	−.0658	+.0310	+.0112	−.0027	−.0119	−.0172	−.0190
	0.6	+.5989	+.1207	+.0460	−.0033	−.0336	−.0498	−.0549	+.0241	+.0071	−.0067	−.0166	−.0225	−.0245
	0.4	+.4378	+.0786	+.0280	−.0033	−.0214	−.0306	−.0333	+.0157	+.0036	−.0049	−.0100	−.0127	−.0135
	0.2	+.1189	+.0269	+.0109	−.0009	−.0036	−.0049	−.0053	+.0058	+.0060	+.0115	+.0186	+.0241	+.0262
	0	−.0694	0	+.0042	+.0115	+.0182	+.0227	+.0242	0	+.0212	+.0576	+.0911	+.1135	+.1212
		R_y \ x/a	−.0694	+.0806	+.3383	+.5271	+.6368	+.6725						
$a/b = 1$	1.0	+1.2115	+.2613	+.0883	−.0105	−.0654	−.0927	−.1008	0	0	0	0	0	0
	0.8	+.9958	+.2146	+.0727	−.0097	−.0551	−.0774	−.0840	+.0429	+.0134	−.0051	−.0464	−.0224	−.0243
	0.6	+.6250	+.1547	+.0525	−.0083	−.0411	−.0566	−.0611	+.0309	+.0090	−.0069	−.0169	−.0222	−.0238
	0.4	+.3984	+.0916	+.0305	−.0043	−.0216	−.0290	−.0310	+.0183	+.0069	+.0029	+.0030	+.0045	+.0053
	0.2	+.0434	+.0303	+.0127	+.0047	+.0033	+.0042	+.0046	+.0061	+.0149	+.0339	+.0542	+.0689	+.0742
	0	−.0939	0	+.0074	+.0199	+.0311	+.0384	+.0409	0	+.0369	+.0996	+.1556	+.1919	+.2043
		R_y \ x/a	−.0939	+.1167	+.4453	+.6760	+.8043	+.8450						
$a/b = 3/2$	1.0	+1.6267	+.3304	+.0700	−.0345	−.0730	−.0844	−.0865	0	0	0	0	0	0
	0.8	+1.0875	+.2609	+.0569	−.0286	−.0589	−.0670	−.0683	+.0522	+.0116	−.0068	−.0143	−.0165	−.0169
	0.6	+.5876	+.1778	+.0399	−.0195	−.0385	−.0422	−.0422	+.0356	+.0115	+.0017	+.0011	+.0035	+.0049
	0.4	+.3166	+.0981	+.0239	−.0096	−.0116	−.0101	−.0090	+.0196	+.0177	+.0315	+.0495	+.0634	+.0685
	0.2	−.0540	+.0302	+.0140	+.0140	+.0211	+.0273	+.0296	+.0060	+.0369	+.0912	+.1388	+.1699	+.1805
	0	−.1168	0	+.0159	+.0388	+.0565	+.0668	+.0702	0	+.0796	+.1939	+.2823	+.3340	+.3506
		R_y \ x/a	−.1168	+.2429	+.6510	+.8793	+.9832	+1.0123						



Moment = (Coefficient) (pb^2)
Reaction = (Coefficient) (pb)



POSITIVE SIGN CONVENTION

FIGURE 1.—*Plate fixed along three edges, moment and reaction coefficients, Load l, uniform load.*

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Client UNC		WO/Job No. U290AO	
Subject Decommissioning Pipe Loadings		Date 5/30/84	By [illegible]
		Checked 7/12/84	By [illegible]
Location 105-Buildings		Revised	By

OBJECTIVE

To determine effects of soil and equipment loads on piping that will occur during the 105 facility decommisioning. To establish what sizes and types of piping will require slurry filling or other means to minimize subsidence of the mound.

ASSUMPTIONS

1. Soil is dry gravelly material ≅ 100 pcf and will not be compacted.

2. Filling will be done by bottom dumper trucks with two trailers. Each trailer capacity of 50 cy.

3. Maximum height of soil over pipe ≅ 65'

4. Exst pipe cover is a minimum 2'-6"

5. Assume effects of loadings on pipes 24" diameter or smaller can be neglected. These pipes will not cause damage to vehicles if they fail, and will not create large areas of subsidence

6. Material around pipe has settled completely after 40 years so that no stresses occur due to settlement in trench - disregard Martens formulas

KAISER ENGINEERS
HANFORD

Revision

DESIGN ANALYSIS

Client UNC		WO/Job No. U290AO	
Subject Decommissioning Pipe Loadings		Date 6/6/84	By AB Langevin
		Checked 7/12/84	By Q. Vergu
Location 105 Buildings		Revised	By

Types and sizes of below grade pipe (Ref. Pathway Lists)

Vitrified Pipe
6, 24, 8, 15, 12, 4,

Asb. Cem. 4"

Rein. Conc.
30, 48, 36, 60, 30, 20, 42, 12

Cast Iron
6, 12, 20, 4, 16, 18, 2, 10, 3, 8

CS - (Assume Sch. 40)
54, 66, 12, 20, 4, 24, 2, 60, 16, 3/4", 72"

CS - Sch 20
20, 18

CS - Sch 80
2,

5'-6" X 5'-6" Conc. Sewer (2 side by side)
10' x 7' Conc. Duct
8' x 10' Tunnel
Stack Breeching
Pipe Tunnels.
32" Vent Exhaust Duct
60", 42" 24" Effluent lines. (Type of Pipe?)
8'-8" x 8'-8" Intake/Exhaust Conc. Duct
12' x 12' Conc Pipe Tunnels

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Client	UNC	WO/Job No.	U290AO
Subject	Decommissioning Pipe Loadings	Date 5/31/84	By [illegible]
		Checked 7/12/84	By [illegible]
Location	105 Buildings	Revised	By

Wheel Load in kips applied to one lineal foot of pipe (Due to 116k wheel load)

Depth of Cover (ft) \ Pipe Size (Inches)	12"	24"	30"	36"	42"	72" – Estimate Approximate Values
2'	11.14	18.10	20.65	22.62	23.78	34
3'	6.03	10.78	12.88	14.50	15.66	21
4'	3.60	6.73	8.35	9.86	10.67	14
6'	1.62	3.25	4.06	4.87	5.10	8
8'	0.93	1.86	2.32	2.67	3.02	5
5'	2.43	4.52	5.68	6.73	7.42	10

Loads on pipe due to soil cover

$(65')(100\ lb/ft^3) = 6500\ psf = 6.5\ ksf$

12" pipe → 6.5 k
24" pipe → 13.0 k
30" pipe → 16.25 k
36" pipe → 19.5 k
42" pipe → 22.75 k
60" pipe → 32.5 k
66" pipe → 35.75 k

Client	UNC	WO/Job No.	U290AO
Subject	Decommissioning Pipe Loadings	Date 6/12/84	By [illegible]
		Checked 7/12/84	By [illegible]
Location	105 Buildings	Revised	By

Concrete Pipe - 30, 36, 42, 48, 60 diameters

Assume pipe is ASTM C76 Class II
Find allowable loads using the 3 edge bearing load to produce ultimate failure from fig 4.13 Conc Pipe Hndbk. Use a load factor of 1.9 (Soil should be well consolidated)

Pipe	Allow load (k)	
30"	7.125	all ≥ 6.5 due to earth load.
36"	8.55	
42"	9.975	
48"	11.4	
60"	14.25	

Concrete pipe can take earth loads

From chart on p.5 we can see that wheel loads are too great with only 2' or 3' of cover for 5' of cover: Wheel loads are:

Pipe	Load (k)		
30"	5.68	< 7.125	Conc. Pipe will take wheel loads with a min. 5' of cover. Some of this pipe may already have this amount of cover
36"	6.73	< 8.55	
42"	7.42	< 9.97	
48"	≅ 9	< 11.4	
60"	≅ 9	< 14.25	

4.12—RECOMMENDED MAXIMUM DEPTH OF TRENCH REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE ASTM DESIGNATION: C76-57T—CLASS I

Internal Diam. Inches	Minimum Three-Edge Bearing Load to produce 0.01-inch crack (800 D)	Minimum Three-Edge Bearing Load to produce Ultimate Failure (1200 D)	RECOMMENDED MAXIMUM DEPTH IN FEET TO BOTTOM OF THE PIPE							
			CLASS A BEDDING (Concrete Cradle)		CLASS B BEDDING (First Class)		CLASS C BEDDING (Ordinary)		CLASS D BEDDING (Impermissible)	
			100* Soil	130* Soil	100* Soil	130* Soil	100* Soil	130* Soil	100* Soil	130* Soil
	lb. ft.	lb. ft.								
60	4000	6000	41.2	22.2	19.0	14.0	15.8	12.1	12.6	10.5
66	4400	6600	40.6	22.9	19.7	14.7	16.1	12.9	13.1	11.1
72	4800	7200	40.4	23.6	20.4	15.5	16.9	13.5	13.8	11.8
78	5200	7800	40.7	24.5	21.0	16.1	17.6	14.2	14.7	12.5
84	5600	8400	40.5	25.1	21.5	16.7	18.2	14.9	15.2	13.1
90	6000	9000	39.3	25.8	22.2	17.5	18.8	15.5	15.8	13.8
96	6400	9600	39.7	26.5	22.8	18.1	19.5	16.3	16.4	14.4
102	6800	10200	39.7	27.0	23.3	18.8	20.2	17.0	17.0	15.1
108	7200	10800	39.5	27.8	24.0	19.5	20.8	17.6	17.7	15.7

Trench width assumed 24" wider than O.D. of pipe.
Factor of safety of 1.0 on minimum 0.01-inch crack strength.

4.13—RECOMMENDED MAXIMUM DEPTH OF TRENCH REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE ASTM DESIGNATION: C76-57T—CLASS II

Internal Diameter Inches	Minimum Three-Edge Bearing Load to produce 0.01-inch crack (1000 D)	Minimum Three-Edge Bearing Load to produce Ultimate Failure (1500 D)	RECOMMENDED MAXIMUM DEPTH IN FEET TO BOTTOM OF THE PIPE							
			CLASS A BEDDING (Concrete Cradle)		CLASS B BEDDING (First Class)		CLASS C BEDDING (Ordinary)		CLASS D BEDDING (Impermissible)	
			100* Soil	130* Soil	100* Soil	130* Soil	100* Soil	130* Soil	100* Soil	130* Soil
12	1000	1500		21.8		8.3	13.0	6.7	7.7	5.0
15	1250	1875		25.0		9.9	15.2	7.7	8.9	5.7
18	1500	2250		27.3	No	11.0	16.5	8.6	9.8	6.4
21	1750	2625		28.8	Limit	11.8	17.6	9.4	10.5	7.0
24	2000	3000		28.9		12.5	18.0	10.0	11.1	7.6
27	2250	3375		29.6	39.9	13.2	18.5	10.5	11.7	8.0
30	2500	3750	No	30.0	34.9	13.9	18.9	11.0	12.2	8.5
33	2750	4125	Limit	30.3	30.2	14.3	19.3	11.6	12.6	8.9
36	3000	4500		23.8	21.3	13.1	15.2	10.7	11.4	8.5
42	3500	5250		24.8	21.4	13.9	16.2	11.4	12.1	9.3
48	4000	6000		25.1	22.6	14.9	17.3	12.3	12.9	10.1
54	4500	6750		26.9	22.8	15.8	18.0	13.0	13.7	10.8
60	5000	7500		27.9	23.6	16.6	18.6	13.8	14.5	11.6
66	5500	8250	86.7	28.5	24.2	17.2	19.1	14.6	15.2	12.3
72	6000	9000	79.5	29.0	24.9	17.9	19.8	15.3	15.9	13.0
78	6500	9750	66.2	30.3	25.7	18.6	20.9	16.1	16.7	13.6
84	7000	10500	62.1	30.7	26.3	19.3	21.4	16.7	17.3	14.1
90	7500	11250	58.6	31.5	26.7	19.9	22.0	17.4	17.9	15.0
96	8000	12000	57.2	32.2	27.3	20.8	22.6	18.0	18.5	15.6
102	8500	12750	56.1	32.5	28.0	21.2	23.1	18.7	19.2	16.3
108	9000	13500	55.2	32.9	28.5	21.9	23.8	19.3	19.8	16.9

Trench width equal [illegible] for pipe [illegible] in inside diameter. [illegible] 1.0 on [illegible] plus 24" for pipe [illegible] in inside diameter. [illegible]

DESIGN ANALYSIS

Client	UNC	WO/Job No.	U290AO
Subject	Decommissioning Tunnel Loads	Date 6/84	By [illegible]
		Checked 7/12/84	By [illegible]
Location	105 Buildings	Revised	By

OBJECTIVE

Analyze tunnel to determine effects of soil loadings and equipment wheel loads. Determine when tunnel fails, and use this example to draw some general conclusions about capacity of other tunnels in the 105 areas.

ASSUMPTIONS

1. Soil - dry gravelly ≅ 100 pcf
2. Max wheel load from bottom dumper truck. See Pipe Load Calculations.
3. Tunnel has 3' slab and 1' walls - If it fails, most other tunnels will fail under similar loads.

ANALYSIS METHOD

1. Choose 3 cases to analyze
2. Find moments at ends using moment distribution.

REFERENCES

1. ACI Design Handbook (Flex 1.1)

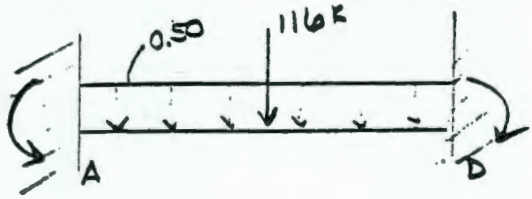
CONCLUSIONS

Tunnel will fail under direct wheel load or under 65' of earth. Tunnel under 8' soil load and distributed wheel load is close to failure. On the basis of these preliminary calculations assume all tunnels will fail.

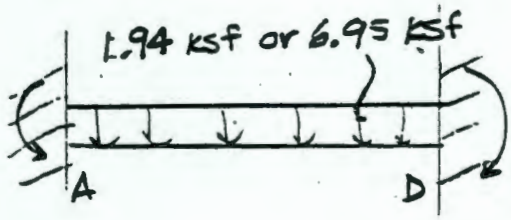
DESIGN ANALYSIS

Client	UNC	WO/Job No.	U290A0
Subject	Decommissioning Tunnel Loads	Date 6/84	By [illegible]
		Checked 7/12/84	By [illegible]
Location	105 Buildings	Revised	By

Find fixed end moments

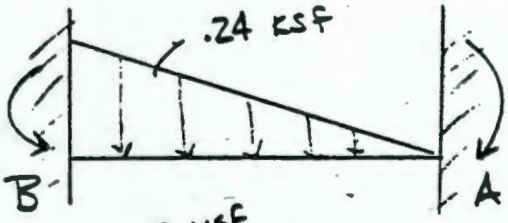


$$M_A = M_D = \frac{(0.50)(13)^2}{12} + \frac{116(13)}{8} = 196 \text{ k-ft}$$



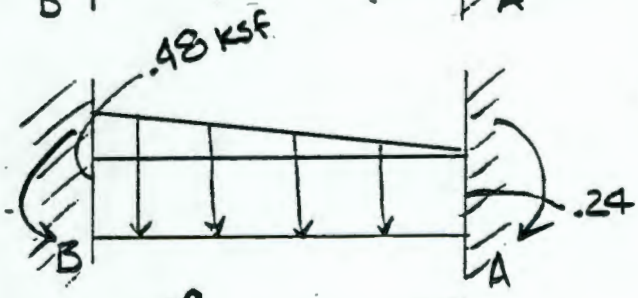
$$M_A = M_D = \frac{(1.94)(13)^2}{12} = 27 \text{ k-ft}$$

$$M_A = M_D = \frac{(6.95)(13)^2}{12} = 98 \text{ k-ft}$$



$$M_B = \frac{3wL^2}{60} = \frac{3(.24)(8)^2}{60} = 0.768 \text{ k-ft}$$

$$M_A = \frac{2wL^2}{60} = 0.512 \text{ k-ft}$$

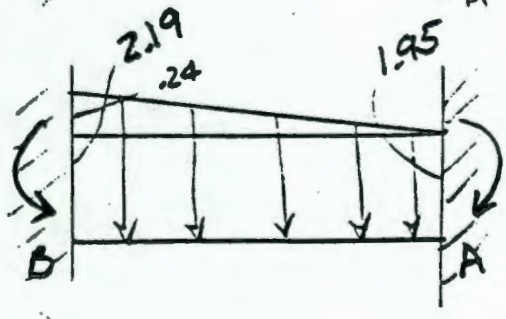


$$M_B = \frac{w_1L^2}{20} + \frac{w_2L^2}{12} = (.24)(8)^2\left(\frac{1}{20}+\frac{1}{12}\right)$$

$$M_B = 2.05 \text{ k-ft}$$

$$M_A = \frac{w_1L^2}{30} + \frac{w_2L^2}{12} = .24(8)^2\left(\frac{1}{30}+\frac{1}{12}\right)$$

$$M_A = 1.79 \text{ k-ft}$$



$$M_B = \frac{(.24)(8)^2}{20} + \frac{(1.95)(8)^2}{12} = 11.2 \text{ k-ft}$$

$$M_A = \frac{(.24)(8)^2}{30} + \frac{1.95(8)^2}{12} = 10.9 \text{ k-ft}$$

6352

Stiffness of Members

Top Slab $\frac{4EI}{L} = \frac{4E\ 12(36)^3/12}{156''} = 1196E$

Walls $\frac{4E\ 12(12)^3/12}{96} = 72E$

DESIGN ANALYSIS

Client UNC	WO/Job No. U290A0		
Subject Decommissioning Tunnel Loads	Date 6/84	By [illegible]	
	Checked 7/12/84	By [illegible]	
Location 105 Buildings	Revised	By	

Find Allowable Moments for (Assume $f'_c = 3000$, $f_y = 40{,}000$)

36" Slab w/ #6 @ 12 EWEF

12" Wall w/ #4 @ 12 EWEF

36" Slab

$$F = \frac{bd^2}{12{,}000} = \frac{12(33)^2}{12{,}000} = 1.089$$

$$\rho = \frac{A_s}{bd} = \frac{.44}{12(33)} = 0.0011 \longrightarrow K_u = 39$$

$$M_{allow} = F K_u = (1.089)(39) = \underline{42.5 \text{ k-ft}}$$

for 36" slab $M < M_{allow}$ for all 3 cases OK

12" Wall

$$F = \frac{bd^2}{12{,}000} = \frac{12(10)^2}{12{,}000} = 0.10$$

$$\rho = \frac{A_s}{bd} = \frac{0.20}{(12)(10)} = 0.0016$$

Say $f'_c = 3000$

$f_y = 40{,}000$

From Flex 1.1 $\longrightarrow K_u = 56$

$$M_u = F K_u = (0.10)(56) = \underline{5.6 \text{ k-ft}}$$

for 12" wall $M > M_{allow}$ for cases 1 and 3 and is close to failure for case 2 (4.01 k-ft < 5.6 k-ft allowable moment)

∴ Assume all tunnels will fail.

KAISER ENGINEERS
HANFORD

Revision

DESIGN ANALYSIS

Client	UNC	WO/Job No.	11290A0
Subject	INSITU REACTOR DISPOSAL	Date	JUNE 89 By S. VERTNER
		Checked	7/12/89 By A. U. Eggen
Location	105KE/KW	Revised	By

$$\sigma_{SOIL} = \frac{\text{TOTAL SOIL WT.}}{\text{TOTAL AREA}} = \frac{4,473,469.0}{1098.2(144)} = 28.3 \text{ psi}$$

TOTAL Average Bearing Stress including Soil = 193.0 + 28.3 = 221.3 psi

CHECK 4'0 THICK WALL FOR ALLOWABLE Compression STRESS. USE ACI 318-51 FOR Design values

From Sect. 1112 For Reinf. Concrete Walls

if $h/t < 10$ Allow. Stress = $.25 f'_c$

$\frac{6.33}{4} = 1.58 < 10$ ok $\sigma_{allow} = .25(3000) = 750.0$ psi

Since 750 > 221.3 four foot thick walls ok. for additional Stress due to soil loading.

DESIGN ANALYSIS

Client UNC WO/Job No. U290A0
Subject INSITU REACTOR DISPOSAL Date JUNE 84 By S. VERTHER
Checked 7/12/84 By
Location 105KE/KW Revised By

or $K^2 + .0293K - .0295 = 0$ $\quad j = 1 - \frac{K}{3} = 1 - \frac{.1571}{3} = .948$

$K_1 = .1571 \quad K_2 = \cancel{-.1864}$

$M_c = \frac{1}{2} f_c K j b d^2 = \frac{1}{2}(1350)(.16)(.95)(12)(96)^2 = 1.13E7$ in-lb

$M_s = A_s f_s j d = 1.69(20000)(.95)(96) = 3.08E6$ in-lb

Use Smaller Allow. Mom. $= \frac{3.08E6}{12} = 256880$ ft-lb

Since Allow Mom of 256880 ft-lb > 62180 ft-lb
or 90445

Mat Foundation appears to have the capacity to support additional 5 meters of soil without overstressing. Tunnels beneath Mat do not require filling with grout or earth.

Check Stress in Beam w/o Reinforcement

$S = \frac{bh^2}{6} = \frac{12(96)^2}{6} = 18432.0$ in^3

$\sigma_{max} = \frac{90445(12)}{18432.0} = 59$ psi TENSION

Allowable Tension $\cong .03 f'_c = .03(3000) = 90$ psi
ACI SEC 1207

Since Allow Tension = 90 psi > 59 psi
Mat Foundation O.K. even w/o reinforcement.

DESIGN ANALYSIS

Client UNC WO/Job No. 1290A0

Subject INSITU Reactor Disposal Date JUNE 84 By S. Kestner

Checked 7/12/84 By J. N. Engen

Location 105KE/KW Revised By

Total Existing Moment due to dead load = Moment Due to SLAB + Moment Due to downspout

$$= \frac{w_D l^2}{8} + \frac{Pl}{4}$$

$$= \frac{4(150)(9.83)(29.4)^2}{8} + \frac{24\,754.4(29.4)}{4}$$

$$= 819\,410.3 \text{ ft-lb}$$

Allowable Additional Live Load = w_L

$$w_L \frac{(9.83)(29.4)^2}{8} + 819\,410.3 = 1,681,358.3$$

$$w_L = \underline{811.6 \text{ psf}}$$

Assuming soil wt. of 110 pcf

$$w_L = \frac{811.6}{110} = 7.4' \leftarrow \text{Allowable Additional Soil}$$

Using Working Stress design on inner rod room Floor east of C.J.

DESIGN ANALYSIS

Client UNC WO/Job No. U250-A0

Subject INSITU Reactor Disposal Date June 89 By C. Fleener

Checked 7/17/89 By [illegible]

Location 105KE/KW Revised By

Check SLAB using Ultimate Strength

$M_u = \phi \rho f_y b d^2 \left(1 - .59 \rho \frac{f_y}{f'_c}\right)$ $\rho = \frac{A_s}{bd} = \frac{.79}{(12)(44.5)} = 1.4774E-3$

$M_u = .9(1.4774E-3)(40000)(12)(44.5)^2\left(1 - .59(1.4774E-3)\frac{40}{3}\right)$

$= 1{,}250{,}850.6$ IN-lb $= 104237.6$ Ft-lb

$M_{allow} = 1.4 M_{D.L.} + 1.7 M_{L.L.} = 1.4 \frac{W_D l^2}{8} + \frac{1.7 W_L l^2}{8}$

or $\frac{1.4(4)(150)(21.83)^2}{8} + \frac{1.7 W_L (21.83)^2}{8} = 104237.6$ Ft-lb

$W_L = 535.2$ lb/ft^2

$= \frac{535.2}{110} = 4.9'$ ← Allowable Additional Soil using Ultimate Strength design on inner rod room floor WEST OF C.J.

Since Inner Rod Room Floor EAST of C.J. has a higher uniform load capacity assume WEST SIDE controls the allowable soil load.

For Report Amount Overstressed for 65 Feet of Soil using W.S.D. $= \frac{65}{3.04} = 21$

Overstress Factor using Ultimate Strength $= \frac{65(1.4)}{4.9(1.4)} = 13$

Burying of 100 Area
Facilities (continued)

III. Compaction and Settlements:

Table I shows the dry densities associated with the gravels placed at various relative densities. It further indicates the settlements associated with fill densification after placement. For this project, one of the considerations is whether or not to spend extra effort to compact the gravel during placement. Realistically, if grading equipment is conscienciously routed over fills in place so good coverage is obtained, the resulting density would probably be about 65% relative density (see Col. 4 of Table I). Again, it is realistic to assume that such a fill, after years of seasoning, might reach a maximum relative density of 75%. As indicated in Table I, this would result in a 3.2% settlement. If on the other hand, a heavy vibratory compactor were to make 2 passes over each fill lift (using 12 to 18 inch lifts), a fill of 70% relative density would probably result. Again, assuming a seasoned relative density of 75%, the maximum settlement would be about 1.5% (see Col. 5, Table I). In either case, one cannot foresee any detrimental effects from these relatively small post construction settlements

IV. Special Fill Within Reactor:

Consideration is being given to filling the reactor and some immediately adjacent areas with a weak grout (300 psi strength). Alternatively, the pit run gravel might be used and placed by using a clamshell. The former would experience essentially zero settlements. The latter would probably be placed at about 55% relative density. Assuming that with seasoning the fill eventually attains a relative density of 75%, the resulting settlements would be in the 5% to 6% range, (see Col. 2 of Table I) or say 3 feet for a 50 foot high fill. If this latter scheme is used, an extra 3 of fill height should be placed in order to ultimately have the desired reactor gravel cover.

V. Demolition Rubble:

Rubble from demolished structures is to be left in place around the central reactor facilities. It is estimated that this rubble will be of the order of 3 of 4 feet deep. If grading equipment is well routed over this rubble area after the initial lift has been placed or a vibratory compactor makes several passes over the initial lift in order to get as much gravel fill into the rubble voids as possible, it is estimated that subsequent settlements within 4 feet of rubble should not exceed an order of magnitude of say 6 inches.

VI. Tunnel Collapse:

The requirement of whether or not to fill tunnels is a complex issue. Assume, say an 8x8 foot tunnel withstands the grading equipment loading as well as initially the total fill load, but fails due to roof deterioration after a number of years. Such a failure would not cause a stability problem of the mound as a whole.

TABLE I

RELATIVE DENSITY AND % SETTLEMENT

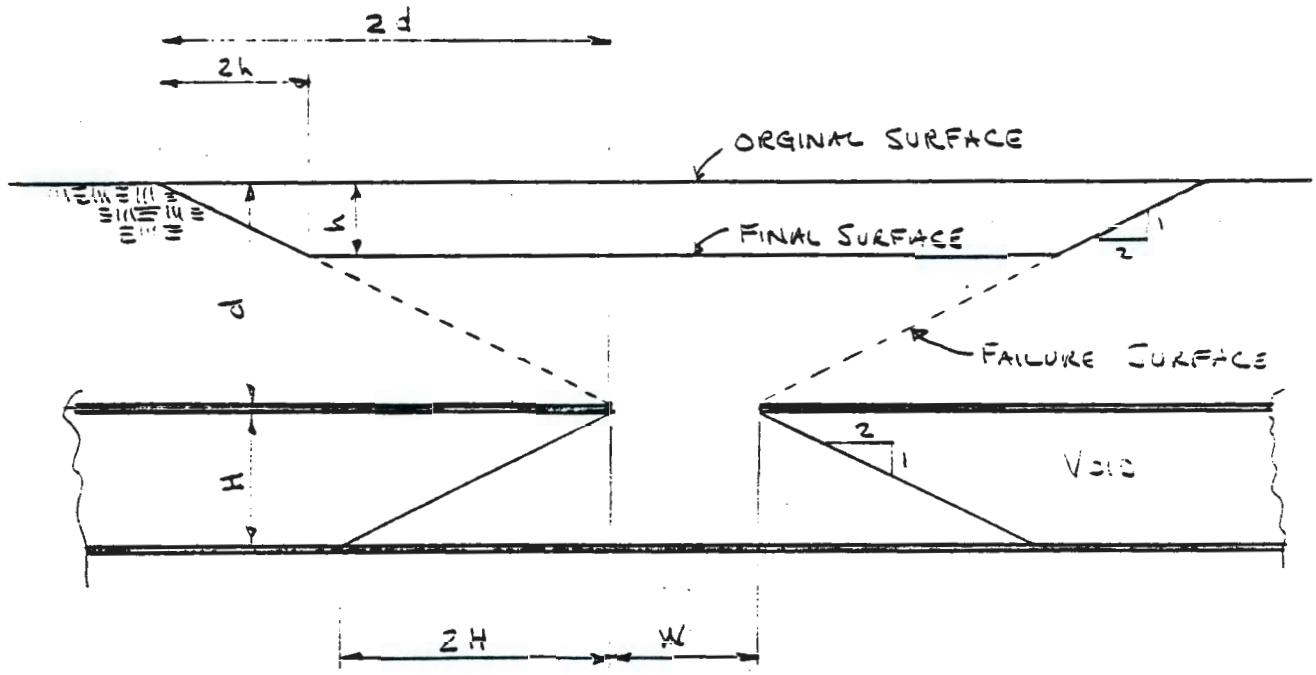
Relative Density	Dry Density #/Ft^3 (1)	% Settlement Associated With Fill Densification After Placement					
		(1)	(2)	(3)	(4)	(5)	(6)
50%	92.9	**					
55%	94.3	1.5	**				
60%	95.8	2.8	1.6	**			
65%	97.2	4.6	3.1	1.5	**		
70%	98.8	6.4	4.8	3.1	1.6	**	
75%	100.3	8.0	6.4	4.7	3.2	1.5	**
80%	102.0	9.8	8.2	6.5	4.9	3.2	1.7

(1) Based on: Maximum Density = 109#/ft^3
Minimum Density = 81#/ft^3

** Placed Density

DESIGN ANALYSIS

Client	UNC	WO/Job No.	17200
Subject	IN SITU REACTOR DISPOSAL SOIL SETTLEMENT	Date 7/13/84	By J.W. [illegible]
		Checked 7/13/84	By [illegible]
Location	100 AREAS	Revised	By



ASSUME - VOID HAS H x H CROSS SECTION DIMENSIONS.

FAILURE SURFACE IS A CONE

VOLUME IN VOID

$$V_v = \left[wH + \tfrac{1}{2}(4H)(H) \right] H = wH^2 - 2H^3$$

VOLUME BETWEEN ORGINAL SURFACE & FINAL SURFACE

$$V_c = \frac{\pi}{12} h \left[(4d+w)^2 + (4d+w)(4d+w-4h) + (4d+w-4h)^2 \right]$$

$$= \frac{\pi}{12} h \left[(4d+w)^2 + (4d+w)^2 - (4h)(4d+w) + (4d+w)^2 - 2(4d+w)(4h) + (4h)^2 \right]$$

$$= \frac{\pi}{12} h \left[3(4d+w)^2 - 3(4h)(4d+w) + (4h)^2 \right]$$

$$2H^3 + wH^2 - V_c = 0$$

DESIGN ANALYSIS

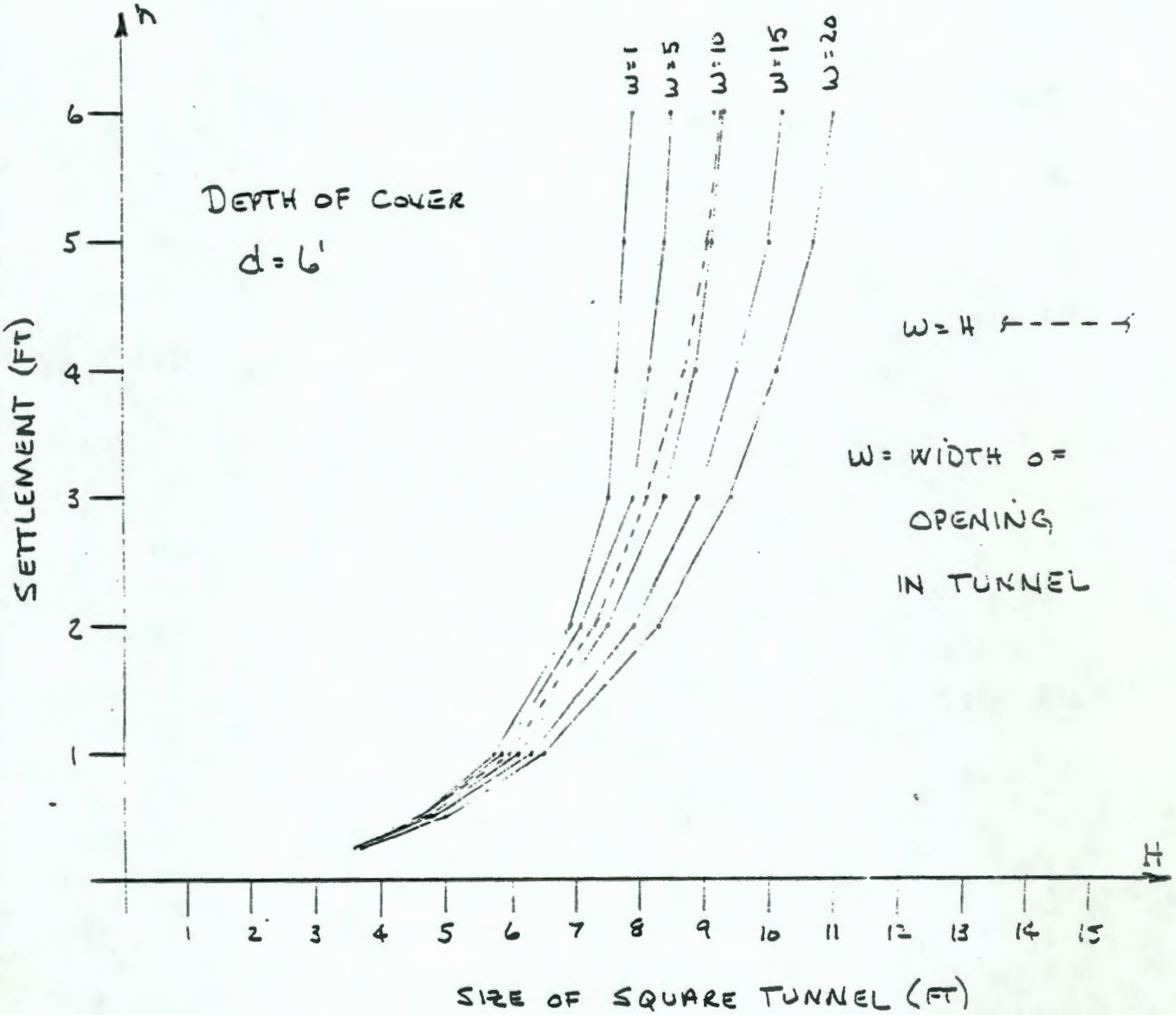
Client: UNC
WO/Job No.: U2-3AS
Subject: Inactive Reactor Decom. Soil Settlement
Date: 7/6/88 By: J. V. [illegible]
Checked: 7/13/84 By: [illegible]
Location: 100 AREAS
Revised: By:

h FT	w FT	d FT	V_c YD³	H FT
1	3.7	3	6	3.7
2	4.4	3	9	4.4
3	4.6	3	11	4.6
1	4.5	4	10	4.5
2	5.5	4	18	5.5
3	6.0	4	23	6.0
4	6.1	4	26	6.1
1	5.2	5	16	5.2
2	6.4	5	30	6.4
3	7.1	5	40	7.1
4	7.5	5	47	7.5
5	7.7	5	50	7.7
1	5.9	6	23	5.9
2	7.3	6	44	7.3
3	8.1	6	61	8.1
4	8.7	6	74	8.7
5	9.1	6	83	9.1
6	9.2	6	88	9.2
1	6.5	7	31	6.5
2	8.1	7	60	8.1
3	9.2	7	86	9.2
4	9.9	7	107	9.9
5	10.3	7	121	10.3
6	10.6	7	132	10.6
7	10.7	7	138	10.7
1	7.1	8	40	7.1
2	8.9	8	80	8.9
3	10.1	8	115	10.1
4	10.9	8	114	10.9
5	11.4	8	167	11.4
6	11.8	8	185	11.8
7	12.1	8	198	12.1
8	12.3	8	206	12.3

CO4 Richland, WA

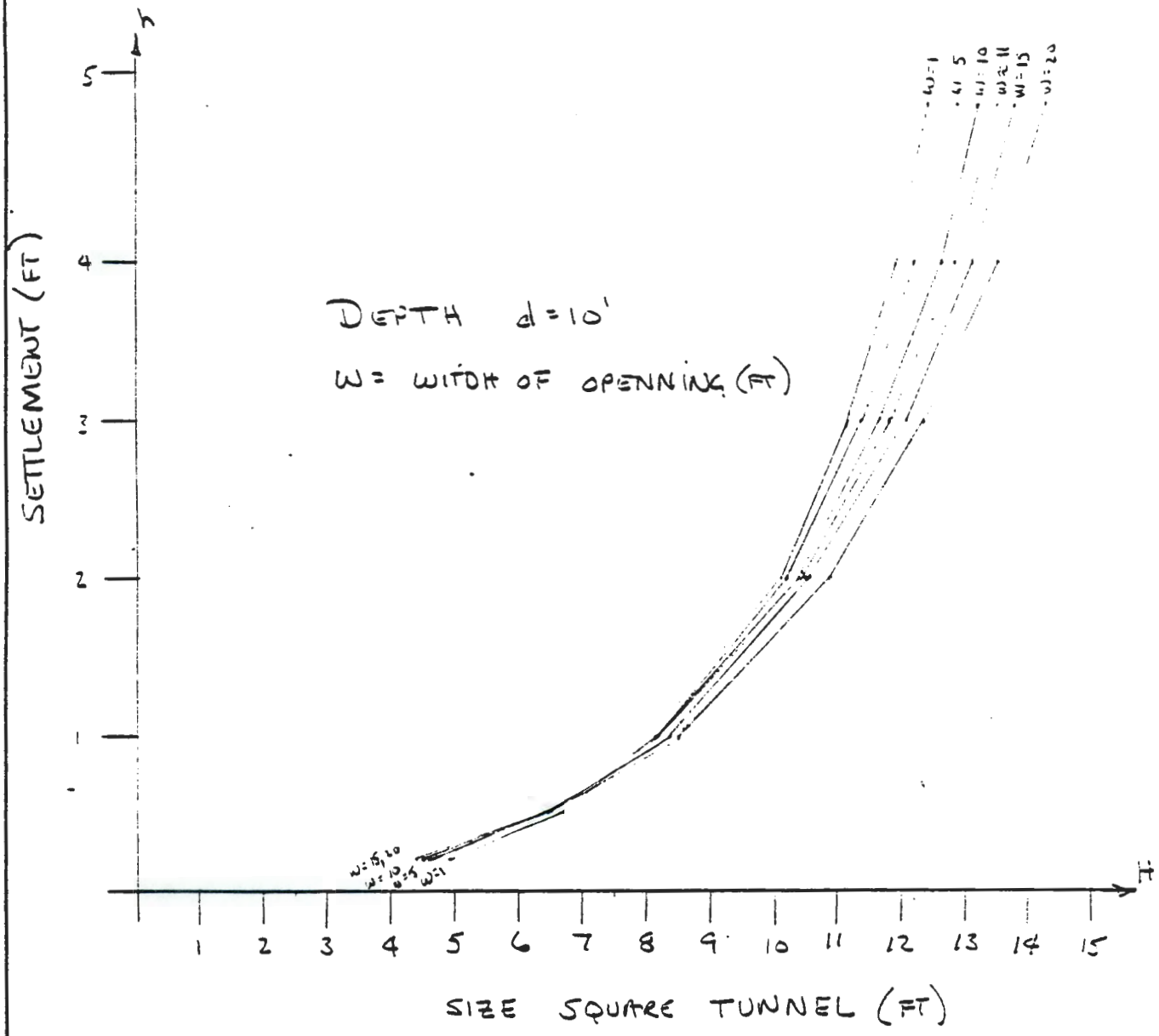
DESIGN ANALYSIS

Client	UNC	WO/Job No.	U290AD		
Subject	INSITU REACTOR DISPOSAL	Date	7/6/92	By	J. V. FEGER
	SOIL SETTLEMENTS	Checked	7/15/92	By	[illegible]
Location	100 AREAS	Revised		By	



DESIGN ANALYSIS

Client	UNC	WO/Job No.	U230AD		
Subject	INSITU HEATER DISPOSAL SOIL SETTLEMENT	Date	7/6/84	By	J. H. EGGER
		Checked	7/13/84	By	[illegible]
Location	100 AREAS	Revised		By	



APPENDIX F

DCS Work Scope Statement of Instructions

Total Pages: 13
Date: 3-2-87

This information was received from UNC Nuclear Industries and is included intact and unaltered except for pagination. The report is now designated a Decommissioning Conceptual Study to differentiate the document from a Projects Department Conceptual Design Report; to avoid confusion between the Surplus Facilities Management Program Operations and Construction Operations Methodology.

UNC NUCLEAR INDUSTRIES

A UNC RESOURCES Company P.O. Box 490 Richland, Washington 99352 Telephone 509/376-7411

April 9, 1984

Mr. T. A. Przybylski
Sr. Project Manager
Kaiser Engineers Hanford
P. O. Box 888
Richland, Washington

Dear Mr. Przybylski:

PROPOSED IN-SITU DECOMMISSIONING OF THE EIGHT SHUT-DOWN REACTOR 105 BUILDINGS IN THE 100 AREAS: REQUEST FOR A CONCEPTUAL DESIGN REPORT AND COST ESTIMATE

References:

1. Letter P. W. Griffin (UNC) to T. A. Przybylski (KEH), Subject, "Proposed In-Situ Decommissioning of the Eight Shut-Down Reactor 105 Buildings in The 100 Areas: Request for a Conceptual Engineering Study and Cost Estimate," dated Feb. 24, 1984.

2. J. A. Adams, J. C. Chattin, P. W. Griffin, M. C. Hughes, Assessment of Decommissioning Alternatives For The Shut-Down Hanford 100 Area Facilities, UNI-2619, UNC Nuclear Industries, Richland, WA, 1984.

3. Preliminary Engineering Study: Cocooning of 105-F Reactor, KEH R-83-14, Rev. 1, Kaiser Engineers Hanford, Co., Richland, WA, 1983.

The letter of instructions (Reference 1) provides an attached Work Plan (see enclosure 1) to be used in conjunction with the applicable material in Reference 2 and 3 for preparation of a Conceptual Design Document with Cost Estimate (defined March 9, 1984 as "Conceptual Design Report/Cost Estimate"). Work Order Number B-32207, dated February 23, 1983, was placed to fund the initial work-effort to provide cost and completion date estimates for preparing the subject Conceptual Design Report/Cost Estimate. UNC and Kaiser Engineers Hanford (KEH) representatives met February 28, 29, and March 21, 1984, and discussed details on the scope of work. Also, a field inspection of the reactor 105 Buildings in the 100-C and -KW Areas was performed on March 5, 1984 and another for the 100-D, -DR, and -H Areas on March 16, 1984. A large amount of information has been exchanged by these various means. Therefore, the following consolidated statement of instruction is provided to ensure the Kaiser Engineers Hanford work scope is clearly defined.

ducts and water lines, fuel storage basins, transfer pits, downcomers, 3X ball room, valve pits, etc. The voids requiring fill shall have the void volumes and void locations with reference to existing architectural drawings listed for each reactor 105 building. The list shall be submitted for review within three weeks of receiving follow-on work authorization. The following techniques shall be included for evaluating and determining the most cost effective method:

- using a wrecking ball for breaking open roofs/tops of tunnels and void spaces for direct dumping placement of fill material,
- dropping wrecking ball down through downcomer baffles to produce a fill pathway opening for direct dumping placement of fill material,
- dropping wrecking ball down through sample rooms roofs/floors to produce a fill pathway opening for direct dumping placement of fill material, and
- the heavily reinforced void spaces (e.g., 3X ball room in 105-C, etc.) existing under the reactor should be evaluated for the need of filling to provide stability and/or prevent future subsidence.

The filling techniques should consider use of conveyors, slurry pumping, as well as direct deposit, etc.,

- removal of asbestos lagging, transite, and/or other hazardous material required by Federal, State, and Local requirements. Variances from the norm shall be well substantiated and documented,
- demolish the various building levels in a safe and cost-effective manner that protects the worker and the reactor blocks containment integrity. All equipment, structures, and material outside the shielding walls shall bé dispositioned with the most cost-effective means. In almost every case the items can be ripped-out with D&D techniques that most generally utilize brute force, (i.e., wrecking ball, bull-dozer, explosives, etc.). Only those structures that require removal to facilitate other work should be demolished. Therefore, the need to remove above grade walls that will reside within the berm shall be evaluated and the most cost effective means implemented.

must be marked in such a way that the boundaries of each unit can be easily defined. Three permanent survey marker control points, referenced to United States Geological Survey or National Geodetic Survey control stations, must be established on the site to facilitate surveys. The control stations must provide horizontal and vertical controls as against USGS or NSG record files.

- The facilities are very similar in design; however, individual differences must be evaluated such as reactor block sizes, building sizes, construction material, etc. The similarities in the facilities and repetitive work efforts will affect cost and work duration as the learning curve improves with innovations and procedural streamlining for each follow-on facility.

The subject request shall use the report format for Conceptual Design Reports (CDR) and cost estimates. The basic approach presented in the initial meetings looks good; only minor rearranging of topics to CDR format will be needed. The preferred method (most cost effective) cost estimate shall be placed in the CDR document.

UNC will receive four copies of all alternative cost estimates evaluated. The document cost estimate shall utilize a work breakdown structure (WBS) to establish a functional tool for tracking jobs, identifying variances, and future project development. The basic WBS (enclosure 2) has been developed and is in the process of being modified and expanded for the specific alternatives. The cost estimate shall use the D&D liquidation rates provided by Decommissioning Services/Planning on March 19, 1984. The cost estimates shall use the five-year budget forecast information provided by Decommissioning Services/Planning (March 19, 1984) as guidelines for establishing a levelized work effort ceiling. The current budget funding level will be the only guidelines on developing alternatives for determining the most cost-effective plan.

The Conceptual Design Report and Cost Estimate for the subject facilities are requested by June 29, 1984, in support of the long-range plan targeted for issue July 31, 1984. The close schedule between the two documents will require maintaining a flow of information from the CDR as it is developed. UNC requires the review and concurrence points provided in enclosure 3. This cooperation has worked well in the past and is imperative in meeting this schedule.

ENCLOSURE I
TO
REQUEST FOR CONCEPTUAL DESIGN REPORT/COST ESTIMATE FOR IN-SITU DECOMMISSIONING SHUT-DOWN REACTOR 105 FACILITIES IN THE 100 AREAS

Work Plan

In-situ decommissioning means disposing of the reactor facility in place--as opposed to hauling it away for disposal elsewhere. It is accomplished by installing some form of long-term protective barrier that will isolate the radioactive residues from pathways to man.

For the Hanford production reactors, the only in-situ decommissioning alternative considered practical would consist of a mound of clean earth and concrete rubble. The earth would be taken from local gravel pits near the reactor sites, and the clean concrete rubble would be provided by the demolished reactor building superstructures. Although such an earthen mound would not provide an eternal barrier between the reactor block and the surrounding soils, it would provide a degree of environmental isolation superior to that achievable by dismantling the high-integrity reactor shields and block and then burying the disturbed radioactive material in a conventional shallow land low-level waste disposal site. The 9000-ton reactor block, left intact, would serve as its own high-integrity, long-term radiological burial container. A typical reactor block consists of a strong steel outer shell, a 40 to 80 inch thick biological shield comprised of alternating layers of steel and Masonite, and an 8 to 10 inch thick cast iron thermal shield, all encasing a very stable stack of graphite blocks. This structure could reasonably be expected to provide long-term containment capability under environmental conditions far harsher than any that may be encountered in the dry Hanford soil. And even if by accident or design the reactor block were opened up, any radionuclides still remaining within it would be chemically "locked up" in the physical matrix of cast iron and graphite and would not readily migrate to the environment or contaminate human food pathways.

These 42 to 56 foot high, 3 to 5 foot thick reinforced concrete walls would provide a strong extra barrier around the reactor block and would assist in retaining the buried materials in one place. Then the entire facility site would be filled in and mounded over with earth, gravel and building superstructure rubble to a minimum depth of 5 m (16 feet) above the reactor block. The mound would be sloped to minimize run-off erosion, blended with the surrounding terrain, covered with topsoil, and seeded to establish indigenous, shallow-rooted plant growth.

In addition to meeting the technical requirements for decommissioning, the in-situ decommissioning mode as described here would yield very favorable cost, schedule, and occupational radiation exposure figures. The materials and equipment required for this mode are all simple, relatively inexpensive, and available on the Hanford Area. The concrete rubble for the backfill and mound will come from the demolished reactor building superstructure. And for the clean earth/gravel component, the Hanford Area abounds in richly graveled alluvial agglomerates that are ideally suited for forming erosion-resistant earth barriers. This indigenous material is abundantly available near the reactor sites, and can be trucked to the work sites using ordinary earth moving equipment and procedures. About 100,000 yd^3 plus of dirt would be needed for each reactor facility backfill and mound. Gravel pits for this material are close by. For example, the earth for the F Reactor fill would be taken from gravel pit No. 18, about 2 miles from the reactor site. Other convenient gravel pits are available for the other reactors. Once installed, the mounds would require minimal maintenance, and would not have to be removed or modified after any specified time period. The in-situ decommissioning mode described here is an immediate, permanent, and complete decommissioning method for the shut-down Hanford production reactors.

(Plan 1) 1.3.1.6 Collapse Structure Outside Shielding Walls

(Plan 2) 1.3.1.6 Remove and/or Open Roofs/Floors and Fill Structure Outside Shielding Walls with Minimal Structure Removal/Collapsing.

1.3.1.7 Fill Space Within Shielding Walls

1.3.1.8 Remove Structure Above Shielding Walls (reduce shielding wall height)

1.3.1.9 Mound Area with a minimum of 16 ft (5 meters) over the Reactor Block

1.3.1.9.1 Move Rubble to within Mound perimeters

1.3.1.9.2 Load, Haul, Place

1.3.1.9.3 Compact

1.3.1.9.4 Stabilize and Revegetate Surface

1.3.1.10 Civil Survey Location

APPENDIX G

Physically Handicapped Assessment

Total Pages: 1
Date: 3-2-87

Accessibility for the Handicapped

The proposed project requires physically capable workers to do construction and demolition work for the restoration of the site to near natural conditions and is therefore exempt from compliance with the Architectural Barriers Act (P.L. 90-480) and follows instructions in the Federal Management Regulation (41 CFR 101-91.6). This project will not inhibit proper access to the site for authorized personnel.

APPENDIX H

Plant Forces Work Review

Total Pages: 2
Date: 3-2-87

This Plant Forces Work Review was prepared using the Decommissioning Conceptual Study (DCS) draft cost estimate and no differences in the work plan are reflected in the finalized DCS.

UNI-2898 REVO

PLANT FORCES WORK REVIEW

Review Request No. UNC 84- 70

Date 9/19/84

Title	Project or Work Order or A.R. No.	Area	Bldg. No.
In-Situ Decommissioning Of The Eight Shut-Down Reactor 105 Buildings In The 100 Areas		100 B,D,H, F & K	105 B,C D,DR,H,F, KE & KW

Operation Authorizing Work	Operation to Accomplish Work
UNC - Decommissioning Services Section	

COMPLETE DESCRIPTION OF WORK TO BE PERFORMED

DESCRIBE THE WORK TO BE PERFORMED AND DISCUSS THE FOLLOWING POINTS:

A. Relationship of this job to associated work (program or physical association) planned or underway either by plant or construction forces.

B. Performance of work by construction forces at the same or adjacent locations at the same time.

C. Nature and cost of any work on foundations, structures, or general utility systems.

A. UNC Decommissioning Services will in-situ decommission the eight shut-down reactor 105 Buildings in the 100 Areas. Decommissioning the reactor buildings involves the major tasks of contamination fixing, demolition, and burial. The decommissioning work will be performed by UNC personnel, site D&D workers, an off-site explosives consultant, and an off-site earth moving contractor. Initially, decommissioning workers will fix loose contaminants to the extent necessary to prevent radionuclide release during building demolition. Areas below grade will be filled with slurry, rubble, and/or soil, so decontamination or fixing in these areas will be minimal. Contamination on surfaces which could disperse to other areas when disturbed can be removed by dry vacuuming, or the contamination will be fixed using either a latex-based film or a sodium silicate solution. Each stabilized reduced structure will be mounded over with approximately 300,000 (plus) cubic yards of pit run gravel by a subcontractor capable of expeditious movement of large volumes of earth.

B. Decommissioning does not plan or anticipate any work adjacent to plant forces.

C. Decommissioning of facilities is primarily radiological characterization, stabilization, demolition, and burial for in-place disposal.

ESTIMATED COST OF WORK

* 1. PROCURED EQUIPMENT	$ 1,013,000
* 2. MATERIALS OR EQUIPMENT PURCHASED FOR SHOP FABRICATION	0
3. SHOP LABOR (INCLUDING IME)	0
* 4. JOB SITE MATERIAL	-
5. JOB SITE LABOR (INCLUDING IME)	39,273,000
6. OTHER COST (DESIGN, FIELD INSPECTION, AND CONTINGENCY)	1,947,000
7. GENERAL OVERHEAD	-
TOTAL JOB	$ 41,220,000

* Include estimated fair value or new cost of material or equipment acquired on site

UNC NUCLEAR INDUSTRIES

Based on careful consideration of all aspects of the work as described above, the work is hereby assigned to UNC Nuclear Industries forces for performance.

SUBMITTED [redacted] (Name)

APPROVED K. L. Schlueter for K. E. Fields (Name)

CONCURRENCE [illegible] (Counsel)

UNITED STATES DEPARTMENT OF ENERGY

The work assignment specified above has been reviewed and is approved.

Chairman, Labor Standards Board [illegible] 10/10/84

BO-5400-153 (3-83)

APPENDIX I

Outline Specifications

Total Pages: 2
Date: 3-2-87

OUTLINE SPECIFICATIONS

DIVISION 2 - SITEWORK

Section 02070 Selective Demolition

1. Demolish concrete, steel, and masonry with wrecking ball.
2. Demolish concrete with explosives.
3. Cut structural and reinforcing steel.
4. Move and distribute rubble.
5. Cap utilities.

Section 02200 Earthwork

1. Backfill: Gravel as defined in ASTM D 563 with less than 15% passing the No. 50 sieve.
2. Mound Cover Stabilization: Broken basalt rock, 3 inch minimum size.

Section 02900 Landscaping

1. Topsoil: As defined in ASTM D 563.
2. Shallow rooted indigenous plants.

DIVISION 3 - CONCRETE

Section 03300 Cast-In-Place Concrete

1. Survey Monuments per HPS AC-5-31.

Section 03363 Specially Placed Concrete

1. Weak Concrete Slurry: Pumped into place, minimum strength, 300 psi at 28 days.

DIVISION 9 - FINISHES

Section 09805 Special Protective Coatings

1. Fixative Coatings for Contamination Control: Sodium silicate coating or unpigmented latex.

APPENDIX J

Sketches

Total Pages: 26
Date: 3-2-87

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Section A-A B,D&F Plants	J-4
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Floor Plan DR Plant	J-6
Section A-A DR Plant	J-8
Section B-B DR Plant	J-9
Floor Plan C Plant	J-10
Section A-A C Plant	J-12
Section B-B C Plant	J-13
Floor Plan H Plant	J-14
Section A-A H Plant	J-16
Section B-B H Plant	J-17
Floor Plan K East & K West Plants	J-18
Section A-A K East & K West Plants	J-20
Section B-B K East & K West Plants	J-21
Mound Contour Plan (105-B,D&F)	J-22
Mound Contour Plan (105-DR)	J-23
Mound Contour Plan (105-C)	J-24
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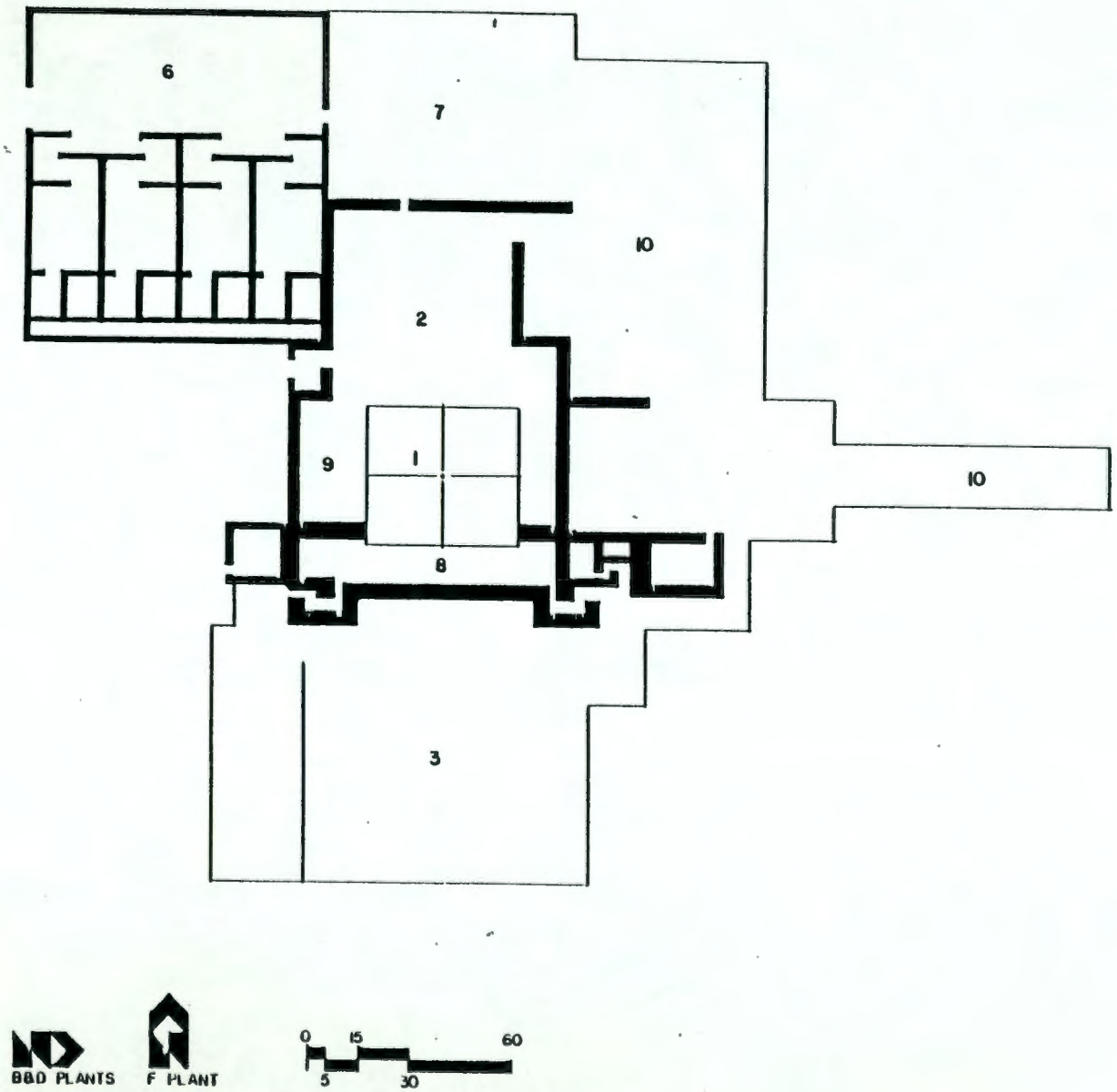
Mound Contour Plan (105-K East & K West)	J-26



FLOOR PLAN B,D&F PLANTS

ELEVATION 0'-0"

LEGEND

1 PROCESS AREA (Reactor Block)
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS

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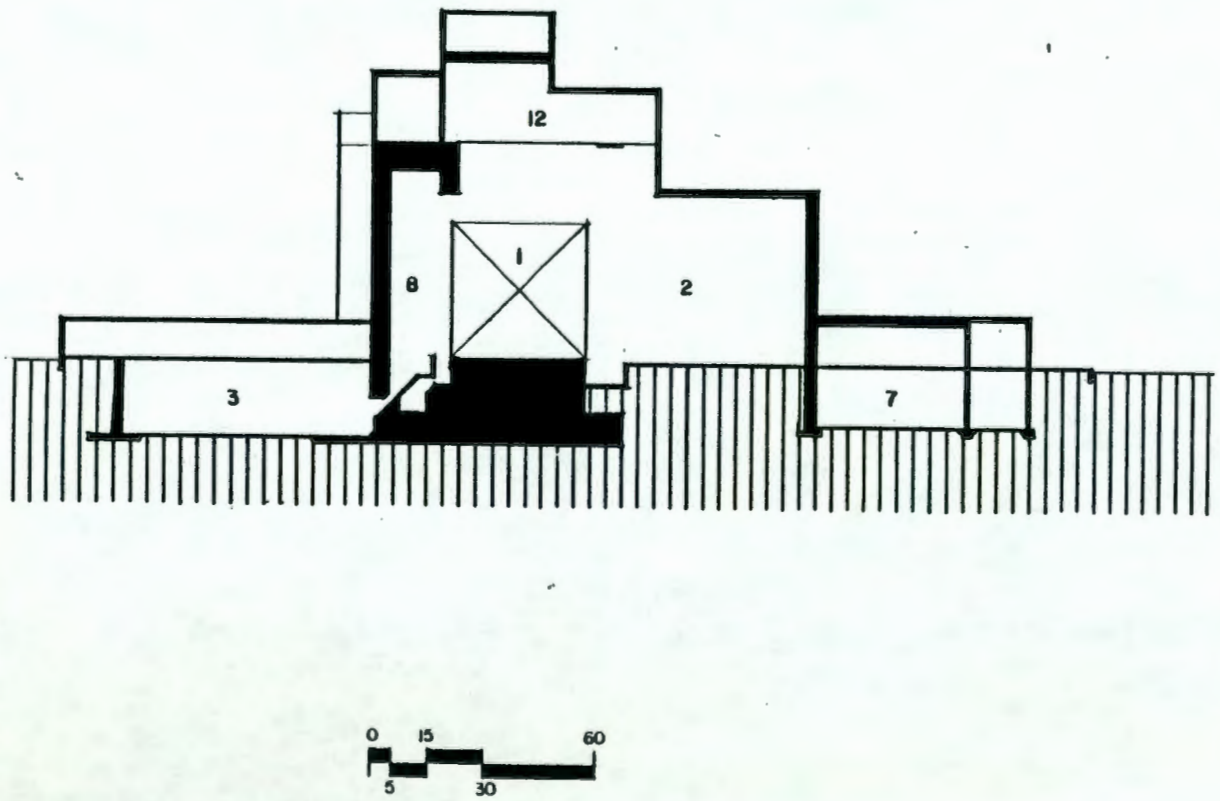

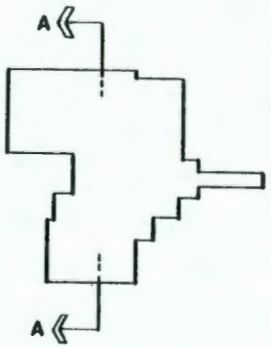

SECTION A-A B,D&F PLANTS

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS
11 MISC. BELOW GRADE ROOMS
12 MECHANICAL EQUIP. ROOMS

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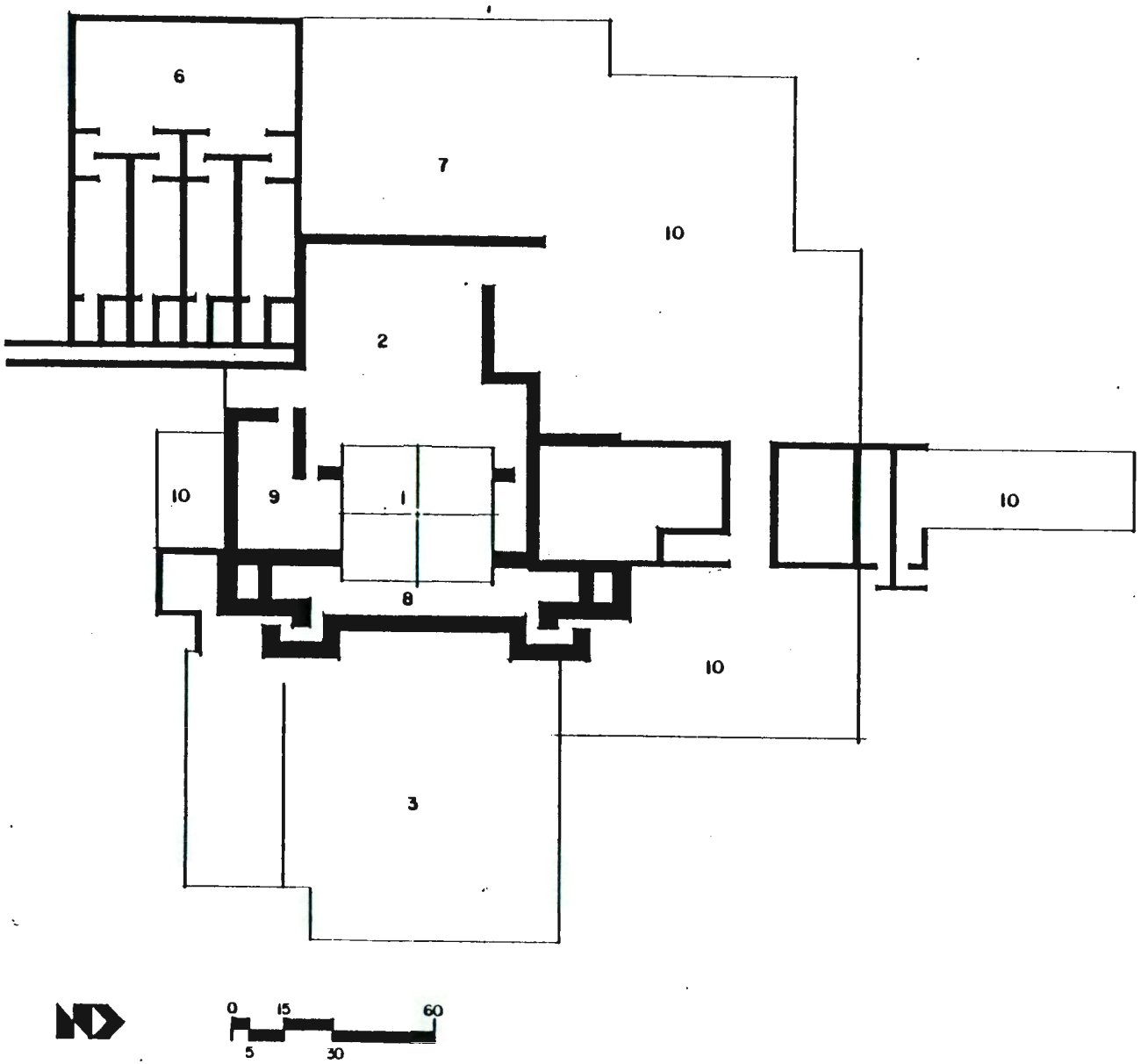
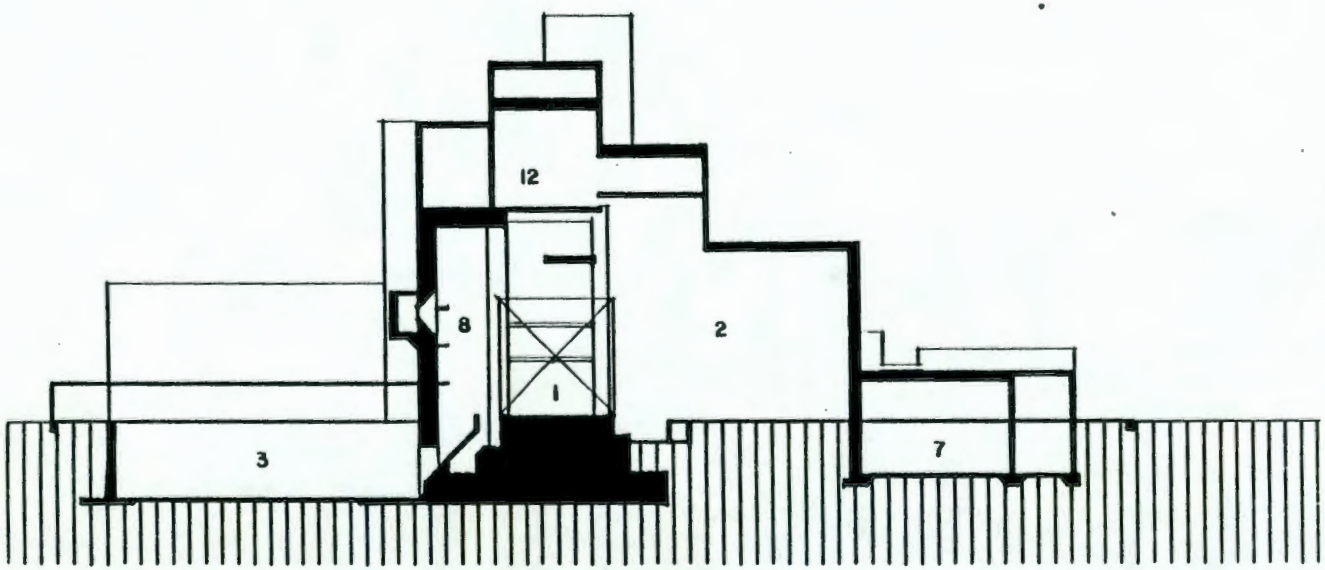


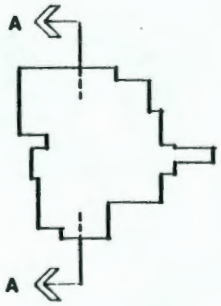
FLOOR PLAN DR PLANT

ELEVATION 0'-0"

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY
10 MISC. ABOVE GRADE ROOMS

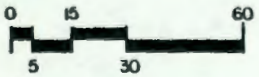


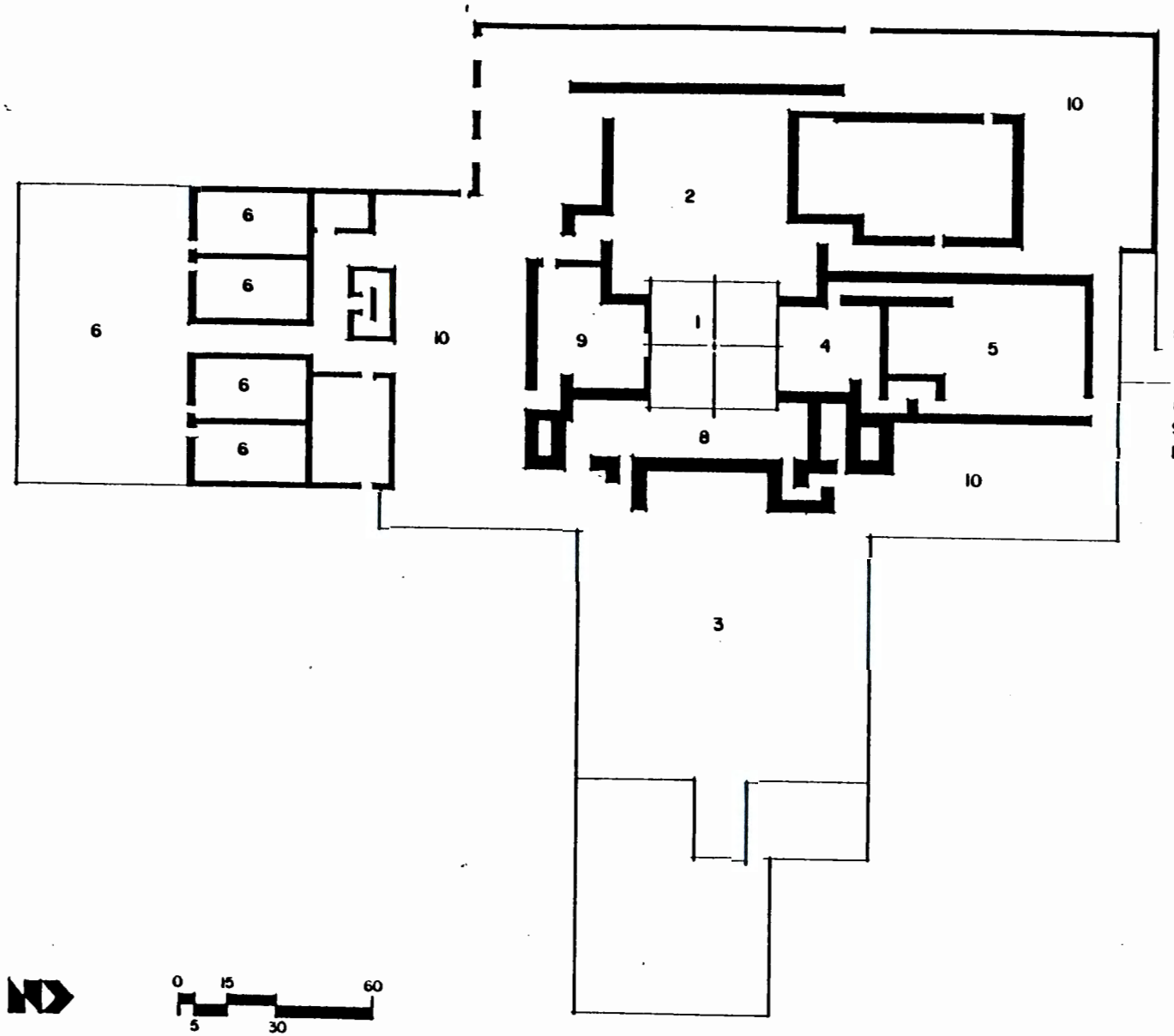


SECTION 'A-A' DR PLANT

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY
10 MISC. ABOVE GRADE ROOMS
11 MISC. BELOW GRADE ROOMS
12 MECHANICAL EQUIP. ROOMS





FLOOR PLAN 'C' PLANT

ELEVATION 0'-0"

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY/EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC ABOVE GRADE ROOMS

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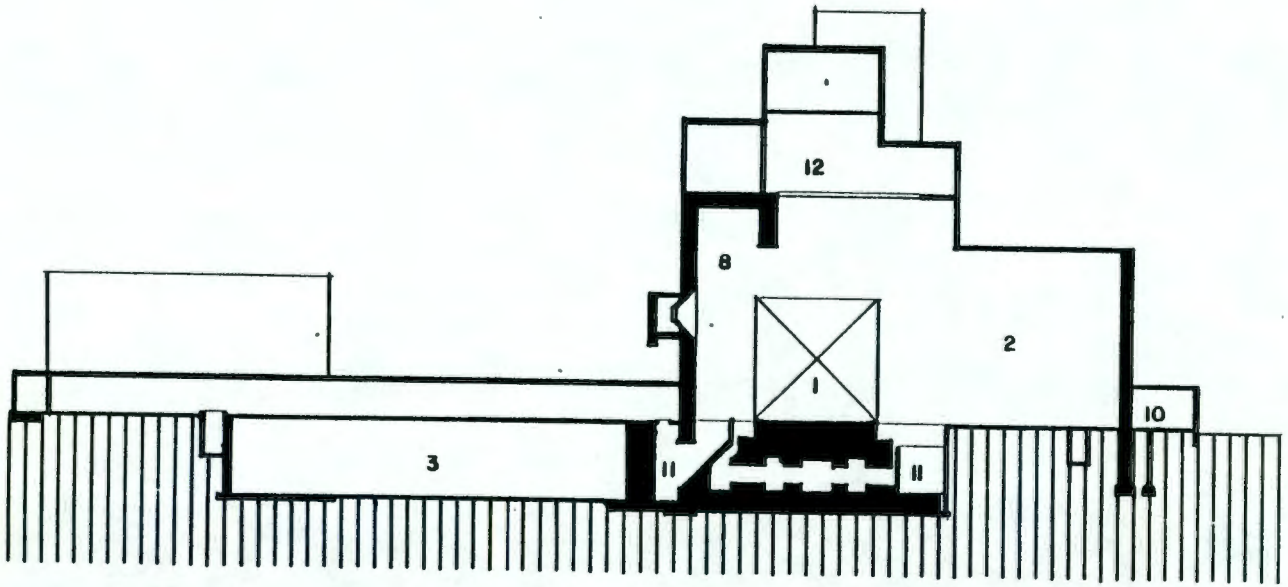
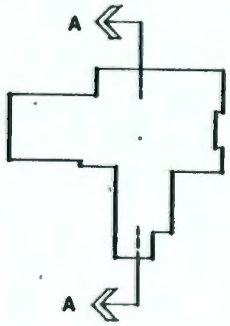
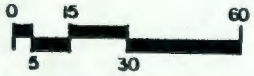




SECTION 'A-A' C PLANT

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS
11 MISC. BELOW GRADE ROOMS
12 MECHANICAL EQUIP. ROOM



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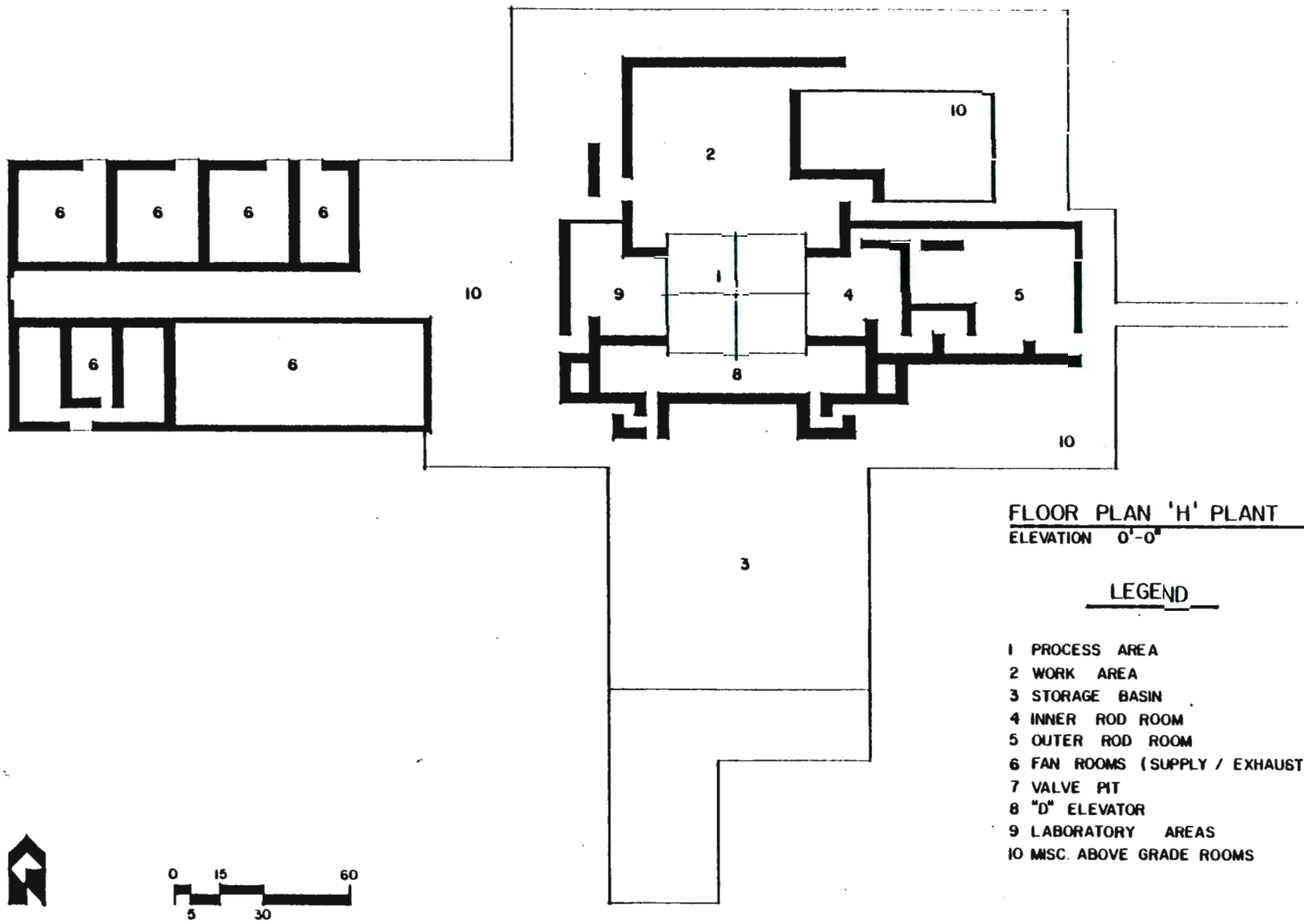

FLOOR PLAN 'H' PLANT
ELEVATION 0'-0"

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS

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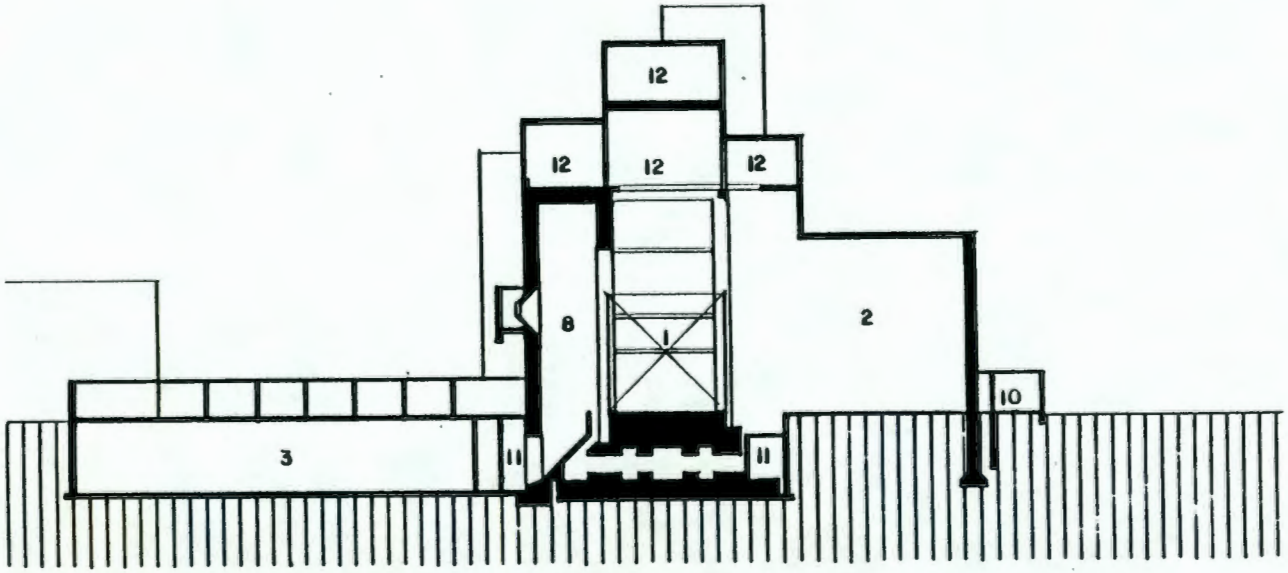
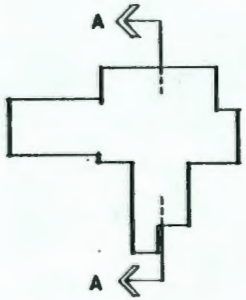
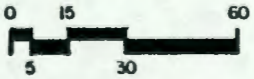




SECTION A-A 'H' PLANT

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS
11 MISC. BELOW GRADE ROOMS
12 MECHANICAL EQUIP ROOMS



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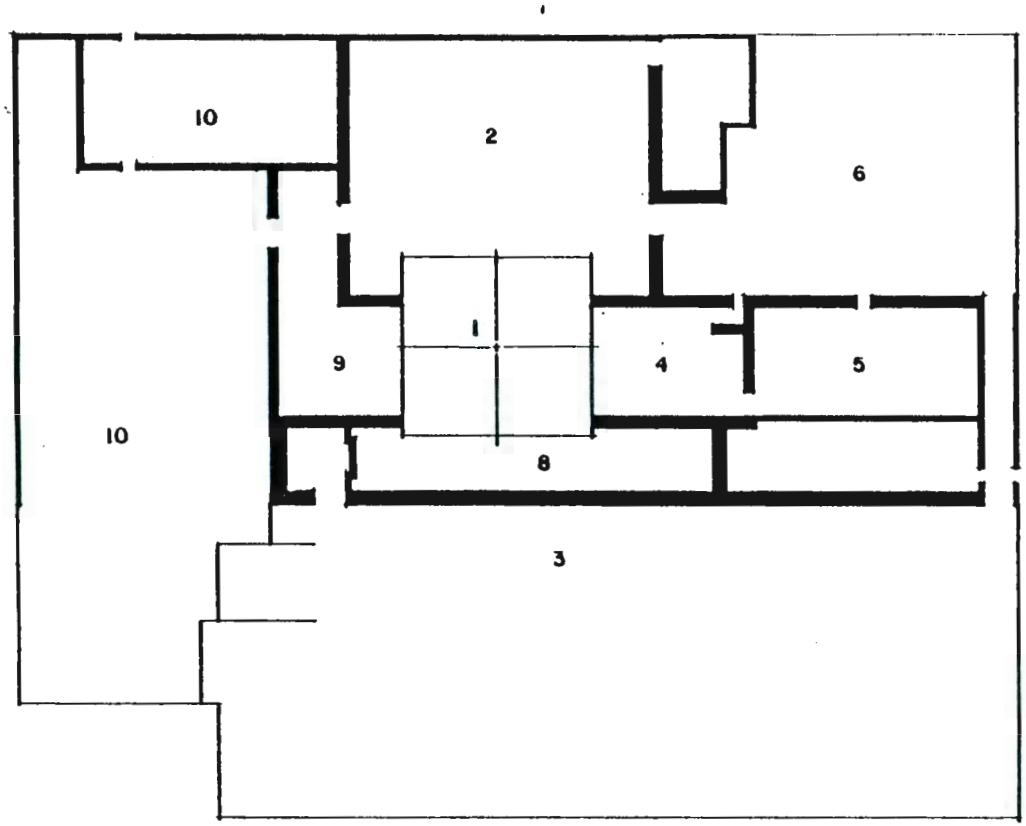

FLOOR PLAN K EAST & K WEST PLANTS EL. 0'+0"

LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS

0 15 60
5 30

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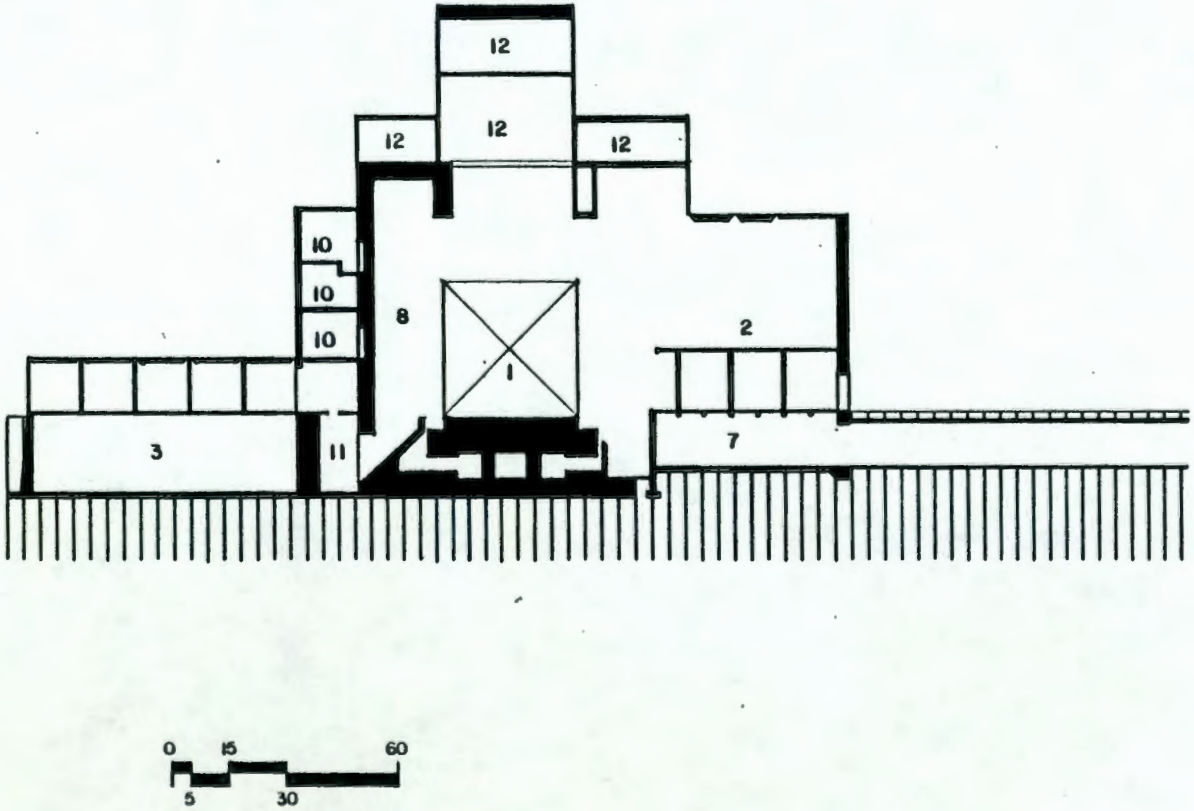
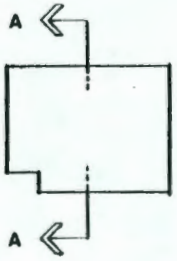
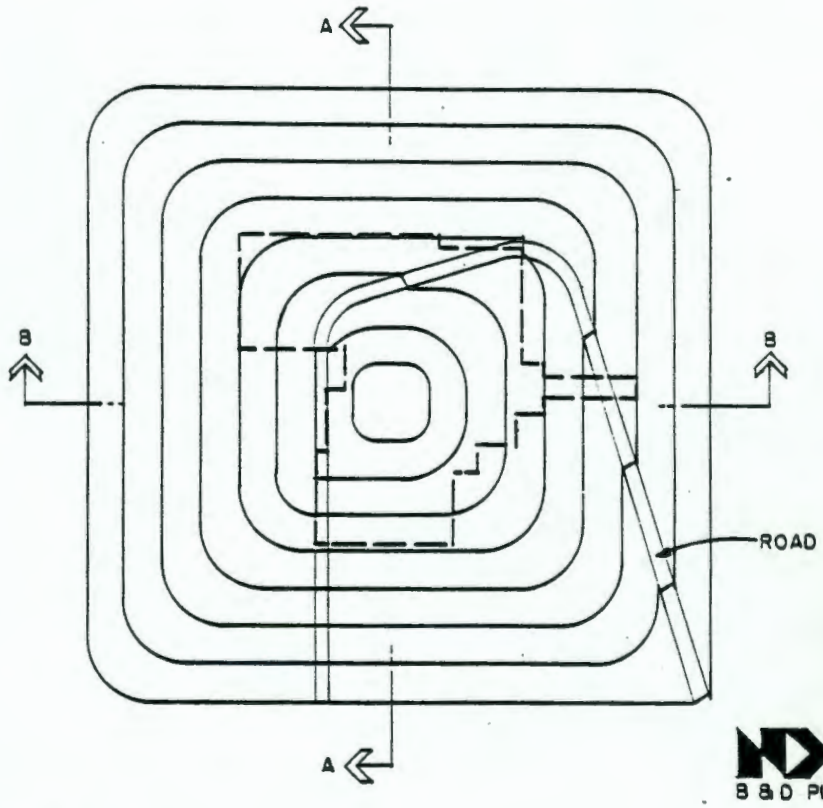


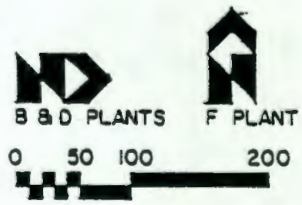


SECTION 'A-A' K EAST & K WEST PLANTS

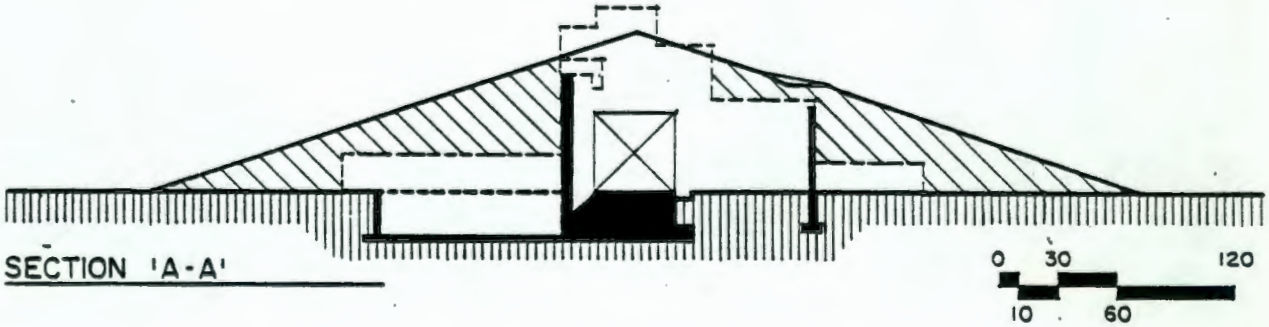
LEGEND

1 PROCESS AREA
2 WORK AREA
3 STORAGE BASIN
4 INNER ROD ROOM
5 OUTER ROD ROOM
6 FAN ROOMS (SUPPLY / EXHAUST)
7 VALVE PIT
8 "D" ELEVATOR
9 LABORATORY AREAS
10 MISC. ABOVE GRADE ROOMS
11 MISC. BELOW GRADE ROOMS
12 MECHANICAL EQUIP. ROOMS

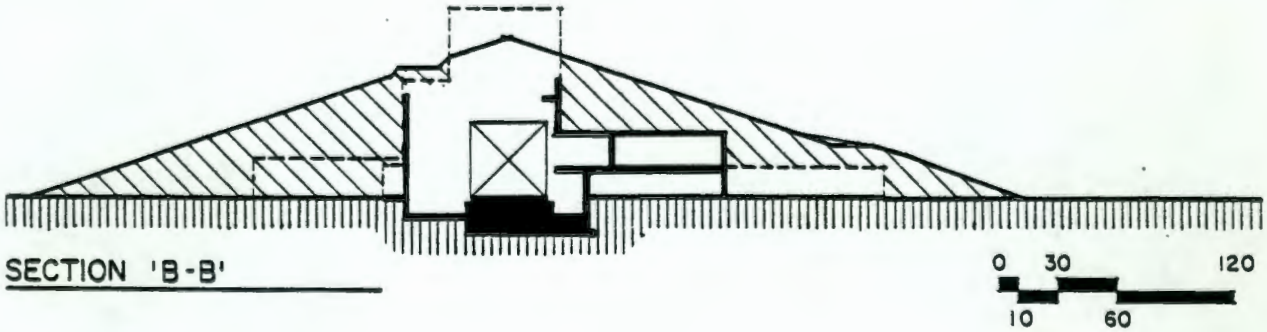




MOUND CONTOUR PLAN
(105-B,D & F)



SECTION 'A-A'



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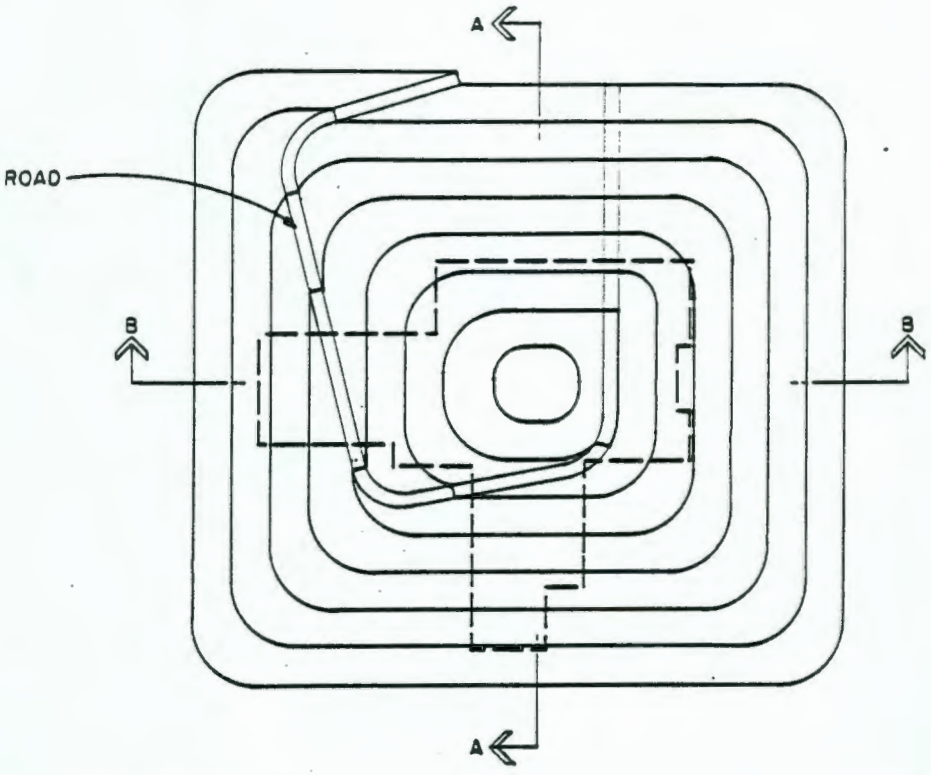
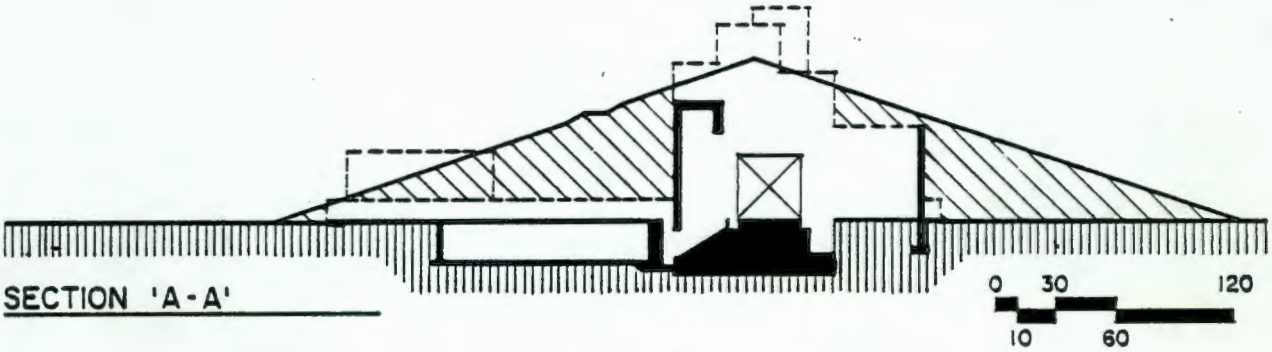


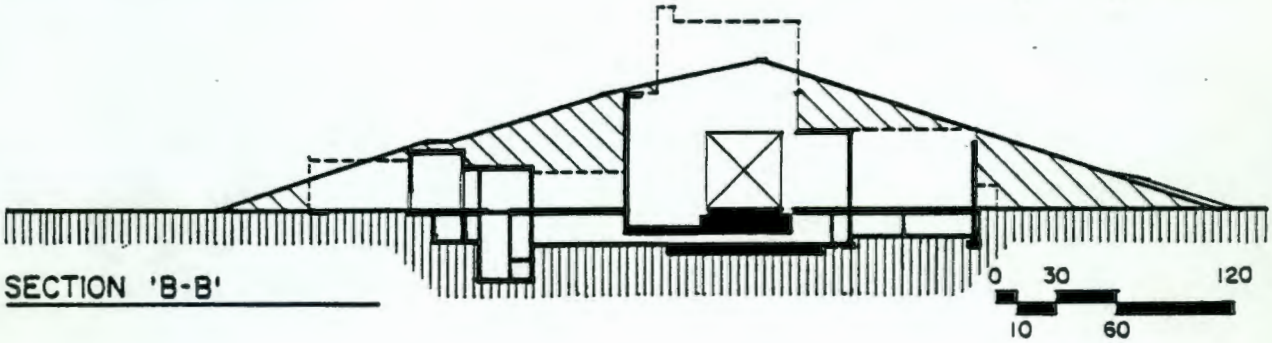
MOUND CONTOUR PLAN
(105-C)

0 50 100 200



SECTION 'A-A'

0 30 120
10 60



SECTION 'B-B'

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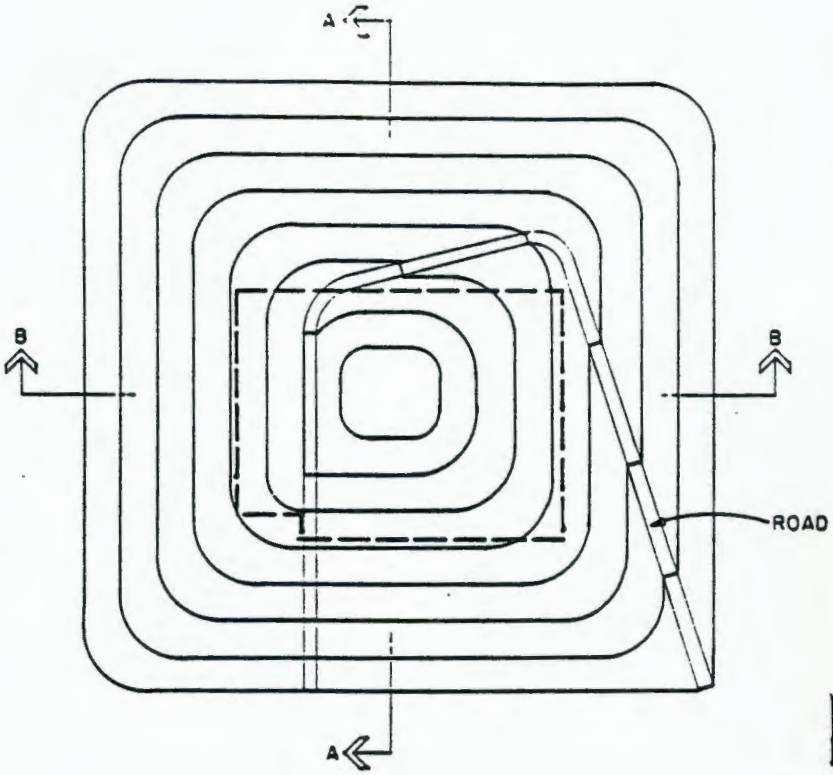
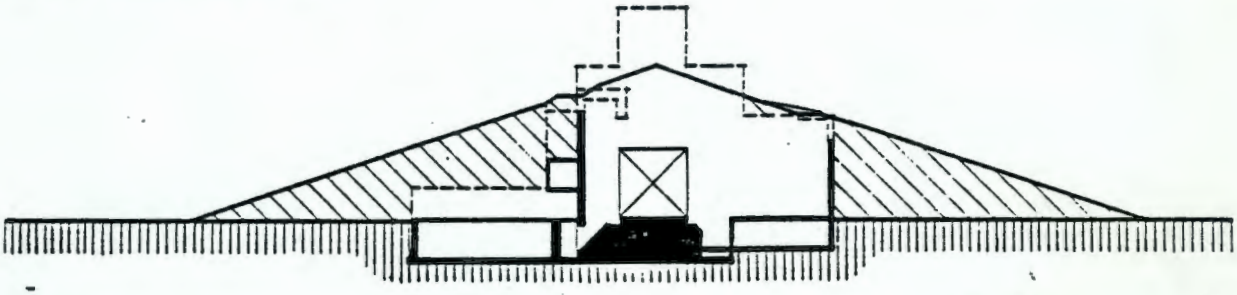
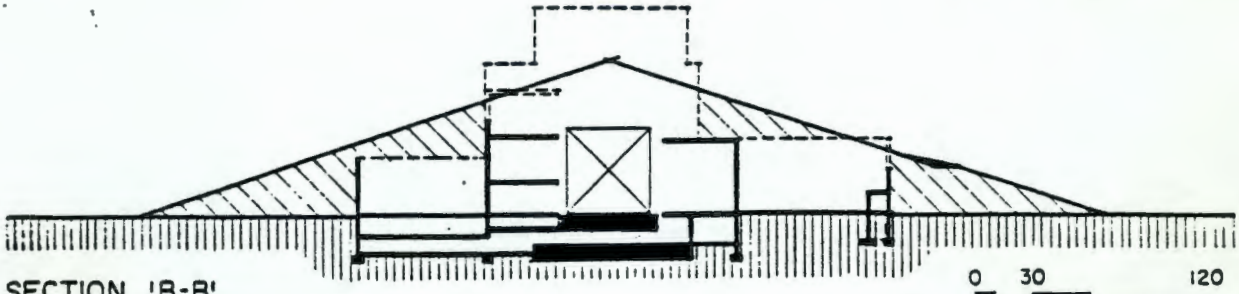
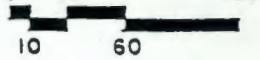
10 60



MOUND CONTOUR PLAN
(105-K EAST & K WEST)



SECTION 'A-A'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