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1977 ELECTRIC UTILITIES ENGINEERING CONFERENCE

March 13-25, 1977

SUBJECT NO. 13

CONF-770362--

STATUS OF THE CLINCH RIVER BREEDER REACTOR PLANT

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INTRODUCTION

The Clinch River Breeder Reactor Plant Project, referred to as the CRBRP Project, is the joint Government and industry effort to build the Nation's first large scale demonstration breeder nuclear power plant. The CRBRP is designed to demonstrate the commercial potential and environmental advantages of a large-scale LMFBR as a source of electrical generation in a utility environment.

The Project will be a major step in the successful transition from the Government's 25-year development of LMFBR technology to large-scale demonstration of the fast breeder concept. It will serve as a focal point where, for the first time, individual plant components developed in previous research will be assembled and operated as an integrated unit on a large scale.

Knowledge gained from operation of earlier LMFBR facilities will be incorporated into the CRBRP design, and assumptions regarding economy, reliability, safety, and environmental impact will be tested through on-line operations within a utility system. The resulting information will be available to both Government and industry for further LMFBR development.

PROJECT OBJECTIVES

The objectives of the Project are aimed at meeting the basic needs for the CRBRP. First, the CRBRP is a necessary step in the evolution of major plant equipment. Each of its heat transfer components is approximately two and one-half times as big as those utilized in the FFTF. That is within the range of size extrapolation successfully handled by high-technology industry. The larger jump from the FFTF size equipments to a fully commercial plant would require major extrapolation, with undue development risks and significant potential for technical problems.

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Second, the CRBRP will develop an industrial equipment manufacturing base for the LMFBR. We have about 15 major vendors under contract now to supply equipment, and, before the project is complete, hundreds of industrial concerns will be providing technology and equipment to support the project. Thus, we are developing the industrial organizations that will supply equipment for the prototype large breeder reactors and for the commercial units to follow.

Third, the total design, manufacturing, licensing, and construction experience developed through the Project will be a necessary ingredient for encouraging the required investment in a commercial breeder reactor industry. This confidence will be developed not only in the utility industry but also in the reactor manufacturers, the fuel suppliers, and the equipment suppliers. Without this confidence, further progress in the commercialization of the LMFBR would be impossible.

Fourth, we will fully develop the necessary safety, licensing, and environmental precedents in an open regulatory forum. Each of the significant issues raised will be openly addressed and resolved. The precedents set by the licensing of the CRBRP will define to the utility industry those design features in an LMFBR that are acceptable to regulatory agencies, and their resolution will allow the industry to predict a licensing timetable for future LMFBRs with reasonable confidence.

Lastly, the CRBRP will demonstrate reliability, maintainability, and safe operation in the electric utility environment. By participation in this program, the utility industry will gain the confidence that each of its members needs to proceed independently into the planning and construction of its own LMFBRs.

CRBRP DESIGN PARAMETERS

The plant, pictured in Figure 1, is sized at 350 net electric megawatts, or approximately one-third the size of the largest nuclear and fossil-fired power plants being built today. CRBRP technology will be largely prototypic of that to be employed in commercial LMFBRs, although there will be size differences in the equipment.

The overall plant layout is shown in Figure 2. The plant has three primary and intermediate sodium loops and one turbine generator. Flexibility has been included in the design to take advantage of expected advances in technology, such as higher performance fuel. Capability is provided to exploit the potential stretch rating of the nuclear steam supply system by providing a 15-percent capability margin in the turbine generator. The key plant design parameters are summarized in Table 1.

TABLE 1

MAJOR PLANT PARAMETERS

• Thermal Power, MW	975
• Gross Electrical Power, MW	380
• Design Life, Years	30
• Reactor Mixed Mean Outlet - Temp., °F	995
• Steam Pressure at Turbine Throttle, psi	1450
• Steam Temp. at Turbine Throttle, °F	900
• Feedwater Temp., °F	450

DESIGN AND PROCUREMENT PROGRESS

This past year has been an important and eventful year for the Project, not only because the CRBRP has figured in the national news as part of the ERDA program to deal with the energy crisis but also because of the substantial progress made by the Project.

The reference design for the CRBRP has been established and published. It includes all system descriptions, flow diagrams, conceptual general arrangement drawings, equipment list, and Project schedules. The Project has progressed into the detailed design phase and procurement activities. This section summarizes the design and procurement status of some of our major components.

The reactor vessel, shown in Figure 3, is presently in fabrication at Babcox and Wilcox Company under a cost-plus-fixed fee contract placed in May, 1976. The vessel is 20-1/2 feet in diameter and 57 feet tall, and it varies in wall thickness from 2-1/2 to 3-1/4 inches. Figures 4, 5 and 6 picture components of the reactor vessel in fabrication.

The core support structure shown in Figure 7 is the largest structure in the reactor vessel. Final design was the responsibility of the Westinghouse Advanced Reactors Division, and a firm-fixed price fabrication contract was let in March 1976 to Allis Chalmers, Inc. Figures 8 and 9 show fabrication operations.

We are into final design on the core former structure, upper internals structure, and horizontal baffle. Long-lead materials procurement action has been initiated for the core former structure and upper internals structure.

The carbon silicon steel reactor vessel head depicted in Figure 10 has an outside diameter of over 22 feet, a thickness of 22 inches, and a weight of

802,000 pounds. It consists of three offset rotating plugs to enable positioning of the in-vessel fuel handling machine over any location of the core to facilitate timely refueling operations. Long-lead material for the closure head was ordered in January 1975, and a cost-plus-fixed fee contract for manufacture was placed with Chicago Bridge and Iron in November 1975. Figures 11 and 12 show the plugs in fabrication.

The heat transport system includes primary and secondary sodium loops which have identical primary and secondary sodium pumps. Byron Jackson is the vendor for the pumps and will build them on a cost-plus-incentive fee contract placed in June 1975. The pump design shown in Figure 13 is improved over the early conceptual designs. Improvements include a reduction in shaft height of seven feet, easing of net positive suction head requirements, higher mechanical efficiency, and reduced communication with the pump tank. Each pump will deliver 33,700 gpm at a discharge head of 458 feet of sodium. The pump motors are powered by mg sets which supply the variable frequency ac power required to permit load following. Since it is desirable to maintain unity power to flow ratio in an LMFBR, the primary and intermediate pumps must be capable of variable speed operation. The present design permits load following between 40% and 100% of full power.

Atomics International was awarded a letter contract in September 1975 as the vendor for the steam generator module pictured in Figure 14. A prototype unit will be tested in near prototypical operating conditions and may be usable as a spare following testing. The design involves the use of the "hockey stick" concept in which 757 109-mil croloy tubes, 5/8 inch in outside diameter, are back-face welded to the croloy tube sheets. The radius of curvature of the tubes is kept high, and the tube material purity requirements are made stringent by special fabrication processes such as vacuum arc remelting. These requirements are imposed to minimize the potential for flaws in the tubes and tube-to-tubesheet joints.

The intermediate heat exchanger as shown in Figure 15 was designed by Foster Wheeler Energy Corporation under a firm-fixed price contract entered into in July 1975. Foster Wheeler will build the three units required under a change notice to the contract approved in April 1976. The outward appearance of the CRBRP IHX is much like that of the FFTF IHX, but refinements permit much closer tube spacing and thinner tubesheets. Those refinements involve the use of straight tubes, front-face tube-to-tubesheet welds, and a downcomer expansion bellows. We believe that this IHX can readily be scaled up from the CRBRP size to commercial size with only minor additional refinements.

Each IHX has 2350 tubes of 7/8 inch diameter and 45-mil wall thickness, with a heat transfer area of 15,800 square feet. Each transmits 325 MWt of heat at a log mean temperature difference of 68°F.

To summarize, substantial progress has been made in the procurement of major plant equipment. The major hardware contracts placed, listed in Table II, plus those in negotiation cover two-thirds of the total Project equipment costs. Now, with our major long lead items on order, the Project is entering into procurement of build-to-print items.

TABLE II
MAJOR CRBRP EQUIPMENT CONTRACTS

- Containment Vessel
- Reactor Guard Vessel
- Reactor Vessel
- Core Support Structure
- Closure Head
- Control Rod Drive Mechanism
- Check Valve
- Intermediate Heat Exchanger
- IHX Guard Vessel
- Plant Pumps
- Pump Guard Vessels
- Pump Drive System
- Steam Generators
- Sodium Dump Tanks
- Turbine Generator

LICENSING PROGRESS

No discussion of Project status would be complete without a discussion of licensing. The major CRBRP licensing milestones are shown in Figure 16. The Environmental Report was completed in October 1974 and was submitted to the Atomic Energy Commission at that time. Questions were asked by the AEC. When the AEC was split into ERDA and the Nuclear Regulatory Commission early in 1975, NRC continued the questioning. The Project provided answers to add information considered necessary by NRC. After review of the additional information, NRC accepted the Environmental Report for docketing on April 10, 1975.

Additional questions were raised by NRC during its review, and answers were submitted by the Project. NRC issued its Draft Environmental Statement (DES) on February 12, 1976 which was favorable to the Project.

Following a comment period, NRC delayed issuance of the Final Environmental Statement (FES) until some 13 specific issues have been resolved. The Project submitted information to achieve the required resolution of these issues and a very favorable FES was issued on February 6, 1977. The Project is now in preparation for the public hearings expected to begin in April. If all goes well, the Project anticipates the granting of a Limited Work Authorization (LWA) to commence site preparation in August 1977.

While these efforts are under way in the environmental area, there has been a parallel effort on the safety analysis of the plant. The Preliminary Safety Analysis Report was accepted for docketing by the NRC in June 1975. NRC has asked a large number of questions concerning the Report: there were more than 1100 questions in the first round, and over 250 have already been received in the second round. We have answered nearly all of the questions that we have received.

To help ensure a timely Construction Permit, the Project has developed an integrated set of detailed schedules aimed at resolution of specific issues involved in the safety analysis of the plant. With a concentrated Project and NRC effort in the area, we anticipate beginning mat construction in the latter half of 1978.

In late 1975 through mid-1976, the Project submitted information to supplement the PSAR on the subject of hypothetical core-disruptive accidents - probability of occurrence, accident progression, and radiological consequences. The result has been NRC agreement that such accidents need not be included as design-basis events for the CRBRP. Rather, the CRBRP will be shown to provide reasonable margins for protection of public health and safety.

It is clear that the licensing of a first-of-a-kind plant is not an easy task, but the Project is making marked progress: the Environmental Report is docketed, a favorable Final Statement has been issued, we are about to begin

Environmental Hearings leading to an LWA, and anticipatory actions are underway to facilitate a timely Construction Permit.

SUMMARY

To summarize, the nuclear steam supply system for the CRBRP is well along in planning, design, and manufacture. We are staying close to our planned costs, schedules, and spending while achieving our technical objectives. All major long-lead equipment is on order, and build-to-print equipment is entering the procurement process. Our schedule is controlled in the short run by licensing requirements; our immediate need is for the Limited Work Authorization so we can start moving earth.

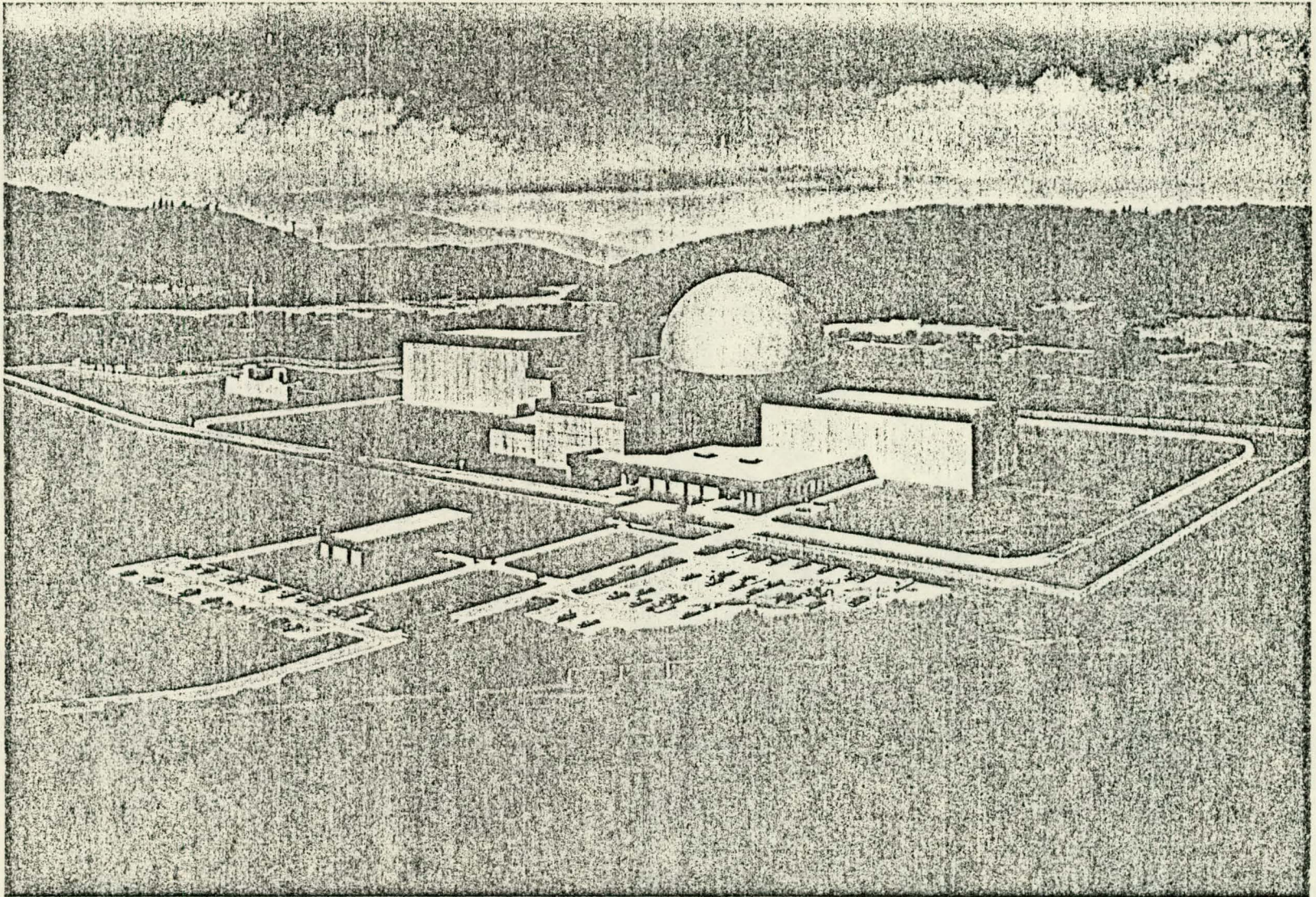
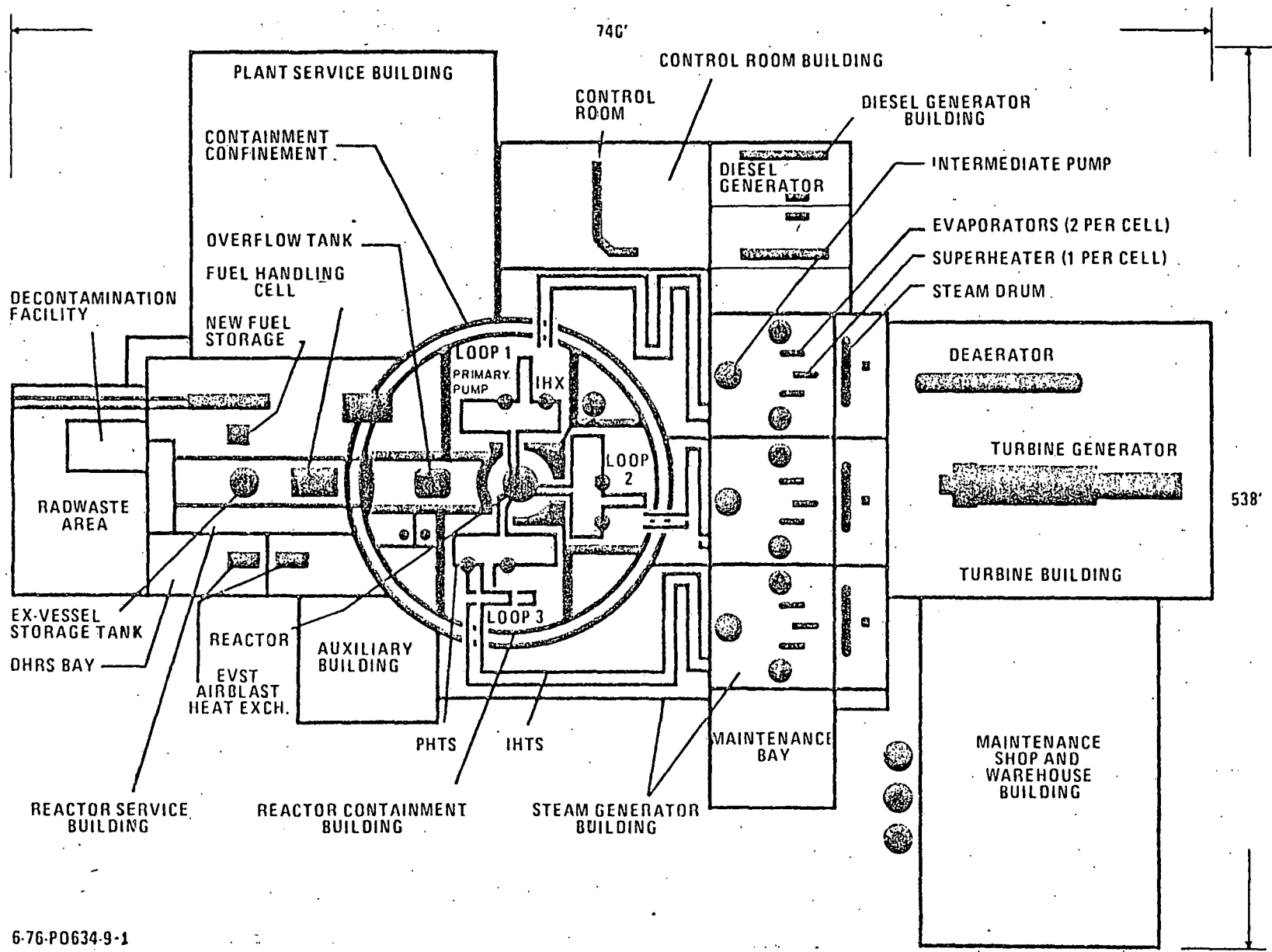


FIGURE 1

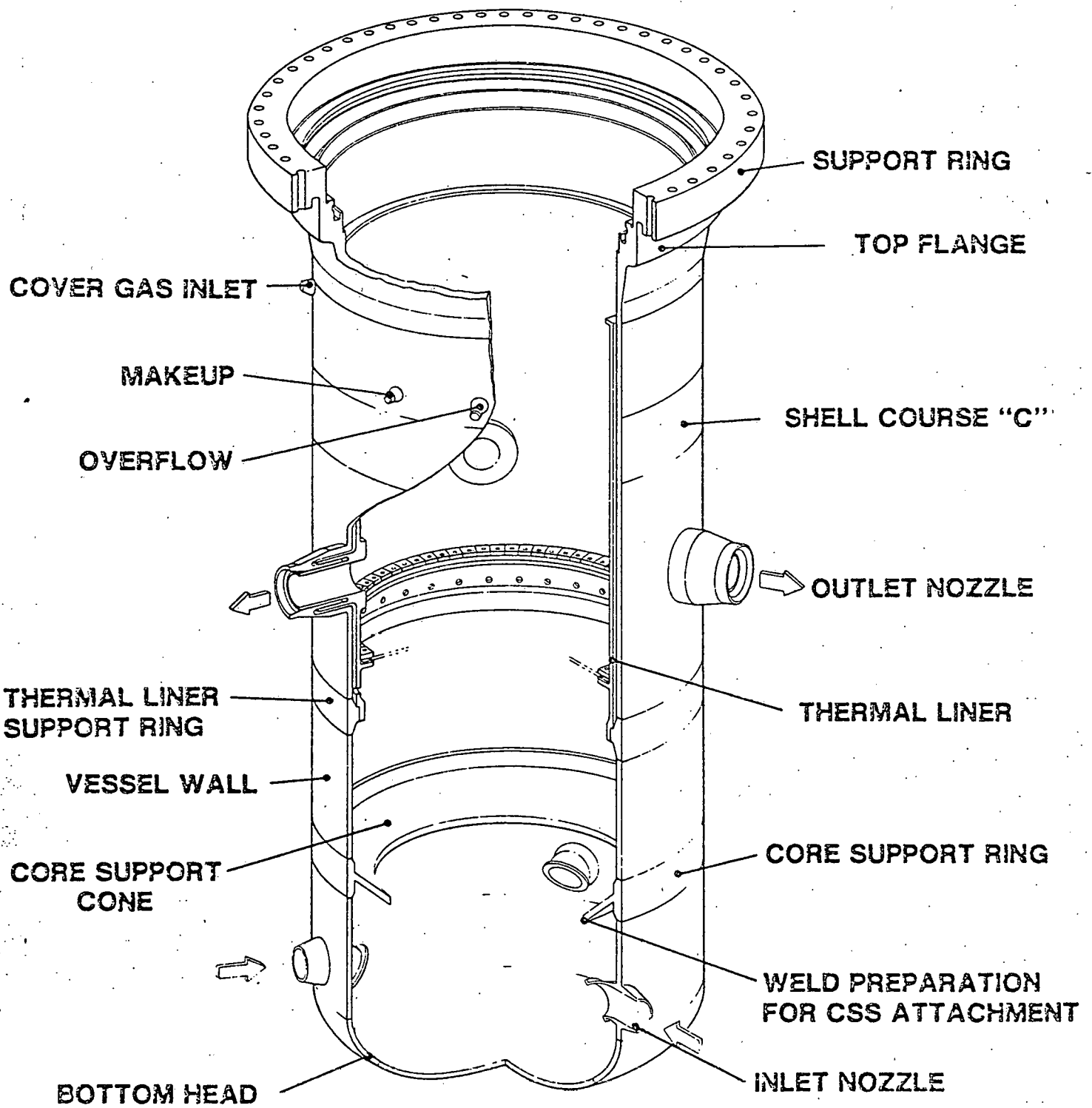
CRBRP OVERALL LAYOUT (PLAN VIEW)



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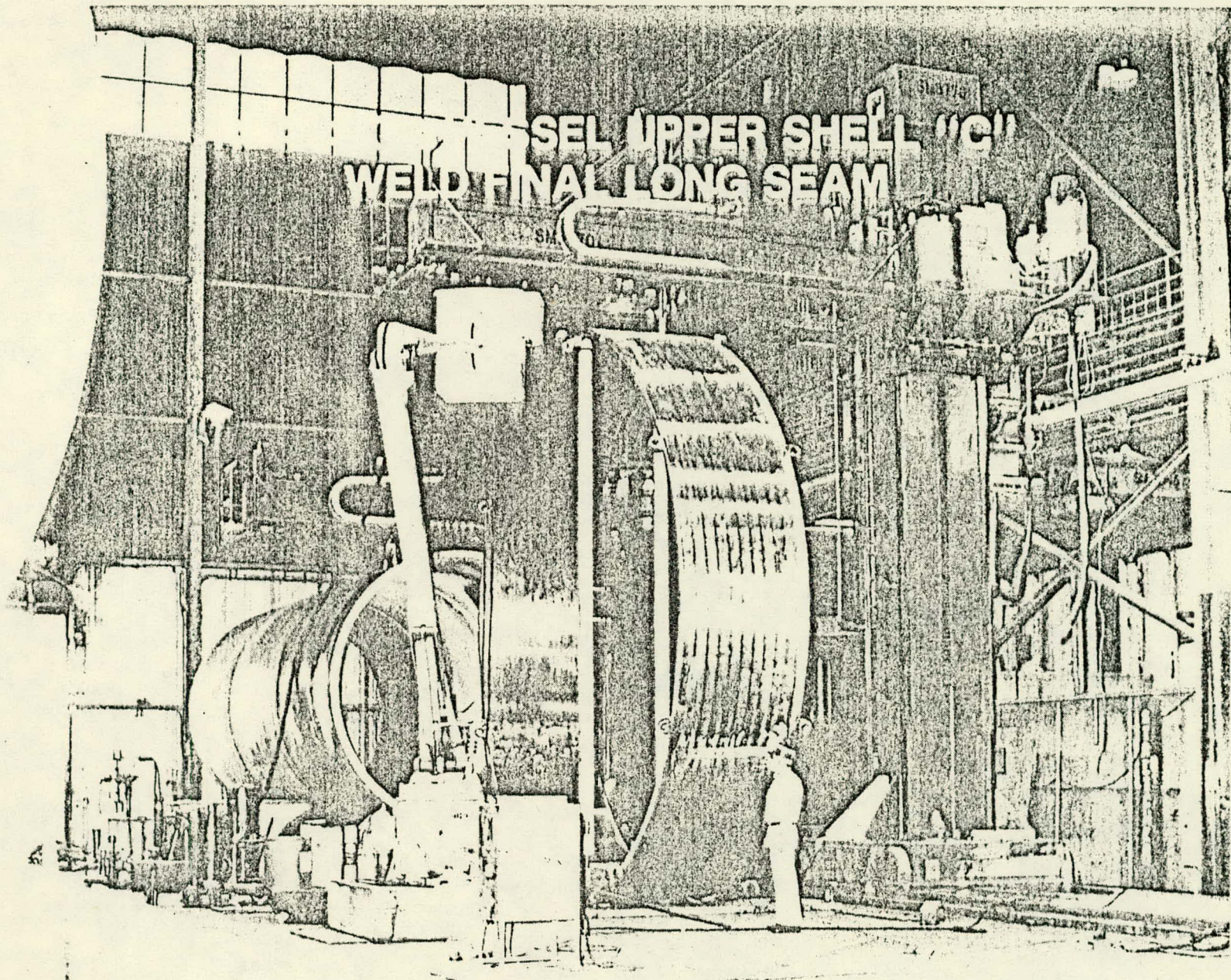
FIGURE 2

REACTOR VESSEL



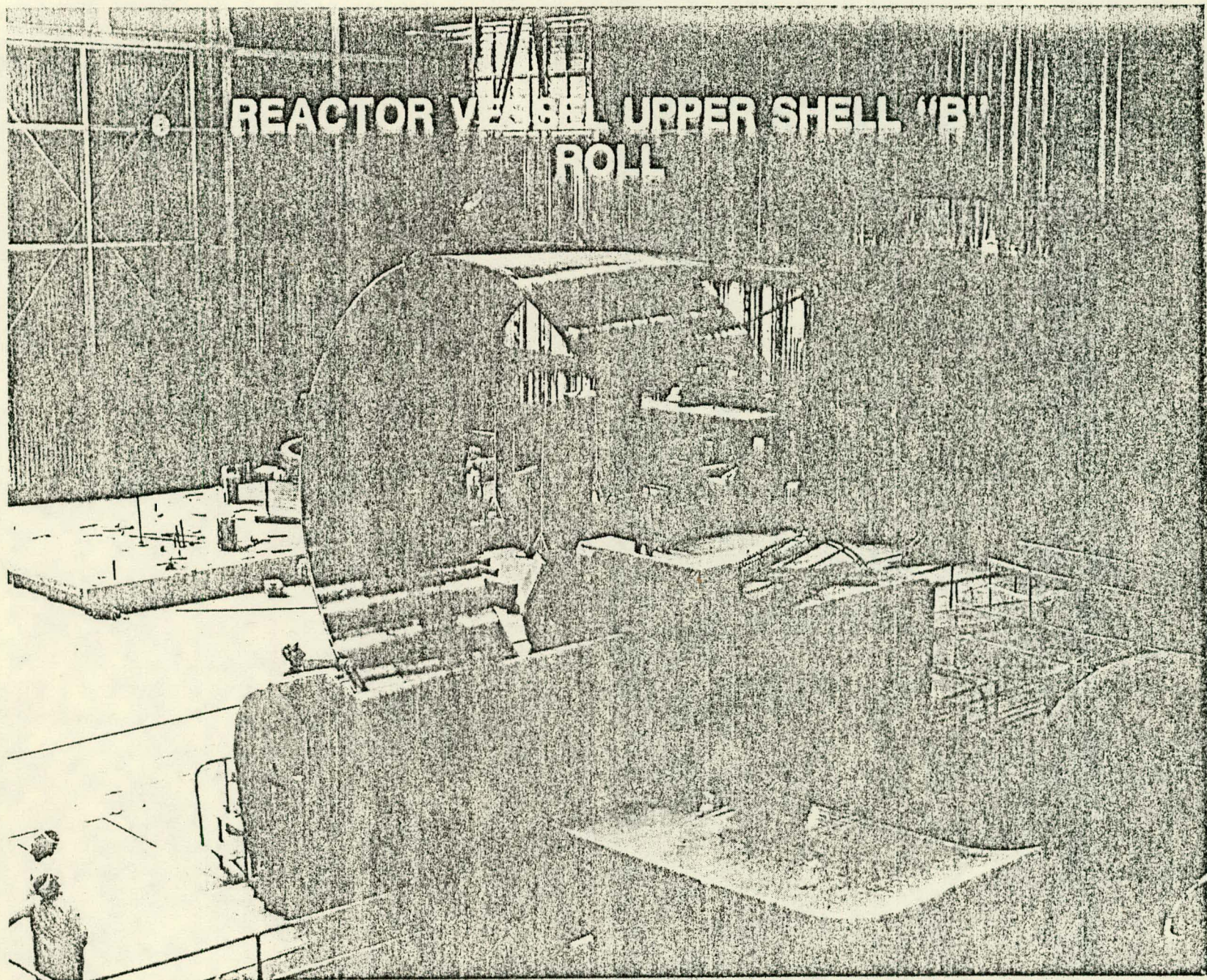
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FIGURE 3



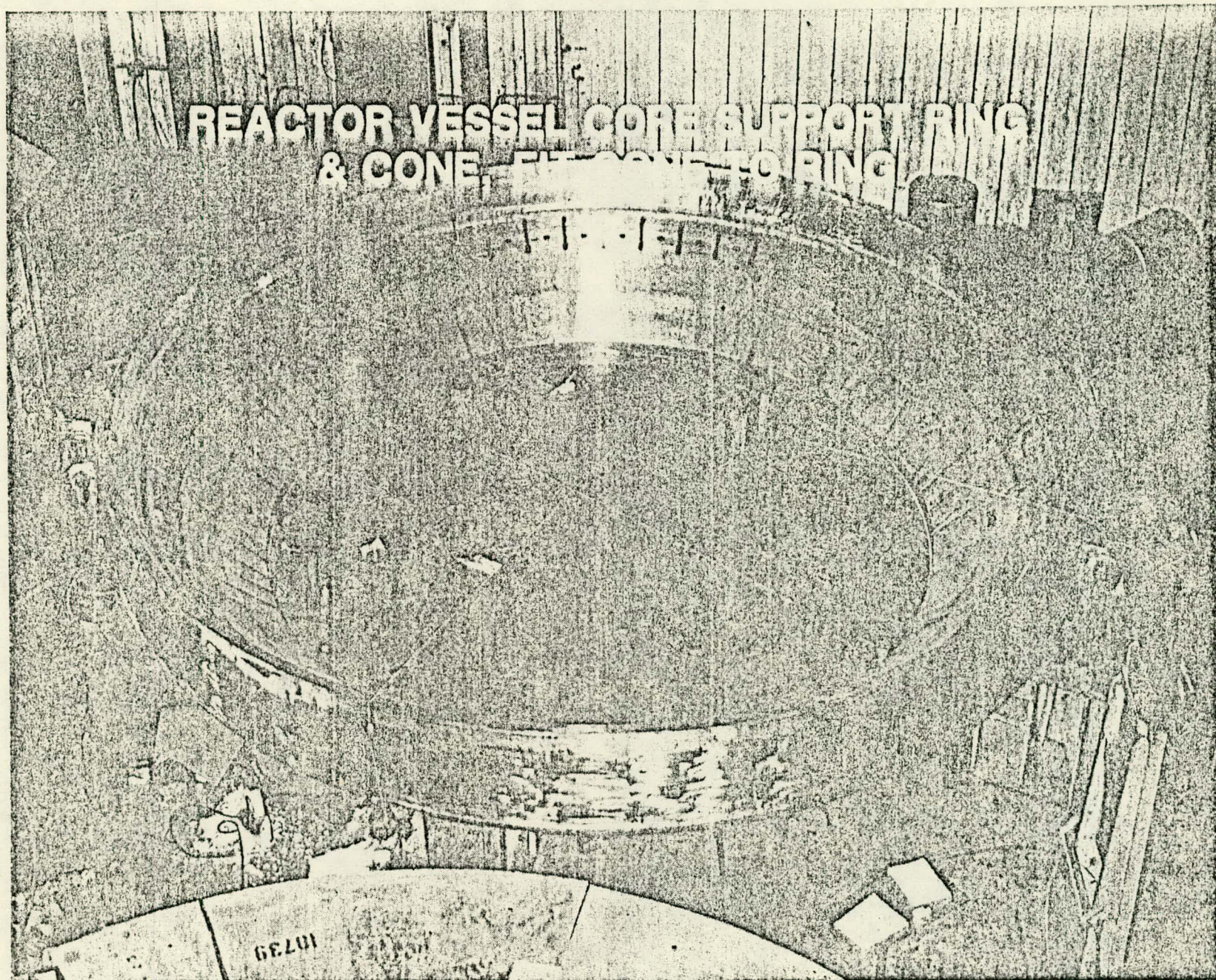
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FIGURE 4



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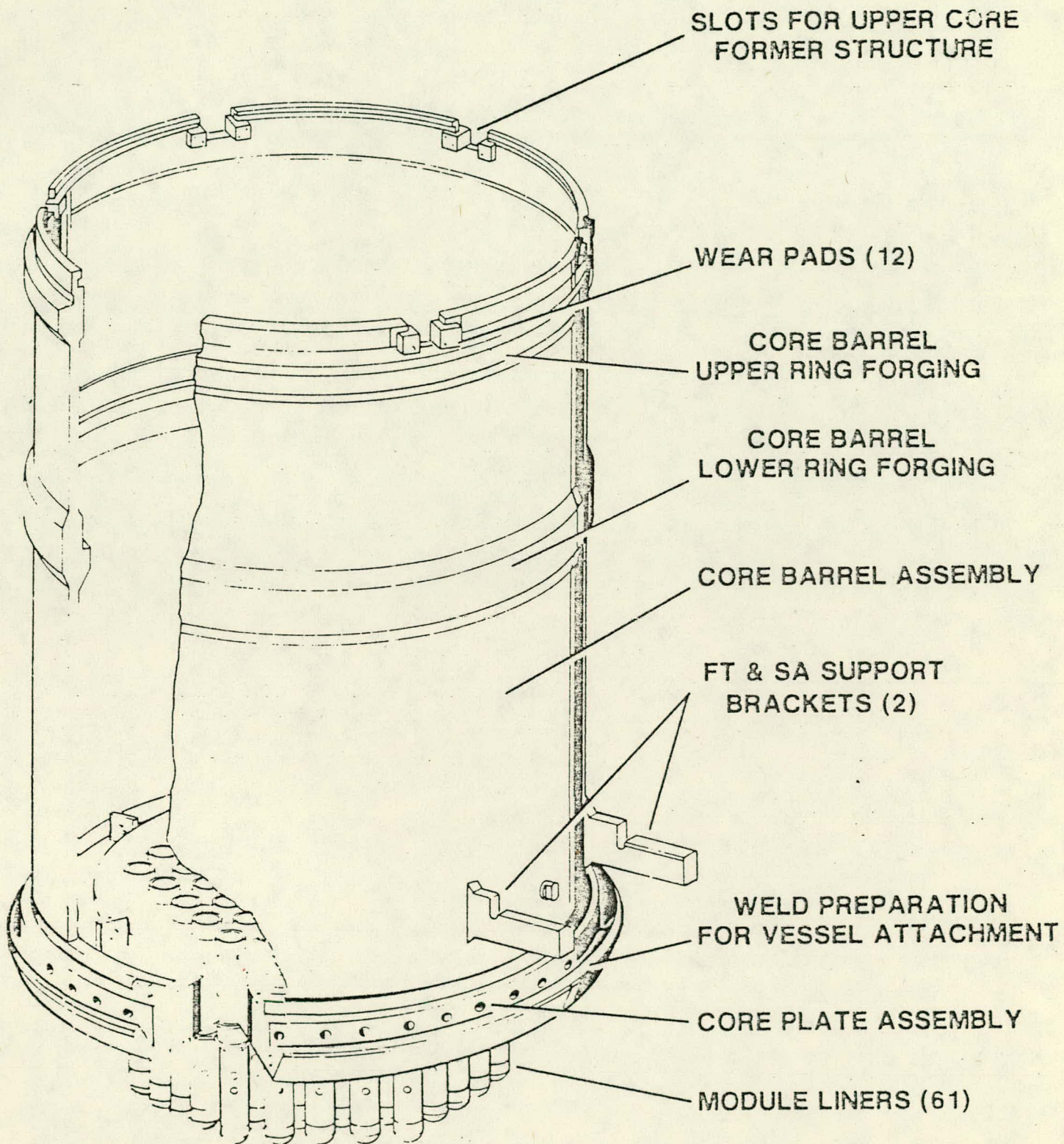
FIGURE 5



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FIGURE 6

CORE SUPPORT STRUCTURE

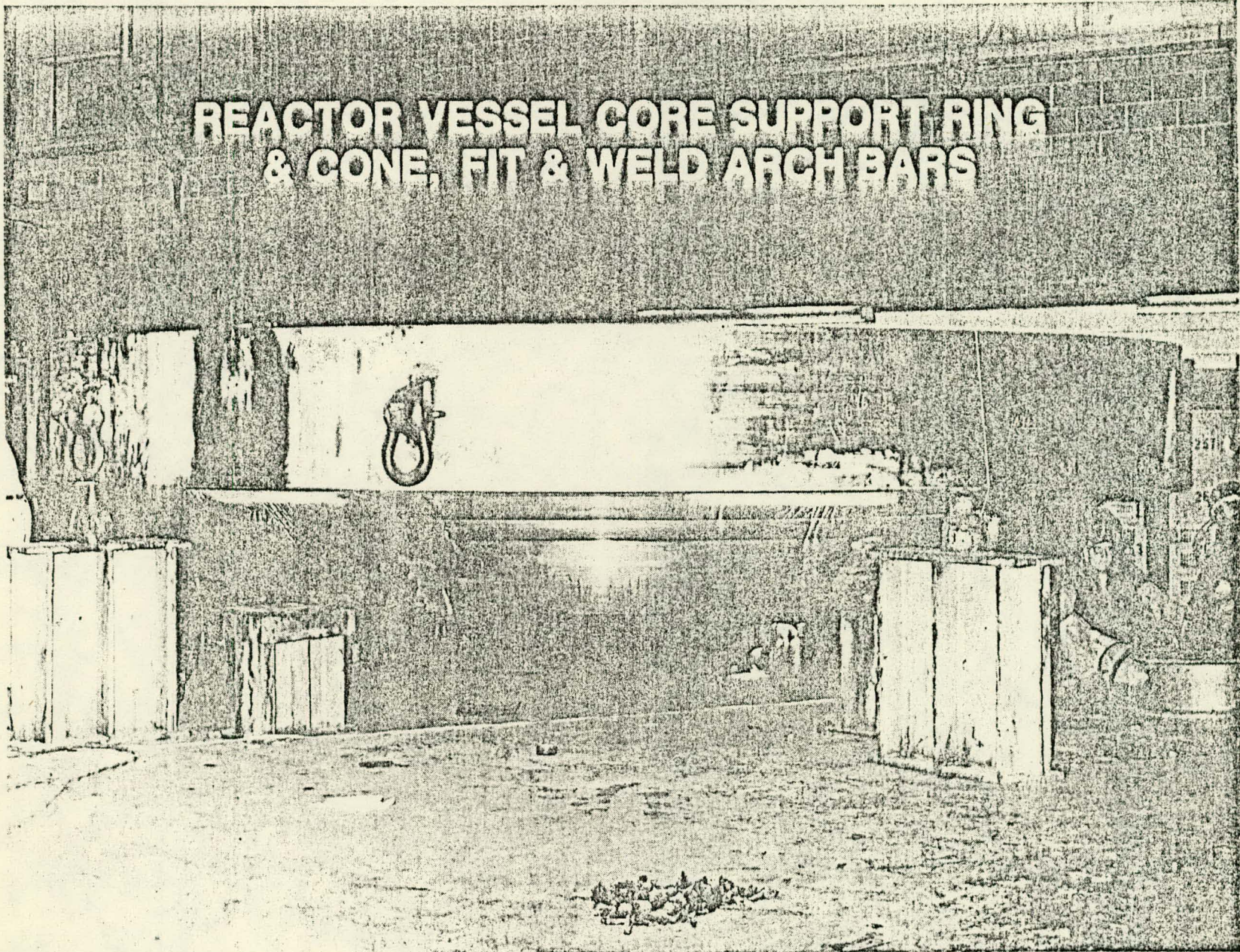


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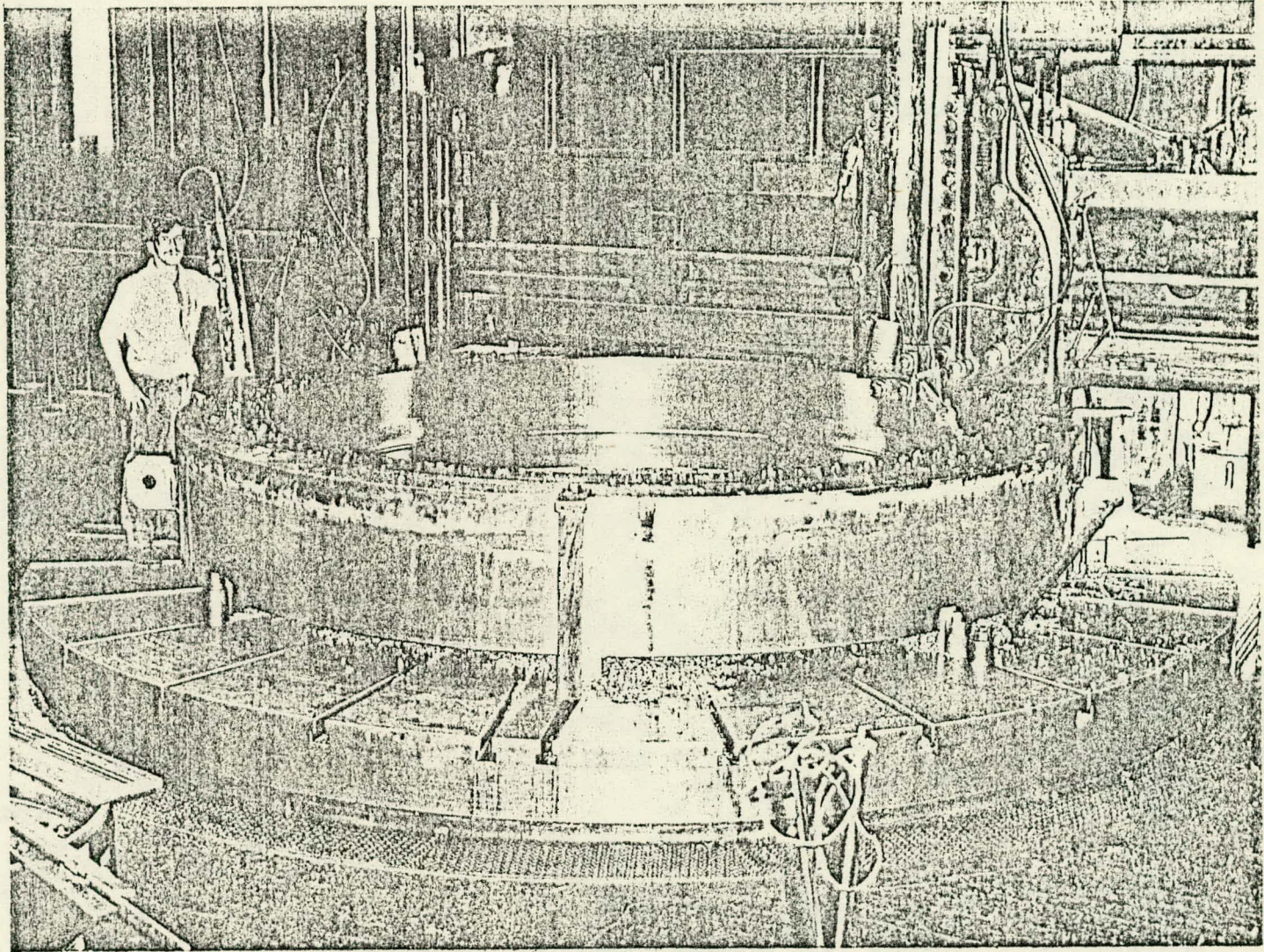
FIGURE 7

**REACTOR VESSEL CORE SUPPORT RING
& CONE, FIT & WELD ARCH BARS**



10-76-P0745-51

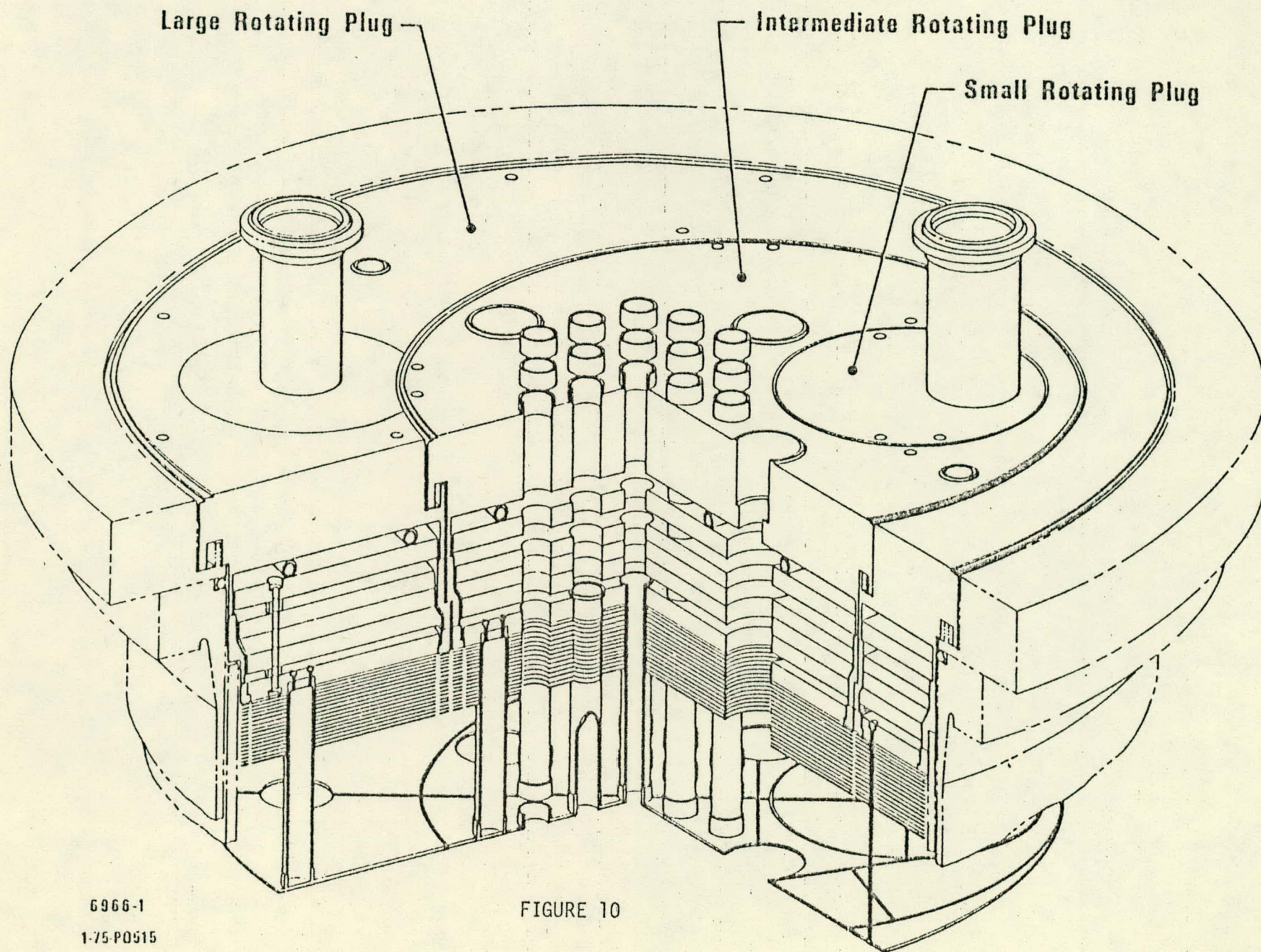
FIGURE 8



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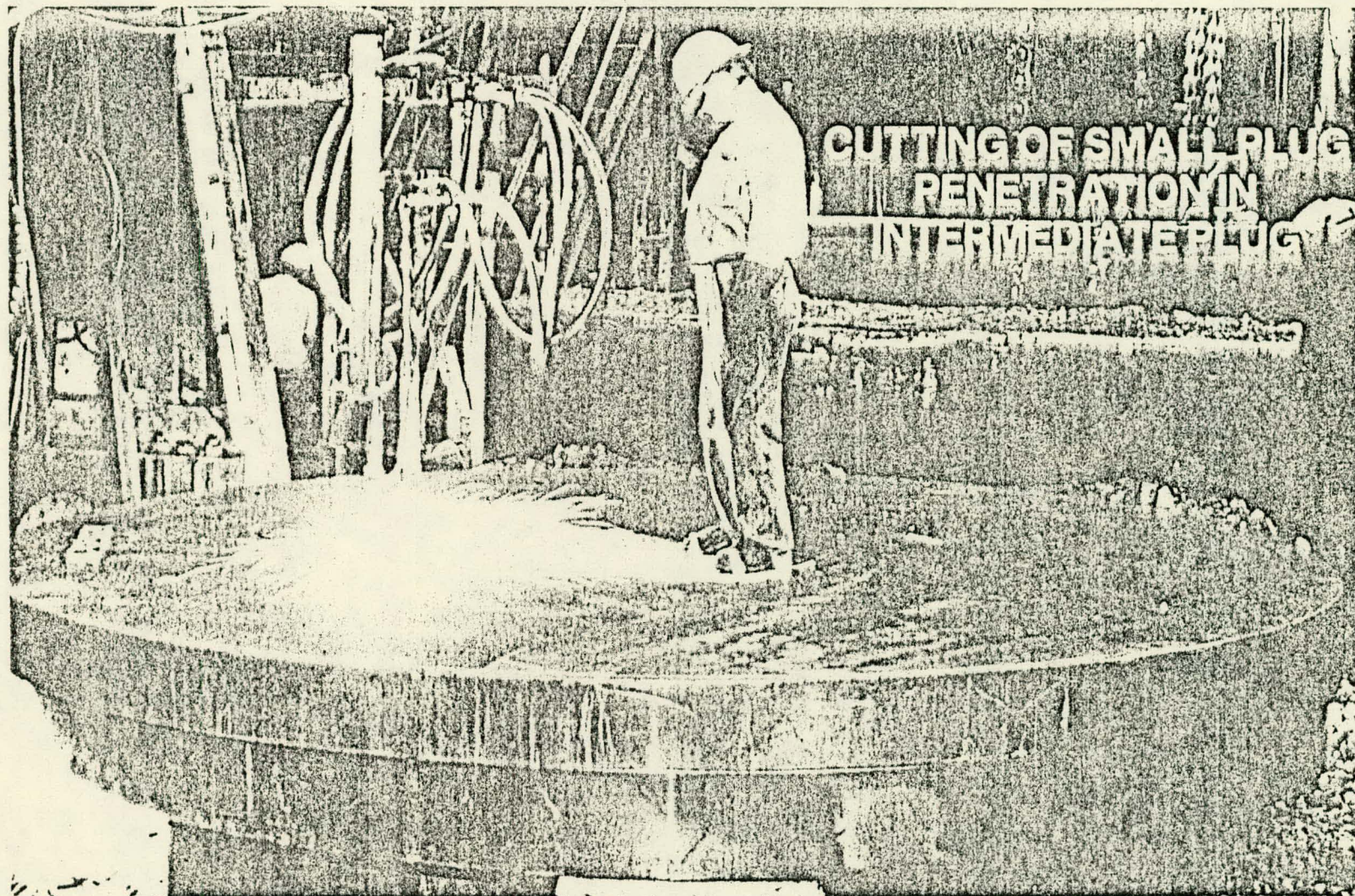
FIGURE 9

CRBRP REACTOR CLOSURE HEAD ASSEMBLY



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1-75-P0515

FIGURE 10



3-75-P0515-50

FIGURE 11

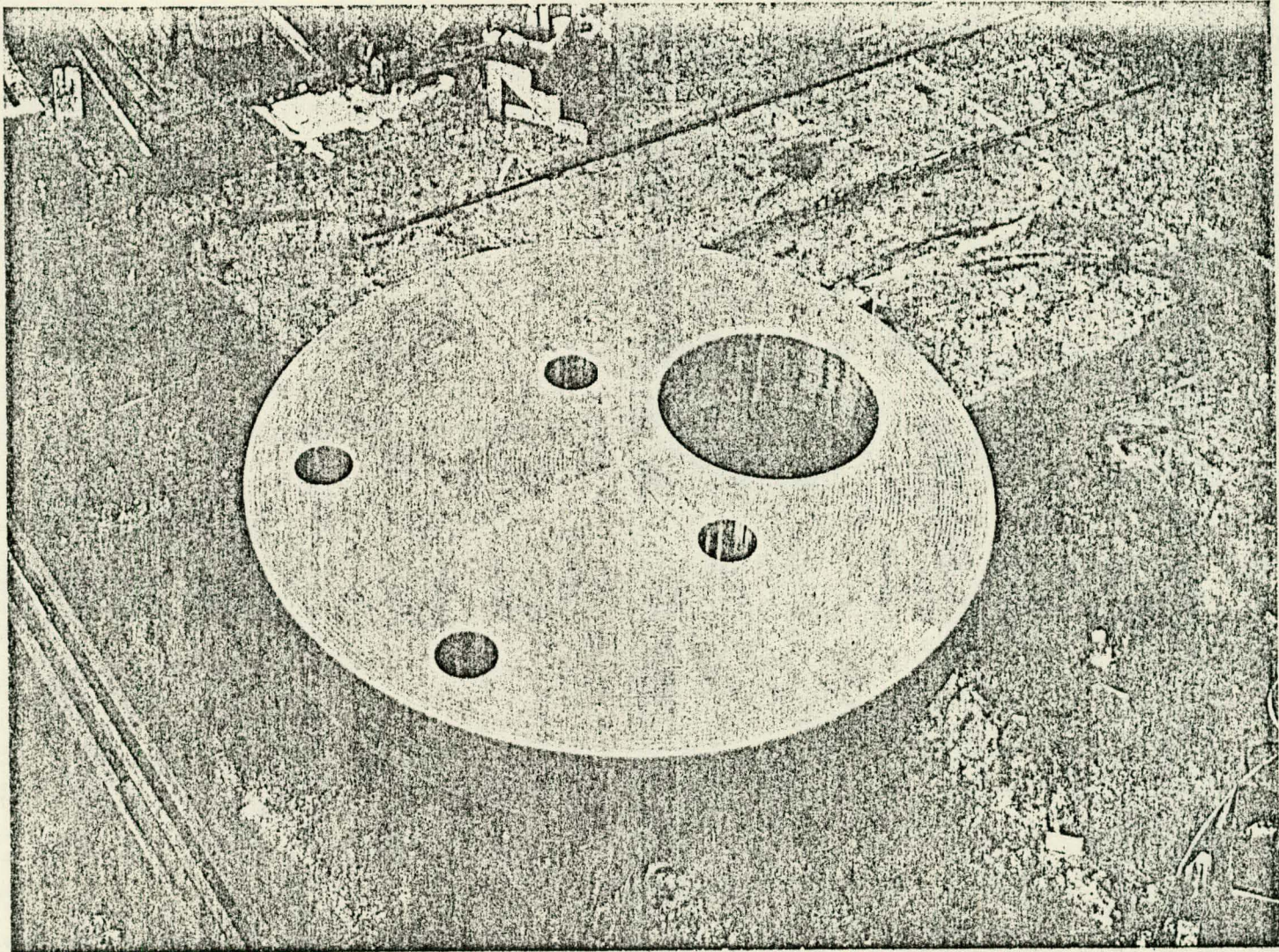


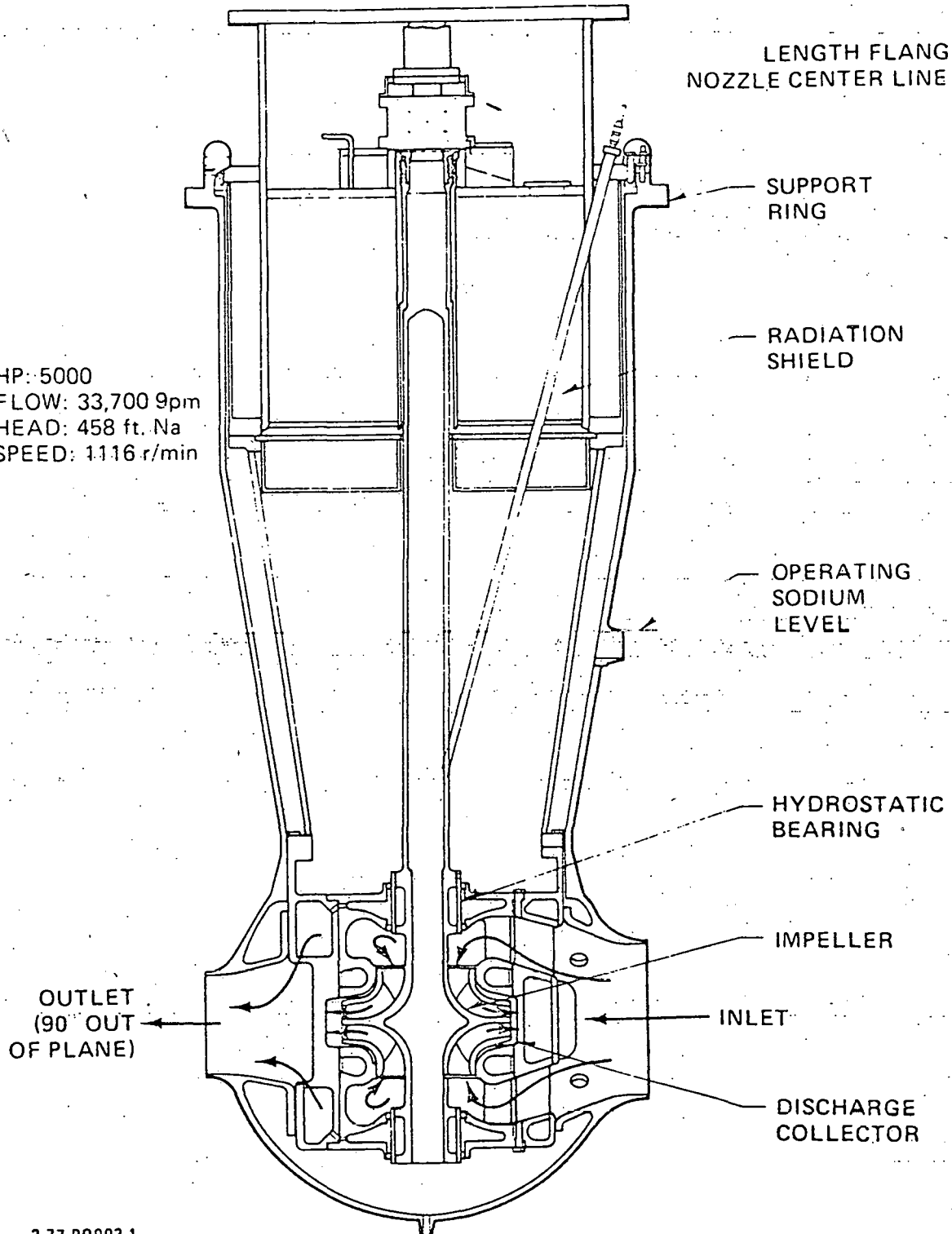
FIGURE 12

CRBRP PUMP

DIAMETER AT
SHIELD PLUG 96 in.

LENGTH FLANGE TO
NOZZLE CENTER LINE 15 ft - 9 in.

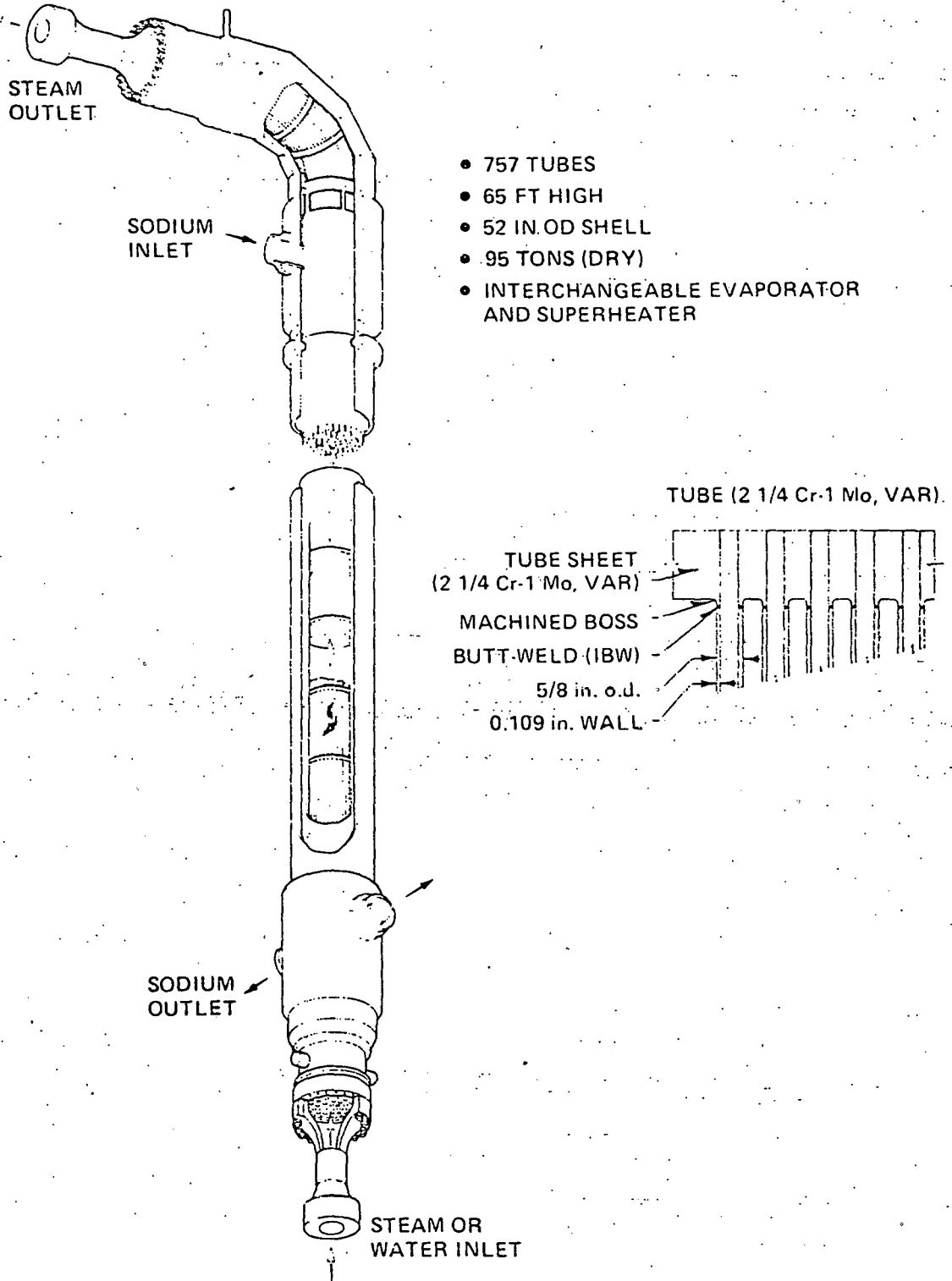
HP: 5000
FLOW: 33,700 gpm
HEAD: 458 ft. Na
SPEED: 1116 r/min



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FIGURE 13

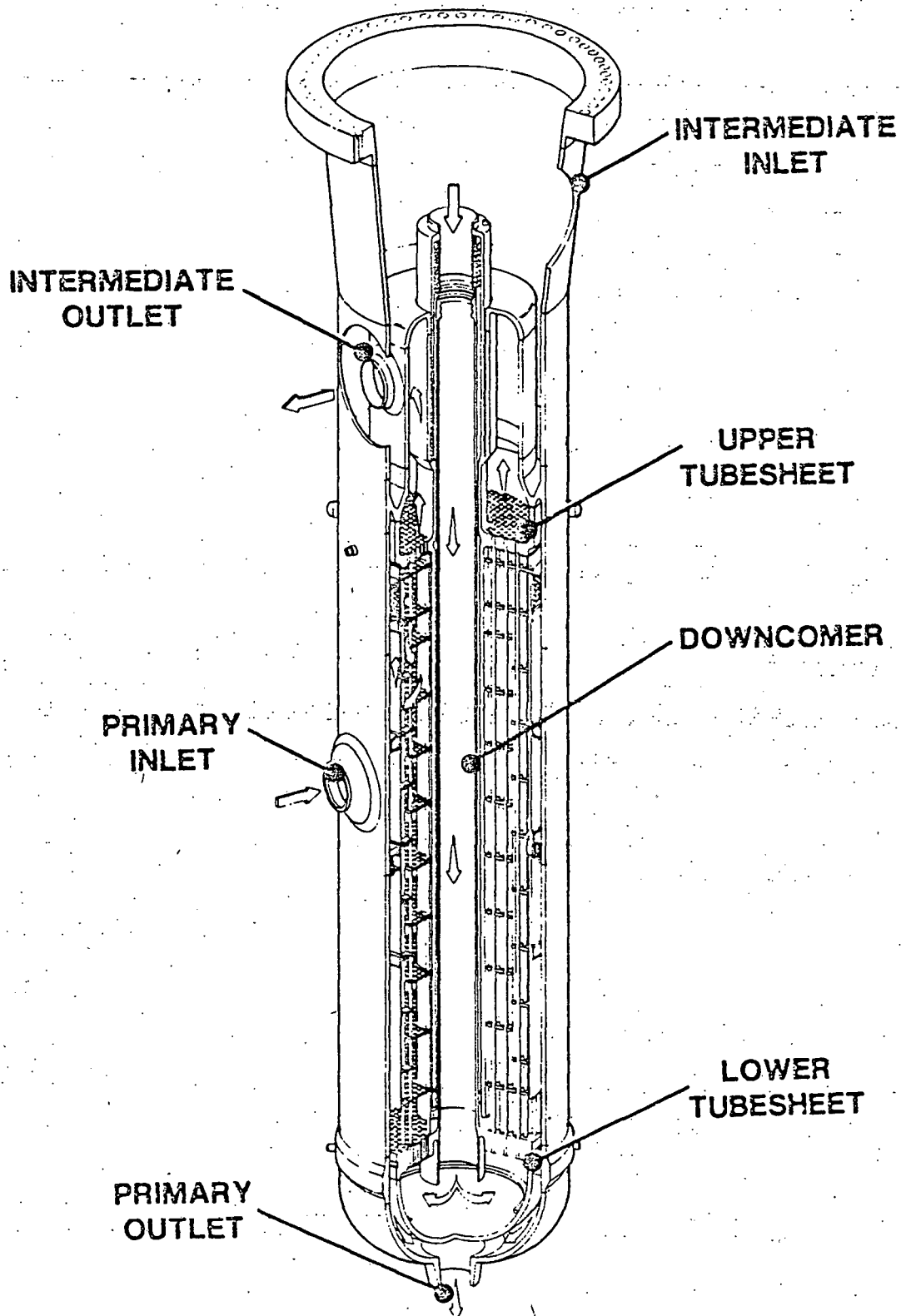
CRBRP EVAPORATOR/SUPERHEATER



2-77-P0903-2

FIGURE 14

INTERMEDIATE HEAT EXCHANGER INTEGRAL DESIGN



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FIGURE 15

CRBRP PROJECT LICENSING MILESTONES

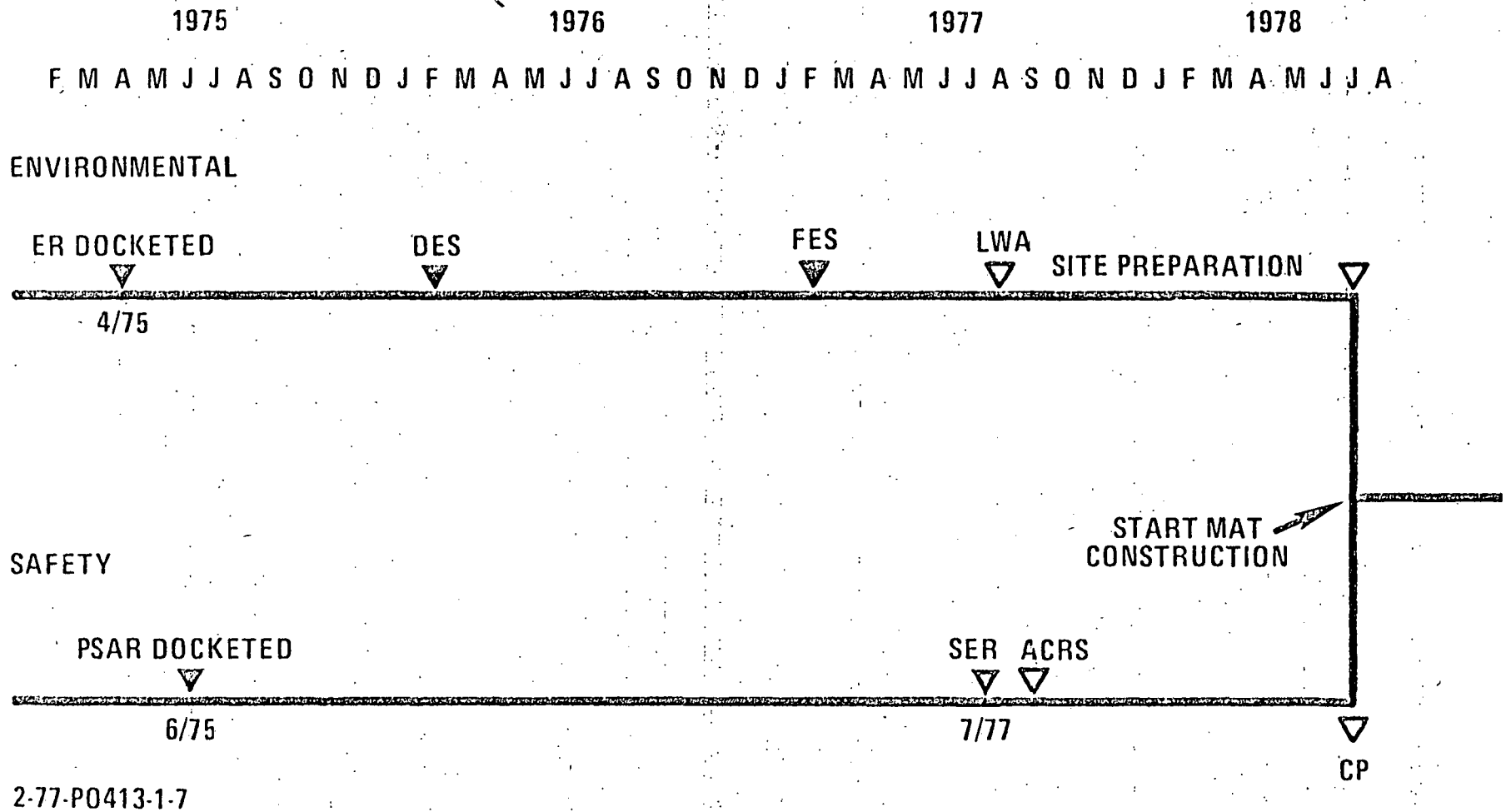


FIGURE 16