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FROM: J. P. Gill and T. E. Cole

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ORNL-CF-54-8-163
ORNL-CF-54-9-234

ORNL-CF-54-10-164
ORNL-CF-54-11-110
ORNL-CF-54-12-213
ORNL-CF-55-1-186

ORNL-CF-55-2-187
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GENERAL

An abstract report has been received from the Reactor Experimental Engineering Division reporting the conclusions reached as a result of the investigation made of the limitations of the ORR as regards increasing the power level. The following is taken from the letter by H. C. Claiborne:

"For finding the limiting power, the criteria applied were: (1) inlet water temperature, 120°F ; (2) maximum allowable surface temperature at any point, 210°F ; (3) main circulating pumps capable of delivering 18,000 gpm at design pressure drop.

Reactor Core

The core design limits the power to about 30 MW. It may be possible to increase the power up to 20 or 30% by allowing a higher maximum surface temperature in the fuel elements (local boiling in the core probably cannot occur for temperatures $\leq 230^{\circ}\text{F}$. For greater power increases, the only practical method is to lower the inlet cooling water temperature. This would require considerably greater capacity increase in the external heat exchangers, and possibly refrigeration for summertime operation."

"- - - - makes the tank and facilities capable of withstanding 30 MW operation even when the heat generation rate is taken as 12.5 watts/gm near the surface. Since the recent experimental value for heat generation is about 5.6 watts/gm, it appears that operation at 65 MW is permissible for these parts of the system.

The most probable place for boiling to occur appears to be between the tank and the lead radiation shield. It is quite possible that improvement can be attained by finding the optimum thickness and spacing for the shield. This is unnecessary, however, since the reactor core limits the permissible power."

The above information was developed as a result of about one man month effort in evaluating the limiting features. Considerable additional time amounting to several man months was spent in investigating methods for making gamma heating calculations.

Approval of the request for additional funds in the amount of \$275,000 made necessary primarily by additional construction costs, as set forth in the last report (February 15, 1956), was received from the AEC.

A Steering Committee Meeting was held on February 23, 1956 primarily to discuss the numerous requests for space, air conditioned enclosures, etc., that had been received by the Project and the Reactor Operations Department. This matter was reviewed and representatives of various groups outlined requirements based on their proposed programs. Due to the number and nature of the requests this matter was referred to the Reactor Operations Department and it was agreed that they would review the requests and present the information in the form of a proposal to meet the requirements. The general progress of the construction work was presented and a description of the reactor and experimental facilities as planned at that time was given with a number of preliminary drawings being shown to make the description more clear.

The results of the review of requests from the experimenters led to a proposal by the Laboratory to the AEC for additional construction in the ORR Building as follows:

<u>Item</u>	<u>Estimated Cost</u>
Completion of second floor	\$125,000
Air condition entire building	98,000
Hot cell over canal	175,000
Freight elevator	54,000
Chemistry hot cell for short-lived radioisotopes	50,000
Cryostat room	13,000
	<u>\$515,000*</u>

*Including engineering costs

In addition to the above a request was made for an additional \$146,000 to provide for construction contingencies on the AEC Contract for construction of the building.

If the additional \$515,000 can be made available to permit changes to be made before operation of the reactor is started, savings in time and construction cost can be realized. A period of about six months will be required for installation of the reactor and control system and for reactor start-up. It is anticipated that the awarding of the contract for the additional items would be scheduled so the work could be performed during that period. We have not yet received any comment from the AEC on this matter.

BUILDING - CONSTRUCTION

Construction is proceeding at a very slow rate, the current schedule for completion of the building, reactor shielding and the cooling system indicates that the contractor should be about 90% complete; estimated per cent of the work actually completed is 45%.

The reactor structure foundations have been completed and further work in this region is now being delayed by the lack of acceptable welding of aluminum pipe by the mechanical sub-contractor. Progress is being made toward resolving this difficulty, however the situation is not entirely cleared up at this time.

Delivery and erection of the cooling tower for the reactor pool cooling loop has been effected and installation of the main cooling loop radiators has been started; all pumps are on hand. The crane trolley is scheduled for shipment during the week of May 21, 1956, and will be installed on arrival; this will permit closing in the east end of the building. The third floor level is progressing satisfactorily and installation of the moveable type partitions will very nearly complete work in this area.

The Engineering Department and the ORR Project are continually working on a number of items regarding construction of the building. Numerous small changes and revisions are being made to the drawings in order to correct errors and numerous deviation requests are being made to the Contractor to provide added utility to the building in terms of use by the experimenters. In addition, a considerable effort has been found necessary to insure that the Contractor and his sub-contractors meet the requirements of the Specifications and drawings. This latter item is probably due in large measure to the fact that we are working with lump-sum contractors and therefore the attitude is to provide the minimum they can get by with. This attitude has required that we provide very close checks on their work and material and has resulted in very high inspection costs.

REACTOR DESIGN AND PROCUREMENT

Orders have been placed for all fabricated components, hardware and other materials necessary for the reactor installation with the exception of the shim-safety rods, now in the final stages of design. With the exception of the reactor vessel all items should be delivered without interrupting the presently estimated installation date of October 1, 1956.

As mentioned in the previous progress report a number of experiments were to be conducted at the BSF in order to evaluate the benefits of a D₂O reflector in the region of the ORR beam holes. As a result of these experiments (described in another section of this report) modifications were made to the reactor vessel design which will allow this system to be operated initially with light water with provisions for installation of a D₂O system at some later date. The O. G. Kelley Company, now fabricating the vessel, has quoted an additional \$6,695 for this work and will extend the delivery date about four weeks to October 1, 1956.

In general, the fabrication of the vessel, now approximately 25% complete, is progressing satisfactorily. Aluminum welding by the O. G. Kelley Company is meeting our original specifications, and apparently acceptable fabrication procedures have been submitted for the deep hole drilling operations, machining of the lattice housing and welding of the beam hole tubes, all of which were considered major problems during the design stage.

Other recent modifications to the reactor vessel design included the elimination of the flat sections at the sides of the north and south experimental facilities at the obround section, and increasing the size of the openings in the large reactor cover plate from six inches to eight inches at two places. The latter was at the request of the APPR Project, now in the process of designing a core experiment.

The fabrication of the bottom plug and mechanical controls is 60% complete. Assembly in the shop should start within the next week.

Following criteria and requirements established by the Reactor Controls Department the Engineering Department has completed preliminary design on the servo control unit. This unit can be mechanically connected to any of the shim rod drive mechanisms to control within limitations the travel of that particular rod. Final design is scheduled to be completed by July 1, 1956. Since approximately three months will be required for the shop fabrication, testing of this unit will probably be done in conjunction with the final testing of the reactor mechanical controls in the building.

The fabrication of the beryllium reflector elements by Brush Beryllium Company has been completed and they will be shipped to ORNL within the next few weeks. End boxes are to be fabricated and attached by the ORNL Shops.

A table showing the procurement status for the major reactor components is attached.

The design has been completed and orders are now being placed for a major portion of the handling tools and auxiliary equipment necessary for the initial operation and servicing of the reactor. They should be on hand long before their required December delivery. The pool bridge and universal plug coffin are in the process of redesign to provide greater utility.

INSTRUMENTATION AND CONTROL

A contract has been awarded to the Taylor Instrument Company of Rochester, New York to fabricate three (3) amplifier cabinets, fabricate and wire one (1) console and the twelve section vertical board for the ORR Control Room. All devices will be supplied, installed and wired by

Taylor, except our usual nuclear instrumentation and a number of recorders which are on hand. The arrival of two amplifier cabinets is expected during the week of 5/21/56.

Detailed interconnection drawings are now being firmed-up and should be completed within a month.

Bids have been received on 36,000 feet of five (5) conductor cable for interconnections. These bids are now being reviewed.

A decision to execute the present concept of the servo has been rendered by the project staff, and engineering is proceeding along this line.

The pool level alarms and building evacuation horns have been designed, and the hardware for these devices is being procured.

The magnet coils for the rods have been wound and potted, and equipment to test the rod drives is being collected.

Fifteen hundred (1500) feet of 7 tube cable for the pneumatic devices is being purchased, and the majority of the process instruments have been ordered.

EXPERIMENTAL FACILITIES

As a result of additional investigations and discussions involving the HRP, Chemical Technology, Operations and the ORR Design Group within the past few months, a number of changes have been made in the concept of the North Experimental Facility as described in the last progress report. The design now being followed involves the use of either light or heavy water as a reflector filling the entire volume of the obround facility from the face of the lattice to the nose of the large plug, around forty gallons. This is shown in the attached sketch. Two experiments as large as ten inches in diameter and two experiments as large as three inches in diameter

can be inserted in the large plug and penetrate the liquid reflector to the face of the lattice. This arrangement appears to be somewhat more flexible for the experimental program. The experiments now being conducted at the LTR are limited to six inches in diameter and there is no immediate demand for changing the size of these experiments or the manner in which they are handled, although it is generally agreed that at some future time there would be definite advantages to being able to insert plugs as large as ten inches in diameter. The present design will allow this to be accomplished whereas a permanent beryllium reflector for the large facility can be installed for one size experiment only.

On the above basis the ORR Group is proceeding with the detail design of the large plug for the North Facility, the dummy plugs, seals, shielding, etc., for the initial installation. As is the case with the beam hole facilities, the D_2O system will probably not be installed initially.

The Engineering Department is currently designing the experiments for each of the four available holes in the North Facility, designated as HN-1, HN-2, HN-3, and HN-4, for the HRP Program (a loop experiment and a rocking bomb experiment), the Chemical Technology Division (plutonium recovery process), and the Analytical Chemistry Group (pneumatic rabbit tube installation and station).

Design of the equipment to be initially installed in the North Facility will be completed by September 1st, with fabrication to be completed for installation by November 1, 1956.

The above design is presently being reviewed by the ANP Division to determine the desirability of using a similar installation for the South Facility.

Studies have been completed on the equipment to be installed in the beam hole facilities for initial operation. They are to be reviewed at a meeting to be held with the experimental groups and the Operation Department within the coming week. The design work on these facilities is scheduled to be completed by July 1st, with fabrication to be completed by November.

The Operations Department has prepared a list of experiments now planned for the ORR. A copy is attached.

One area of design that has yet to be investigated by the ORR Project Group is the design and installation of the hydraulic rabbit tubes and station. Depending upon the design manpower available within the next few months this may or may not become part of the initial installation.

INSTALLATION AND TESTING

The "Installation and Testing" phase of the ORR Project will include all of the work to be performed by Laboratory forces during the period from the completion and acceptance of the construction to the start of the critical experiments, approximately sixteen weeks. This work can be summarized as follows:

- a) Reactor component installation
- b) Reactor controls installation
- c) Cooling systems instrumentation installation
- d) Extension and modification of building and services
- e) Hydraulic and thermal testing of the reactor and pool cooling system
- f) Reactor controls check-out
- g) Experimental facilities installation
- h) Installation and testing of the building decontamination system
- j) Temporary and permanent thermocouple installation

Proposed Experiments for the ORR

FACILITY	PROJECT OR DIVISION	EXPERIMENTERS	PROGRAM
BEAM HOLES			
HB-1	Physics	Schmitt	Fission Fragment - Time of Flight
HB-2	Physics	Wollan	Spectrometer
HB-3	Physics	Wollan	Spectrometer
HB-4	Chemistry	Levy	Spectrometer
HB-5	Health Physics ($\frac{1}{2}$ time)	Yockey	?
HB-6	Physics	Hervey	Time of Flight Spectrometer
LARGE FACILITIES			
HN-1 (10")	HRP	HRP	HRP Loop
HN-4 (10")	Chem-Tech	Arehart	Chem Process Loop
HN-2 (3")	HRP	HRP	Rocking Bomb
HN-3 (3")	Chem-Anal-Chem	Brosi - Leddicotte	Pneumatic Tube
HS-1 (10")	ANP		
HS-4 (10")	ANP		
HS-2 (3")	?		Not definite
HS-3 (3")	?		
POOL FACE			
A	Solid State	Crawford	2" x 6" Irrad. Facility
B	Solid State	Berggren	12" x 16" High Temp. Irrad. Facility for large metal specimens
C	Solid State	Blewitt	10" x 10" Cryostat for Low Temp. Irrad. and Withdrawal
D	Solid State	Wilson	4" x 12" Elevated Temp. Creep Test Facility
E	Solid State	Wilson	4" x 12" ANP Fuel Test
F	Solid State	Stevens - Nelson	2" x 6" Water Cooled Facility Operated as Hydraulic Facility

Proposed Experiments for the ORR

FACILITY	PROJECT OR DIVISION	EXPERIMENTER	FLUX	OUTSIDE CONNECTION	PROGRAM
CORE SPACE					
1*	Solid State	Sisman	Fast	No	Ceramics & Plastics Irrad.
1*	Solid State	Sisman	Fast	Yes	Ceramics & Plastics Irrad.
1*	Solid State	Sisman	Fast	Yes	Organic Loop
1	Solid State	Morgan	Thermal	Yes	Ceramic Fuel Element
1	ANP	Keilholtz	Thermal	Yes	Loop
1	ANP	Keilholtz	Thermal	Yes	Loop
1	ANP	Keilholtz	Fast	No	----
1	HR	Berggen	Fast	No	Special Element
1	ANP	Zukas	Thermal	Yes	----
1	Solid State	Blewitt	Fast	Yes	Metal Crystals
1	Solid State	Wittels	Fast	No	Non-Metal Crystals
1	Chem-Tech	Arehart	----	Yes	Dynamic Chemical Process Experiments
1	Chem-Tech	Arehart	----	Yes	Dynamic Chemical Process Experiments
1	G. E.	Collins	Thermal	Yes	Irradiation Facility
3	Operations	Cox	Thermal	No	Radioisotope Production
2*	Operations	Cox	Fast	No	Radioisotope Production
2	APPR	Neill	Thermal	Yes	Fuel Test

*Partial Fuel Element

GAMMA IRRADIATION FACILITY	PROJECT OR DIVISION	EXPERIMENTER	PROGRAM
3 Spaces - 3" x 3" x 24"	Solid State	Sisman	Plastics Irradiation
1 Space - 3" x 3" x 24"	Chem-Tech	Watson	Irradiation Facility

Each phase of the work is now being investigated for the purpose of determining the manpower requirements, possible omissions, procedures and specifications involved. This information will be distributed for comment within the next month.

NUCLEAR EXPERIMENTS AND STUDIES

A number of experiments to determine the rate of gamma heating in various structural members of the ORR were performed using the BSR. The results have been published in ORNL-CF-56-3-72.

Experiments to determine the effect of heavy water reflection in the vicinity of the ORR beam holes were performed in the BSR. The results indicate that some increase in flux is to be expected if D_2O is used. Quantitative evaluation of the data is not yet complete.

A computational program to determine the nuclear parameters for various core configurations has been started. Six configurations will be studied initially using the three region three group code developed by Nelson. Some results are expected by the end of June.

FUEL ELEMENTS

Since the fuel element planned for use in the ORR differs slightly from the elements used in the MTR, primarily in the end box fittings, it was decided to run a hydraulic test on the element to verify the pressure drop calculations and to observe the flow distribution in the various channels. The fuel element tested was the nineteen plate Mark 11 Type described in Drawing No. D-24078.

These experiments were conducted by E. S. Bettis in Building 9201-3, Y-12, with hydraulic facilities existing there.

In general the experimental results were very close to the calculated values and the change in end boxes has resulted in a considerable reduction in the pressure across the element required to attain the water velocity required. The pressure drop across an MTR element for 30 f.p.s. velocity is about 37 psi, for the same velocity the ORR element requires only about 21.5 psi.

This work is reported in ORNL-CF-56-4-27.

MISCELLANEOUS

A scale model of the ORR Reactor Structure ($\frac{1}{2}$ inch = 1 foot) is now being fabricated by the ORNL Carpentry Shop and should be available by June 1st. A second model of the reactor and experimental facilities in more detail and of a larger scale ($1\frac{1}{2}$ inches = 1 foot) will then be started for delivery by September 1st.

All of the material is now available for the reissue of the "Reactor Hazards' Report" and the publication of the first part of an overall Project Report "The ORR Reactor Building, Reactor Structure and Services". Both should be distributed by June 15th.

A list of the expenditures and cost estimates for the ORNL portion of the ORR Project is attached.

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ORR PROJECT
STATUS OF REACTOR AND EXPERIMENTAL FACILITIES COMPONENTS
May 15, 1956

ITEM	DESCRIPTION	REMARKS	SCHEDULED DELIVERY
1	Reactor Tank	O. G. Kelley Co. - Design 85% complete - Fabrication 25% complete	9-1-56
2	Mechanical Controls	ORNL Shops - Fabrication 60% complete	8-1-56
3	Grid Plate	Harig Mfg. Co. - Fabrication 60% complete	7-1-56
4	Fuel Elements (Dummy)	ORNL Metallurgy - Fabrication to start 7-1-56	9-1-56
5	Reflector Elements (Be)	Brush Beryllium Co. - Fabrication 90% complete	6-1-56
6	Reflector Elements (Al)	ORNL Shops - Awaiting material	9-1-56
7	Shim Rod Lower Bearings	ORNL Shops - Fabrication 70% complete	6-15-56
8	Bearing Support Plate	ORNL Shops	
9	Upper Grid Mechanism	ORNL Shops - Fabrication 5% complete - Awaiting material	8-1-56
10	Shim Rods	ORNL Metallurgy - Design 90% complete	9-1-56
11	Large Facilities Head	ACF Industries - Order placed 4-19-56	8-23-56
12	Cooling Line Expansion Joint	Out for rebids - Six weeks delivery on this item	7-15-56
13	Aluminum Grating	Southern Welding & Machine Co. - Order placed 4-19-56	6-20-56
14	Stainless Thermal Shields	Alloy Fabricators - Order placed 4-19-56	8-1-56
15	Special Aluminum Gaskets	ACF Industries - Order placed 4-19-56	8-23-56

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ORR PROJECT
 STATUS OF REACTOR AND EXPERIMENTAL FACILITIES COMPONENTS
 May 15, 1956

ITEM	DESCRIPTION	REMARKS	SCHEDULED DELIVERY
1	Reactor Tank	O. G. Kelley Co. - Design 85% complete - Fabrication 25% complete	9-1-56
2	Mechanical Controls	ORNL Shops - Fabrication 60% complete	8-1-56
3	Grid Plate	Harig Mfg. Co. - Fabrication 60% complete	7-1-56
4	Fuel Elements (Dummy)	ORNL Metallurgy - Fabrication to start 7-1-56	9-1-56
5	Reflector Elements (Be)	Brush Beryllium Co. - Fabrication 90% complete	6-1-56
6	Reflector Elements (Al)	ORNL Shops - Awaiting material	9-1-56
7	Shim Rod Lower Bearings	ORNL Shops - Fabrication 70% complete	6-15-56
8	Bearing Support Plate	ORNL Shops	
9	Upper Grid Mechanism	ORNL Shops - Fabrication 5% complete - Awaiting material	8-1-56
10	Shim Rods	ORNL Metallurgy - Design 90% complete	9-1-56
11	Large Facilities Head	ACF Industries - Order placed 4-19-56	8-23-56
12	Cooling Line Expansion Joint	Out for rebids - Six weeks delivery on this item	7-15-56
13	Aluminum Grating	Southern Welding & Machine Co. - Order placed 4-19-56	6-20-56
14	Stainless Thermal Shields	Alloy Fabricators - Order placed 4-19-56	8-1-56
15	Special Aluminum Gaskets	ACF Industries - Order placed 4-19-56	8-23-56

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ORR PROJECT

STATUS OF REACTOR AND EXPERIMENTAL FACILITIES COMPONENTS (CON'T)
May 15, 1956

ITEM	DESCRIPTION	REMARKS	SCHEDULED DELIVERY
16	Ion Chamber Shields	ORNL Shops - Material now on hand	7-1-56
17	Ion Chamber Shield Support	Order to be placed with ORNL Shops, Design complete	9-1-56
18	Wall Thermal Shields	ORNL Shops - Material now on hand	7-1-56
19	Pool Side Facility Enclosure	To be redesigned at a latter date	11-1-56
20	Large Facility Dummy Plugs	Design to be completed 8-1-56, Materials ordered	11-1-56
21	Large Facility Main Plugs	Design to be completed 7-1-56, Materials ordered	11-1-56
22	Beam Hole Dummy Plugs	Design to be completed 7-1-56, Materials ordered	
23	Barytes Block Shielding	Knox-Block	8-1-56
24	Beam Hole Lead Bricks	On hand	
25	Miscellaneous Reactor Hardware	Final order placed 4-24-56	9-1-56
26	Installation Materials	Final Order placed 4-24-56	9-1-56

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ORR PROJECT

ORNL Accounts & Expenditures
May 1st, 1956

Account No.	Description	Cost or Estimated Cost	Jan.	Feb.	March	April	Total to Date
x3900-15	Preliminary Design	99,657					99,657
x3900-1900-2	A-E Services - Part I	71,736					71,736
*3900-1900-3	Inst. and Controls Design	60,000	1,820	1,763	1,623	1,641	40,245
x3900-1900-4	A-E Design Criteria	23,709					23,709
x3900-1900-5	5 MW Cooling System Design	15,536					15,536
x3900-1900-6	Utilities & Site Design	14,319					14,320
*3900-1900-7	Reactor Design	92,000	626	285	400	551	85,461
x3900-1900-8	Controls Development	25,000	1,442	2,380	2,173	1,723	26,712
*3900-1900-9	Controls Purchase	108,900	1,007	671	1,443	1,236	7,494
*3900-1900-10	Instrumentation Purchase	23,500	1,949	1,993	776	169	8,083
x3900-1900-12	20 MW Cooling System Design	33,080					33,080
x3900-1900-13	A-E Services - Part II	24,362					24,362
x3900-1900-14	Reproduction for Contract Dwgs. & Specs.	5,270					5,269
*3900-1900-15	Site and Utilities Preparation	6,425	2,221	282	260	106	6,082
*3900-1900-17	Inspection of Construction	50,000	4,426	3,370	2,559	2,084	36,796
*3900-1900-18	Utilities and Site Construction	42,125	1,913	206	1,186	1,817	18,641
*3900-1900-19	Beryllium Reflector Purchase	100,000					88,200
*3900-1900-20	Reactor Unit Purchases	150,000	442	2,302	3,177	7,905	14,754
*3900-1900-21	A-E Service - Part III	23,903	1,309	582	1,765	2,514	20,006
*3900-1900-22	Reactor Controls Installation	41,000					
*3900-1900-23	Cooling System Inst. Installation	15,000					
*3900-1900-24	Lead Shields - Fabrication	6,000	11	744	224	614	1,593
*3900-1900-25	Lower Bearings and Support Plate	7,000	265	1,375	974	892	3,506
x3900-1900-26	Lead Brick	1,739		1,739			1,739
*3900-1900-27	Mechanical Controls Fabrication	65,000	48	10,181	17,351	20,563	48,143
*3900-1900-28	Upper Grid Mechanism Fabrication	20,000				137	137
*3900-1900-29	Large Facilities Purchase	42,000				30	30
3900-1900-	Reactor Assembly & Installation	65,000					
3900-1900-	Beam Hole Components	20,000					
3900-1900-	Rabbit Tube Installation	10,000					
3900-1900-	Fuel Element (Dummy)	10,000					
3900-1900-	Design of Bldg. Decontam. System	5,000					
3900-1900-	Installation of Bldg. Decontam. System	35,000					
		<u>1,312,261</u>	<u>13,653</u>	<u>27,873</u>	<u>33,851</u>	<u>41,982</u>	<u>695,291</u>
x	Work Completed - Account Closed	21,739					
*	Work in Progress - Accounts Open						
	Contingency						
	Total	<u>1,334,000</u>					

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