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HDC-2466

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January 23, 1952

TO: V. D. Nixon

FROM: RT Jaske, EL Reed, GM Roy, GH Strong

INTERIM REPORT RDA-DC-3 AND PROGRAM X

I. Introduction

It is the intent of this report to summarize Reactor Unit's progress on RDA-DC-3 and Program X from the date of inception, October 6, 1951, through January 12, 1952.

Manpower assigned to the project has been as follows:

	October 6	November 1	December 1	January 12
Supervision (Project Engineer)	1	1	1	1
Analysis	1	1	3	4
Process Unit	2	7	8	11
Building and Services	2	4	6	8
Electrical	1	1	1	1
	6	14	19	25

The report is divided into four sections covering:

1. Basic Reactor Criteria
2. Process Unit Design
3. Building and Services Design
4. Electrical

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II. Basic Reactor Criteria (G. M. Roy)

Reactor Size

Considering the basic objectives of lower capital cost and reduced unit operating cost, studies were completed establishing reactor dimensions with a desirable balance of the nuclear and engineering problems involved. The dimensions established are as follows:

7½"	Lattice Spacing
3220	Process Tubes
33'	Active Process Tube Length (5' longer than 105C)

The choice of 3220 process tubes resulted principally from studies of engineering design problems, such as the length of control rods and process water piping limitations, together with considerations of operating efficiency. The choice does not necessarily represent any type of optimum.

The choice of lattice spacing was made with the assistance of Technical Section and was based on a balance of reactivity and conversion ratio with decrease in lattice unit spacing. Calculated and measured data were used. Although maximum gains would result with a 7" lattice spacing (or less), a 7½" spacing represents a workable minimum considering the problems of process tube assembly and process piping design.

The results of the studies on which the choice of active tube length was made is given in detail in HDC-2395. These calculations were made on the basis of the 105C annulus, although the annulus for RDA-DC-3 design has not yet been firmly established. Further calculations, based on variables of heat transfer, tube inlet pressure and reactivity and intended to determine the annulus size, are about 70% complete. When completed, the results of this study will be used to determine the best annulus for a given tube length. For the study, the tube inlet pressure and slug surface temperature were assumed to be fixed.

Water Requirements

Water flow and pressure requirements have been tentatively established. The nominal design value is 100,000 gpm. at 400 psia header pressure. The maximum design value is 140,000 gpm. at 600 psia header pressure.

A study is about 65% complete determining power output as a function of season of the year. The results of this study will be used to determine the average yearly power possible with different water plant capacities when slug surface temperature, tube outlet temperature, and specific power are limited. This data will provide information for an economic evaluation of the cost of increasing water plant capacity as compared with the value of production gains.

Calculations intended to establish shut-down requirements similar to those presented in HDC-2043 are about 20% complete. When the annulus size has been established, a study of start-up requirements will be made.

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Control

To aid in the preliminary design work on the process unit and on the building, tentative operational and safety control systems were established with the assistance of Technical Section. The final determination of vertical and horizontal control system pattern is about 90% complete in the case of the horizontal rods, and about 75% complete for the safety system. A proposed basis which will permit final determination of the safety system pattern is contained in HDC-2462. Approval of the basis will be requested before February 1.

The ink control system is to be designed for the use of 20 control tubes. Required flow rates and expected temperatures have been calculated.

General

In addition to the specific items listed above, information and design analysis have been furnished as requested for reactor components. For example, pressure drop calculations have been made to assist in the process piping design, shielding recommendations have been made on several components, and control rod size calculations have been made.

III. Process Unit Design (E. L. Reed)

General

Process Unit Design on RDA-DC-3 was started on October 6, 1951, with the assignment of one engineer full-time and two part-time. Engineers assigned to this phase of the project were increased to seven (four full-time and six half-time) by November 14. Currently, eleven engineers are assigned (nine full-time and four half-time).

Using the basic reactor criteria as described in Section II, design of the following components has been started:

1. Moderator
2. Concrete Biological Shield
3. Process Tube Assembly
4. Process Piping
5. Effluent Water System
6. Operational Control System
 - (a) Horizontal Rods
 - (b) Ink System
7. Safety Control System
 - (a) Ball Control System
 - (b) Vertical Rods
8. Test Facilities

Moderator dimensions, shielding thicknesses and space allowances for thermal shield and gas plenum have been established, permitting the determination of overall reactor dimensions and providing information for the establishment of associated building dimensions, access, and services.

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References:

SK-1-20160 (H-1-21403) - Basic Process Unit Dimensions
HDC-2411 - Moderator Dimensions
SK-1-20169 (H-1-21400) - Process Unit Longitudinal Cross Section
(1st issue complete)
SK-1-20170 (H-1-21401) - Process Unit Transverse Cross Section
(1st issue complete)
SK-1-20171 (H-1-21402) - Process Unit Plan (1st issue complete)

Moderator

Moderator design is directed toward the following objectives:

1. Packing symmetrical about unit centerlines
2. Maximum use of full-length stock
3. Minimum special machining (keyways, etc.)
4. Minimum number of block sizes and shapes
5. Dimensioning for ease of manufacture

Pertinent data from HDC-2411 is as follows, with the 105-C equivalent in parenthesis:

Dimension inlet to outlet	33' - 5 $\frac{1}{4}$ "	(28'-0")
right to left	40' - 11 $\frac{1}{4}$ "	(35'-8")
bottom to top	40' - 11 $\frac{1}{4}$ "	(35'-7-1/8")
Machined material	2812 tons	(1800)
Raw material	* 4854 tons	(2800)
Reflector right to left	30"	(25 9/16)
Reflector inlet to outlet	28"	(28)

* Using some graphite from "C" inventory with high waste. For new rough graphite properly sized, 4374 tons are required.

Physical and nuclear testing of graphite of the kind expected to be available for this project has been initiated by Technical Section. Reallocation of 105-C graphite was made to provide 980 tons of green material for Program X. Details are available in HDC-2400.

The following is the status of drawings:

SK-1-20044 (H-1-21410)	- Outlet face elevation	Complete
SK-1-20040 (H-1-21411)	- Right side elevation	30%
H-1-21412	- Left side elevation	30%
H-1-21413	- Typical even layer pattern	10%
H-1-21414	- Typical odd layer pattern	10%
SK-1-20152	- Packing Transverse Study No. 1	100%
SK-1-20153	- Packing Transverse Study No. 2	100%
SK-1-20157	- Packing Tube Layer Study	100%

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Biological ShieldGeneral Description

A concrete shield is proposed for the biological shield because adequate shielding can be obtained for about one-third the cost of a laminated shield of steel and masonite. Shield thicknesses have been determined utilizing heavy-aggregate concrete similar to that used in the Brookhaven shield. Heavy aggregates used in this mix are coarse-steel punchings and fine limonite-ore which are dispersed in a rich portland cement paste. Shield thicknesses are as follows:

Total Thickness *

Front	5'-3"	*Includes 2 - 1 inch skin plates
Discharge	3'-9"	
Sides	5'-3"	
Top	6'-10"	(63 inch heavy aggregate concrete and 18 inch ordinary concrete)

Permanent forms for placing concrete will be fabricated from steel plates and rigidly braced. These plates will serve later as a covering for the unit, and will aid in centering tubes, attaching the process-tube assembly and providing a gas seal. Front and discharge faces will be constructed first, the sides second and the top shield placed after the packing has been assembled.

Plates and tubes for the front and discharge faces will be fabricated off the job, shipped to the site, assembled near the unit and then hoisted into place. These plates will be approximately 1 inch thick, 5 ft. wide and 45 ft. long. The box consisting of two plates, tubes and bracing is called a crate. Mechanical connections are being designed for connecting the tubes to the skin plates. This reduces welding distortion and permits a final adjustment of tube alignment after the crates have been positioned. Omega gas seals will be used between crates and along expansion joints.

For the top and side shields, a structural steel framework will support the skin plates and the dead load of the concrete fill and embedded items. The skin plates will be welded to provide a gas-tight structure. The concrete will be reinforced to resist (a) temperature stresses and (b) dynamic stresses produced by the vertical rod system. The sides and top shields are being designed to behave integrally as a monolithic structure. The front and discharge faces of the biological shield will be (a) restrained from moving in the direction of the process tubes, and (b) free to expand or contract laterally. The inside faces of the biological shield will be water-cooled.

In general, the design of the biological shield provides for the following:

1. Adequate shielding (radiation level: 1 mr per hr.)
2. Optimum wall thicknesses consistent with shielding requirements and minimum tube length.
3. A considerable saving in cost, ease in construction, and adequate control in maintaining tolerances in the tube pattern.
4. Stability under normal loading conditions and resistance to earthquake and blast loads.
5. Provisions for thermal effects.
6. A gas tight enclosure for the unit.

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Summary of Work Performed

Recent designs have been prepared with the intent of eliminating welding distortion where possible. These designs incorporate crates extending the full width of the front and discharge faces of the biological shield, mechanical connection of tubes, and omega-seal strips. Welding will be limited to tack-welding for fixing the final position of each tube and obtaining gas seals between flanges (if used) and the outer skin plates. The flanges (if used) will be welded after the concrete has been placed in the shield.

Three cross-section drawings and two elevations have been completed which illustrate preliminary details for the complete biological shield. These are:

- SK-1-20169 - Longitudinal Cross Section
- SK-1-20170 - Transverse Cross Section
- SK-1-20171 - Sectional Plan
- SK-1-20167 - Shield Crate
- SK-1-20168 - Shield Crate

Work is proceeding on tube details, arrangement of crates and their fabrication.

A study is being made which compares the cost of the proposed concrete shield with that of an iron-masconite shield. This detailed cost study is 50 percent complete.

Work has started on the design of the cooling system for the biological shield. Spacing of cooling tubes in the interior faces are tentatively as follows: 22.5 inches on the sides and top, 30 inches on the front and discharge faces.

Preliminary work on the design of concrete mixes has shown that suitable density and composition can be obtained by the Prepak method. The mix incorporates steel punchings and coarse limonite ore in a weight ratio of 7 to 3, a void content of 42% and portland cement grout. A test program to determine handling, physical and shielding properties of this Prepak concrete has been discussed with a representative of the Prepak Company. A contract is in preparation which will cover test work necessary to obtain data for possible use of the method on the top shield of the "C" pile and data required for RDA-DC-3. It is expected that tests will begin the latter part of January. A long range program on heavy aggregate concretes and their shielding properties, is being worked out in cooperation with the Pile Technology Unit.

Process Tube Assembly

The selected design basis for the process tube assembly is a "gun-barrel and do-nut" tube entry sleeve of a type similar to those used in existing reactors. Preliminary design has been done on a tapered-sleeve arrangement which offers considerable advantage in size, cost and simplicity. However, at the present time there is not sufficient information available on the shielding effectiveness of this arrangement to justify it as a design basis.

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An assembly simulating the RDA-DC-3 gun-barrel and do-nut sleeve is 95 percent fabricated for test of shielding effectiveness. Completion of fabrication is expected by January 15, 1952, and test results by February 15, 1952. Purpose of testing is a shielding check of the elimination of two "steps" along the length of the assembly which, if eliminated, may reduce the cost of each assembly approximately \$100 or approximately \$630,000 for the reactor. In addition, a shielding check of a taper-sleeve assembly is programmed with secondary priority. These tests are covered in TR-74, issued 11-9-51. Drawings are as follows:

- SK-1-20027) - Do-nut Assembly for "A" Test Hole
- 20036)
- 20025) - Tapered Sleeve Assembly for "A" Test Hole
- 20031)

Deflection testing of the tapered sleeve process tube assembly is covered in T.R. 73, issued 11-24-51. The test assembly is 80% fabricated, with a target date of February 1, 1952, for completion of testing. Associated with this test is a check of the effect of deflection loading on a tube entry graphite block of the size planned for use with this design.

- SK-1-20158) - Deflection Test Assembly
- SK-1-20159)

The process tube length will be 48' - 2" plus or minus a few inches. The operating conditions permit the use of 23 tubing with 72S cladding with a safety factor (ratio of yield strength to fiber stress) not lower than 1.75. However, an investigation of the possible use of 63S tubing (72S clad) has been started by the Technical Section. Extrusion trials are called for in a contract with Alcon. It is doubtful whether questions of manufacturing technique, electrolytic corrosion with graphite, van stone flanging, etc., can be resolved in time to apply 63S tubing on Program X even if 63S is found to be desirable.

At the expected maximum water flow per tube (50 gpm), the pressure drop for inlet flexible connectors (pigtails) is excessive with sizes smaller than a 1" tubing or equivalent. Therefore, a flexible connector using 1" tubing has been designed and procurement of test samples initiated. These are expected to be available within a few weeks. Two purposes are intended:

- (1) a check of the feasibility of manufacturing such a connector and
- (2) deflection and pressure drop testing.

Design status on the appropriate drawings is as follows:

- SK-1-20032 - Experimental Flexible Inlet Connector 100% complete
- H-1-21900 - Inlet Arrangement 20%
- H-1-21901 - Outlet Arrangement 20%
- H-1-21902 - Inlet Nozzle Assembly (1st issue complete)
- H-1-21903 - Outlet Nozzle Assembly (1st issue complete)
- SK-1-20030 - Inlet Nozzle Pattern (1st issue complete)

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Process Piping

The process piping design involves principally the problems of providing for approximately 60 percent additional flow as compared to 105-C in a space reduced appreciably by the reduced lattice spacing. The first step taken was the preparation of layouts determining that the design conditions can be met without exceeding water flow velocities used in 105-C. This is possible by the use of twin three-inch headers on the front face fed from four 36-inch risers, and by the use of rectangular crossheaders on the rear face discharging into two 42-inch risers. These arrangements are shown on the following drawings:

- SK-1-20037 - Header Layout
- SK-1-20147 - Piping - Outlet End

Consideration is now being given to the use of smaller line sizes where the reduction in size and cost, with attendant simplification in fabrication and access, may be justified for operating and economic reasons. For example, a design study is underway to modify the method of providing a gas seal at the junction of gun barrel and shield face to permit the use of single four-inch crossheaders.

Bellows-type expansion joints to absorb thermal expansion along the rear face crossheaders have been worked into the preliminary design and will probably be proposed as a design basis.

A study of the valve pit piping (proposed valve pit is under the work area) has been started for the purpose of early correlation of the piping with the building design. Preliminary information is shown on SK-1-20174. With the assistance of the HDA-DC-6 (Water Plant) engineers, a sizing study of the feeder lines from 190 has been started and is now 75 percent complete.

Effluent Water System

Two problems have received design consideration: (1) providing capacity for the 140,000 gpm maximum water flow and (2) use of a design which is less costly and more easily constructed than the cascade type downcomers used in DR, H, and G.

Four possible systems have been considered in some detail as follows:

1. SK-1-20043 - "Silo" Type. This arrangement proposed the use of a U-tube to maintain constant level in the 105 downcomer, the outer leg of the U-tube being a large diameter (20 ft.) "silo" outside the 105 building. The "silo" discharged in a relatively thin overflow into a basin beneath, from which the water was directed to the river. This arrangement has the primary disadvantage of excessive cost, as opposed to the advantages of no wearing parts, no valves, and a constant discharge head.
2. SK 1-20041 - Orifice Type. For this scheme the water would be maintained at a level near the top of the outlet riser by means of orificing downstream. Combinations of parallel orifices would be used to accommodate varying flows. Matching of orifices over the required flow range produced what are considered to be undue complications in this system, requiring a multiplicity of valves for selection of orifice combinations.

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3. SK-1-20146 - Throttling Valves. Valves controlled to maintain constant level in the vertical discharge pipe were considered in this proposal. The presence of moving parts subject to maintenance in the effluent lines is the disadvantage here as opposed to lower first cost.
4. SK-1-20148 - Energy Absorber. In this system, a flow resistance is introduced into the downspout by dividing the downspout into a large number of small vertical passages. The entrance to the passages is in steps at the upper end, thus providing that more sections of the passages come into use as the flow increases. Provision is made for escape of air carried in with the water in those passages running partially full. The intent of the design is to so size the flow passages to have head loss equal to the height the water must normally fall, thus dissipating the energy in the water as it is generated without allowing free fall.

Design effort is now concentrated on No. 4 on the basis that it offers the best possibilities for simple economical construction. The responsible engineer visited Bureau of Reclamation headquarters in Denver, January 10, to review this design proposal with their hydraulic specialists. If detailed problems cannot be satisfactorily solved, a cascade-type downcomer can be used.

Horizontal Rods

Horizontal rod design to date has been based on use of a rod similar to that used in 105-C except of a smaller diameter (2 5/8" O.D. vs 3" O.D.) and of increased length for the larger pile.

The rod pattern has been tentatively established and coordinated with the packing as 24 rods in four vertical rows of six each symmetrically located about the unit centerline. The pattern has been checked to verify the adequacy of space allowance for the rod drive mechanism.

A rod operating diagram has been completed to furnish dimensional data for correlating the building provisions in the inner and outer rod rooms. Significant data is as follows:

Overall Rod Length	96' - 6 7/16"
Stroke (Normal)	38' - 5"

Drawings and status are as follows:

SK-1-20161-H Rod Operating Diagram (1st issue complete)
SK-1-20163-H Rod Installation Arrgt. (1st issue complete)

Ink Control System

An "ink" system is planned for inclusion in the design, capable of providing supplementary control by introducing into a pattern of tubes parallel to the process tubes a neutron-absorbing fluid or "ink" of variable concentration. Plans are for the use of potassium tetra-borate solution of concentration variable from 0 to 10 percent in twenty (20) tubes. The ink tubes replace process tubes in a selected pattern and provide for introduction of the ink in a central core and ink return in an annulus surrounding the core, with the entire ink assembly centralized within a process tube carrying process water flow.

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The auxiliary equipment includes:

1. Ink mixing and storage tank
 - (a) Instrumentation for concentration control
2. Supply pumps
3. Retention tank
4. Evaporator for reclaiming chemicals

A flow diagram has been completed. Tentative equipment sizes have been selected and vendor contact initiated. A layout of the ink tube and nozzle is complete. Equipment location is tentatively determined.

Drawings and drawing status are as follows:

SK-1-20045	-	Flow Diagram	100% complete
SK-1-20173	-	Ink Tube Assembly	100% complete

Safety Control System

The safety control system planned for Program X comprises the use of vertical rods in conjunction with a ball system. HDC-2462 describes a recommended basis for determination of the pattern of vertical openings. It provides for a combination of approximately sixty (60) ball slots with 35 - 40 vertical rods. Studies to work from this basis to a firm pattern of slot arrangement are being carried out in cooperation with Technical Section and are about 75 percent complete.

Rod size will be 2 5/8 inch outside diameter with a rod design similar to that used in 105-C. A space study investigating the use 105-C rod winches has been completed (SK-1-20180). It is intended to investigate simplification of the winch design as well as alternate designs for operating the rods.

For the ball system, two ball handling methods have received preliminary design attention. These systems are an electromagnetic conveyor and a pneumatic conveyor, both initially considered for the rapid-return of balls (10 minutes) on the basis of possible elimination of vertical rods completely. Both systems are based on the use of a separate handling system for each ball slot. Therefore, either system is readily adaptable to the use of a single one of these units for a slow-speed handling system.

Successful operation of a model of the electromagnetic system (moving-field solenoid) has occurred at the General Engineering Laboratory in Schenectady. Further details are covered in Section IV of this report.

A system arrangement drawing for the pneumatic conveyor is complete. Equipment sizes have been tentatively determined and space allocations studied. For a fast-return system the components required for each slot are:

1. Conveyor Tube
2. Cyclone Separator
3. CWS Filter
4. Blower and Motor Drive - 50 HP
5. Discharge Duct to Gas Tunnel

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A single set of the above equipment can be used for a slow-speed system.

Reference is made to the following drawings:

SK-1-20172	- Pneumatic Ball Conveyor System	(1st issue complete)
SK-1-20150	- Electroveyor	(1st issue complete)
SK-1-20142	- Ball Hopper Below Pile	(1st issue complete)

Test Facilities

Pending receipt of a description of desired test facilities from Technical Section, design work has been limited to a study of the possibility of providing a limited number of test holes parallel to the process tubes with the objective of furnishing a facility where test samples larger than process slugs can be irradiated and discharged into the storage basin.

Layout drawings are in process for the following possible installations:

1. Maximum size test hole utilizing space in one graphite block.
2. Maximum size test hole utilizing space available by removing four process tubes.

Drawing status:

SK-1-20173 - 3 5/8 inch Test Hole (1st issue complete)

IV. Building and Services (R. T. Jaske)

Summary

Work is actively being carried out on detailed scope-design for a 105 Reactor Building. Drawings being produced are of a form readily convertible to construction drawings on Program X if authorized. Completion is reported on a basis of percentage complete for Program X rather than for RDA-DC-3 scope alone.

The basic scope drawings of architectural, structural, heating and ventilation, mechanical equipment and electrical are essentially complete. Descriptive criteria are well along towards completion. Twenty detailed architectural and structural drawings providing a working design for structural steel and concrete, and eighteen mechanical drawings for drainage, service piping and ventilation have been started. Overall percentage completion of engineering effort on RDA-DC-3 scope is 75%. Program X scope design drawings which have been started average 50% complete at this writing. Mechanical equipment outline drawings providing a scope for C, D and F elevator design by the vendor are in progress. A detailed report on drafting status is included as Appendix I of this document.

Sufficient information is available to start writing requisitions February 1st for major building and services items, such as reinforcing steel, piping, heating and ventilating equipment, electrical, etc. A partial structural steel take-off can be made at this time and a complete one by February 15, 1952.

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Detail

Architectural and Structural Design

The Key Plan is ready for Working Committee and Design Committee approval. Structural steel design is about 50% complete; the major trusses are under investigation at this time. Columns up to Elevation 53'-0" are all sized. Structural steel drafting is started. Drafting manpower shortage has slowed progress on this phase of the work but preliminary conversations with Pacific Car and Foundry indicate that they are willing and able to produce engineering drawings at our direction as a part of a fabrication order if we cannot find personnel in time. This type of arrangement will permit the earliest possible delivery of steel, because it will be possible to order bulk shapes immediately upon receipt of a directive. Sufficient information is available to start negotiations immediately.

Concrete design is about 25% complete. Footings are being sized, and major component walls and floors checked for rough size. Calculation of reinforcing steel sizes and quantities has been started. The major drafting effort to this time has been on concrete in order to set critical dimensions.

Building layout commenced October 7, 1951 with a study and review of operational requirements and investigation of past difficulties experienced in construction and procurement. Studies of past and existing codes were used to determine a new basis of construction consistent with past practice and changing conditions learned from the years of operation.

Four sets of floor plans, sections and elevations of the proposed building, based on a reactor size for 3220 tubes and 1300 MW, were prepared during October with the assistance of the Reactor Section, Technical Section and D&C Construction representatives. A meeting was held November 9th to review the data of the studies at which time the present design was approved as a basis. The major objectives of this design are as follows:

1. Reduce the cost of construction by cleaning up the lines of the building to eliminate wings, protrusions, outside stairs and duct work and other costly appendages.
2. To utilize more effectively the excavations which are needed as a bare minimum for construction of the reactor proper and to minimize backfilled areas.
3. Locate office personnel in one zone in order to avoid unnecessary traffic through the process area.
4. Study and eliminate, if feasible, such devices as exhaust fan seal pits, labyrinths, sewage lift stations, and other time-consuming construction details.
5. Increase the utility of the building during the construction period to allow complete framing of structural steel and allow completion of the heating and ventilating system in order to permit process unit work to go on in controlled temperatures. Rearrangement of the construction crane facilities is badly needed as this item controls fabrication time on the process unit.
6. Utilize any constructive idea that may improve the process efficiency in regard to metal handling, access to work on ruptured slugs, etc.

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Progress in fulfilling these objectives is essentially 100%. The studies have been completed and the results are incorporated in the floor plans listed in Appendix I and the Structural Criteria in Appendix II of HDC 2435. Individual highlight items to be pointed out are as follows:

1. No basements, tunnels, or underground passage ways are employed unless excavations have been previously made for the purpose of construction of storage basins or the reactor proper.
2. Storage basin monorail and catwalks are supported by a system of overhead trusses, spanning from dividing wall to dividing wall. The basins are clear and open, eliminating all expensive form work previously required for concrete pedestals and supports.
3. A set of floors has been placed around the rear shielding wall by which access to the rear face can be had through numerous openings in the barrier wall. Maximum use of these spaces for instrumentation, viewing and ready rooms and other dual uses are incorporated.
4. The objective of concentrating personnel has been achieved.
5. The electrical equipment has been placed within the heavy walls in order to provide some protection from blast for critical equipment.
6. All shielding walls throughout the building have been analyzed for effectiveness, and reduction made where technically possible. Meetings held with the Radiological Sciences Department provided firm bases on which to judge these designs.
7. The water-filled windows previously used have been eliminated in favor of lead glass windows because studies demonstrated better visibility can be attained for one-fifth the cost (a savings of approximately \$100,000).
8. The structural system being employed permits maximum use of bar-joints. This allows steel savings up to 15% in some cases without sacrifice in strength.
9. Elevator travel above the top of the unit has been eliminated in view of the high cost of servicing these little used levels. Adequate winches are provided for removal of VSR equipment.
10. The storage basin size has been correlated with the new pile size and space has been provided for three months metal storage while operating at 1700 MW and 400 grams per ton concentration. Space for 1200 buckets is provided with improved crane and truck access.

Heating and Ventilation

One line drawings and air quantity distribution are well under way. Fan room equipment layouts are approved by the Reactor Section. Information available from the design of previous reactor buildings and operation experience was reviewed and a new ventilation basis established. A six-minute air change will be used in the work area, horizontal rod room, laboratories, etc.; the balance of the area has been determined by standard heating and ventilating practice. This has the effect of reducing the specific requirements, a major factor in some particular zones such as the rear face, inner rod room and experimental levels. Since the new building is larger in volume, due to the larger size of the reactor, the air quantities will be the same as 105-C (160,000 CFM).

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The Reactor Section is spending \$4000 to \$6000 per year on the repair of insulation on outside duct work. Aside from the awkward appearance of these ducts, this continuous maintenance and high first cost is unnecessary by proper design. All duct work in the new design is inside the building and can be installed in its entirety without interference in reactor construction. The building arrangement permits early installation of the heating and ventilating equipment so that it may be used for heating during construction.

Other than the points covered, the design follows the same general scheme used in previous reactor buildings with the exception that for emergency air supply both air washers are connected to a single turbine driven supply fan which results in the net saving of one turbine supply fan unit and some building space (approximately \$9,000).

Service Piping

The design drawings and the major piping drawings have been started. Service piping systems are being scoped. Piping codes have been established for the design, and descriptive criteria are in preparation.

Careful consideration has been given to past errors and inadequacies. The need for all services has been re-justified on a point by point basis. The general principle of using loops around the building has been retained in order that portions of the line may be maintained without interrupting service; however, in order to clear corridors and other working areas a maximum use is made of the basement areas.

Drainage in 105-C and E was conducted to an extremely low point (minus 34 feet) in the building and then pumped out using electrically driven pumps in a lift station. Analysis of these designs showed that 95% of this effluent can be brought out at levels no deeper than minus 10 feet. Only a few floor drains in the region of minus 17 and minus 22 feet actually require lifting. In the new design, gravity is used for all of the steady loads, with four small (1 inch) jet lines to drain small sumps which are strategically located in the sub-basement. Drains are segregated in cold drains, potentially contaminated drains and hot drains. Additional gravity drainage provides discharge of effluent from a single tube containing a ruptured slug into a contaminated crib in the event a quick shutdown will not provide sufficient time to dislodge the ruptured piece.

The following systems are included in the building services.

1. Building compressed air, 100 psi.
2. Instrument compressed air, 60 psi. and 15 psi.
3. Vacuum cleaning system.
4. Fresh air breathing system.
5. Storage basin cleaning system.
6. Sanitary and filtered water systems.
7. Fire protection systems as applicable.
8. High and low pressure steam.

Gas system piping within the building is being designed to eliminate the requirement for workers to crawl through the 24" supply lines in order to install instrument tubing used for gas analysis. A junction box consisting of a large tee is provided directly beneath the reactor in order to take these lines out to the gas instrument room which has been moved to the minus nine level.

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Mechanical Equipment Design

Descriptive scope drawings and specifications will be ready for the elevator vendor about January 22nd. One notable design improvement provides for the placing of the "C" elevator adjacent to the smaller, more mobile "F" elevator. The "F" elevator can then be used to service the "C" elevator at any level at which the latter may be engaged, and allows the transfer of palletized metal charges from "C" level to the charging elevator. This will allow maintenance and charging to go on side by side without interruption. Elevator vendors have been contacted and state that their standard practice can meet these requirements.

"F" elevator will also service the various electrical machinery levels, as well as the experimental levels. "F" elevator does not travel above the top of the unit; all lifting from and to the top of the building is handled by the rod room crane at Elevation 107 feet.

The "D" elevator requirements are essentially the same as previously used for other building designs, with the exception that the bridge will be longer due to the expansion of span required by the larger process unit.

All labyrinths for shielding purposes have been eliminated in the interest of reducing form work and speeding up closing in of the building. Each labyrinth contains over 200 yards of concrete and very costly form work. The use of doors cut the cost of the entrances in half. Lead-brass doors, hydraulically operated, will furnish necessary shielding.

Door layout drawings are complete at this time. The door design incorporates panic stops, safety interlocks, releases and other devices to insure proper operation.

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V. Electrical (G. H. Strong)

General

Thirteen scope drawings for RDA-DC-3 have been completed to date. Three more scope drawings remain to be completed; of this number two are now in process. It is expected that all electrical scope drawings for a new pile will be completed by January 25, 1952.

A start has been made on drawings for Project X. If Program X is authorized, these drawings will be used as construction drawings. At present, it is contemplated that the electrical design will require about 150 final drawings. Of this total number of drawings a start has been made on about 50. Thirteen of this total number are included in the scope drawings. To date approximately 10% of final design (on all drawings) has been completed. Drawings found to be critical on C-431-B are receiving special attention and, of these, three are 30% to 60% completed.

Elevator

The electrical sections of the elevator specifications have been completed. Some complication is introduced by the requirement that the C elevator adjust to the level of the F elevator, and also a requirement that the F elevator be synchronized with some of the Health Monitor Beckmans in the building.

Electroveyor For Ball Transport

Progress is well under way on a method of transporting safety control system balls from below the pile to their hoppers in the top shield by electromagnetic means. The design aim for this system has been transport of the balls within a time sufficiently short that the balls could be utilized as a method for scram shutdown instead of vertical rods, thus eliminating need for vertical rods. Even if used for a combination ball and rod system, this method of ball transport offers potential advantages such as absence of moving parts, etc.

A solenoid system, the most promising of six possible methods for electromagnetic conveying, has been selected to receive design and test emphasis. It consists of a series of iron-clad solenoids arranged along the length of the conveying tube. Solenoids are energized in sequence to move the balls along the inside of the tube.

The limitation on speed of transport appears to be the flow rate out of the reactor. Indications are that this can be increased to give a flow period of about one minute. Initial planning was done on the basis of using one conveying tube for each slot of balls. Since costs can be reduced materially by limiting the number of tubes, design studies are now considering the feeding and transport of perhaps 15 - 25 percent of the balls at a time. It is feasible by this method to transport the entire charge within the 10 minute period allowed.

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Electroveyor development is being carried out with the assistance of the General Engineering Laboratory in Schenectady. To demonstrate the principle, two scale models (one six inches high and one six feet high) have been constructed, both of which have operated successfully. A third model two feet high is now under construction. The six inch model is available in Richland for demonstration.

Some design effort has been devoted to a device for coil replacement by rewinding coils in place for ease of maintenance.

Design work has been started on a full-scale prototype which is scheduled for completion by June, 1952.

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REACTOR BUILDING 105 -- ARCHITECTURAL

Total No. 50

<u>Title</u>	<u>Dwg. No.</u>	<u>%</u>
Arch.--Key Plan	H-1-21001	60%
Arch.--Floor Plan Below 0'0"	H-1-21002	30%
Arch.--Floor Plan-El. 0'0" Process Area	H-1-21004	40%
Arch.--Floor Plan-El. /15'0" Process Area	H-1-21005	40%
Arch.--Floor Plan-El. /28'0" Process Area	H-1-21006	40%
Arch.--Floor Plan-El. 0'0" Storage & Transfer Area	H-1-21007	40%
Arch.--Floor Plan-El. /15'0" Storage & Transfer Area	H-1-21008	40%
Arch.--Floor Plan-El. /28'0" S & T Area	H-1-21009	40%
Arch.--Floor Plan-El. /38'0"	H-1-21010	40%
Arch.--Floor Plan-El. /51'6"	H-1-21011	40%
Arch.--Floor Plan-El. /66'0"	H-1-21012	10%
Arch.--Roof Plan	H-1-21015	30%
Arch.--Sections & Dets.	H-1-21016	40%
Arch.--Sections & Dets.	H-1-21017	40%
Arch.--Sections & Dets.	H-1-21018	40%
Arch.--Sections & Dets.	H-1-21019	40%
Arch.--Sections & Dets.	H-1-21020	40%
Arch.--Sections & Dets.	H-1-21021	20%
Arch.--Sections & Dets.	H-1-21022	20%
Arch.--Sections & Dets.	H-1-21023	20%
Arch.--Elevations	H-1-21024	50%

REACTOR BUILDING 105 -- STRUCTURAL

Total No. 63

Struct. Steel Fan Room Roof Floor Plan, Sections & Details	H-1-21101	40%
Struct. Steel Transfer, Storage, Floor & Roof Plan	H-1-21102	10%
Struct. Steel Transfer Storage Section & Details, Office Area Roof Plan	H-1-21105	40%
Struct. Steel Stairways Plan, Sections & Details	H-1-21123	10%
Struct.-Excavation Plan	H-1-21051	
Struct.-Allowable Loads on Floor	H-1 21052	20%
Struct.-Conc.-Foundation Plan Process Area Plan Below 0'0"	H-1-21053	40%
Struct.-Conc.-Foundation Plan--Storage & Transfer Area--Plan Below 0'0"	H-1-21054	20%
Struct.-Conc.-Foundation Plan--Process Area El.-17'6"	H-1-21055	40%
Struct.-Conc. Plan at El. 0'0" Process Area	H-1-21056	40%
Struct.-Conc. Plan at El. 0'0" Storage & Transfer Area	H-1-21057	10%
Struct.-Conc. Plan at El. /15'0" Process Area	H 1-21058	40%
Struct. Conc. Plan at El. /23'0" Process Area	H-1-21059	40%
Struct.-Conc. Plan at El. /15'6" Process Area	H-1-21060	10%
Struct.-Conc. Sections & Dets. Below 0'0" Process Area Sht. 1	H-1-21063	20%
Struct.-Conc. Sections & Dets. Below 0'0" Process Area Sht. 2	H-1-21064	20%
Struct.-Conc. Sections & Dets. Below 0'0" Process Area Sht. 3	H-1-21065	20%

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DETAIL DRAWINGS -- HEATING & VENT.

Total No. 26

<u>Title</u>	<u>Dwg. No.</u>	<u>%</u>
H & V - One Line Duct Diag. Plan	H-1-21151	60%
H & V - One Line Duct Diag. Sections	H-1-21152	60%
H & V - One Line Duct Diag. Plan	H-1-21153	60%
H & V - Exhaust Fan & Duct Plan & Elev.	H-1-21158	60%
H & V - Exhaust Fan & Duct Details	H-1-21159	10%
H & V Supply Fan & Duct Plan & Elev.	H-1-21161	60%
H & V Supply Fan & Duct Details	H-1-21162	10%

DETAIL DRAWINGS & PIPING

Total No. 55

Piping Arrgt. Plan - Drainage Foundation Plan Sh. 1 - El. -17'6"	H-1-21186	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 2 - El. -8'2"	H-1-21187	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 3 - El. -0'0"	H-1-21188	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 4 - El. -0'0"	H-1-21189	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 5 - El. -15'0"	H-1-21190	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 6 - El. -28'0"	H-1-21191	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 7 - El. -38'0"	H-1-21192	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 8 - El. -15'6"	H-1-21193	60%
Piping Arrgt. Plan - Drainage Foundation Plan Sh. 9 - El. -66'0"	H-1-21194	60%
Piping Arrgt. Det. Drainage - El. 0'0"	H-1-21199	10%
Piping Arrgt. Gen. Basic Piping Plans A	H-1-21202	60%
Piping Arrgt. Gen. Basic Piping Plans B	H-1-21203	60%

PIPING ARRGT. WATER

Piping Arrgt. F.W.-S.W.-R.W.- Piping Plans A	H-1-21205	10%
Piping Arrgt. F.W.-S.W.-R.W.- Piping Plans B	H-1-21206	10%
Piping Arrgt. F.W.-S.W.-R.W.- Piping Details A	H-1-21207	10%

PIPING ARRGT. AIR PIPING

Piping Arrgt. Air Piping Plans	H-1-21211	10%
Piping Arrgt. Air Piping Details A	H-1-21212	10%

PIPING ARRGT. STEAM PIPING

Piping Arrgt. Steam Piping Plan A	H-1-21214	30%
Piping Arrgt. Steam Piping Plan B	H-1-21215	40%
Piping Arrgt. Steam Piping Plan A	H-1-21216	20%

RDA-3 - 105 BUILDING - MECHANICAL EQUIPMENT

Total No. 76

Mech. Equip. - Storage & Transfer Area Monorail System	H-1-21310	10%
Mech. Equip. - Pick up Station Arrgt.	H-1-21325	10%
Mech. Equip. - "C" Elevator - Arrgt.	H-1-21265	70%
Mech. Equip. - "C" Elevator - Section & Details	H-1-21266	70%
Mech. Equip. - "D" Elevator - Section & Details	H-1-21271	70%

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