QUARTERLY PROJECT REPORT
ELK RIVER REACTOR
Contract No. AT(11-1)-654
AEC Research And Development Report

March - April - May, 1959

Prepared by
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ALTERNATE DESIGN STUDY

During the period covered by this report, the AEC requested Allis-Chalmers to perform a study on the following three points:

1. Performance capability of the reference design and provisions required to provide 116 TMW reactor output,

2. Fuel costs of the reference design versus alternate fuel media and cladding,

3. Reactor control modifications to provide sufficient reactivity to eliminate soluble "hold down" poisons, permit higher power operation and obtain a greater reactor fuel life.

The above points were raised at a meeting between the Atomic Energy Commission and Allis-Chalmers representatives at Germantown on April 2, 1959. Authorization for performing the study was given by the Chicago Operations Office of the Atomic Energy Commission by telegram on April 3, 1959. Work was initiated on April 6, 1959 and was completed on May 11, 1959.

In order to determine the ultimate reactor power output of the Elk River design and potential modifications required to insure 116 TMW performance, it is necessary to examine in detail three technical areas:

1. Recirculation of primary water through the reactor core which in turn involves problems of steam entrainment and forced versus natural circulation,

2. Thermal performance of the fuel elements which involves problems of boiling burnout and melting of the center of the oxide pellets,

3. Reactor control and nuclear fuel materials which are interrelated by virtue of the change in control rod worth with nuclear fuel media and cladding.

An investigation of these three areas was to be made in keeping with the three objectives as set forth in the AEC meeting of April 2. Various solutions and alternative designs were to be proposed in order to achieve these objectives. Information was to be provided comparing the alternatives on the basis of the following factors:

1. Material and engineering costs involved in modifications,

2. Change in construction schedule and start-up date which would result if the modifications were adopted,

3. Nuclear power costs of each alternative taking into account the attainable MWD/TON burnup of the fuel and cost of fabrication,
4. Influence on containment and hazards resulting from possible plant modifications and/or alternative fuel element materials.

By discussion with the COO of the Atomic Energy Commission a study scope was developed to answer, in so far as time permitted, as many of the above questions as possible. This scope covered an examination of the recirculation problem by studying:

1. The ultimate power output using the 7 foot diameter reference design vessel and natural recirculation,

2. An increase in vessel diameter to 10 feet to insure 116 TMW output using natural recirculation,

3. The addition of pumps and other equipment to insure 116 TMW output using forced recirculation and the 7 foot diameter reference design vessel.

In order to evaluate these three design alternatives it was necessary to re-examine the containment requirements for the maximum credible accident, plant arrangements, and interrelated engineering features influenced by modifications in design.

The ultimate thermal performance of the fuel element being proposed as the reference design was examined. In addition, a fuel element based on using a smaller pin diameter and providing a larger surface area was detailed. The latter design was selected on the basis of reactor operation at 116 TMW.

In order to increase the MWD/TON burnup of the fuel and lower nuclear power costs, the addition of more nuclear reactivity by going to a larger number of control rods on a closer spacing and alternatively an increase in the size of the reference design rod was examined. Involved in this part of the scope was the design of a zirconium clad-urania meat fuel element. This was to be compared to the reference design stainless steel (300 ppm boron) clad thorium fuel element. The choice of cladding and fuel media influencing not only fabrication costs but also excess reactivity requirements, fuel burnup achieved, conversion ratio, and reactor control rod worth.

In order to conduct this study it was necessary to reduce the Allis-Chalmers manpower effort on the reference design by 50%. In addition, the request for quotation for fabrication the fuel elements was put off until the completion of the study. There has been no apparent slippage to date in the construction schedule which is at this time either on or ahead of prediction. However, the startup date for the reactor was predicated on placing a purchase order for fuel elements on or about the first of May. Unless the fuel vendor is able to shorten the fabrication period it may be necessary to advance the startup date by 30 to 60 days as a result of the delay associated with this study.
The results of the study were covered in detail in the report. Representatives of Allic-Chalmers and the AEC-COO met on May 20, 1959 wherein the AEC stated that the use of Boric Acid for low temperature reactivity control would not be acceptable.

It was therefore agreed that the design should proceed on the basis of alternate 1 of the study which provided wider blade control rods that when used with burnable poison in the fuel elements would provide sufficient control for all conditions.

FUEL ELEMENT AND MATERIAL DEVELOPMENT PROGRAM

Material Development Program

The basic design of the capsule for irradiating ThO₂-UO₂ pellets in the GETR for the material development program was approved in March. General Electric, Vallecitos, experienced difficulty in making ThO₂-UO₂ pellets for capsule irradiation. Densities have been 85% to 92% of theoretical instead of 95% of theoretical. Pellets were consequently ordered by G.E. from Davison Chemical Company. These pellets were received at Vallecitos in May. All required some surface grinding to maintain the annulus specified between cladding I.D. and the pellet O.D.

The 93% dense pellets were of the specified length (0.5 inches). The 95% dense pellets, however, were only 0.38 inches long. The 97% dense pellets were only 0.36 inches long. The die cavity used by Davison was too small for the shrinkage developed at the higher densities. G.E. will employ the short pellets, because initiating the irradiation test is more important than irradiating pellets of the specified length.

The GETR is in its first cycle, and is scheduled for a shutdown around June 12th. The first ERR capsule is scheduled for the second GETR cycle.

Prototype ERR Fuel Element

The prototype ERR fuel element inserted into the EBWR on December 11, 1958 has been functioning without adverse comment. The EBWR is scheduled to be shut down around July 1, 1959 at which time the element will be removed. The element is scheduled to be cut up for inspection and analysis during August, 1959.

Fuel Element Design Specifications

Tentative fuel element specifications were discussed with prospective suppliers and their comments have been evaluated.

Preparation of final specifications for the ERR fuel element was delayed pending decisions relative to the alternate design study. The specifications are to be released for quotations the week of June 22, 1959.
with proposals due by August 10, 1959. Delivery of the completed fuel assemblies is now scheduled to begin September 1, 1960 and must be completed by November 1, 1960.

Fuel Element Design

The request for quotations for procurement of the fuel element assemblies contains four alternates. When all the proposals have been received and evaluated, one alternate will be selected and the purchase order awarded to the successful bidder.

The four alternate fuel element assemblies are:


2. Fuel assemblies as in 1 above, but braced with stainless steel wire mesh shown in attached Drawing 12D-SK-033, which wire mesh replaces the brazed-on clips shown in Items 4, 5, 6, and 9, Details E and F, of Drawing 12D-02000. In addition, one top grid per assembly, and one removable fuel pin per assembly, also shown in Drawing 12D-SK-033, replace one each of corresponding Item 2 and Detail D of Drawing 12D-02000.

3. Engineering Standard No. 3748-3-FE-006. Fuel assemblies comprising swaged fuel pins. Except for the swaged fuel pins, for which no drawing has been made and for which a product specification is issued, the other components are as in 1 above.

4. Fuel assemblies comprising swaged fuel pins as in 3. However, instead of the brazed-on spacing clips shown in Items 4, 5, 6, and 9, Details E and F of Drawing 12D-02000, the swaged fuel pins are to be braced with stainless steel wire mesh shown in Drawing 12D-SK-033. In addition, one top grid per assembly, and one removable fuel pin per assembly, similar to those shown in Drawing 12D-SK-033, are to replace one each of corresponding Item 2, and Detail D of Drawing 12D-02000.

Alternates 1 and 2

The Thoria-Urania ceramic fuel pellets required for alternates 1 and 2 above shall consist of a mixture of thorium dioxide and uranium dioxide, compacted and sintered into uniformly dense right cylinders. The ratio of uranium to oxygen in the uranium dioxide shall be 1:2.00 ± 0.02.

Impurities in the initial fuel components shall not exceed the proportions listed below. The total macroscopic thermal-neutron absorption cross section may be expressed as an equivalent amount of boron. If any one impurity exceeds the specified maximum, the other impurity limits must be adjusted so that the total macroscopic thermal-neutron cross section does not exceed 25 ppm of boron.
### Reactor Core Fuel Loading - Alternates 1, 2, 3 & 4

The reactor will be loaded with 148 standard fuel element assemblies, whose fuel loading is specified below. An additional 22 spiked fuel element assemblies are being provided for standby.

The uranium used shall be fully enriched in the isotope U-235. The specified material percentages and the loading are based on using 93.5% enriched uranium.

<table>
<thead>
<tr>
<th>Parts per Equivalent</th>
<th>UO₂</th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Fluorine</td>
<td>100</td>
<td>0.00971</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td>100</td>
<td>0.00680</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>130</td>
<td>0.53689</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>100</td>
<td>0.20874</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>10</td>
<td>0.03039</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>10</td>
<td>0.00058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>60</td>
<td>0.13864</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>10</td>
<td>0.00194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>1</td>
<td>1.49515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>1.0155</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>0.1</td>
<td>0.00352</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td>3.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Th₀₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P₂O₅</td>
<td>10</td>
<td>0.00068</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaO</td>
<td>10</td>
<td>0.00097</td>
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<td></td>
</tr>
<tr>
<td>MgO</td>
<td>10</td>
<td>0.00029</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na-K-Li, total</td>
<td>100</td>
<td>3.19417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td>50</td>
<td>0.00340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samarium</td>
<td>2</td>
<td>4.94146</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europium</td>
<td>0.2</td>
<td>0.17572</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gadolinium</td>
<td>1</td>
<td>11.55340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysprosium</td>
<td>1</td>
<td>0.33884</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other rare earths, total</td>
<td>50</td>
<td>0.09951</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uranium</td>
<td>10</td>
<td>0.03534</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>1</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO₃</td>
<td>50</td>
<td>0.00922</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe-Cr-Ni, total</td>
<td>25</td>
<td>0.10194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu-Mn-Zn, total</td>
<td>10</td>
<td>0.10097</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sub-Total: 21.55

Total: 24.98
Since it is simpler to adjust the amount of fully enriched UO₂ in the fuel than to obtain close tolerances on the boron content of the stainless steel cladding, ample latitude has been provided between the minimum and maximum acceptable content of boron in the stainless steel cladding. But the amount of fully enriched UO₂ in the fuel is dependent on the amount of boron as burnable poison in the stainless steel cladding, so it is consequently necessary to establish the amount of fully enriched UO₂ required for the fuel after the boron content of the stainless steel is verified by analysis. The nominal amount, therefore, of fully enriched UO₂ in the fuel must be subject to final adjustment within ± 0.2% of the nominal U-235 content stated herein (4.45% ± 0.2%).

(a) **Standard Fuel Assembly Loading - Alternates 1 and 2**

(1) **Fuel Pellets**

Each standard fuel pellet shall contain a nominal 95.24% thorium (95.25% ThO₂) and a nominal 4.45% U-235 (4.44% U²³⁵O₂). All figures for the uranium will require adjustment if the fully enriched UF₆ supplied to the converter by Oak Ridge contains some other content of U-235 than 93.5%. Each pellet may contain up to 0.4% A-C approved densifier (such as CaO, TiO₂) replacing an equal weight of thorium oxide, and some volatilizable binder provided the latter is completely burned out upon firing.

Each fuel pellet shall be a solid right cylinder 0.4075 inch ± 0.002 inch in diameter. The appropriate pellet faces shall be parallel and perpendicular to within 0.005 inch TIR.

The density of each pellet shall be 9.46 g/cc minimum (or a minimum of 94% of theoretical where the theoretical density is 10.07 g/cc). The density of the pellets shall be determined on a geometrical basis by measuring and weighing pellets selected by a statistical method given in MIL-STD-105A, "Sampling Procedures and Tables for Inspection by Attributes".

(2) **Fuel-Rod Loading**

Each fuel rod shall contain a 60-inch ± ¼ inch stack of fuel pellets whose nominal total oxide fuel weight is 1224.49 grams ± 10.00 grams. Each fuel rod shall contain 54.5 grams ± 0.5 gram of U-235 (61.92 grams ± 0.6 gram of U²³⁵O₂), subject to the proviso of (1) above.
(3) **Fuel-Element Loading**

Each standard fuel element shall consist of 25 thoria-urania fuel rods, and shall contain 1362.5 grams + 14.00 grams of U-235 (1548 grams ± 15.00 grams of U²³⁵₀²), subject to the proviso of (1) above. The remainder of the 30.612 kilogram total nominal oxide fuel weight for any element shall be made up with thorium dioxide.

b. **Spiked Fuel Assembly Loading**

(1) **Spiked Fuel Pellets**

Each spiked fuel pellet shall be identical with the standard fuel pellets described in (1) above, except that each spiked pellet shall contain a nominal 90.5% thorium (90.51% thorium oxide) and a nominal 8.9% U-235 (8.88% U²³⁵₀²), subject to the proviso of (1) above.

(2) **Spiked Fuel-Rod Loading**

Each spiked fuel rod shall contain a 60-inch ± ¼ inch stack of fuel pellets whose nominal total weight is 1224.49 grams ± 10.00 grams. Each spiked fuel rod shall contain 109.00 grams ± 1.00 gram of U-235 (123.84 grams ± 1.2 grams of U²³⁵₀²), subject to the proviso of (1) above.

(3) **Spiked Fuel-Element Loading**

Each spiked fuel element shall consist of 25 thoria-urania fuel rods and shall contain 2724.46 grams ± 27.00 grams of U-235 (3095.31 grams ± 30 grams of U²³⁵₀²), subject to the proviso of (1) above. The remainder of the 30.612 kilogram total nominal oxide fuel weight for any element will be made up with thorium dioxide.

The burnable poison (boron) fuel rod tubes for alternates 1 and 2 are described below.

The chemical composition of the steel required for the tubes is:

<table>
<thead>
<tr>
<th>Element</th>
<th>Allowable Amount (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.03</td>
</tr>
<tr>
<td>Copper</td>
<td>0.50</td>
</tr>
<tr>
<td>Manganese</td>
<td>2.00</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.50</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.04</td>
</tr>
<tr>
<td>Silicon</td>
<td>1.00</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.03</td>
</tr>
<tr>
<td>Chromium</td>
<td>18.00 - 20.00%</td>
</tr>
<tr>
<td>Nickel</td>
<td>8.00 - 12.00%</td>
</tr>
<tr>
<td>Boron</td>
<td>600 ± 100 ppm</td>
</tr>
<tr>
<td>Cobalt</td>
<td>200 ppm (Maximum)</td>
</tr>
</tbody>
</table>
Dimensional Tolerances

a. The dimensions of each tube shall be within the tolerances shown on appropriate drawings of the fuel rod tube.

b. Length - All tubes shall be cut to length on the same setup to minimize the differences in the lengths of the tubes.

c. Straightness - The maximum curvature of each tube, before fuel loading, shall not exceed 0.060 inch in 6 feet as measured in any plane.

d. Ovalness - Total ovalness shall not exceed 0.0015 inch in any 62-inch length.

e. Squarness - The ends of each tube shall be square within the length tolerance.

Physical Requirements

a. The ends of the tubes shall be plain and free of burrs.

b. The tubes shall be free of all drawing compounds.

c. The inside surface of each tube shall have a bright finish and be free of scale and oxide film or other foreign materials. The outside surface finish shall be no rougher than 125 RMS.

d. All tubes shall be free from seams, cracks, laps, and shall be free of intergranular attack, resolvable at a magnification of 100 diameters. To avoid intergranular attack, care shall be taken in annealing and pickling. All inclusions, pits, gouge marks, and score marks deeper than 0.0025 inch shall be cause for rejection. Multiple discontinuities are rejectable defects if they occur around any circumference of the tube or if they are aligned along an element of the tube.

e. Finished tubes shall be annealed. The hardness of the annealed tubes should not exceed Rockwell B-89.

Non-Destructive Tests

a. All tubes shall be hydrostatically tested at 1350 psi according to the formula

\[ P = \frac{2ST}{D} \]

where \( P \) = pressure to be tested

\( S = 17,500 \) psi (Mechanical Engineering July 1957, for 304L seamless tubing at 50-100°F)

\( T = \) minimum wall thickness in inches

\( D = \) nominal outside diameter in inches
b. Eddy Current Testing - All tubes shall be subjected to eddy current tests. The eddy current tester shall be adjusted to detect all irregularities, however minute, that completely penetrate the tube wall and all those that are at least 1/16 inch long and one-half as thick as the wall.

Alternate 3 and 4 have fuel assemblies comprising swaged fuel pins. Except for the swaged fuel pins described below, the other components are the same as in alternates 1 and 2 and are not further defined in this report.

The swaged fuel element assembly comprises thoria-urania ceramic fuel rods clad with seamless tubing made of cold drawn A151 stainless steel containing boron as a burnable poison. The chemical composition of the steel tubing is the same as that described for alternates 1 and 2; likewise, the requirement for the composition of the fuel material is the same as for alternates 1 and 2.

Standard Fuel Assembly Loading Alternates 3 and 4

(1) Fuel-Rod Loading

Each standard fuel rod shall contain a nominal 95.24% thorium (95.25% ThO₂) and a nominal 4.45% U-235 (4.44% U₂³⁵₂). All figures for the uranium will require adjustment if the fully enriched UF₆ supplied to the converter by Oak Ridge contains some other content of U-235 than 93.5%.

The density of the fuel in the rod shall be 9.06 gm/cc plus or minus 0.2 gm/cc (or 90% plus or minus 2% of theoretical where the theoretical density is 10.07 gm/cc). The fuel rod shall have uniform distribution of the density within the tolerance limits specified. The vendor shall determine the density on a statistical basis to provide assurance that all rods have a density within the tolerance range specified.

Each fuel rod shall contain 60 inch ± 1 inch of oxide fuel whose nominal total oxide fuel weight is 1159.6 grams ± 1 gram. Each fuel rod shall contain 54.5 grams ± .02 grams of U-235, (61.92 grams of U₂³⁵₂), subject to the above proviso.

(2) Fuel-Element Loading

Each standard fuel element shall consist of 25 thoria-urania fuel rods, and shall contain 1362.5 ± 5 grams of U-235, (1548 grams ± 5.7 grams of U₂³⁵₂), subject to the proviso of a(1) above. The remainder of the 28.99 kilograms total nominal oxide fuel weight for any element shall be made up with thorium dioxide.
Spiked Fuel Assembly Loading

(1) **Spiked Fuel Rod Loading**

Each spiked fuel rod shall be identical with the standard fuel rods described in (1) above, except that each spiked fuel rod shall contain a nominal 90.5% thorium (90.51% thorium oxide) and a nominal 8.9% U-235 (8.88% $^{235}\text{U}$), subject to the proviso of (1) above.

Each spiked fuel rod shall contain 60 inch ± 1 inch of oxide fuel whose nominal total oxide fuel weight is 1159.6 grams ± 1 gram. Each spiked fuel rod shall contain 109.0 grams ± 0.4 grams of U-235, (123.84 grams ± 0.45 grams of $^{235}\text{U}$), subject to the proviso of (1) above.

(2) **Spiked Fuel-Element Loading**

Each spiked fuel element shall consist of 25 thoria-urania fuel rods, and shall contain 2725.0 grams ± 10.0 grams of U-235 (3095.3 grams ± 11.3 grams of $^{235}\text{U}$), subject to the proviso of (1) above.

**Dimensional Tolerances**

a. The dimensions of each rod shall be within the tolerances shown on appropriate drawings of the fuel rod tube.

b. Length - All rods shall be cut to length on the same setup to minimize the differences in the lengths of the tubes.

c. Wall thickness - the 0.020 inch wall shall have a tolerance of plus or minus 0.003 inch.

d. Fuel Diameter - The fuel diameter shall be 0.4075 inch plus or minus 0.004 inch.

e. Straightness - The maximum curvature of each fuel rod shall not exceed 0.050 inch in 5 feet as measured in any plane.

**Physical Requirements**

a. The rods shall be free of all swaging compounds.

b. The outside surface shall be no coarser than 125 RMS.

c. All rods shall be free of seams, cracks, laps, and intergranular attack. To avoid intergranular attack, care shall be taken in annealing and pickling. All inclusions, pits, gouge marks, and score marks deeper than 0.0025 inch shall be cause for rejection. Multiple discontinuities are rejectable defects if they occur around any circumference of the rod or if they are aligned along an element of the rod.
Non-Destructive Tests

Eddy Current Testing. - All rods shall be subjected to eddy current tests. The eddy current tester shall be adjusted to detect all irregularities, however minute, that completely penetrate the tube wall and all those that are at least 1/16 inch long and one-half as thick as the wall. Alternatively, the swaged rods may be non-destructively tested by an A-C approved method
REACTOR VESSEL AND INTERNAL COMPONENTS

Reactors Vessel

Fabrication drawings have been approved for the vessel proper; however, there are some nozzle and steam baffle modifications being made. These modifications are not delaying fabrication. The bottom head forging has been delivered. The upper head was rejected because of insufficient material at the straight flange and is being reforged by the supplier. All nozzle forgings have been delivered except the two required for the revised nozzles. All plate material for the shell has been delivered and the bottom course has been rolled.

Core Support Assembly

The grid forging and support structure weldment is being fabricated. The forging has been delivered but machining was delayed by the revision to the control rod shape. Material for the support structure has not been delivered.

Shroud

Revised drawings have been sent to the vendor and the purchase order revision is being placed. Delivery is expected by November 1, 1959. The old shroud assembly was approximately 82% complete at the time of cancellation.

Inner Thermal And Shock Shield

Fabrication drawings are being reviewed for approval. Material has not been ordered.

CONTROL ROD AND CONTROL ROD DRIVE MECHANISM

To provide the additional reactivity control, formerly intended by the boric acid, the core design was slightly modified by rotating the control rods 45° to now enclose a 2 x 2 fuel element array instead of a 3 x 3 array. This change also makes the rod a 14.7/8" cruciform instead of 10¾". The new design is shown on drawing No. 12.

The slightly closer control rod centers (11.667") is being accommodated in the control rod drive by a slight change in flange design.

The wider control rod cruciform doesn't pose any fabrication problems except to increase some envelope tolerances.

Fabrication drawings for the control rod drives have been approved and fabrication started. Delivery is expected January 1, 1960.
The A-C drawings for the new control rods have been completed and a price revision is being negotiated with the vendor. The purchase order revision is expected to be placed within a few days.

**PROCESS SYSTEMS**

Piping drawings, diagrams and general arrangements were re-submitted to Allis-Chalmers for comments on May 21, 1959. Preliminary comments are being reviewed by the Architect-Engineers for incorporation into the drawings. These drawings have been sent out for quotations and any revisions found necessary by further review and comments shall be made prior to issuing purchase orders.

The preliminary specification W-1639 for the Piping System was released for comments on May 21, 1959. Upon receipt of these comments, the specification will be finalized and approved for construction.

Flexibility analysis of the secondary steam and condensate piping have been completed and stresses are well below the allowable limit.

The purchase order for the Evaporators and Evaporator Sub-Coolers was awarded November 25, 1958 with delivery scheduled for October 1, 1959. The vendor's fabrication drawings have been approved. Evaporator shells have been rolled and stainless steel overlay on tube sheets has been started. All material for the evaporators and sub-coolers has been delivered except the tubes which are currently being hydrostatically tested. Our inspector will visit the suppliers plant on June 9, 1959 to inspect the tubes, observe shop tests and witness testing. If everything is satisfactory, the tubes should be delivered by June 20, 1959.

The purchase order for the heat exchangers specification W-1608 was awarded January 22, 1959 with delivery scheduled for November 1, 1959. Fabrication drawings were approved by Sargent & Lundy on May 26, 1959 and returned to the vendor. Material for the heat exchangers has been delivered and fabrication has started.

The purchase order for the emergency and test condenser was awarded May 11, 1959 with delivery scheduled for October 1, 1959.

Revised prints have been received from the vendor and are being checked for final approval.

The purchase order for the Ion-exchangers was awarded February 2, 1959 with delivery scheduled for October 1, 1959. Engineering is to be completed by June 30, 1959. We expect to have fabrication drawings approved by July 15, 1959 after which fabrication will commence.
The purchase order for the Reactor Purification Circulation and Decay Heat Cooling Pumps was awarded on May 1, 1959 with delivery scheduled for November 1, 1959. A request for certified prints has been sent to the vendor.

The purchase order for the Retention Tank Pump was awarded on May 12, 1959 with delivery scheduled for September 1, 1959. A request for certified prints has been sent to the vendor.

Specification W-1635, Portable Ion-Exchanger was released to Allis-Chalmers Manufacturing Co. for comments on April 29, 1959.

A recommendation of award for specification W-1619, Miscellaneous Heat Exchangers was sent to Allis-Chalmers Manufacturing Co. on May 13, 1959 by the Architect-Engineer and is being processed.

A recommendation of award for specification W-1626, Control Air Compressor was sent to Allis-Chalmers Manufacturing Co. on May 13, 1959 by the Architect-Engineer and is being processed.

A recommendation of award for specification W-1627, Vertical Service Water Pump was sent to Allis-Chalmers Manufacturing Co. on May 13, 1959 by the Architect-Engineer and is being processed.

A recommendation of award for specification W-1628, Boric Acid Air Compressor was sent to Allis-Chalmers Manufacturing Co. on June 10, 1959 by the Architect-Engineer and is being processed.

Specification W-1636, Miscellaneous Tanks, has been revised to incorporate Allis-Chalmers Manufacturing Co. comments and will be released for bids on or before June 12, 1959.

Specification W-1638, Retention Tanks, has been revised to incorporate Allis-Chalmers Manufacturing Co. comments and will be released for bids on or before June 12, 1959.

Specification W-1629, Storage Well Circulating Pump and Shield Cooling Pumps, was released to Allis-Chalmers Manufacturing Co. for comment on June 4, 1959.

Specification W-1640, Make-up Injection Pump and Boric Acid Injection Pump, was released to Allis-Chalmers Manufacturing Co. for comments on June 4, 1959. The boric acid injection pump will be eliminated from this specification, per Allis-Chalmers letter dated June 3, 1959 authorized after confirmation by the AEC-COO.

A recommendation of award for Specification W-1623, Filters, was sent to Allis-Chalmers Manufacturing Co. April 17, 1959 by the Architect-Engineer and is being processed.
Specification W-1634, One (1) Boric Acid System Regenerative Cooler and Specification W-1637, Boron Removal Ion Exchanger which were released to Allix-Chalmers Manufacturing Co. on April 20, 1959 and May 6, 1959 respectively have been cancelled per Allis-Chalmers letter dated June 3, 1959 after conferring with the AEC-COO.

SUPERHEATER

A letter of intent for procurement of the superheater was awarded to the successful bidder on December 23, 1958 at which time initiation of detail design was authorized. The purchase order was awarded on April 27, 1959. Delivery to the site is scheduled for October 15, 1959 with erection after that date.

General arrangement drawings including structure and component locations have been approved.

Prints showing the coal pulverizers and coal piping have been received, checked by Sargent & Lundy and were returned to the vendor with comments.

Reinforcing bar details for the superheater building foundations were received and have been returned with comments. The comments were minor therefore these reinforcing bar details were released for fabrication, however to date revised details for approval have not been received.

Drawings for coal scale and coal flow alarm were returned with comments.

The girt framing for the superheater building was released for ordering material.

REACTOR BUILDING, PLANT FACILITIES, ETC.

General

Fabrication details for reinforcing steel have been received from the fabricator for the lower pours in the containment vessel and have been returned with comments. The comments were minor, therefore these reinforcing bar details were released for fabrication, however, to date the drawing revisions have not been completed.

Elevation drawings for the 440 volt switchgear, Specification W-1607, were received and returned to Maxon Construction Company with comments May 20, 1959. Wiring drawings for this equipment were received and will be returned June 10, 1959.

Drawings for the station battery, Specification W-1611, were received and returned to Maxon Construction Company May 21, 1959.

Auxiliary transformer drawings, Specification W-1617, were received and returned to Maxon Construction Company with comments May 22, 1959.
Drawings showing concrete construction for the emergency air lock, decontamination room, electrical cable room and pipe tunnel were released for construction.

The service water pump foundation and the reactor control room drawings were submitted for comments.

Specification W-1625, Building Work, has been revised in accordance with comments made on the draft and was issued for final comments.

The 30 ton crane has been delivered and is in place.

Prints of the air preheater, dust collector, F.D. fan and I.D. fan have been checked and returned to the vendor.

Specification W-1626, Control Air Compressor, was released for quotations on March 26, 1959 which are due April 13, 1959. The proposals are currently being reviewed.

Comments on Specification W-1630, Air Conditioning Units, were received on April 2, 1959. The specification was revised and released for obtaining of quotations which are due June 23, 1959.

Specification W-1621, Generator Set, was issued to Maxon Construction Company for obtaining quotations. The purchase order was awarded May 15, 1959 with delivery scheduled September 1, 1959.

Work continues on the design and drafting work for the containment vessel floor framing and concrete above the main floor, the service water pump installation, and personnel decontamination room.

Drawings for the electrical installation specification were revised and issued with the specification W-1632 for bid purposes. Quotations are due July 3, 1959.

**Containment Vessel Pressure Test**

The containment vessel has successfully passed the overload and leak rate test and was accepted on May 29, 1959. Following is the description of the pressure test:

The system used was a reference chamber located vertically in the center of the containment vessel. The reference chamber was 10" pipe, approximately 50 ft. long. If the ambient temperature changes at a rate less than 1/2°F per hr. for a period of approximately 5 hrs, the temperature in the reference chamber and containment are essentially the same. Therefore, the % loss can be figured from the pressure change without correction for temperature.

The reference chamber was freon tested and pressure tested for 24 hrs at 25 psig and showed no leakage.
When the test set up was complete, the pressure in the containment vessel was brought up to 2½ psig and the vessel and connections were completely soap tested for leaks. Some leaks were found at plugs used to close off holes for electrical penetrations which were corrected.

The pressure was then taken up for the 26½ psig over-pressure test. The over-pressure was actually 27½ psig which was reached at 2 a.m. Saturday morning. The vessel was held at this pressure for 20 minutes with atmospheric pressure in the personnel air lock and then a valve was opened releasing the pressure to the air lock and the over-pressure was held for another 40 minutes.

The pressure was then reduced to the design pressure of 21 psig and a second complete soap bubble test was conducted on Saturday, May 23. No leaks were found in any welds but a few minor leaks were found around electrical penetration plugs which were repaired.

The first 24 hour period of the leak rate test was started at 1 a.m. Sunday, May 24. Leakage during the first 24 hour period was .115% against a specification allowance of .1%. The test was continued another 24 hrs. and the leak rate for the second period was about .125%. A search was made for the leaks and it was found that the vacuum breakers were leaking so they were blocked off. Small leaks were still noted at electrical penetration plugs which were again corrected.

The test was continued another 24 hrs and showed no leakage when figured at 5 a.m., a period when the temperature in the containment vessel and reference chamber would be the same.

The next 24 hour period showed a negative pressure change of about .04% which would be an indication that the reference chamber was leaking. A natural condition that could cause negative pressure change would be a rapid ambient temperature increase so that the reference chamber stayed cooler than the air in the containment vessel; also, human error in reading the gauges could cause it. After much consideration and discussion of the data, it was decided to continue the test for another 24 hours. This was done and the results showed a leakage of approximately .055%. The test was then concluded on the basis that the reference chamber, including all connections would again be freon tested and that no leaks would be found. This was done and witnessed by Mr. Draper and others and no leaks were found. The data therefore showed that we had a total leakage for the last three twenty-four hour periods of approximately .055%.

The vacuum breakers have been removed and returned to CB&I shops for rework. They will be re-tested at CB&I under our observance before they are returned to the site and installed.
INSTRUMENTATION

Engineering descriptions and block diagrams for the Nuclear Instrumentation, Radiation Monitors and the Rod Control System were contained in Quarterly Report No. ACNP-ERR-3.

Preliminary drawings for Nuclear Instrumentation, Specification 12-I-1, have been received from the vendor and are currently being reviewed.

Proposals have been reviewed for Radiation Monitors, Specification 12-I-3 and Electronic Measuring Equipment, Specification 12-I-5. The purchase orders for this equipment are being processed.

Proposals for the Automatic Combustion Control, Reactor Control, Evaporator Feedwater Control and other process equipment covered by Specification 12-I-12 have been received and are being reviewed.

CONSTRUCTION AT SITE

The sub-contractor has experienced some difficulty in driving the piling for the superheater building. The unsuccessful attempts were caused by the sand caving into the hole after drilling. Rain further hindered the work. After a downpour, most of the sand previously located in the walls was on the floor of the excavation. After cleaning up the debris, the work resumed. The number of piling required for the superheater foundation was increased because the 40 Ton loading specified could not be obtained on the first piling driven.

Piling has been completed for the superheater building and foundation area has been fine graded. A mixture of sand and cement has been installed to assist in retaining the walls of the excavation. The required drains are being installed, at present. Reinforcing steel has not arrived on the jobsite at the present time.

The personnel air lock was delivered to the site on April 27, 1959 and was set in place the next day. All welding has been completed and the X-rays are being reviewed.

The emergency escape hatch arrived on the site on May 4, 1959 and was placed in position the same day. The welding is being done at present.

The containment vessel has successfully passed the overload and leak rate test and was accepted on May 29th. Chicago Bridge & Iron left the jobsite on June 5th, on which date Maxon Construction Company gave their formal acceptance of the containment shell. On June 8th the outer portion of the knuckle section of the lower head of the containment shell was started. After sand blasting, the protective coating was applied to the thickness of 10 mils. To date, approximately 60 percent of the outer portion has been sprayed.
The application of 3/8" nuts to support the forms for the shadow wall has been started. Some difficulty was encountered initially in getting satisfactory welds for the nuts. The difficulties were rapidly corrected.

The first delivery of reinforcing steel is scheduled for the week of June 15, 1959. It is anticipated to start pouring concrete under the reactor vessel June 22, 1959. The second carload delivery of reinforcing steel is expected the week of June 29, 1959. This shipment will contain the reinforcing steel for the first floor of the superheater building. The superheater equipment anchor bolts should be delivered to the site during the week of June 29, 1959 in order to prevent delays.

HAZARDS REPORT

As a result of an evaluation of alternate control schemes for the Elk River Reactor, the AEC and Allis-Chalmers have agreed upon using a revised control rod arrangement. This new arrangement provides additional reactivity control. The increase in control is large enough to permit eliminating the boric acid hold-down system, which would have been used to insure a safety margin of control in the shut down reactor.

The new control arrangement involves using the same number of control rods with the same control rod spacing as in the original core. The cruciforms are rotated through an angle of 45°, however, to provide an additional 42 percent in blade width. Other than this rotation of the control rods and elimination of the boric acid control system, the description of the reactor facility as given in the Preliminary Hazards Report, March 12, 1959, is correct.

The change in control arrangement has required a re-evaluation of the maximum credible accident and associated hazards as well as a review of the reactor core physics. The results of these re-evaluations were contained in supplement No. 1 to the preliminary hazards report which was submitted to the AEC-COO on May 25, 1959. It is assumed that the report is now on the agenda for review by the AEC Hazards Evaluation Board and Advisory Committee on Reactor Safeguards.