

## Office Memorandum • UNITED STATES

Memorandum

Denver, Colorado

TO : Chief, Mechanical Branch

DATE: October 29, 1953

Through: Chief Designing Engineer

FROM : Chief, Engineering Laboratories Branch

SUBJECT: Tests to determine the range of extension and possibility of complete extrusion of double-stem type, rubber-brass gate seals for use under high heads in Snowy Mountain Hydro-Electric Authority Project, Australia

Two double-stem rubber seal specimens were delivered to the laboratory for the tests requested in your memorandum of September 1, 1953: one with a brass bulb shield and brass reinforcing on one stem, from Hungry Horse Dam; and one with no reinforcing, from Grand Coulee Dam (Figures 5A and 5B). The shorter of the two was 12-13/16 inches long, which fixed the dimensions of the test apparatus shown on Figure 1.

The initial tests, using this apparatus and both seals, indicated that a continuous stretch, or creep, and possibly complete extrusion of the seals would occur if they were subjected to high differential heads for long periods. The amount of seal extension for a given head differential was found to vary with the positioning of the seal in the apparatus, the condition of the apparatus, and the elapsed time.

When the pressure head was applied behind the seals for short periods and then released to zero, the seals remained extended for several hours, returning slowly to neutral. Tests were therefore made to determine the amount of extension for given periods of time and differential heads. The tests were repeated for each seal, starting at a low head and progressing to the highest head at which it was felt the seal would not be damaged. Care was taken to not damage the seal since such damage would preclude further extension tests on it. Each head differential was applied for 5 minutes, released to zero for 5 minutes, and then the next head applied until a test was completed. The results of these tests are shown on Figures 2 and 3 and have previously been forwarded to members of your staff.

Because the results of the initial tests indicated that the extension limit for the various differential heads had not been reached, particularly at the higher heads, an attempt was made to evaluate the limits for the all-rubber seal. A displacement gage with a recording milliammeter was attached to the apparatus to record elapsed time and the amount of extension at the center of the seal specimen. To assure uniformity of the tests, the seal

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was removed from the apparatus after the test at each head, allowed to return to a neutral condition of stretch, and replaced after the apparatus was moistened thoroughly with water for lubrication. The results of these tests indicated that the Grand Coulee seal would fail if subjected to a head of 300 feet for 3 minutes, or a head of 200 feet for approximately 3 hours, but would not fail in many hours under a head of 200 feet (Figure 4).

Since complete extension-versus-time tests were time consuming, a program was worked out with members of your staff to obtain the basic information requested in your memorandum of September 1, 1953. It appears now that this information answers only a portion of the design problems and that extension of the test program will be required to obtain sufficient data for design. Tests have not been made with the brass shield removed from the one stem of the Hungry Horse seal, as requested in your September 1 memorandum, because the removal of this brass shield would prevent any further tests on the present design should the test program be expanded. The two test specimens are the only stock available in Denver. Also, it is understood that manufacturers are reluctant to aid on seals with brass in or on the rubber so replacement of the seal would be difficult unless other sections could be obtained from stock in the field. It is doubtful that these sections are available.

Several important questions have been advanced as a result of the tests made thus far. The program could be expanded to include any portion or all of them. The questions of major interest to the designers are listed below:

1. What is the force-versus-displacement relation for the condition of the seat being forced against the seal? (A slight revision of the test apparatus would be required to obtain these results.)

2. What is the extension-versus-time relation for these seals? At what head would the seal be apt to rupture if maintained for 1 or 2 hours, or 2 or more weeks? (These results could be obtained in the present test apparatus.)

3. What is the extrusion head-versus-time relation for the double-stem seal held by end bulbs only (Figure 5c)? (Major revisions to the apparatus would be necessary to obtain these results.)

4. Could some manner of separate brass bulb shield be attached to the Coulee-type seal to reduce the drag encountered in closing? (The actual drag tests would have to be made in a different apparatus or predicted from previous tests; the present apparatus could be used to determine the action of a revised seal with the bulb free to move.)

The results obtainable with the present apparatus, or with minor revisions, would be valuable, not only in the design of new installations, but in the prediction of the action of the seals in the operation of existing installations as well. This memorandum presents the results of tests made thus far for your consideration in deciding whether or not the program should be extended to answer the questions listed above. Should you decide not to continue the test program beyond that requested in your September 1 memorandum, the brass reinforcing will be removed from the Hungry Horse seal, tests made to obtain data similar to that shown on Figures 2, 3, and 4, and the testing terminated.

Technical drawing of a high head gate seal test rig. The drawing includes the following views and components:

- Assembled Section Through Bolts:** Shows the top view of the assembly with dimensions:  $2\frac{3}{8}$ ,  $7\frac{7}{8}$ , and  $\frac{1}{16}R$ . Section lines A-A and B-B are indicated.
- Base plate 1 Req'd:** A rectangular plate with dimensions  $14\frac{11}{16}$  and  $2'$ . It features a central slot and two circular holes. Labels include "Drill & C'bore 8 holes", "Drill 8 holes for  $\frac{1}{2}"$  bolt", and "Seat - 2 Req'd".
- End block:** A component used in the assembly, shown in Section D-B.
- Section D-B:** A cross-sectional view showing the end block, spacer, and base plate. Dimensions include  $6\frac{1}{2}$  and  $\frac{1}{16}$ .
- Plan:** A top-down view of the assembly with dimensions:  $2\frac{3}{8}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2\frac{1}{4}$ , and  $1"$ .
- Side Elevation:** A side view of the assembly with dimensions:  $2\frac{3}{8}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2\frac{1}{4}$ , and  $1"$ .
- End View:** An end view of the assembly with dimensions:  $1"$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2\frac{1}{4}$ , and  $1"$ .
- Section A-A:** A cross-sectional view of the base plate with dimensions:  $14\frac{11}{16}$ ,  $2'$ , and  $1\frac{1}{2}$ .
- Section C-C:** A cross-sectional view of the base plate with dimensions:  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2"$ , and  $1\frac{1}{2}$ . It includes labels for "0.84 C'bore  $\frac{1}{8}$  deep" and "1  $\frac{1}{2}$  C'bore  $\frac{1}{16}$  deep Drill for  $\frac{1}{2}"$  bolt".
- Section D-D:** A cross-sectional view of the base plate with dimensions:  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2"$ , and  $1\frac{1}{2}$ .
- Section E-E:** A cross-sectional view of the assembly with dimensions:  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2"$ , and  $1\frac{1}{2}$ . It includes labels for "0.844 OD", "0.516 ID", "1  $\frac{1}{2}$  C'bore  $\frac{1}{8}$  deep", "1" EH pipe", and "C'bore and tap for  $\frac{1}{8}"$  pipe".
- Section F-F:** A cross-sectional view of the assembly with dimensions:  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $2"$ , and  $1\frac{1}{2}$ . It includes labels for "1" EH pipe" and "C'bore and tap for  $\frac{1}{8}"$  pipe".
- Spacer 6 Req'd:** A component used in the assembly, shown in Section E-E and Section F-F.
- END BLOCK - 2 REQ'D:** A component used in the assembly, shown in Section E-E and Section F-F.
- HIGH HEAD GATE SEALS Test Rig:** The title of the drawing, dated 9-15-53.



FIGURE 3

Note - For each test run the head was reduced to zero and the seal allowed to return to rest, the desired head was then applied and held for five minutes. The seal extensions for these conditions are shown on this chart.

10 X 10 TO THE INCH  
358-5L  
KEUFFEL & ESSER CO.

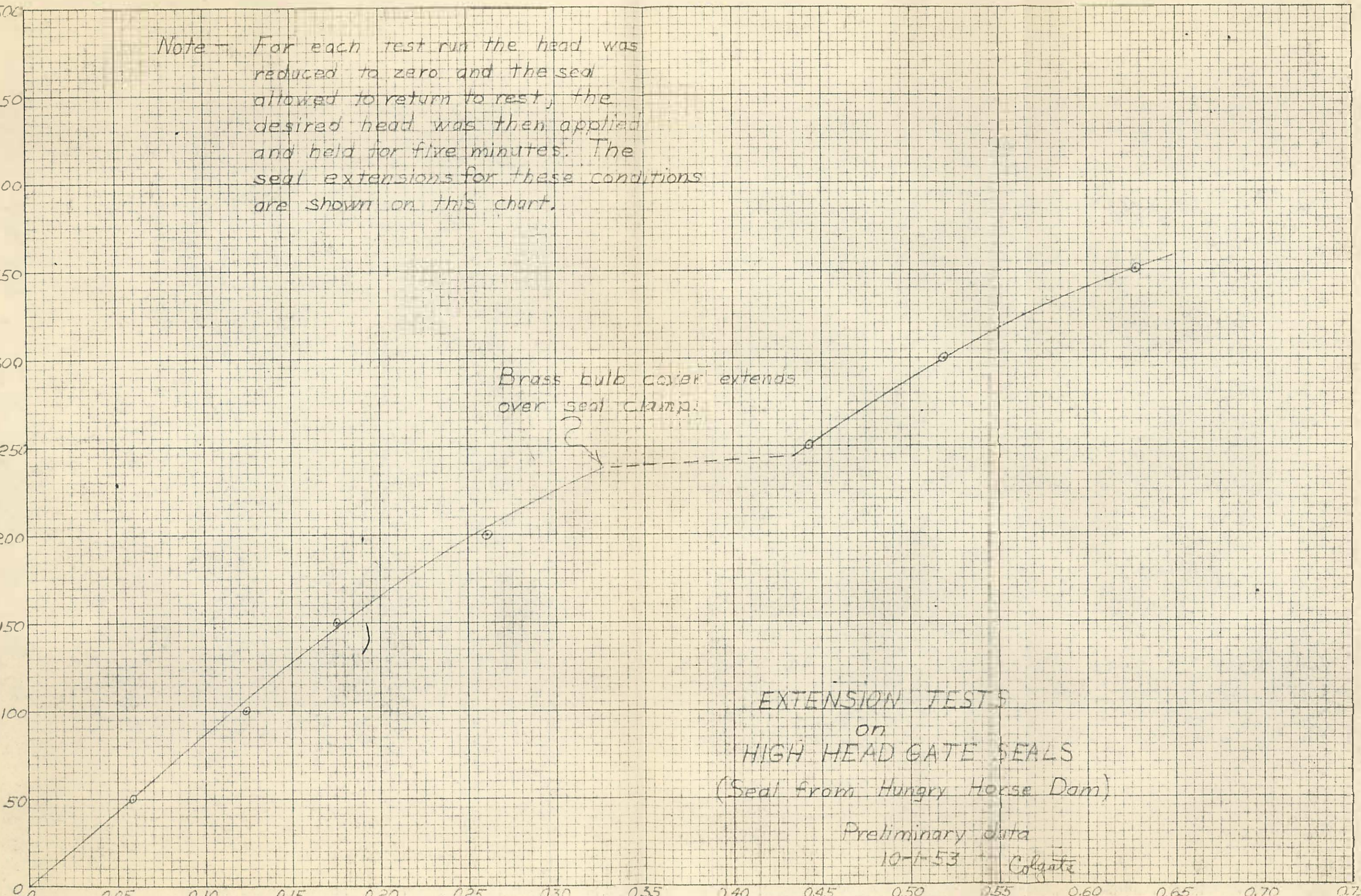
Head Feet of Water

Brass bulb cover extends over seal clamp.

EXTENSION TESTS  
on  
HIGH HEAD GATE SEALS  
(Seal from Hungry Horse Dam)

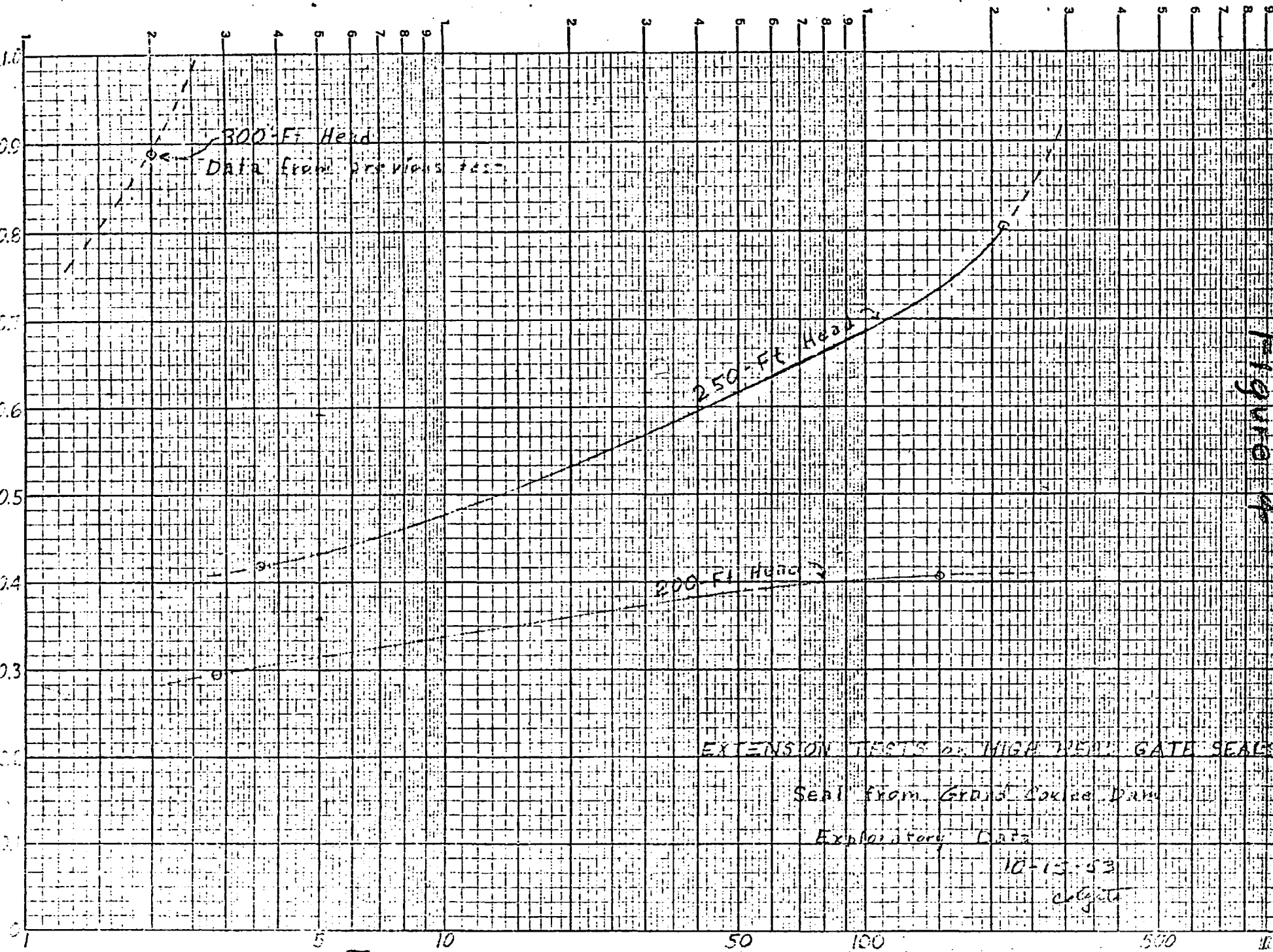
Preliminary data  
10-1-53 Colgate

Seal Extension - Inches





Distance bulb extends from neutral position - Inches



EXTENSION TESTS ON HIGH HEAD GATE SEALS

Seal from Grand Coulee Dam

Exploratory Data

10-13-53

W. J. G. J.

Figure 4

Time of pressure application - Minutes

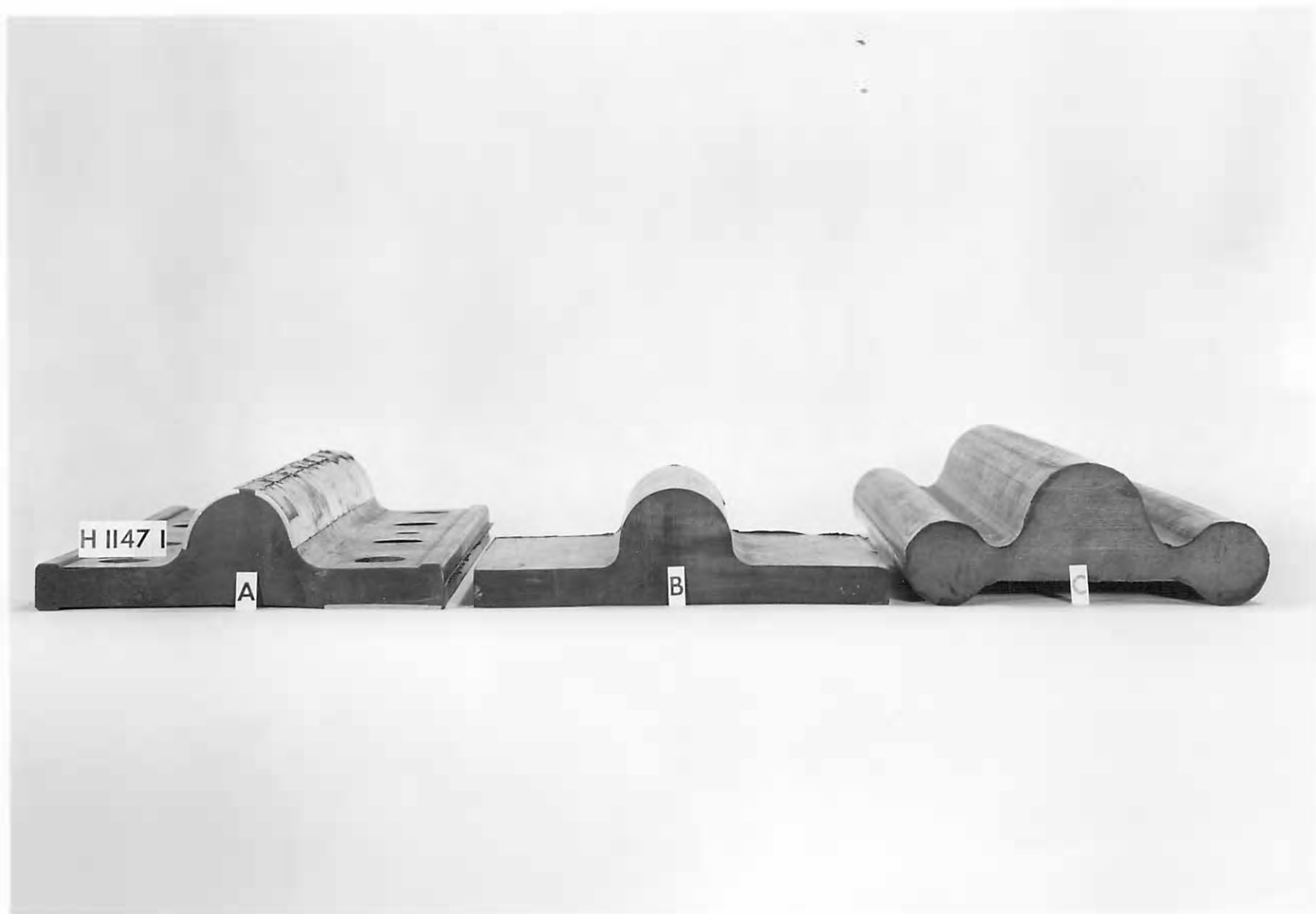




FIGURE 2

Note - For each test run the head was reduced to zero and the seal allowed to return to rest; the desired head was then applied and held for five minutes. The seal extensions for these conditions are shown on this chart.

358-5L  
10 X 10 TO THE INCH  
KEUFFEL & ESSER CO.

Head, Feet of Water

450  
400  
350  
300  
250  
200  
150  
100  
50  
0

Head maintained at 300' for 2 minutes only

EXTENSION TESTS on HIGH HEAD GATE SEALS  
(Seal from Grand Coulee Dam)  
Preliminary data  
10-1-53  
Colgate

Seal Extension Inches

0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00

