A TELEMETERING INSTALLATION TO REPORT COLUMBIA RIVER DATA BY RADIO

By

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INTRODUCTION

The Hanford Atomic Products Operation is located on the right bank of the Columbia River about half way between two tributaries, the Yakima and Wenatchee Rivers.

We, like other industrial operations, use large quantities of cooling water from the river. Like other plants, we are concerned with sufficient flow for adequate supply, with the water temperature for its effect on our needs, and with turbidity for its effect on our water treatment.

Before 1959, the comparatively small Rock Island Dam and reservoir was the only important river structure between HAPO and Chief Joseph Dam. Then it was not too difficult to forecast river changes in time for use to provide corrective measures.

BACKGROUND

Construction of Priest Rapids Dam by the Grant County Public Utility District No. 2 at a point six miles upstream from the Hanford plant boundary has produced changes in the natural river conditions which are of interest to reactor operation.

Normal load factoring causes daily fluctuation in river flow ranging from below 40,000 cfs to over 130,000 cfs. There is a three to six foot change in river elevation nearly every day. River temperatures vary as much as 1° C in one hour's time.

These temperature changes, and to some extent the elevations, affect the optimization of water usage at the Hanford reactors. It is possible to accommodate these changes by adjustment of process conditions, but in order to do this effectively, advance warning is desirable. In addition, a remote but potential serious hazard to the public originating from the interruption of the river flow by failure of gate operation could be eliminated by suitable advance notification. For these reasons, authorization to install a repeater at the new P.U.D.U.S. Geological Survey gage downstream from the Priest Rapids Dam was negotiated and the appropriate equipment was subsequently installed.

DESCRIPTION OF FACILITIES

The U. S. Geological Survey replaced their stream gage at Trinidad, our previous basic monitoring point, because that station will be flooded by Wanapum reservoir now under construction. The replacement was installed two miles below Priest Rapids Dam. At this location the gage measures the same flows as the Trinidad gage except that it includes Crab Creek and other small inflows and also shows the variation in the Priest Rapids Dam discharge. The recorded flows are used by

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many of the important generating plants and power users in the Northwest.

The basic installation was made by the Grant County P.U.D., operator of Priest Rapids and Wanapum Dams, with the engineering collaborations of the U. S. Geological Survey and concurrent agreement of the Bonneville Power Administration.

The prime water level device is a Leupold & Stevens recorder activated by a servo-manometer from a standard bubble gage (Plate 2). This system has a gas pressure tank regulated to deliver small bubbles of gas from the bottom of the river to the surface. The differential pressure between the top and bottom of the river is transferred through a servo-mechanism to a recorder calibrated in feet to report river elevation.

In order to save the installation cost of our own water level gage, a system of instrumentation was designed that would take the output of the U. S. Geological Survey gage and the output of a temperature sensor in the river and transmit data from both to Hanford. This was done by driving a double winding slide-wire with the mechanical output of the gage (see Plates 1 and 2). One winding of the slide-wire changes its resistance from 90 to 100 ohms as the gage rotates through a 50-foot change. This resistance change (90 to 100 ohms) matches the change of our temperature sensing element (RTD) between 0 and 25° C. The other winding on the double slide-wire controls a recorder located at the Priest Rapids Dam control room. Thus, we have two inputs for our telemetering system which change resistance from 90 to 100 ohms, and we are electrically isolated from the U. S. Geological Survey and Priest Rapids Dam recorders by the separate windings on the double wound slide-wire.

All units used in the telemetering system are standard, commercially available pieces of electronic equipment which were purchased and assembled to make the telemetering system.

The resistances of the slide-wire representing water level and of the RTD representing temperature are measured alternately by a Leeds and Northrup 12-point recorder. (See Plate 3.) This recorder serves three purposes. It switches back and forth between water level and temperature at the rate of one point per minute. Second, it prints a record of temperature and water level for use in the event of failure of our radio link. Third, it positions a re-transmitting slide-wire in the recorder to feed information into the radio system.

The re-transmitting slide-wire in the recorder controls a frequency generator to produce an audio-tone between 18 and 30 cycles depending on the position of the pen on the recorder. An 18 cycle tone corresponds to a zero reading on the recorder and a 30 cycle tone corresponds to a full-scale reading.

As the sketch (Plate 1) shows, the 18 to 30 cycle signal frequency modulates a 1000 cycle tone carrier which then goes to a 170 megacycle radio transmitter. Line-of-sight transmission over the 11 miles to Hanford is assured by a 60-foot antenna tower at the gage station (See Plate 4).

At the receiving station the 170 megacycle signal is received and decoded by converting it to a 1000 cycle tone modulated with the 18 to 30 cycle signal, then removing the 1000 cycle component to leave the 18 to 30 cycle signal and then producing a d-c signal proportional to frequency. (Plate 5). The d-c current produced at the output of the frequency converter is zero when the recorder at Priest Rapids reads zero and is .5 milliamperes when the recorder at Priest Rapids reads full scale. This signal drives the receiving recorder in a master-to-slave manner to repeat the data recorder at the Priest Rapids station.

Self-checking devices have been included to indicate errors that might be generated in the telemetering system. If the radio signal becomes too weak to be reliable, a lamp on the receiving set will light and the recording pen will stop moving. Two standard data check readings have been added to the transmitting instrument by connecting standard resistors on two of the 12 recorder inputs. These points always print on the first and next to the last lines of the chart. Any error introduced in transmission can be measured by the error at these points.

We are installing a Hach continuous recording turbidity meter at the gaging station. The output from this instrument will control the slider position on a 90 to 100 ohm slide-wire in the same manner as the water level reading is now handled. We will use a commercially available servo-indicator device for this purpose.

When this signal is put on our system, we will reassign the 12 recorder input points to use four for water level, three for temperature, three for turbidity, and two for data check.

The turbidimeter to be used should require little maintenance. Water enters a vertical tube and over-flows from a smooth flowing surface to a drain. A submersible pump in the river will deliver a continuous water flow through the instrument. A light beam is directed perpendicularly down into the water. Turbid particles in the water will reflect light to selenium photo cells to generate a current which is a measure of turbidity. This generated current will drive a servo type indicator to feed our recorder and telemetering system.

We know of no other arrangement such as we have. The over-all accuracy of the system is ± 0.5 feet for water level and $\pm 0.25°$ C for temperature. Operation since September, 1959, has been very satisfactory. Maintenance calls are made once a month, primarily to replace the chart on the transmitting recorder.

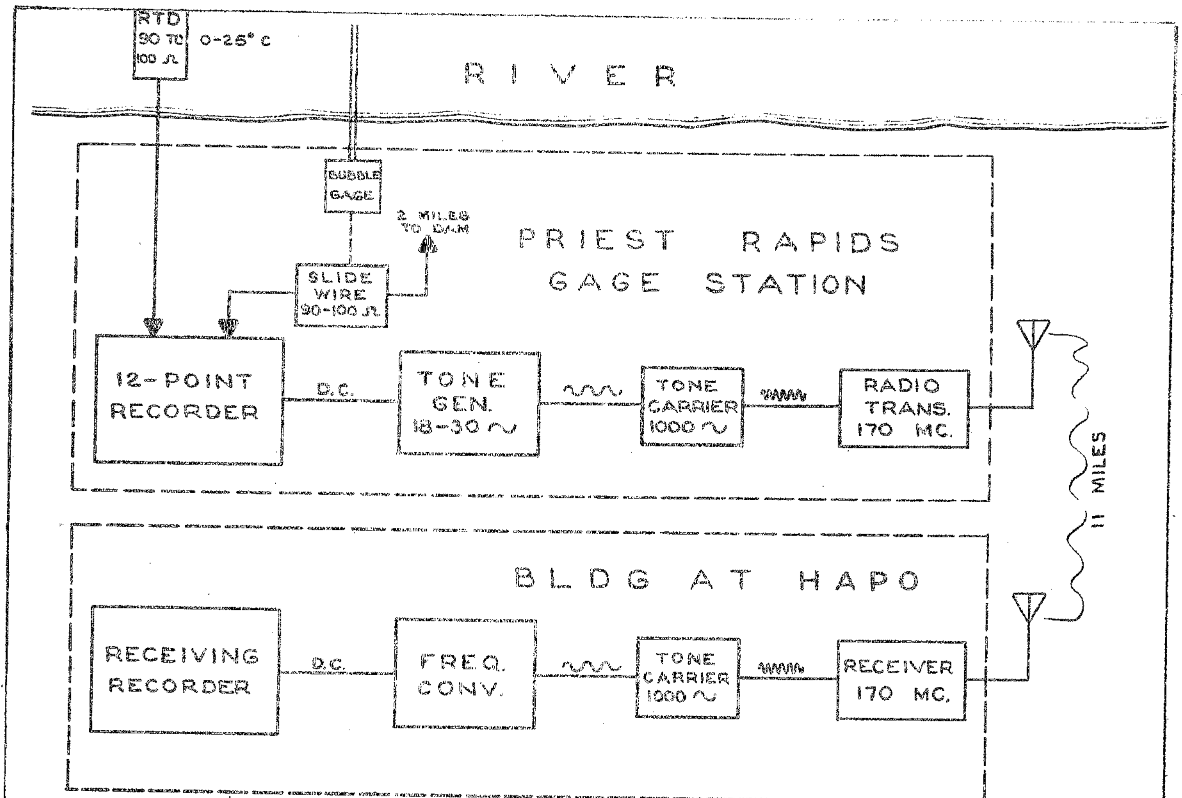
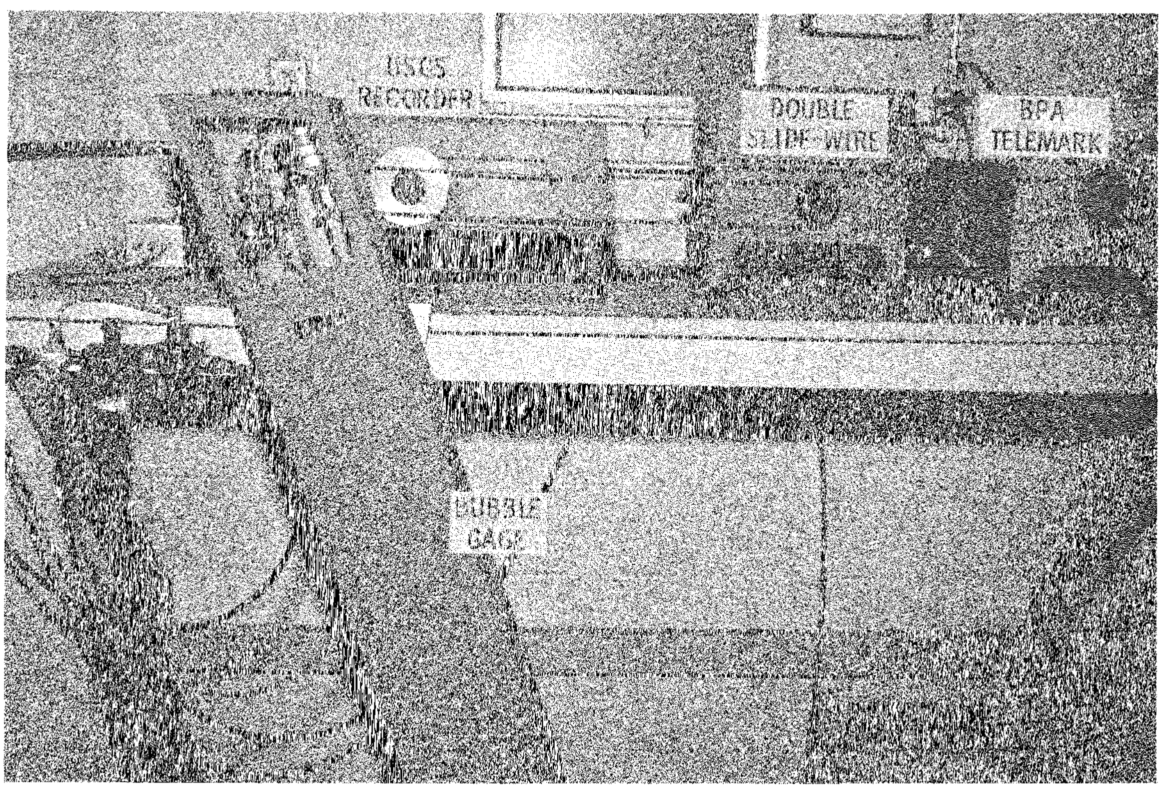


PLATE 1
EQUIPMENT LAYOUT
EACH BLOCK REPRESENTS ONE PIECE OF EQUIPMENT

AEC-GE RICHLAND, WASH.



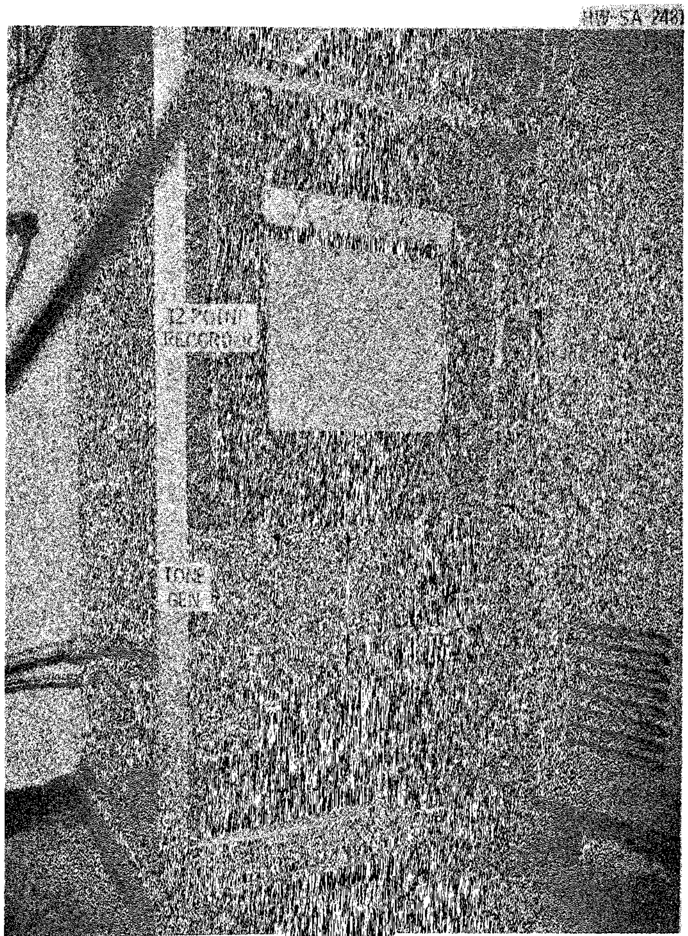


PLATE 3

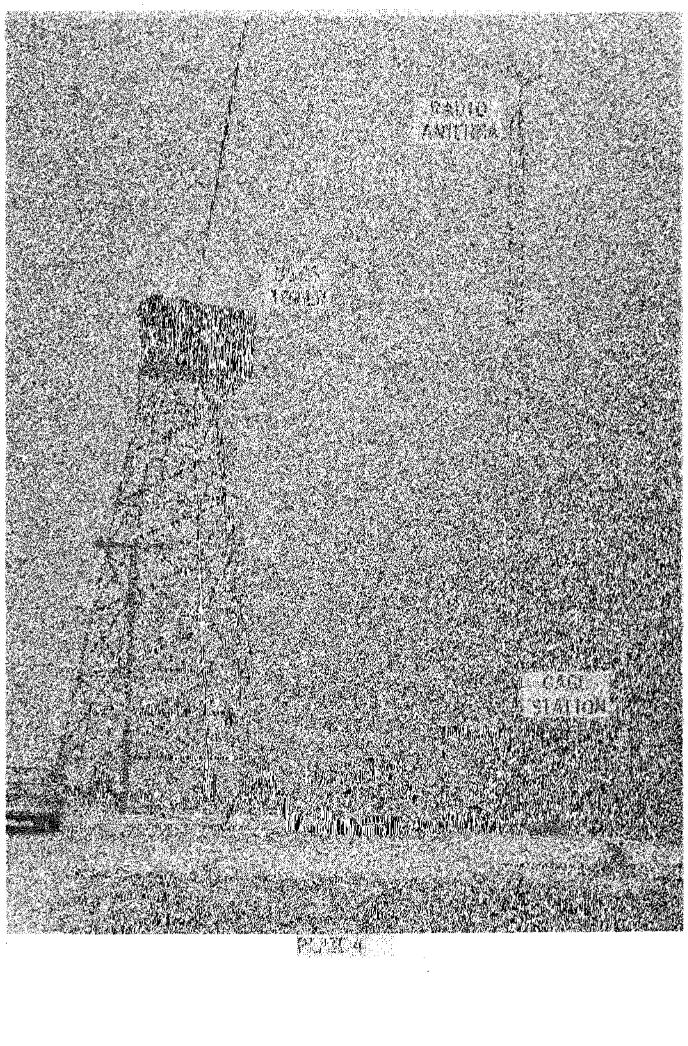


PLATE 4

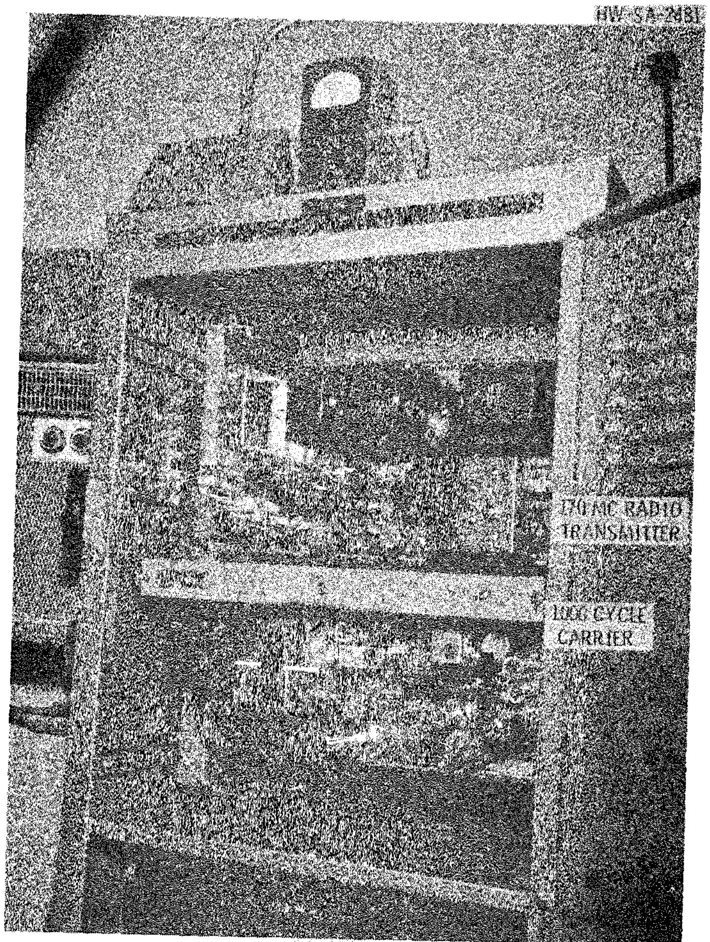


PLATE 5

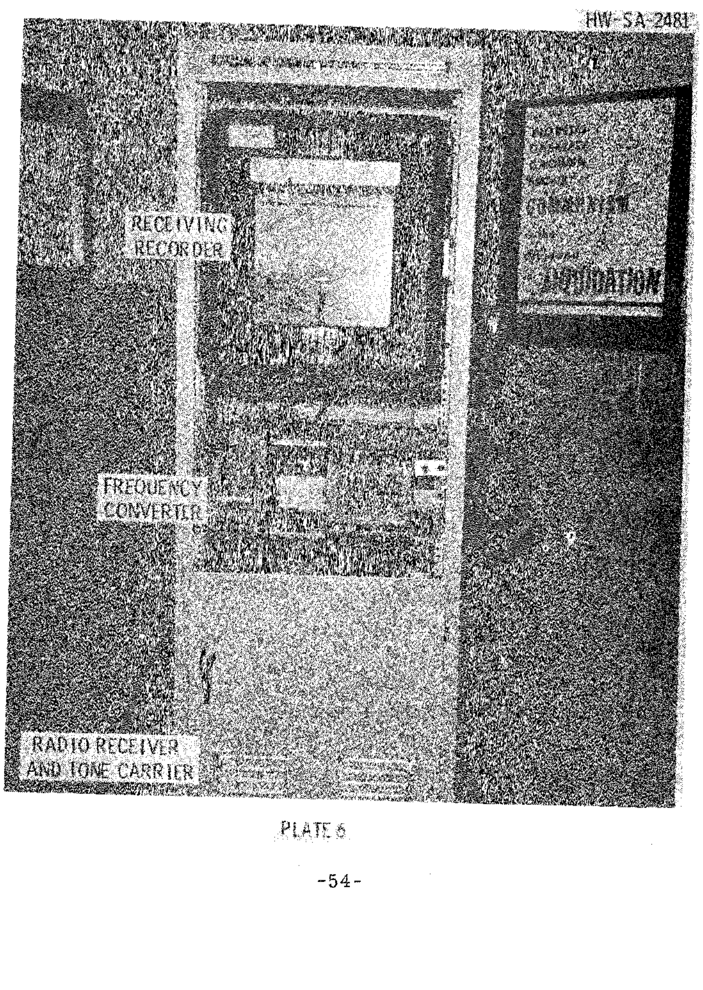


PLATE 6

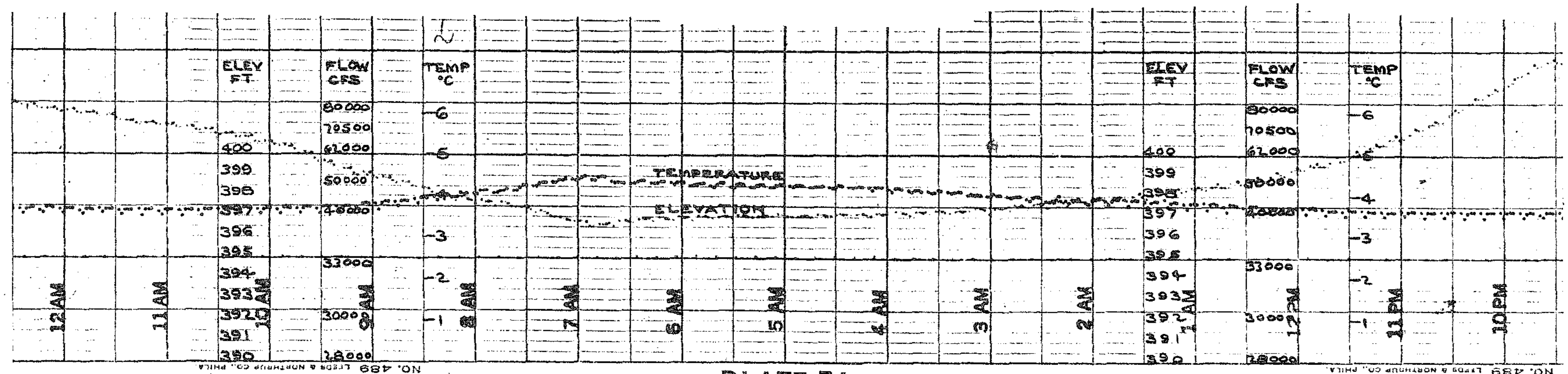


PLATE 7A

CHART FROM RECEIVING RECORDER

HW-SA-2481

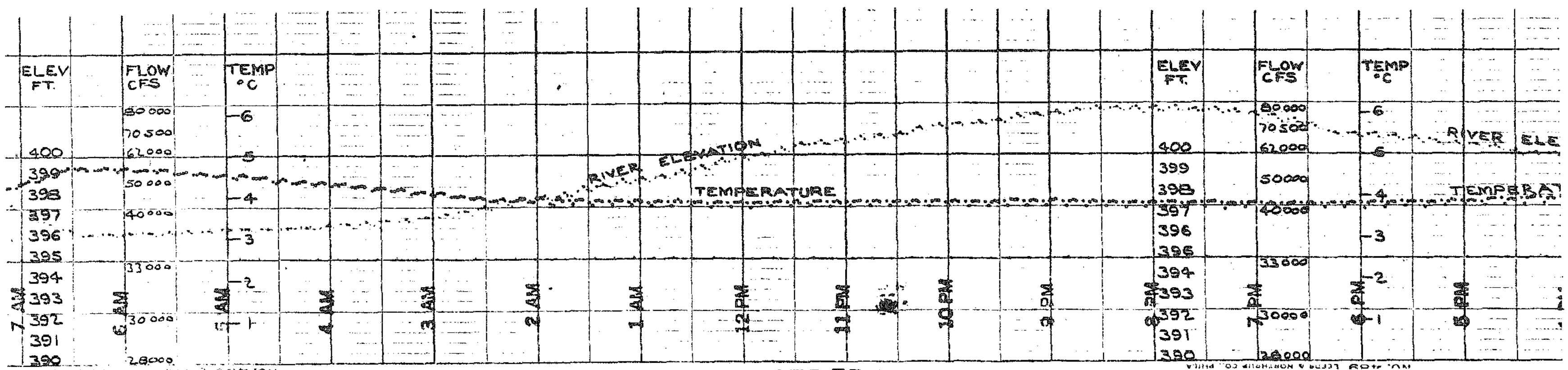


PLATE 7B

CHART FROM RECEIVING RECORDER

HW-SA-2481

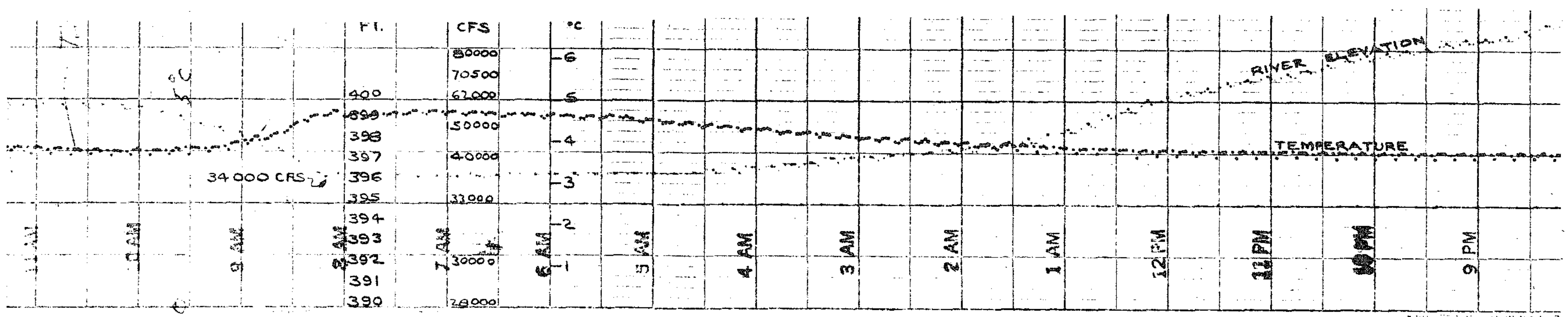


PLATE 7C

CHART FROM RECEIVING RECORDER