UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC LABORATORY REPORT No. 149

DESIGN OF HIGH-HEAD MERCURY MANOMETER
FOR OUTLET WORKS

AT
GREEN MOUNTAIN DAM
COLORADO-BIG THOMPSON PROJECT, COLORADO

By
F. C. LOWE, ASSISTANT ENGINEER

Denver, Colorado
September 18, 1944
1. Introduction. When the hydraulic laboratory was requested to furnish rating curves for the discharge through the tube valves at Green Mountain Dam, it was found that a gage would be necessary to measure pressure head at the valve. A dial gage was first suggested for this purpose, but objections as to the accuracy of a dial gage led to the adoption of a high-head mercury manometer. Dial gages are unquestionably the most practical type for field installations. They are small, easy to read, and sufficiently accurate for most purposes. They do have a disadvantage, however, in not being precise, and may become inaccurate after a long period of service due to wear in the linkage mechanism. Dial gages overhauled and calibrated by the hydraulic laboratory have been found to vary from two to seven percent. Some were accurate at one range of pressure but in error at other pressures. Several large gages were found to be from 20 to 30 percent off due to slippage of the linkage to the dial hand. For these reasons, a dial gage is not entirely reliable. In tests on the 20-inch Shasta Dam tube-valve model at Boulder Dam, they were abandoned in favor of the more cumbersome mercury manometers.

2. Need for accurate pressure gage. The accuracy of a mercury manometer is basic. The height of a column of mercury is a measure of pressure. With corrections for temperature and surface tension, the pressure can be measured as accurately as the reading can be made. There are, however, several disadvantages to a mercury manometer which restrict its use outside of the hydraulic laboratory. The height of the gage often makes it impractical. A gage 19 feet high is required to measure a static head of 250 feet. Nevertheless, such a gage may be installed satisfactorily in a stair well or on a wall next to a permanent stairway, as was done with the gage at Green Mountain Dam (figure 1). The chief troubles experienced by the hydraulic laboratory have not been in the bulk of the gages but in their maintenance. Leakage of mercury at the connections is always a problem. The glass columns break easily, causing the loss of expensive mercury, and dirt and mercuric oxide foul the manometer tubes to such an extent that the top of the mercury column cannot be seen. When it was decided to use a high-head mercury manometer at Green Mountain Dam...
Dam, the more conventional types of mercury manometers were abandoned for a design, perhaps not new, but also not common, which, insofar as possible, will eliminate adverse features of maintenance and also simplify installation. It is the purpose of this memorandum to describe the features of this design in anticipation that occasion may arise where such a gage is needed elsewhere.

3. The Green Mountain mercury manometer. In the new design (figure 2), the manometer tube is a single plastic tube which passes through the cap of the mercury cistern directly into the mercury. Mercury rising in this tube passes no connections; so troublesome mercury leaks are avoided. As the plastic tube is flexible, it will not be broken by a jar or a blow as would glass. Moreover, it has a better appearance on a tall manometer, since glass comes in 3- or 4-foot lengths which must be connected by cumbersome connections. To keep the tube clean and free of mercuric oxide, an inch or two of water should be kept in the manometer tube over the mercury. Corrections may be made for this water, but they will be small. Inserting the water into the tube will be simplified by using a weak solution of aerosol, or other wetting agent. The mercury cistern consists of a cap and a pot. The pressure and the manometer connections are made to the cap which is connected to the gage board by a steel bolt and held in place by two pins. The pot is screwed to the cap. There cannot be any leaks in this cistern because the pot has no openings. The connections to the cap are above the mercury; so only water leaks can occur at that point. To remove the mercury it is only necessary to unscrew the pot. This eliminates opening a valve and catching a stream of mercury in a container; moreover, the inside of the gage and the end of the plastic tube are accessible for cleaning. The exact amount of mercury may be shipped in the pot by capping it. By shipping the correct amount of mercury, servicing of the gage is eliminated, a tedious process. However, in so shipping, the operator is warned to be careful not to spill the contents. The zero of the gage may be marked on the cistern pot and corrections for changes in level calculated. If it is necessary to observe the mercury level in the cistern, a transparent pot of plastic or glass may be used by making minor changes in the design.

4. Installation of gage. The installation of the gage is as follows: (1) mount the gage board; (2) connect the cistern cap to board; (3) connect the pressure and the bleeder line to cap; include valves for closing lines; (4) insert small, steel reinforcing tube in lower end of plastic manometer tube; push reinforced end of manometer tube through the hole in the packing nut on the cistern cap, and tighten nut; (5) fasten manometer tube to gage board with staples; do not drive staples in so tight as to bruise tube; (6) screw cistern pot in place with the correct amount of mercury in pot; (7) pour a small amount of water into top of gage to have an inch or two of water over mercury column; (8) bleed air from pressure line. The gage is then ready for use.
**PLAN SHOWING GENERAL LOCATION**

**ASSEMBLY DIAGRAM**

**DETAIL A**

Note: For details of mercury gage see Dwg. 245-D-2291

**SECTION**

- Std. tubing fitting to seat on top staple to prevent tube from slipping through staples.
- Graduations in feet and tenths
- 6 Brackets for anchoring gage to wall, located as desired.
- Plastic tubing threaded thru staple

**DETAIL B**

- Vent
- Drain
- Pipe not furnished
- Siecker line
- To tube valve #1
- To tube valve #2
- Packing nut
- Zero on gage
- Reinforced tubing
- Mercury pot
- REAR ELEV.

**UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION COLORADO BIG THOMPSON PROJECT-COLO. GREEN MOUNTAIN DAM HIGH-HEAD MERCURY MANOMETER ASSEMBLY**

DRAWN: SUBMITTED: TRACED, C&M: RECOMMENDED: CHECKED: APPROVED:

DENVER, COLO. SEPT. 16, 1944 245-D-2266