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TRAVELER: T. J. Isbester and C. D. Maytum

SUBJECT: Vibration Testing of Outlet Works at Platoro Dam

TRAVEL PERIOD: October 23-25, 1985

PLACES VISITED: Platoro Dam, Colorado

TR-85-38

D-1531

BUREAU OF RECLAMATION
Engineering and Research Center
Denver, Colorado

TRAVEL REPORT

Code : D-253, D-1532 Date: November 4, 1985

To : Chief, Division of Electrical, Mechanical, and Plant Design
Chief, Division of Research and Laboratory Services

From : T. J. Isbester and C. D. Maytum

Subject: Vibration Testing of Outlet Works at Platoro Dam

1. Travel period: October 23-25, 1985.

2. Places or offices visited: Platoro Dam, Colorado.

3. Purpose of trip: To measure the vibration of the 56-inch pipe at the outlet works of Platoro Dam. (Reference: Wire message, Projects Superintendent, Albuquerque, New Mexico, to Engineering and Research Center, dated October 16, 1985.)

4. Synopsis of trip: We left the Engineering and Research Center October 23, 1985 and arrived later that day in Alamosa, Colorado. The following morning we traveled to Platoro Dam, where we met Charles Fisher, Chief, Chama Field Division. While we were there, the site was visited by John Schurer, Paul Clark, and Dr. Chin Y. Lee of the Colorado Division of Water Resources. We performed the testing described in the enclosed appendix to the travel report and returned to Alamosa. The following day we returned to the Engineering and Research Center.

5. Conclusions: The outlet works and discharge pipe performed satisfactorily up to 70 percent of opening with a balanced discharge from both valves. Because of the abrupt increase in cavitation-induced vibration between 80 and 90 percent of valve opening, it is concluded that combined operation of both valves above 70 percent of opening should be avoided to slow down the progression of the cavitation damage that already exists.

6. Action Correspondence Initiated: None.

Noted: NOV 14 1985
L. O. Timblin Jr.
ACTING Chief, Division of Research and Laboratory Services

T. J. Isbester
C D Maytum

Enclosure

CP 11/12/85

Copy to: Regional Director, Amarillo, Texas, Attention: SW-200
Project Construction Engineer, Alamosa, Colorado
Chief, Chama Field Division, ~~Chama~~ Albuquerque, New Mexico

Noted 11-19-85

Blind to: D-215 D-250 D-252 D-253 D-430 (Crysdale) D-1530 D-1532 (Isbester)
D-1500, D-1531 (file)

Chief, Division of Electrical, Mechanical and Plant Design

DMaytum:ksl:11-4-85:V-122/124

Appendix to Travel Report

(Travel by T. J. Isbester and C. D. Maytum, October 23-25, 1985)

When we arrived at Platoro Dam, both valves were discharging at about 5 percent gate opening. Vibration was not significant at this amount of flow.

We set up the charge amplifiers and the Hewlett Packard spectrum analyzer and supplied them with power from a constant-voltage power supply. We installed 10 aluminum mounting pads on the pipe in two lines of 5 pads each. Each line spanned 90° circumferentially on the pipe. One line was located midway between the pipe supports for the first 36-foot section of pipe on the upstream side of the valve house. The other line was installed at the one-third point of the section. The topmost pad of each line was mounted about 5 degrees to the left of the top longitudinal centerline of the outlet pipe, for convenience in installation. (For a symmetrical shell, the choice of location is arbitrary.) Ten pads were provided to give flexibility in the selection of measurement points. In actual operation we found that the use of the two accelerometer positions that were 90° apart on the centrally located line of pads gave satisfactory results.

Test runs were made with balanced valve openings at 25, 50, 60, 70, 80, and 90 percent valve openings. The righthand valve was tested at 50, 60, 70, 80, and 90 percent opening, with the left valve closed. For comparison purposes, the left valve was run at 90 percent opening with the right valve closed. Peak acceleration spectra (acceleration as a function of frequency) were displayed on a CRT by the spectrum analyzer. The data was recorded photographically for each run, and as a backup, each significant data point was written down.

Acceleration measurements on the wall of a thin shell provide a convenient indication of the severity of the internal pressure fluctuations. The data for Figures 1 and 2 were obtained during runs at various percentages of valve opening, with both valves set at the same opening. Figure 1 is a plot of valve opening versus peak acceleration for the maximum frequency component obtained from the acceleration spectra produced by the spectrum analyzer. The slope of the curve increases sharply between 80 and 90 percent of valve opening. A similar tendency is shown in Figure 2 which plots acceleration versus valve opening for the spectral lines at about 30 hertz. There is an abrupt increase in acceleration between 80 and 90 percent of valve opening.

The vibration at small valve openings is probably due to normal flow turbulence. At the valve opening where the combined cross-sectional area of tne two openings is equal to or greater than the area of the 56-inch pipe, the flow control tends to shift from the valves to the 56-inch pipe. At

this point, the back pressure due to the valves is so low that the cavitation index passes through the critical value with a sudden increase in cavitation. The cavitation noise increase shows up very clearly on the accelerometers as well as becoming very prominent acoustically.

Conclusions: The curves of Figures 1 and 2 show an abrupt increase in vibration level between 80 and 90 percent opening on both valves. Because of the deleterious effects of cavitation on the pipe and valve structure, further operation of the valves in parallel above openings of 70 percent should be avoided. Operation of only one valve at any opening up to 90 percent is acceptable.

V-123/124

PLATORO 56-IN. PIPE

PEAK SPECTRAL ACCELERATION OCCURRING AT LOCATION A OR B.

10/24/85

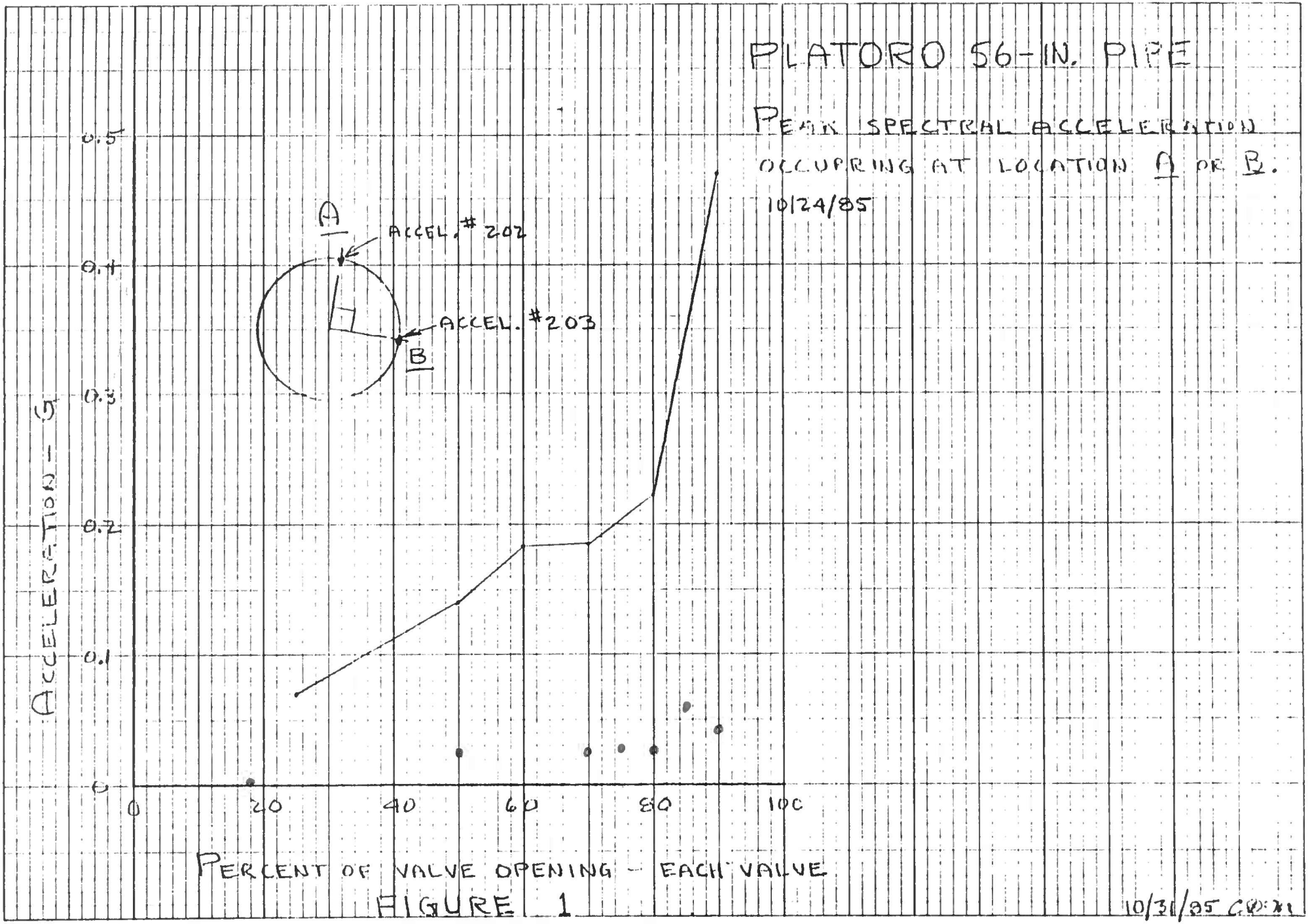

FIGURE 1

10/31/85 CO:X1

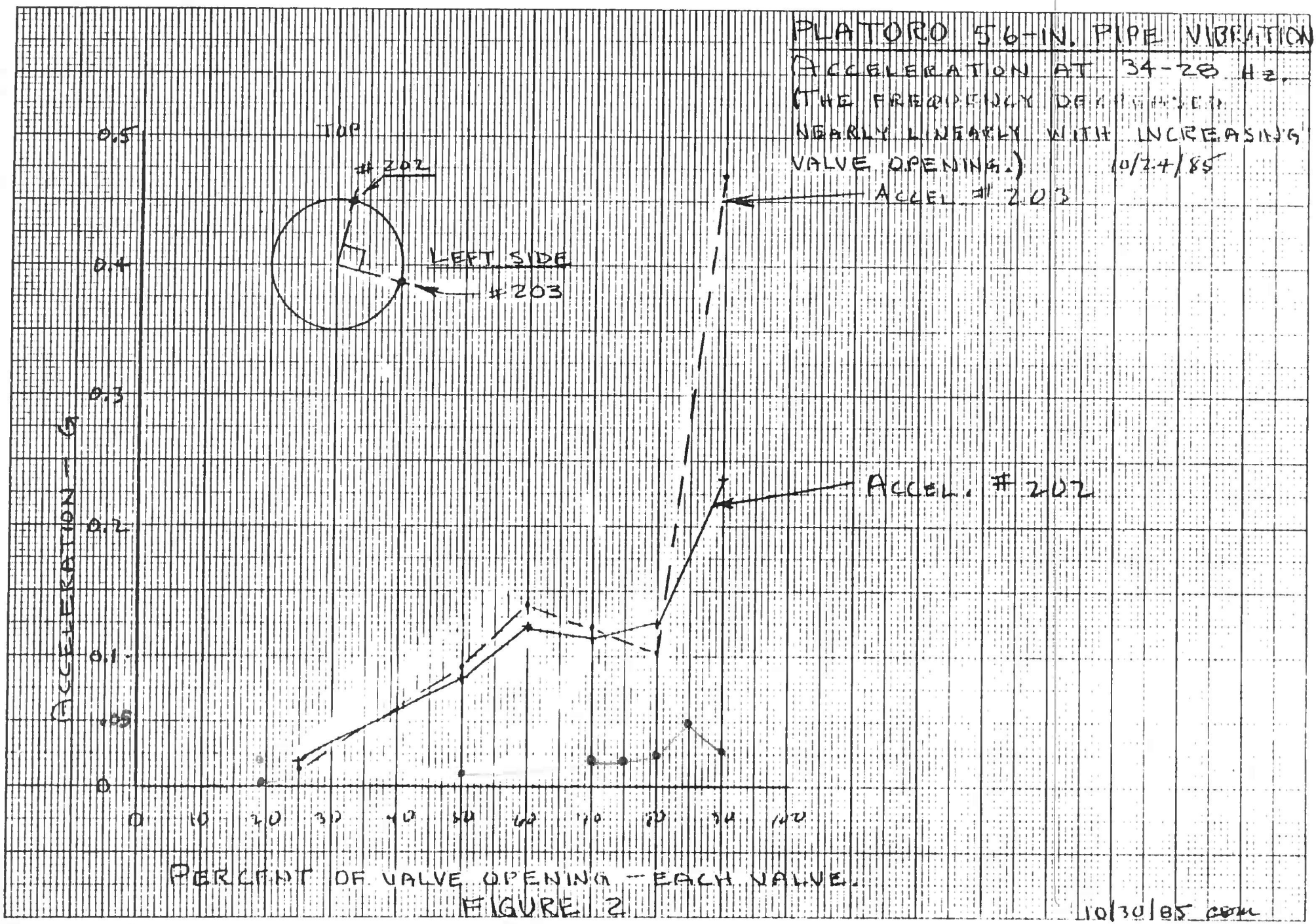

FIGURE 2

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