# DEAD ~~HEAD~~ END TEST

Brent W. Mefford

December 10, 1981

D-1530

Form DFC-11
(12-51)
Bureau of Reclamation

INFORMATIONAL ROUTING

Memorandum

Chief, Water Conveyance Branch

Chief, Hydraulics Branch D. King 12/11/81

Brent W. Mefford, Hydraulic Engineer

Dead ~~Head~~ End Test

Denver, Colorado
December 10, 1981

Design engineers from the Water Conveyance Branch requested the Hydraulics Branch to conduct a series of hydraulic transient tests. By utilizing much of the existing apparatus from the Flexflo surge reliever tests, it was felt a brief series of hydraulic surge tests could be conducted for a minimal cost.

Testing centered on defining hydraulic transients occurring on pipelines containing dead end laterals. The pipeline networks set up for the tests are shown in figure 1.

A high head variable speed pump was used to develop steady-state conditions. Severe hydraulic transients were created by the quick closure of a 4-inch disk-leaf gate valve near the downstream end of the test network. Surge relief protection for the pump was provided by maintaining an open bypass valve downstream of the pump discharge line.

Instrumentation included three variable reluctance-type diaphragm pressure transducers and one linear variable differential transducer to measure gate stroke. They were installed as shown on figure 1. Discharge measurements were taken both upstream of the relief bypass and downstream of the quick closing gate valve. Line pressures were recorded at the pump discharge port and at the three pressure transducer locations identified.

Three different pipe systems were incorporated in the testing. Test setup No. 1 used a straight pipeline without the dead end lateral. For setup No. 2, a 20-foot dead end lateral was added to the pipeline. Test results from the 20-foot dead end failed to adequately define the wave magnitudes. It was determined the dynamic response of the pressure transucers when coupled with the relatively short pipeline was not sufficient to clearly define the first wave characteristics. The pipe network was then altered by adding 20 feet of pipe to the dead end lateral (test setup No. 3).

Hydraulic transient tests were conducted using steady-state line discharges of 0.5, 1.0, 1.5, and 2.0 $ft^3/s$. Figure 2 shows the net head rise at three locations on the system versus steady-state discharge for the four discharge conditions run. Net pressure heads recorded at position 4, obtained using the straight pipe configuration, are also included in figure 2 for comparison.

Basic elastic water column theory applied to the dead end bifurcation tested predicts a 74 percent wave transmittance at the tee followed by a 148 percent wave reflection from the dead end as shown below. (No losses - Ref. USBR Waterhammer Analysis - J. Parmakian.)

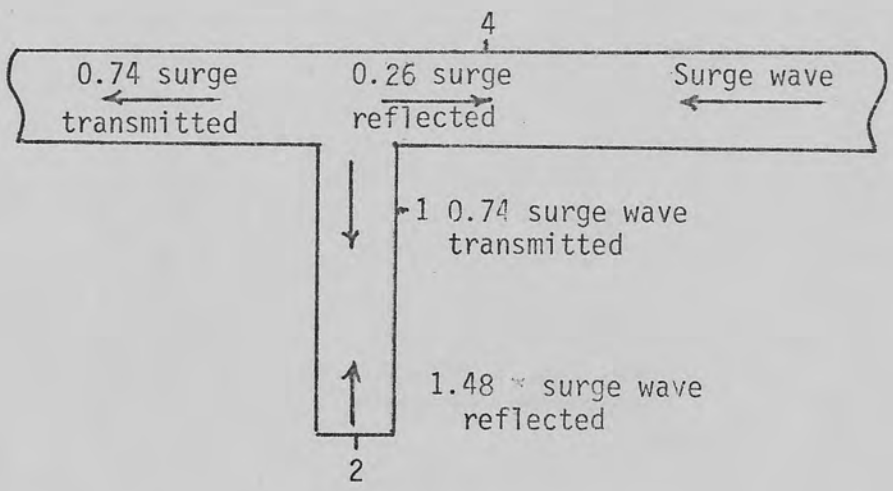



Table 1 provides the surge results for the data shown on figure 2.

Table 1. - Surge pressures as a ~~percent~~ Fraction of the primary wave amplitude

| Run No. | Q $ft^3/s$ | Primary wave percent of surge: Location No. 1 | Primary wave percent of surge: Location No. 2 | Surge wave net head rise (~~ft~~) psi |
|---|---|---|---|---|
| 11 | 0.5 | 0.56 | 1.22 | 98 |
| 12 | | 0.56 | 1.20 | 98 |
| 6 | 1.0 | 0.63 | 1.34 | 163 |
| 5 | | 0.62 | 1.33 | 162 |
| 8 | 1.5 | 0.72 | 1.32 | 206 |
| 7 | | 0.78 | 1.33 | 198 |
| 10 | 2.0 | 0.87 | 1.44 | 216 |
| 9 | | 0.80 | 1.36 | 254 |

Table 1 indicates the percent surge at location 1 exceeds the maximum value theory predicted for discharges above 1.0 $ft^3/s$. The physical constraints of the test apparatus in conjunction with the wave celerity represent limitations under which the above comparisons must be interpreted. Wave speed calculated from the test output varied from 3,300 to 3,400 ft/s. Any initial pressure wave recorded at location No. 4 having a wave front exceeding 0.01 second was attenuated by the reflected wave from the tee section. The test output shows all tests conducted using discharges larger than 0.5 $ft^3/s$ would be expected to contain some degree of wave peak truncation at transducer position 4.

Figure 3 shows the first peak versus the reflected peak at position 1 in the dead end lateral. The reflected peak varied from 195 to 152 percent of the first peak pressure over the steady-state discharge range tested.

Strip chart records of the run test data are included following figure 3.

Attachments
Figures and strip charts

Copy to: D-1530
D-1532
D-1533

Brent W Mefford

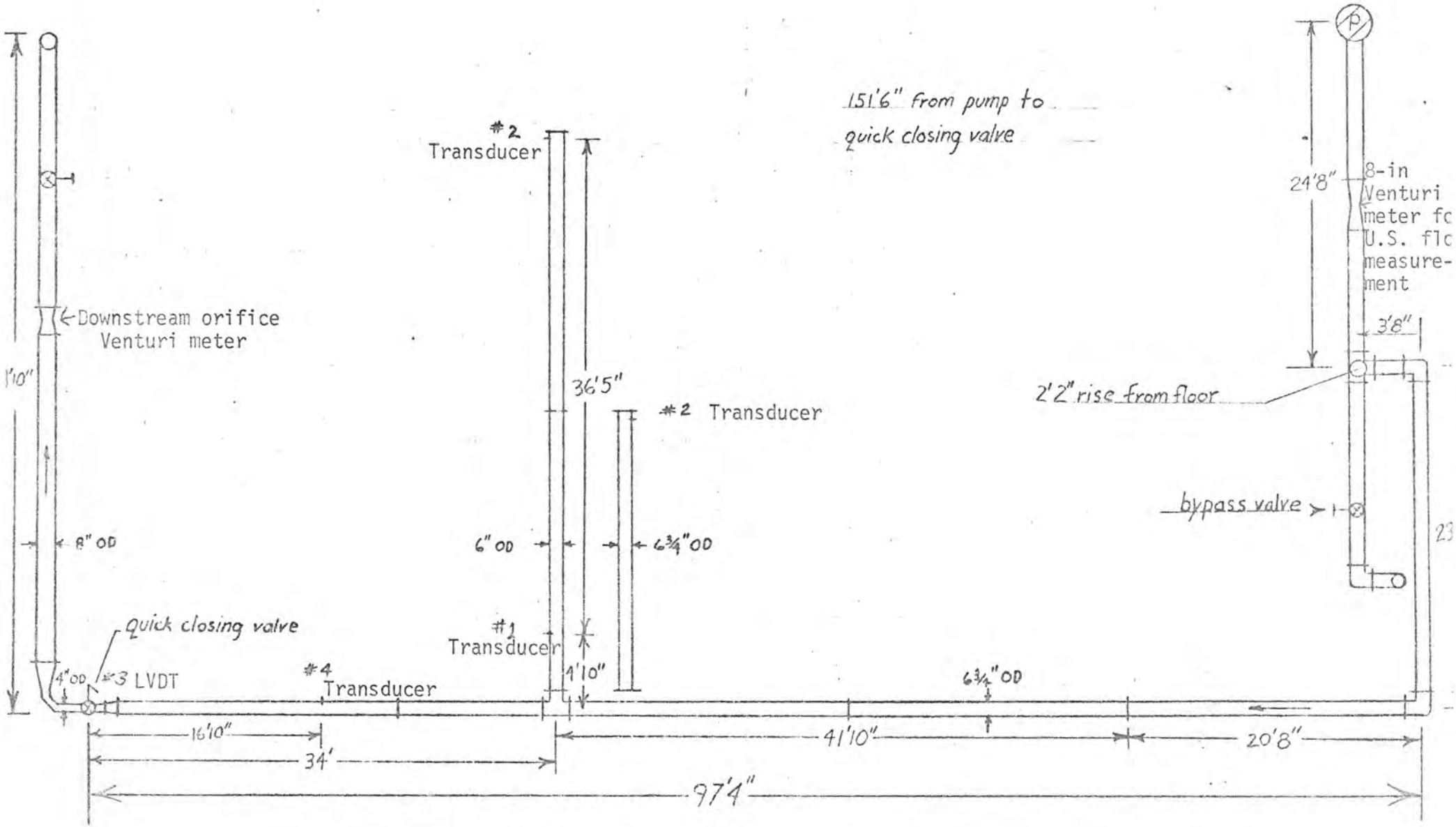



FIGURE 1 *diagram of the flex-flo pipe system*

*scale 1" = 10' (pipe dia. distorted)*

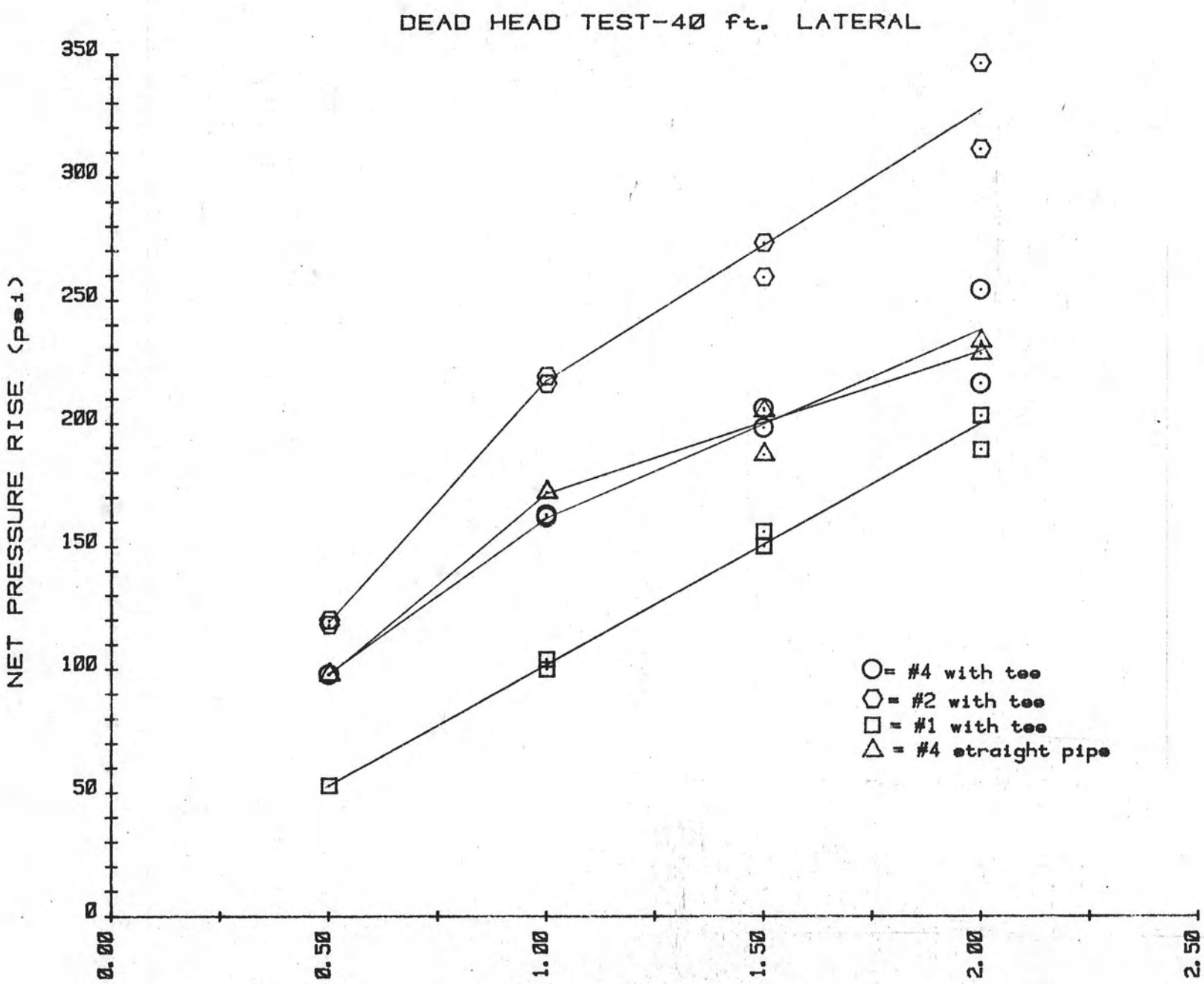



FIGURE 2 - Q (cfs)

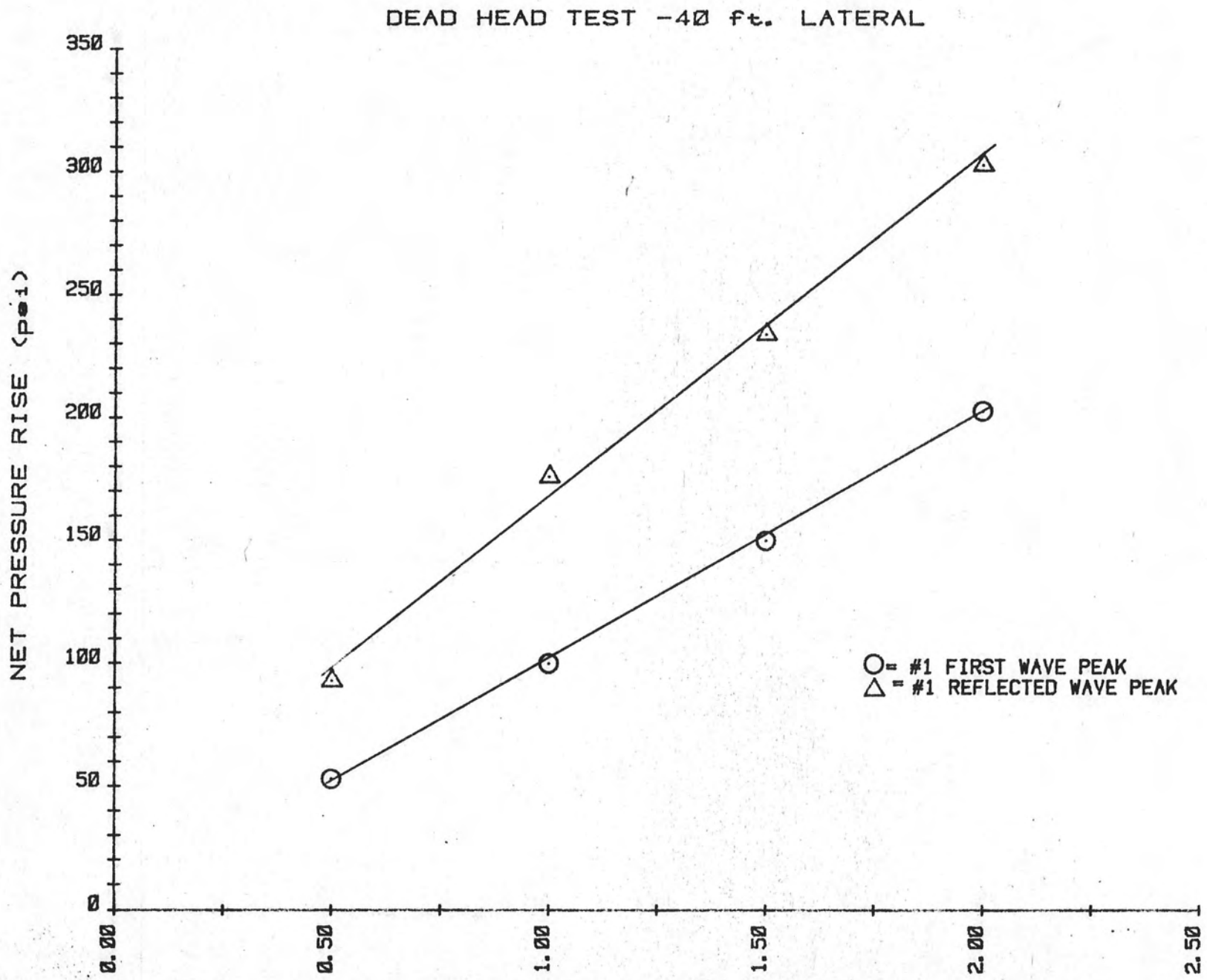
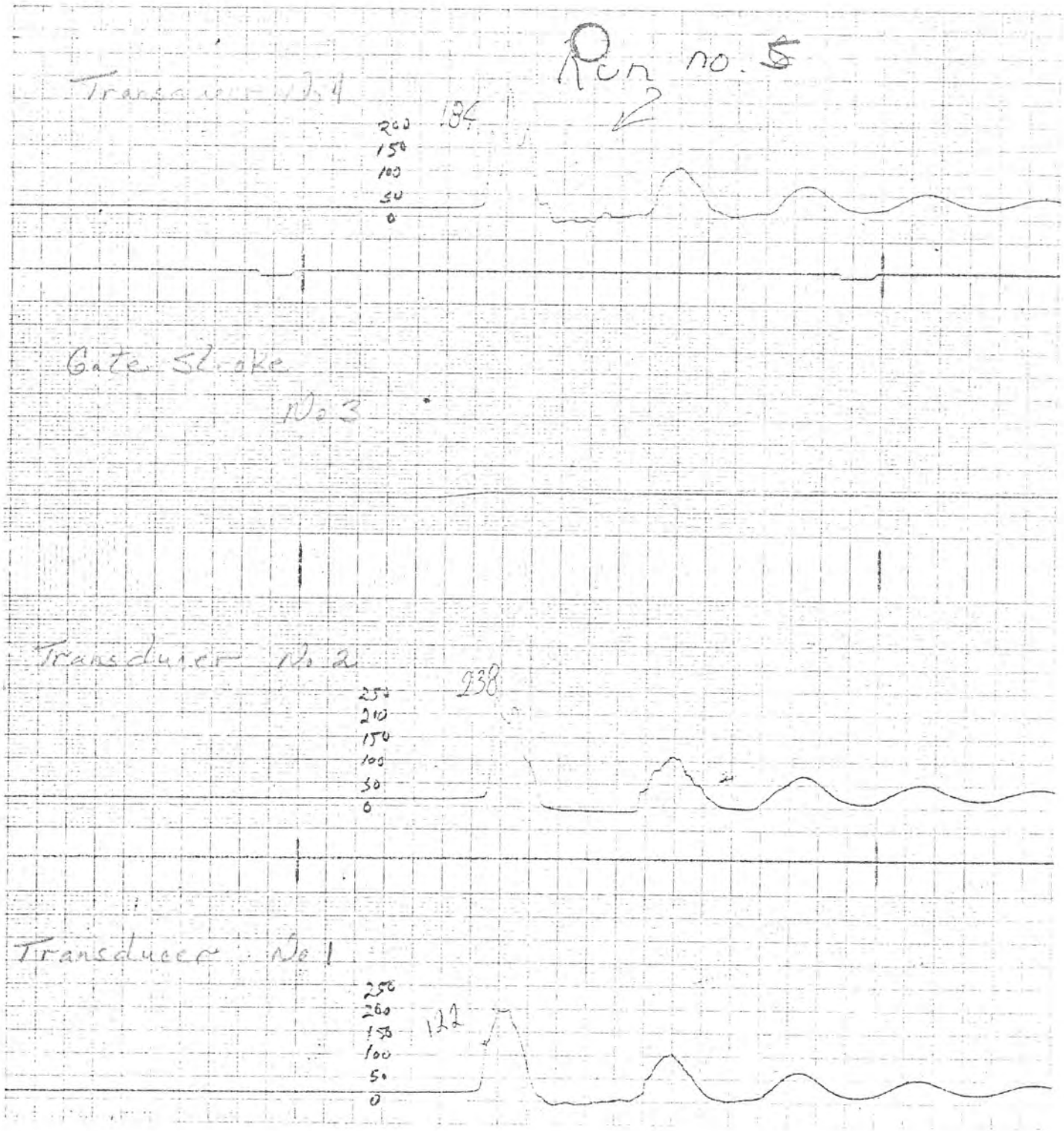
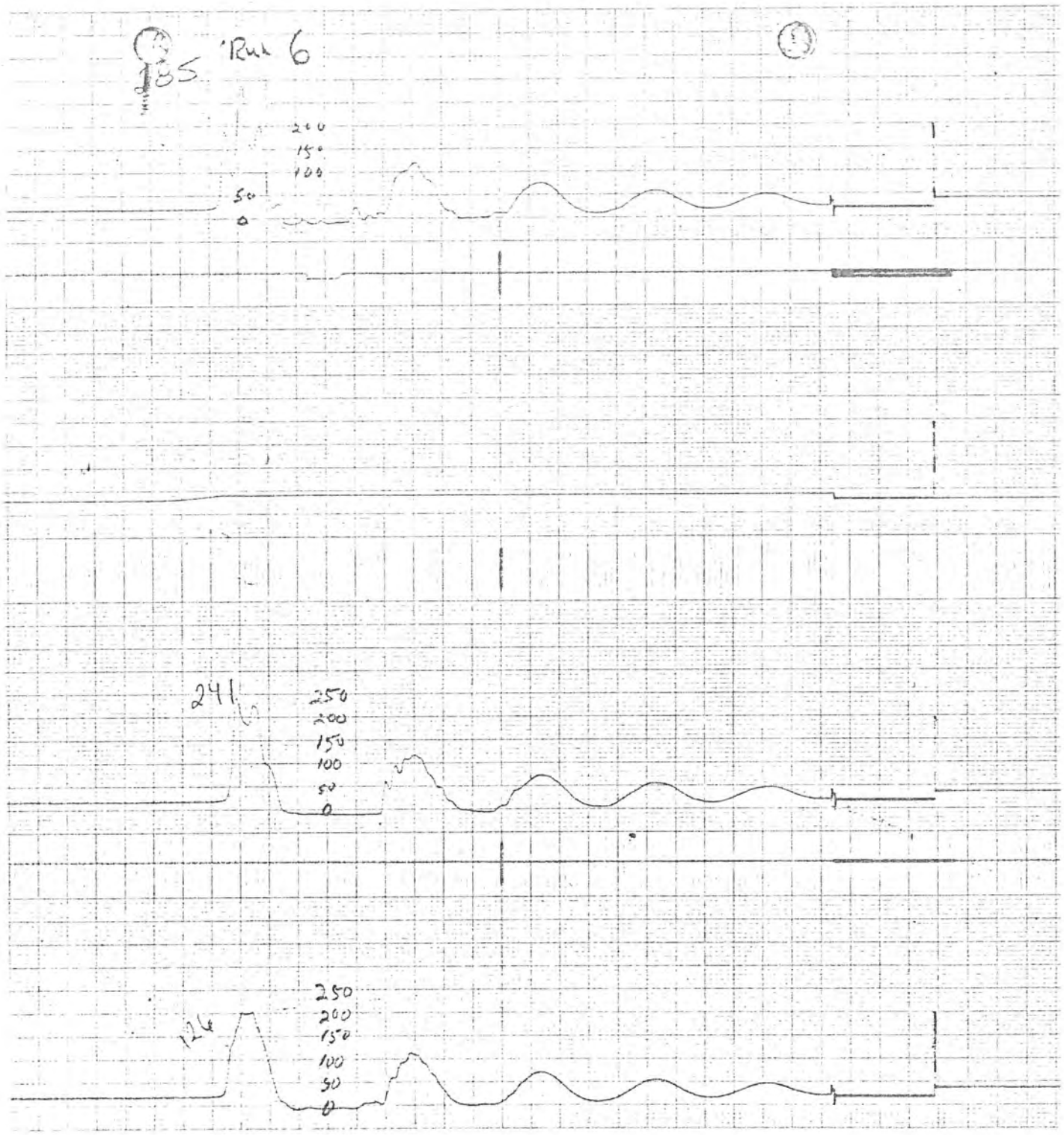


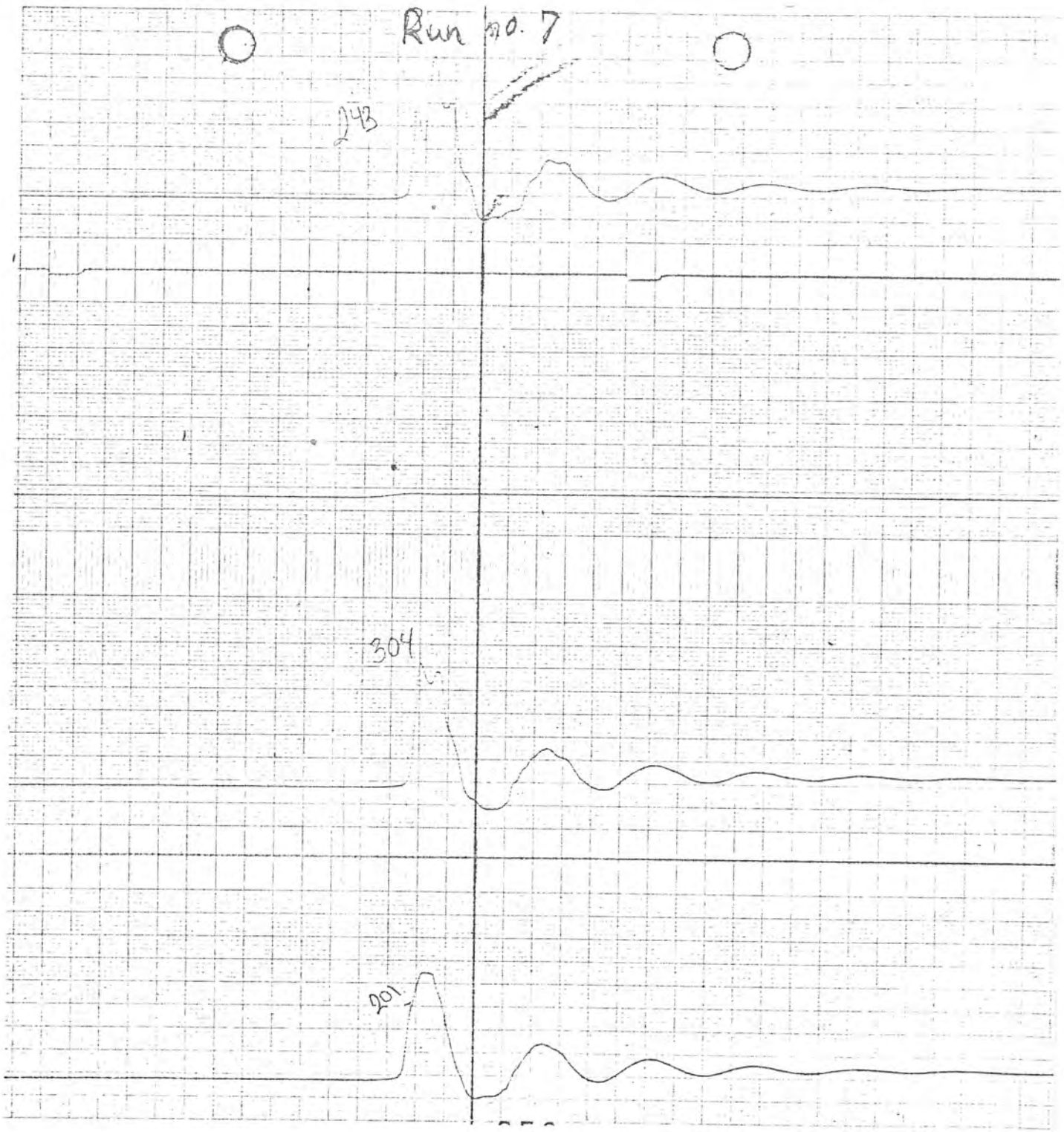

FIGURE 3 - Q (cfs)


Run no. 5
Transducer No. 4
184
200
150
100
50
0
Gate Stroke
No 3
Transducer No 2
238
250
200
150
100
50
0
Transducer No 1
122
250
200
150
100
50
0

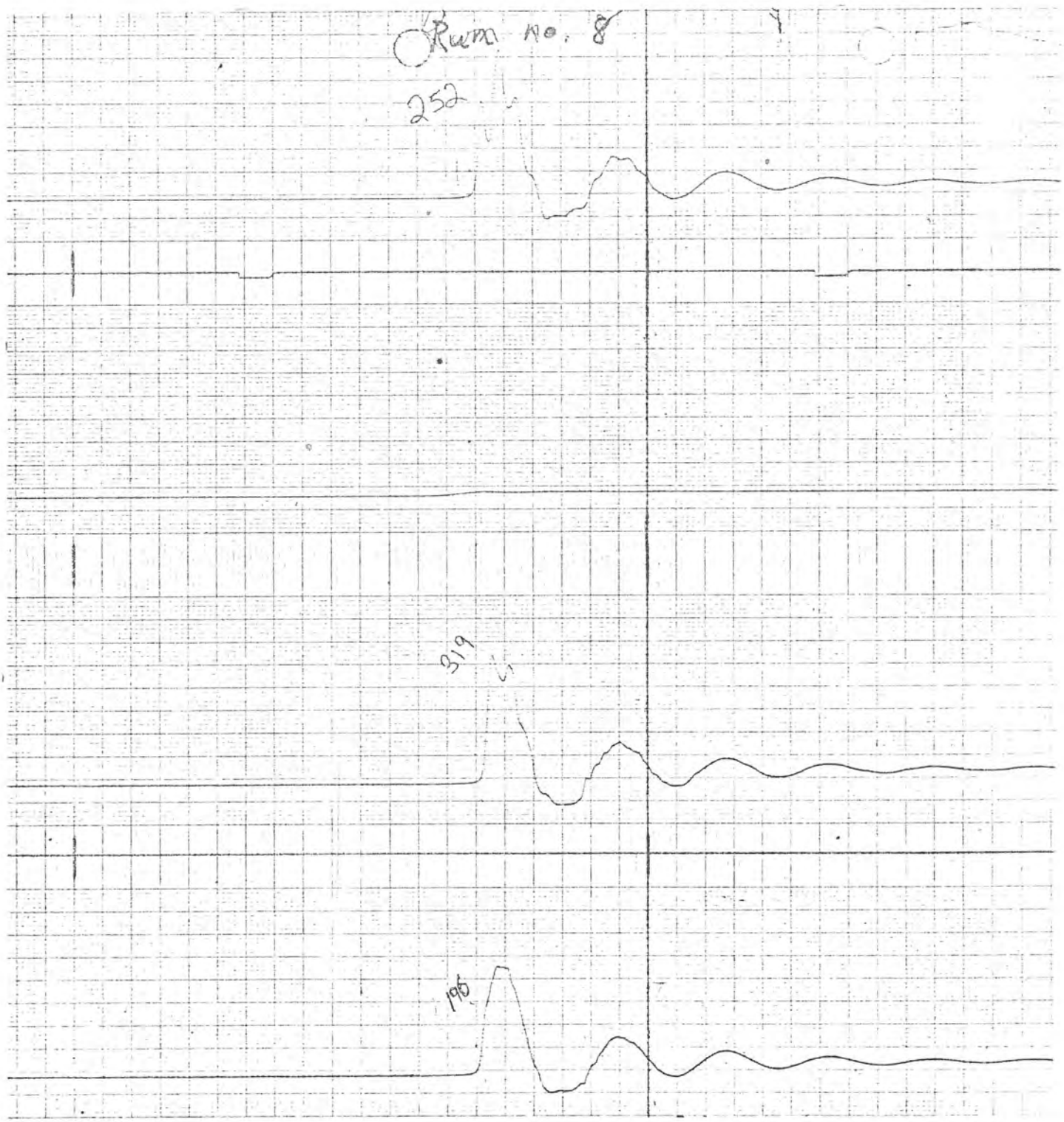
Run No. 5


185 Run 6
200
150
100
50
0
241
250
200
150
100
50
0
126
250
200
150
100
50
0

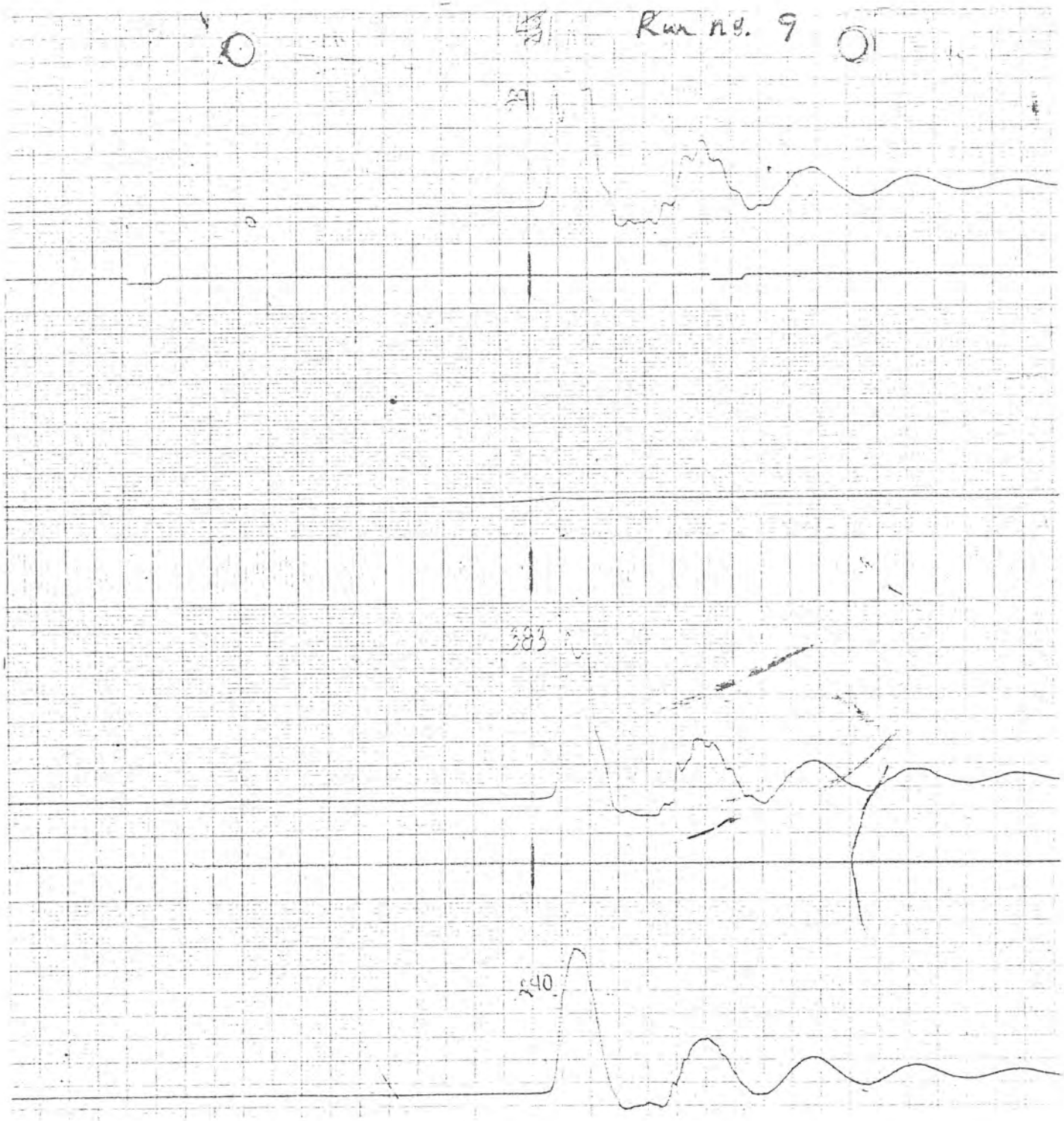
Run No. 6



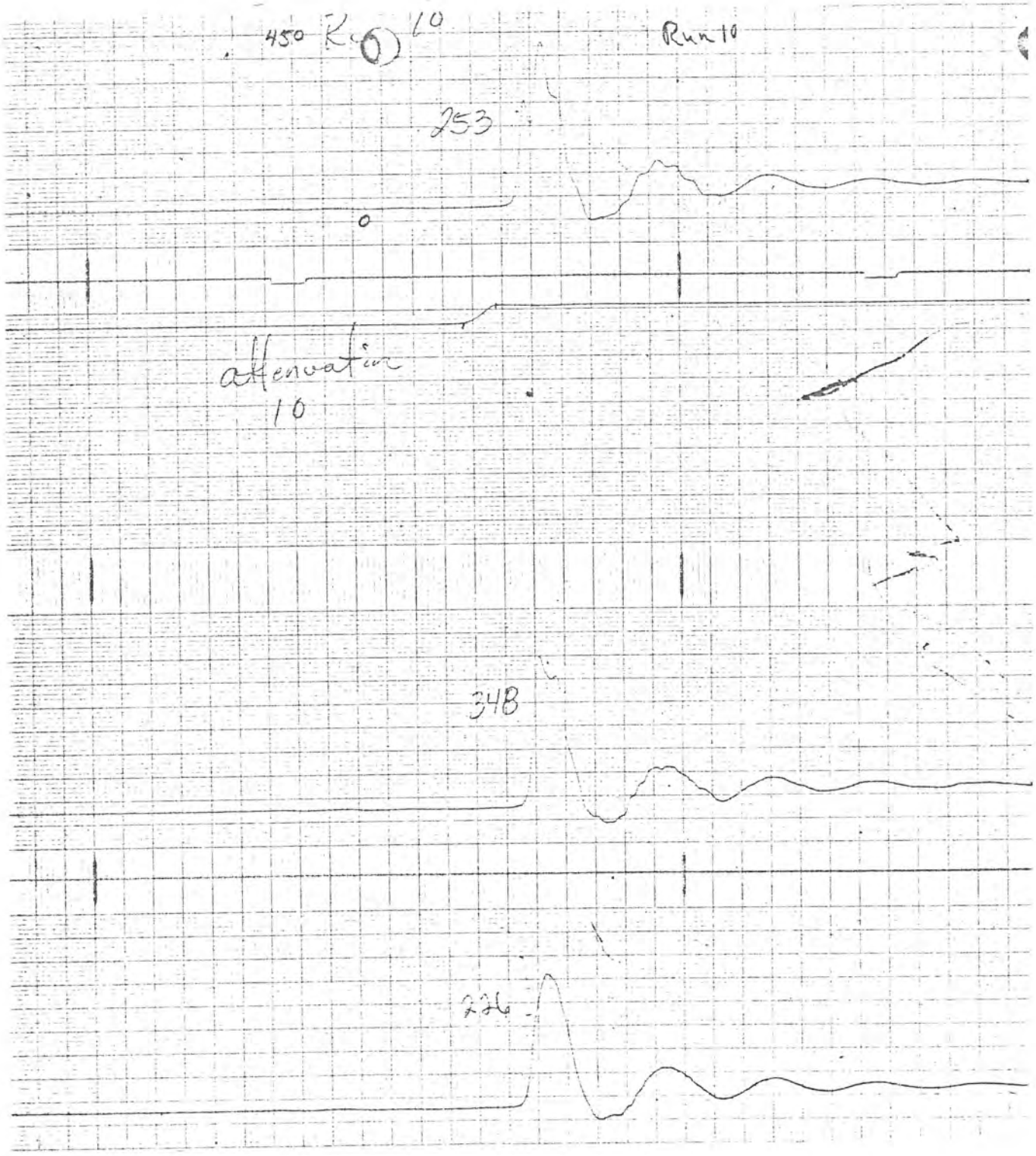

Run No. 7



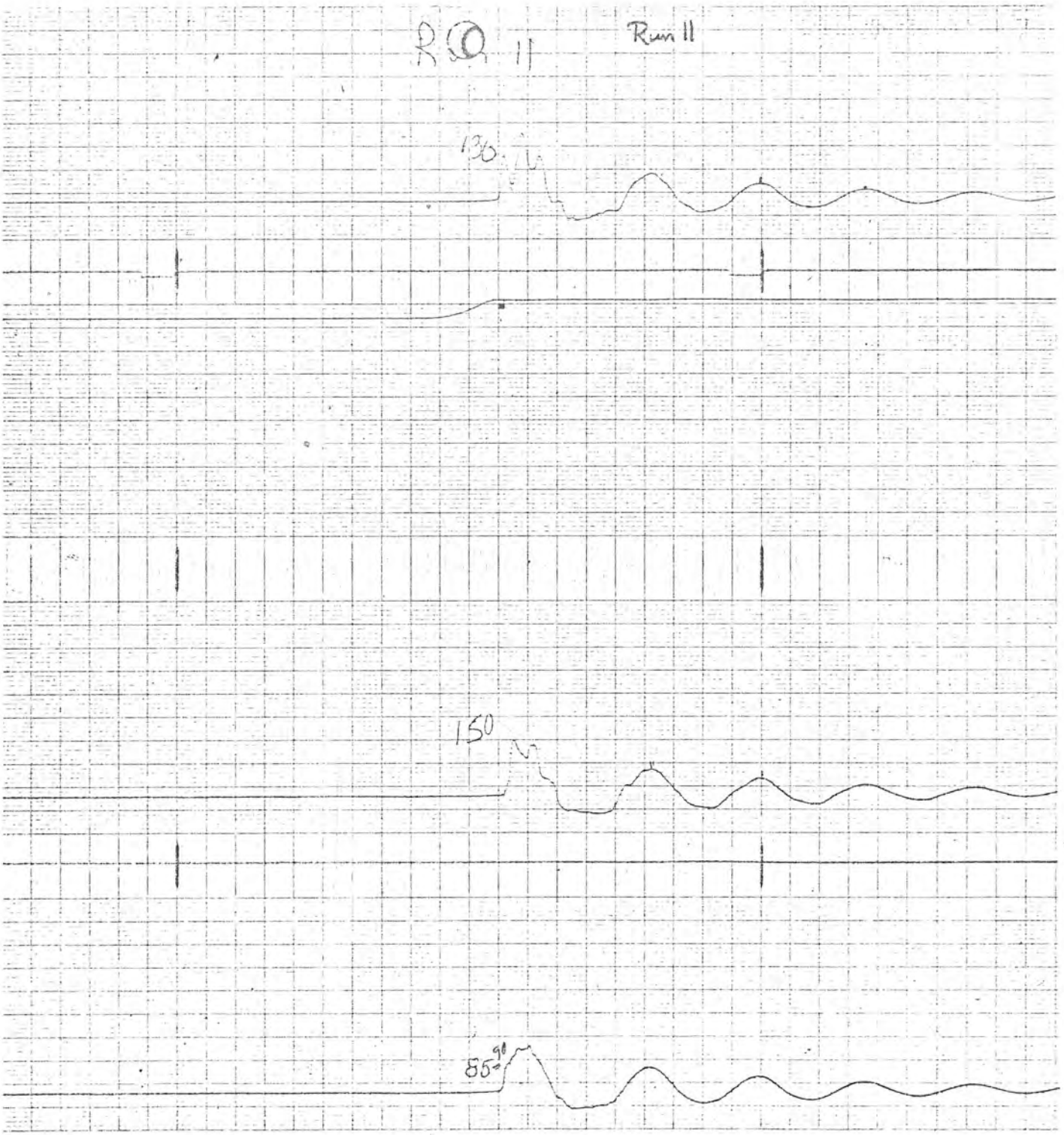

Run No. 8



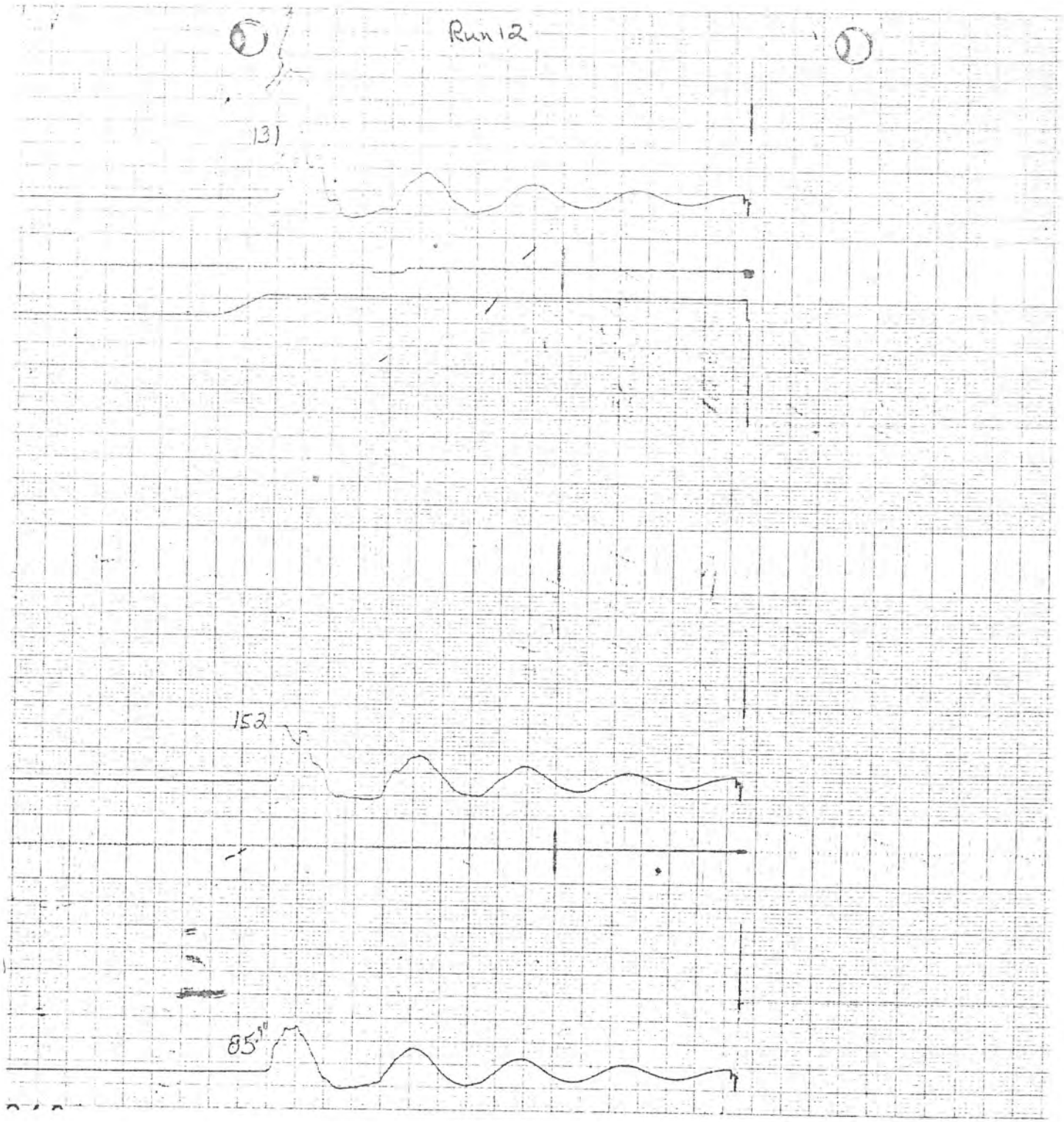

Run No. 9



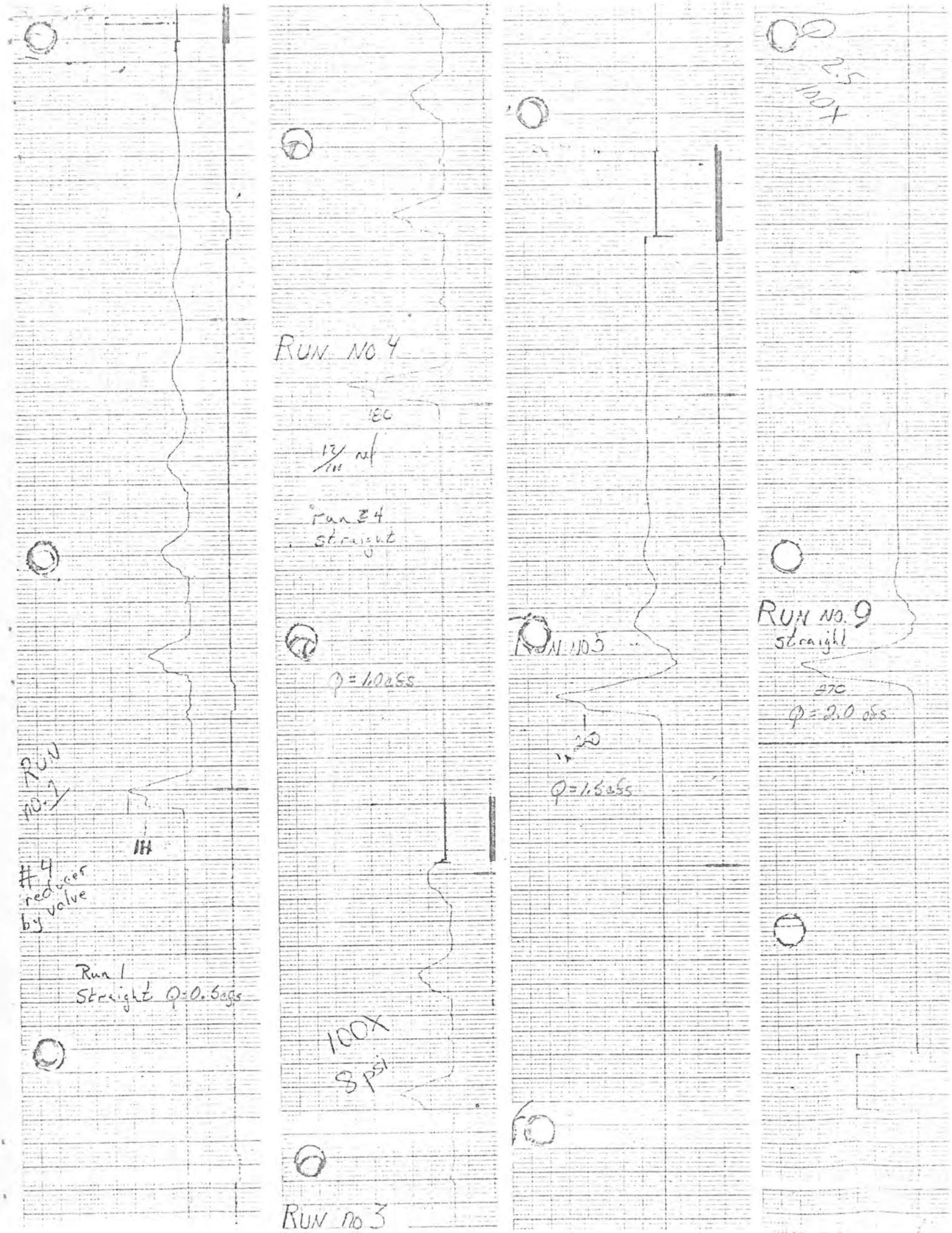

Run No. 10




Run No. 11




Run No. 12




Straight pipe runs