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Managing Water in the West

Water Resources Research Laboratory

Self-Guided Tour:

Overhead West Walkway, Station 4

U.S. Department of the Interior
Bureau of Reclamation

American River Pumping Plant
1:36 scale Hydraulic Model Study

Kathy Frizell

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Background

- In 1965, Congress authorized the Auburn Dam project on the middle fork of the American River in California.
- In preparation for dam construction, a 257 ft high cofferdam was built across the river and a diversion tunnel was constructed.
- Prior to the project, the Placer Count Water Authority (PCWA) had pumped water from the American River near the construction site to supply the county’s water needs.
- Reclamation agreed to supply the PCWA with water during the construction period.

Background (contd.)

- Auburn Dam was never constructed. Reclamation has been supplying PCWA with water every since.
- PCWA has received authority to construct a new permanent screened pumping plant
- After an overtopping event in 1986 washed much of the cofferdam material downstream, PCWA removed most of the remaining coffer dam.
- Remnants of the cofferdam cause a restriction in the river that may impact operation of the planned PCWA pumping plant.

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Model Study Objectives

- Provide information on the flow conditions for the existing channel design
- Identify potential changes in channel geometry at key locations that would improve flow conditions, channel stability
- Monitor movement of coarse bed material through the constructed reach of the Placer Valley Water Authority pumping plant intake structure

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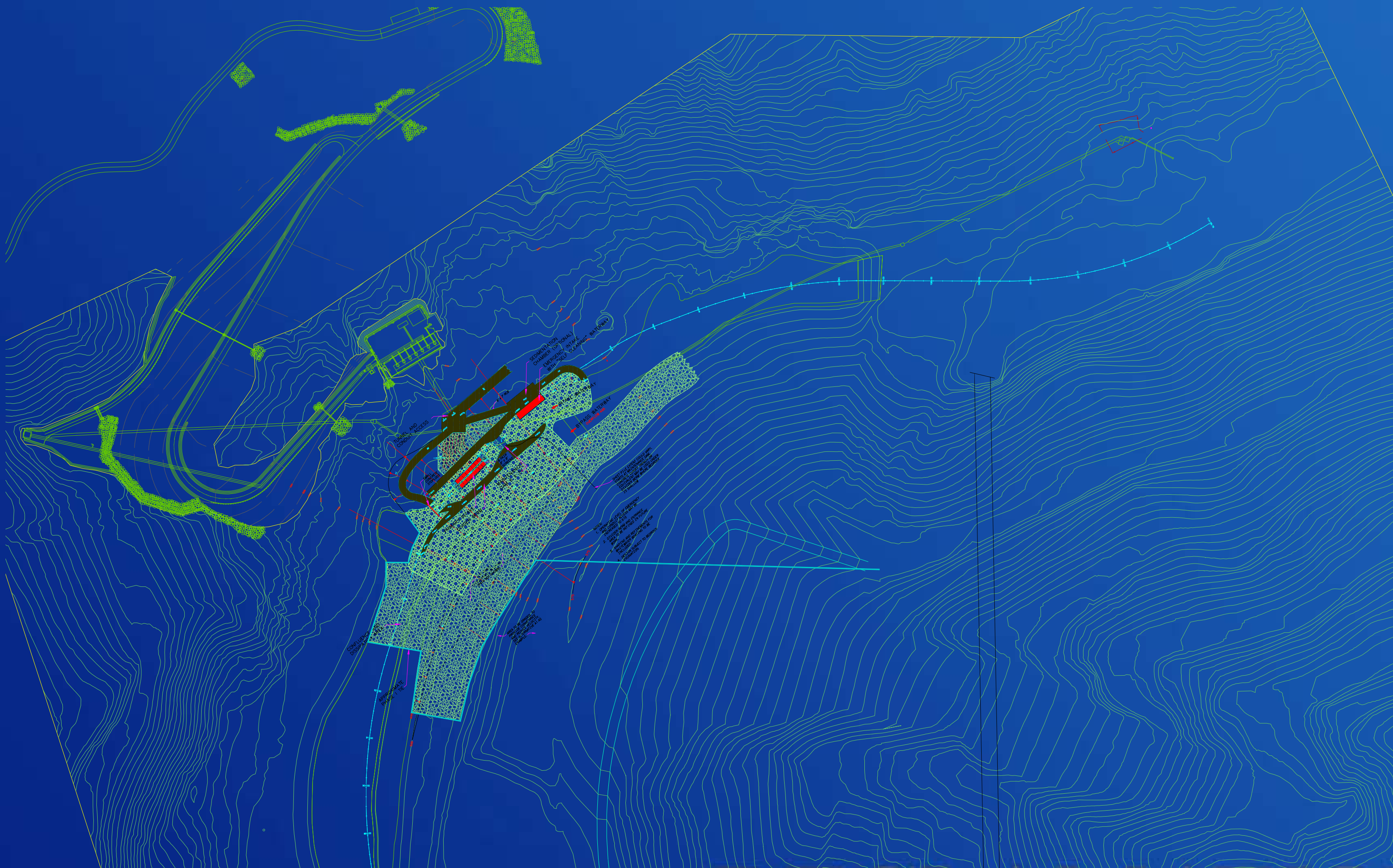
Overall View of American River Site



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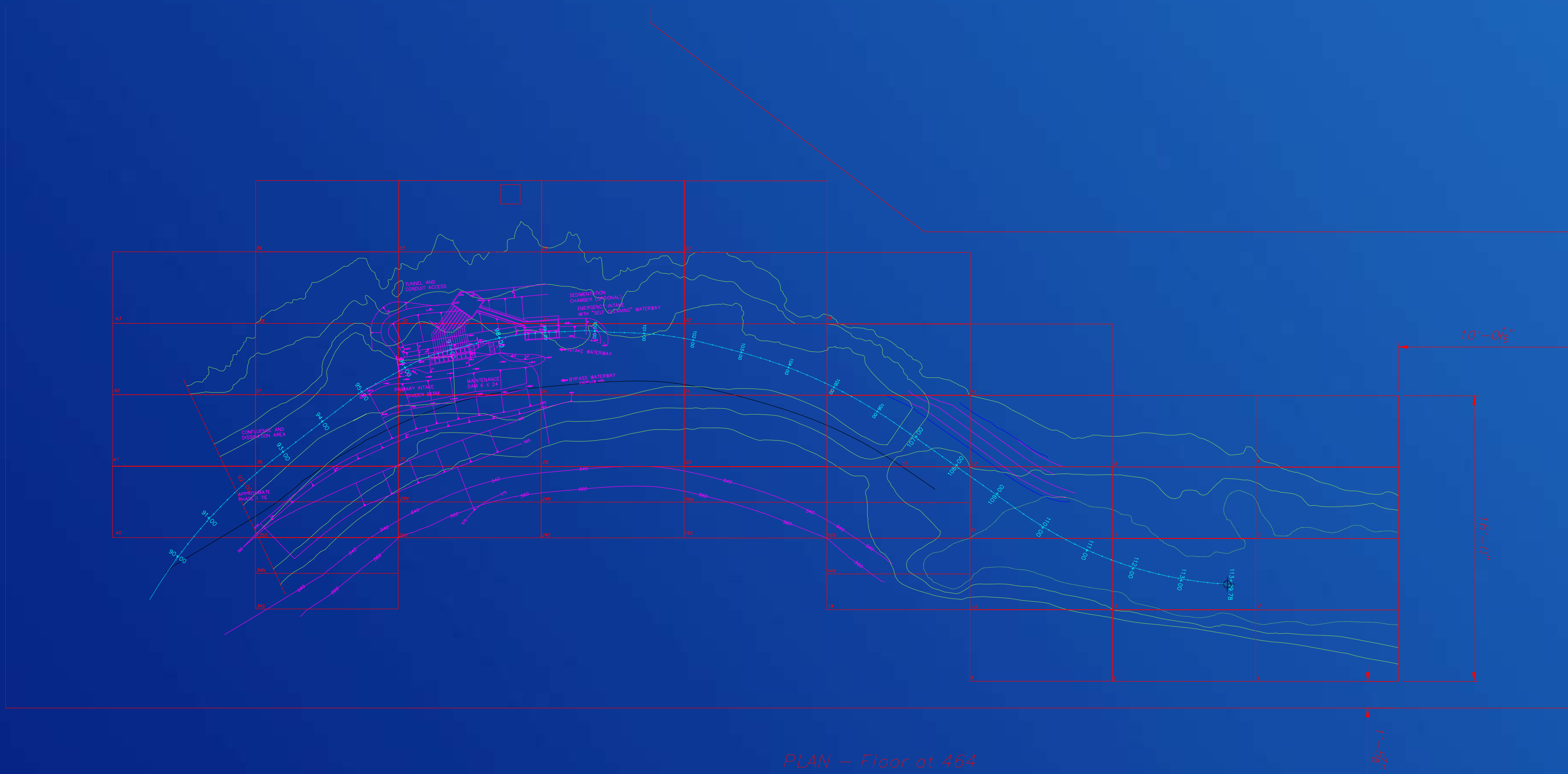
1:36 scale Model Layout



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10-yr Event – Overall view at model start up

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10-yr Event – 72 kcfs – View looking downstream toward cofferdam

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10-yr Event – 72 kcfs – View looking at upstream toe of cofferdam & diversion tunnel intake

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10-yr Event – 72 kcfs – View looking at intake area and adjacent cofferdam toe

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10-yr Event – 72 kcfs – View looking at intake area

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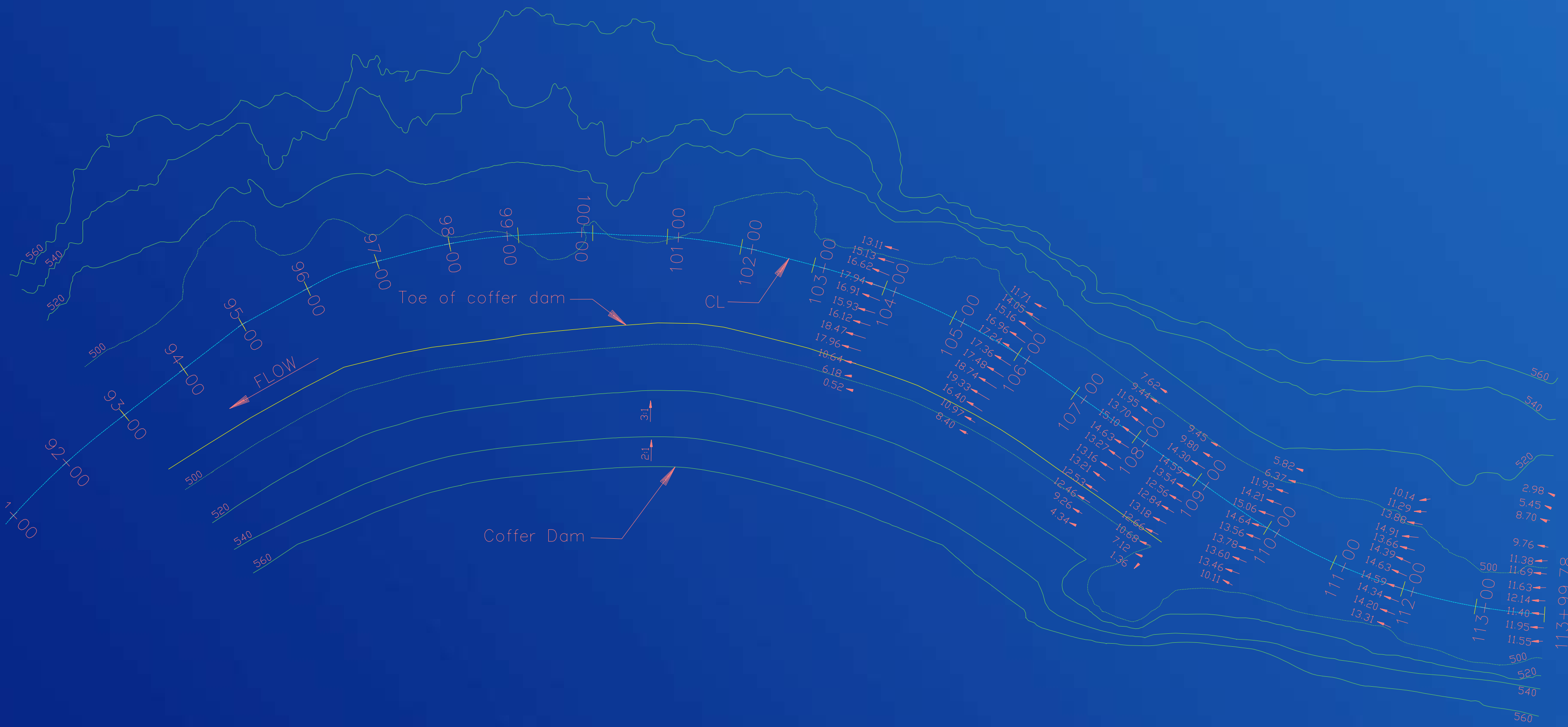
Model contours with stationing and velocity magnitudes for 10-yr event



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Model contours with stationing and velocity magnitudes for 10-yr event

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Model Study Results

Diversion Tunnel fill geometry is outlined in white. It extends to cofferdam toe.

Model Study Results

Sediment deposition pattern after running the model at the 10-year event for most of a day. This is the upstream portion of the river running to the beginning of the intake channel in the background.

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WRRL Field-Based Research

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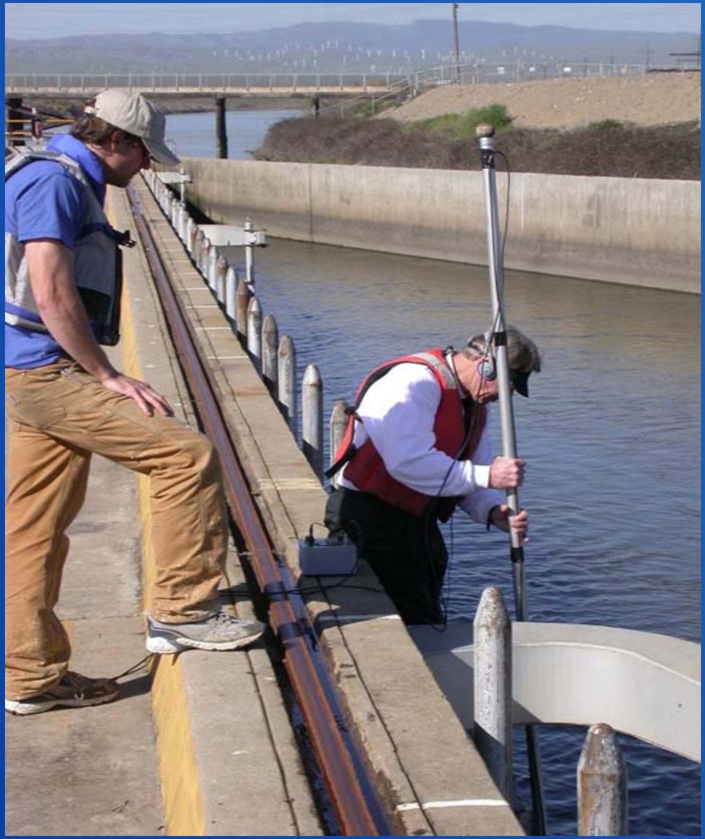
WRRL Field-Based Research

Research activities of WRRL Staff extend well beyond the laboratory confines. We perform a wide range of field-based studies



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Flow-Induced Vibration in a Large Radial Gate

Banks Lake Feeder Canal – Check Structure

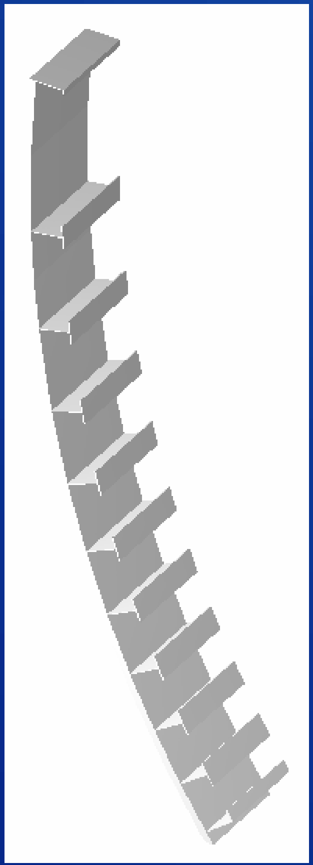
Warren Frizell
Jim Higgs

U.S. Department of the Interior
Bureau of Reclamation

Background

- Concern for stability of the radial gates in the event of a canal lining failure.
- Water would drain from the canal and flow backward through the gates.
- A sectional model was built in Flow-3D in order to more closely look at the flow fields and possible excitation due to a roller or vortex shedding.

Flow 3D Simulations



Stereo lithography file of the gate section

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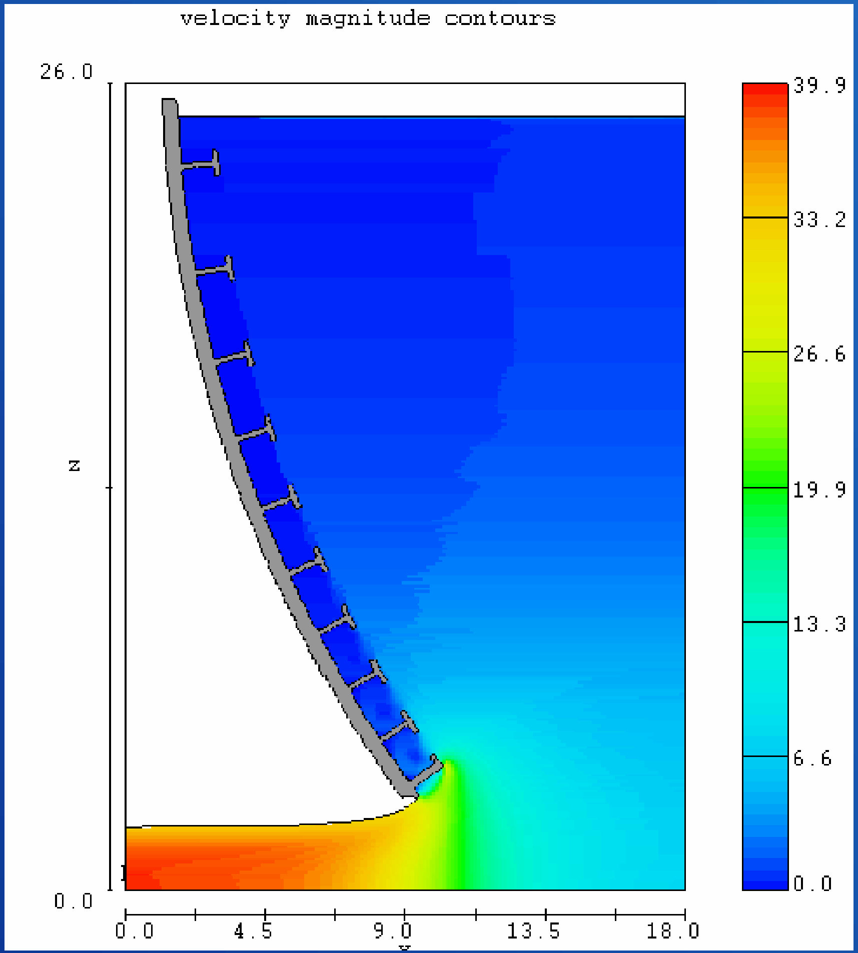
Flow-3D simulations

- 3 ft gate opening
- No vortex



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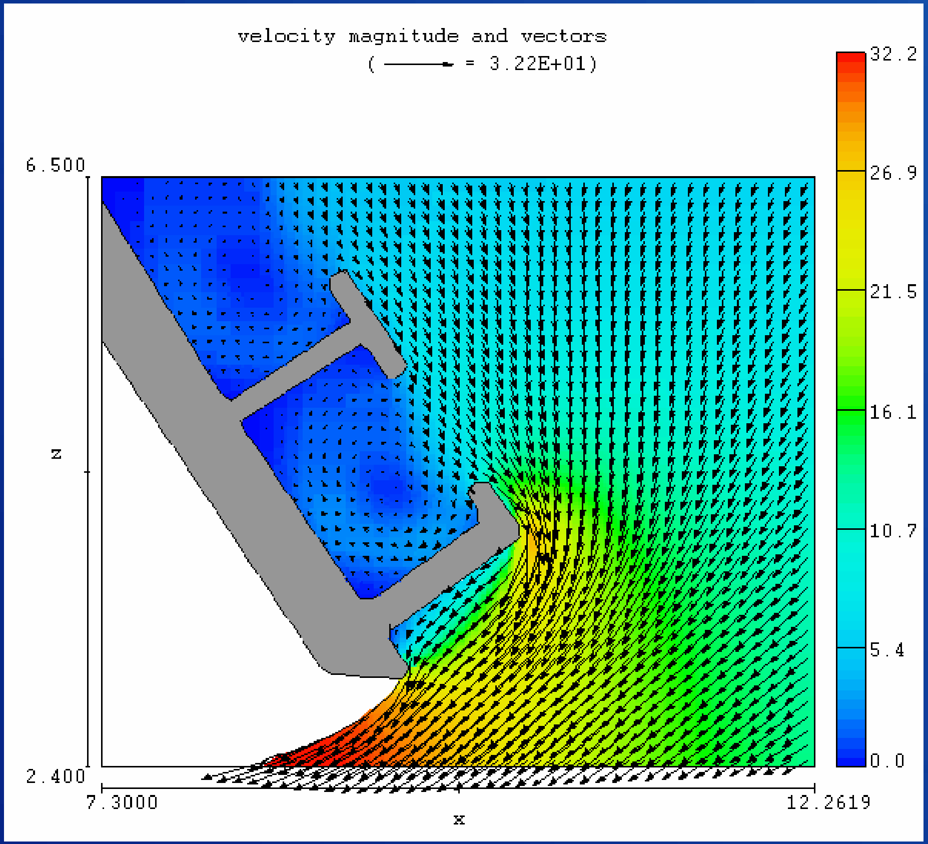
Flow-3D simulations



Velocity- vector and contours

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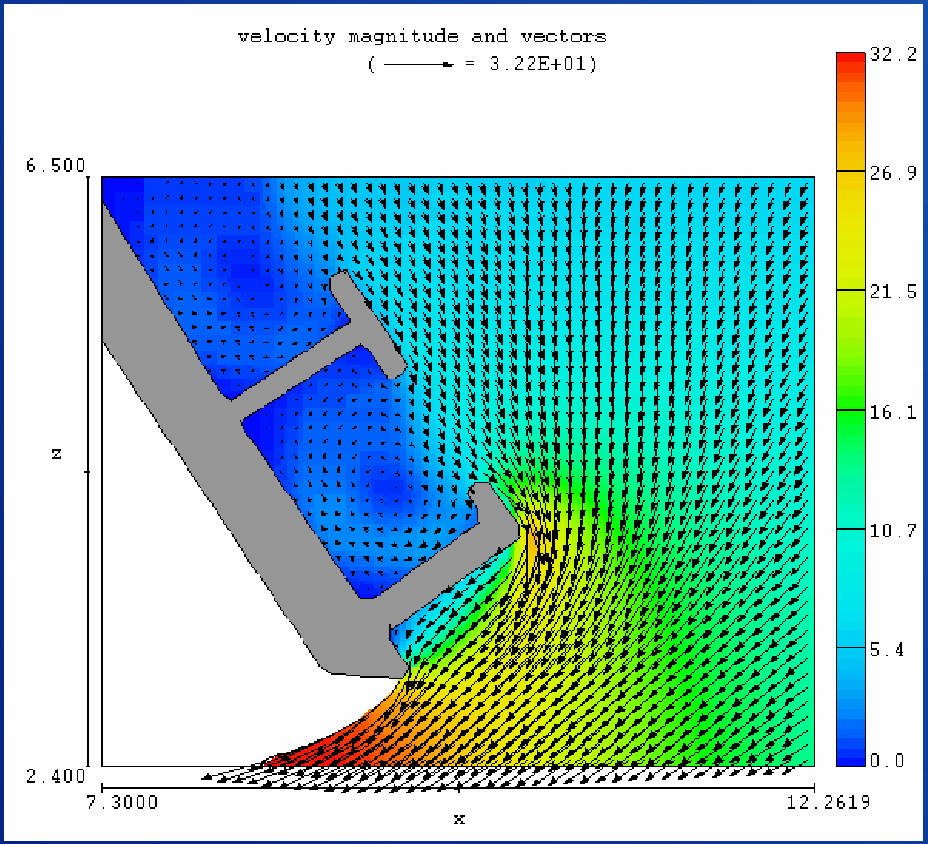
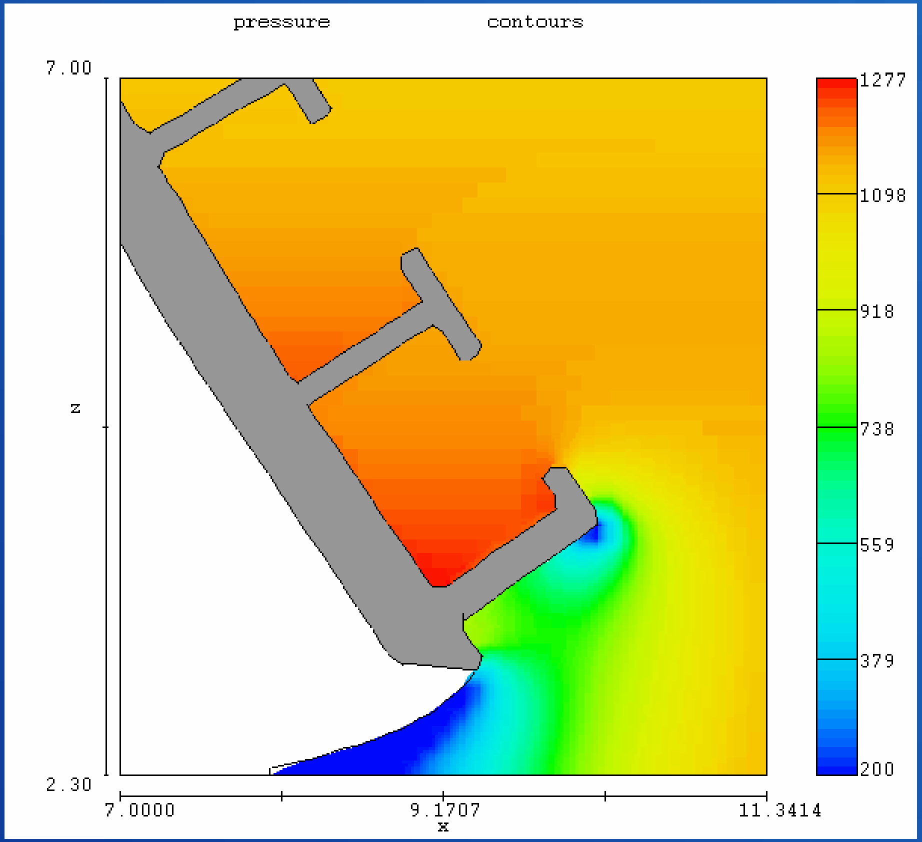
Flow-3D simulations



Velocity- vector and contours



Pressure contours

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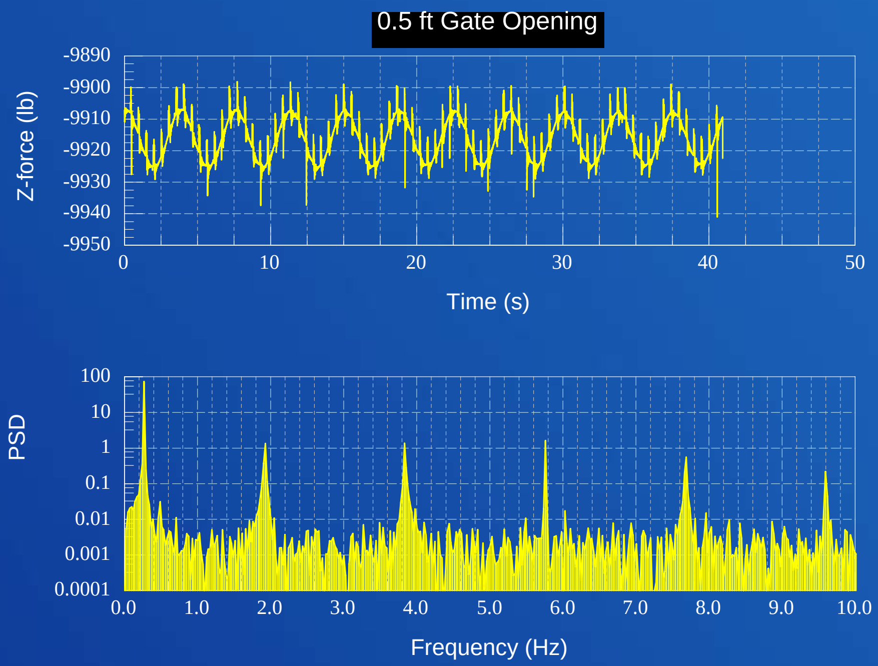
Flow-3D simulations

- Frequency analysis was completed on the x and z direction forces for both the 6” and 3 ft simulated gate openings.
- Periodic excitation was shown but it was very low frequency
- Vortex shedding frequency would be much higher (around 25Hz)



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Banks Lake Feeder Canal – Check structure, 24’ by 25’ Radial Gates

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Installation of Accelerometers

- 5 accelerometers on gates 4 and 5
- 4 in the fore/aft direction, 1 vertical
- Pickup movement of the skin plate
- Impulse/response testing in the air
- Flow induced vibration testing – reverse flow through the radial gate

Crane – basket for installation

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Installation

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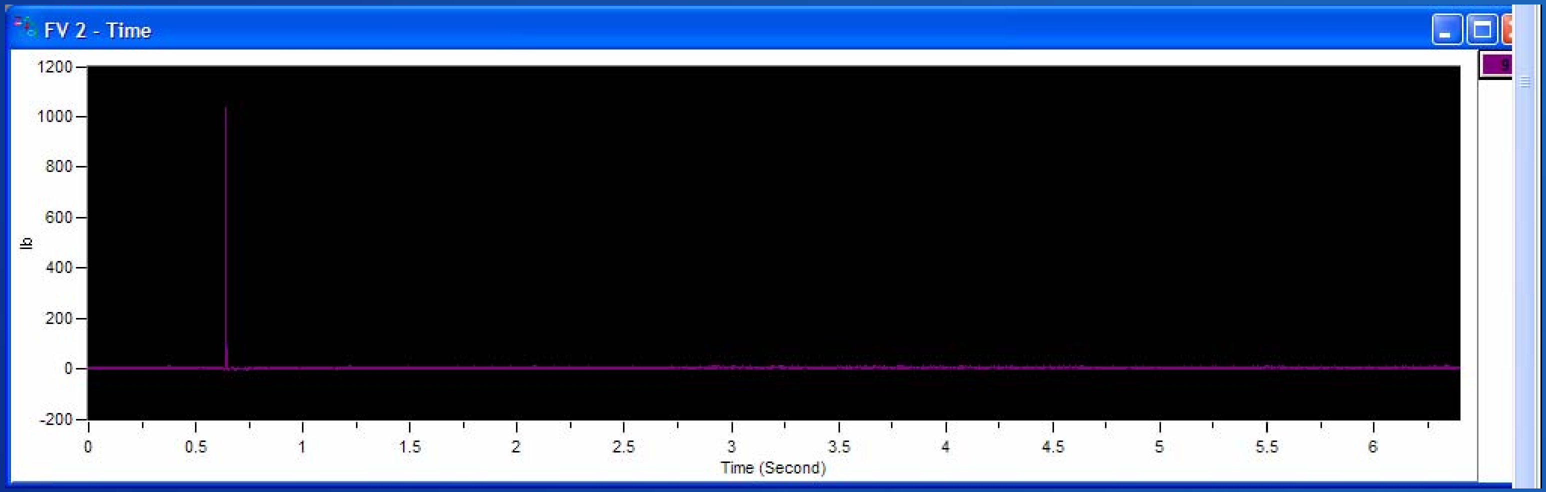
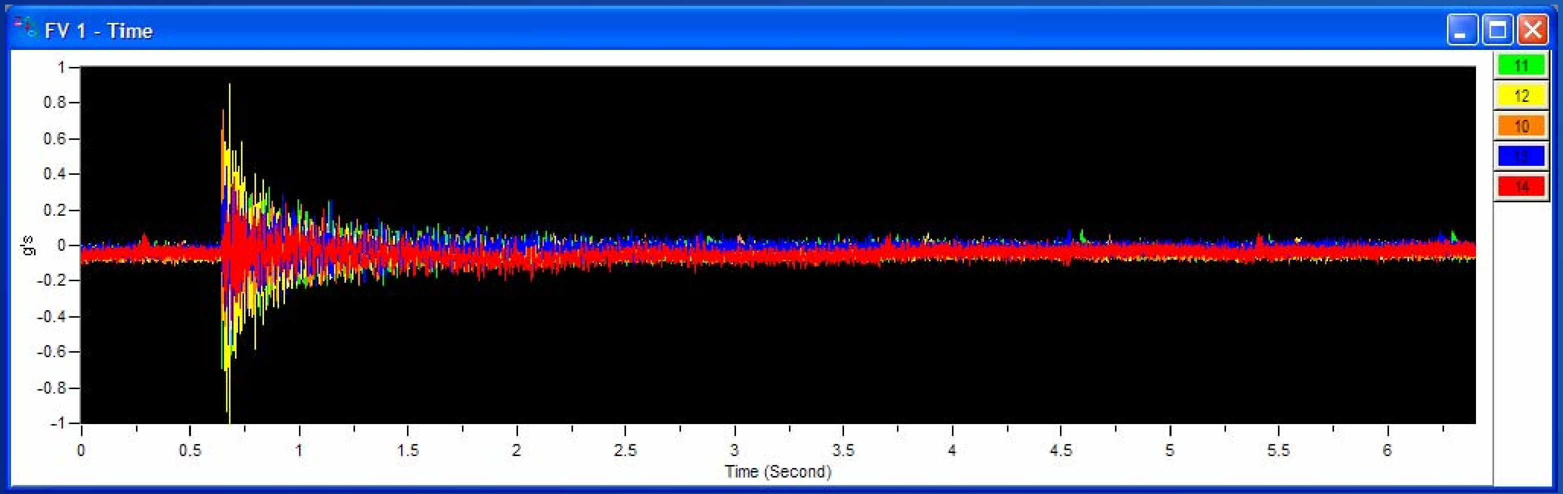
Routing leads

Impulse/Response





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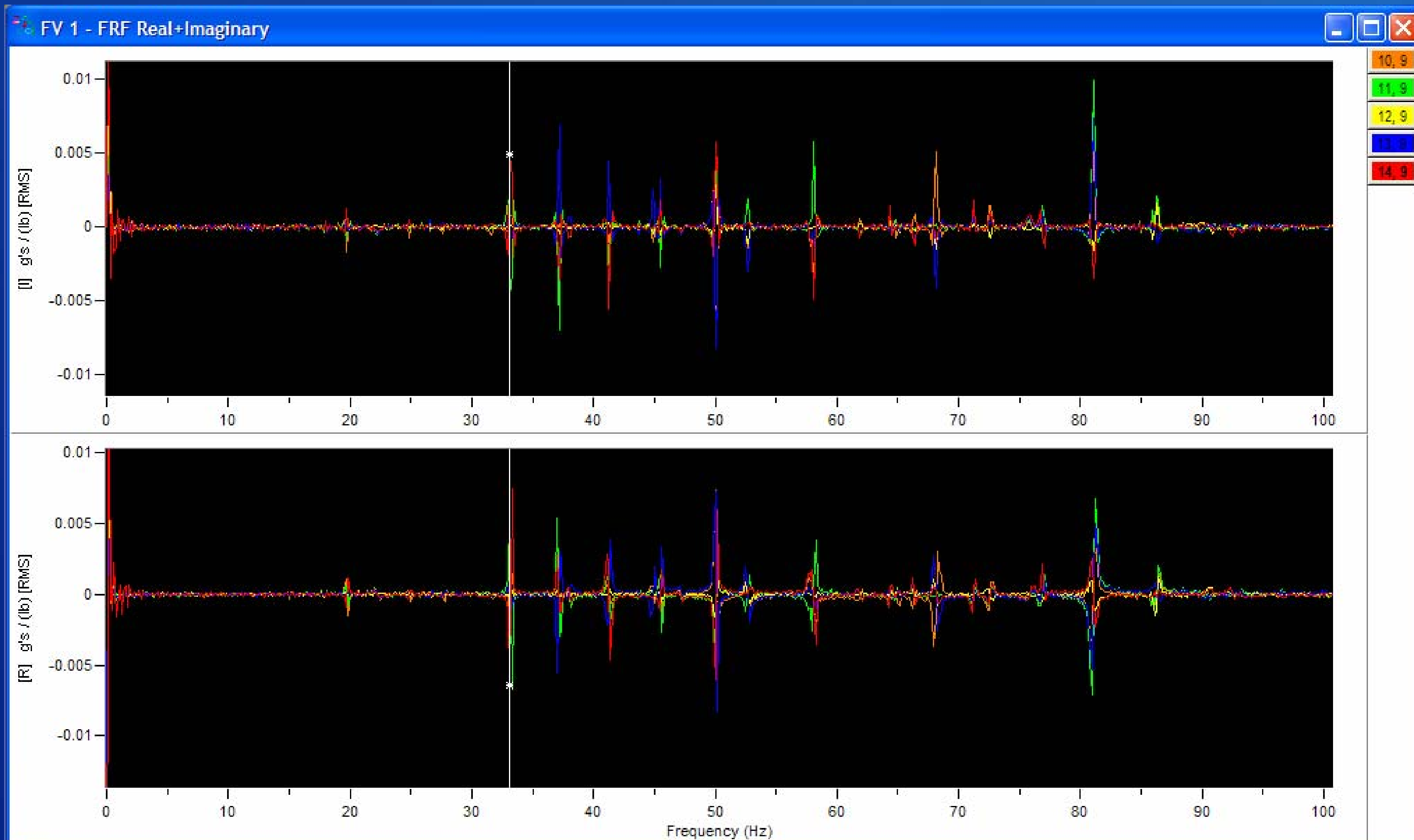
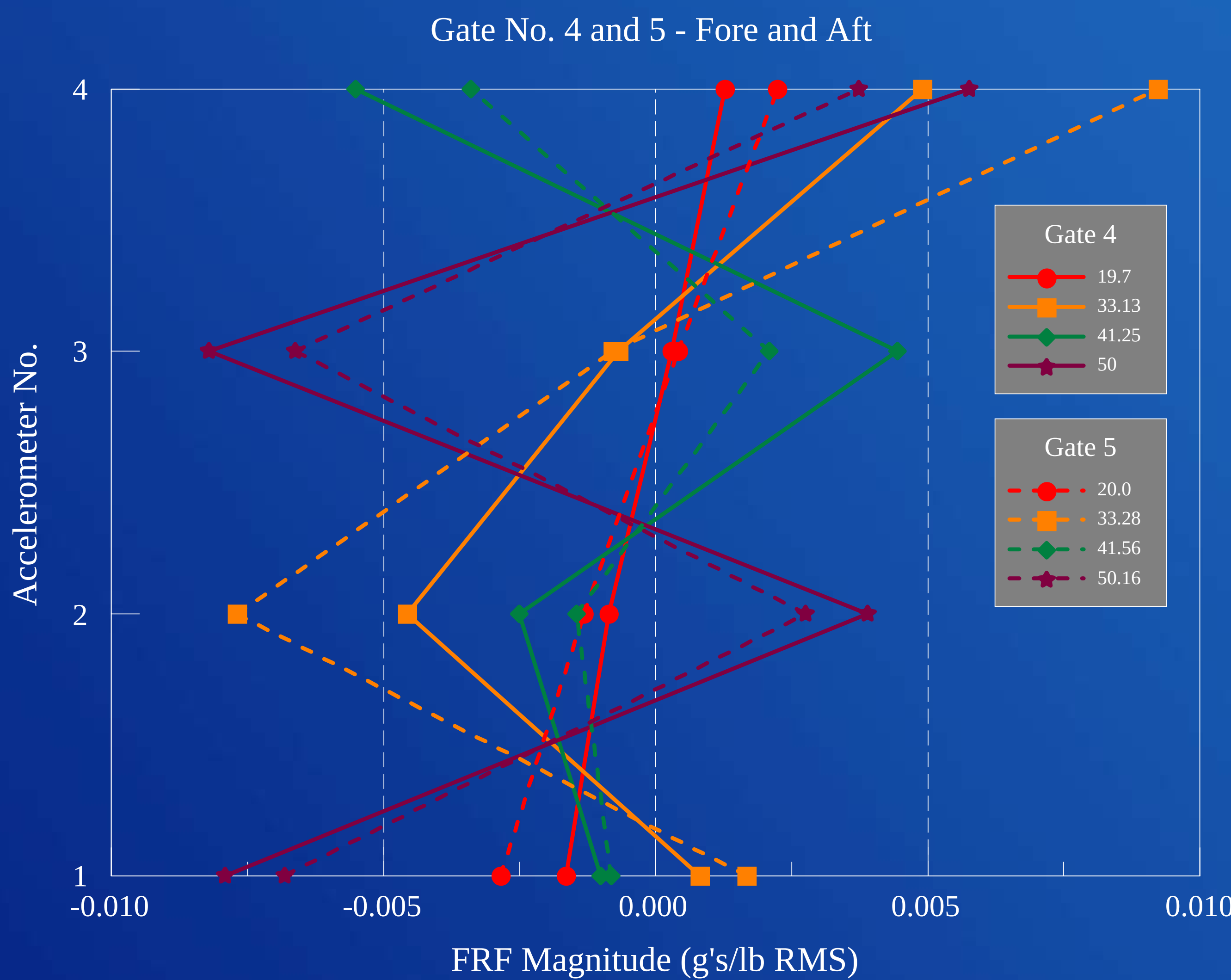
Frequency Response Functions



Mode Shapes



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Flatiron Powerplant Tube Valve

Vibration Testing on the 42-inch Tube Valve at Flatiron Powerplant

June 18, 2003

Warren Frizell

U.S. Department of the Interior
Bureau of Reclamation

Danger, Vibration Bad!

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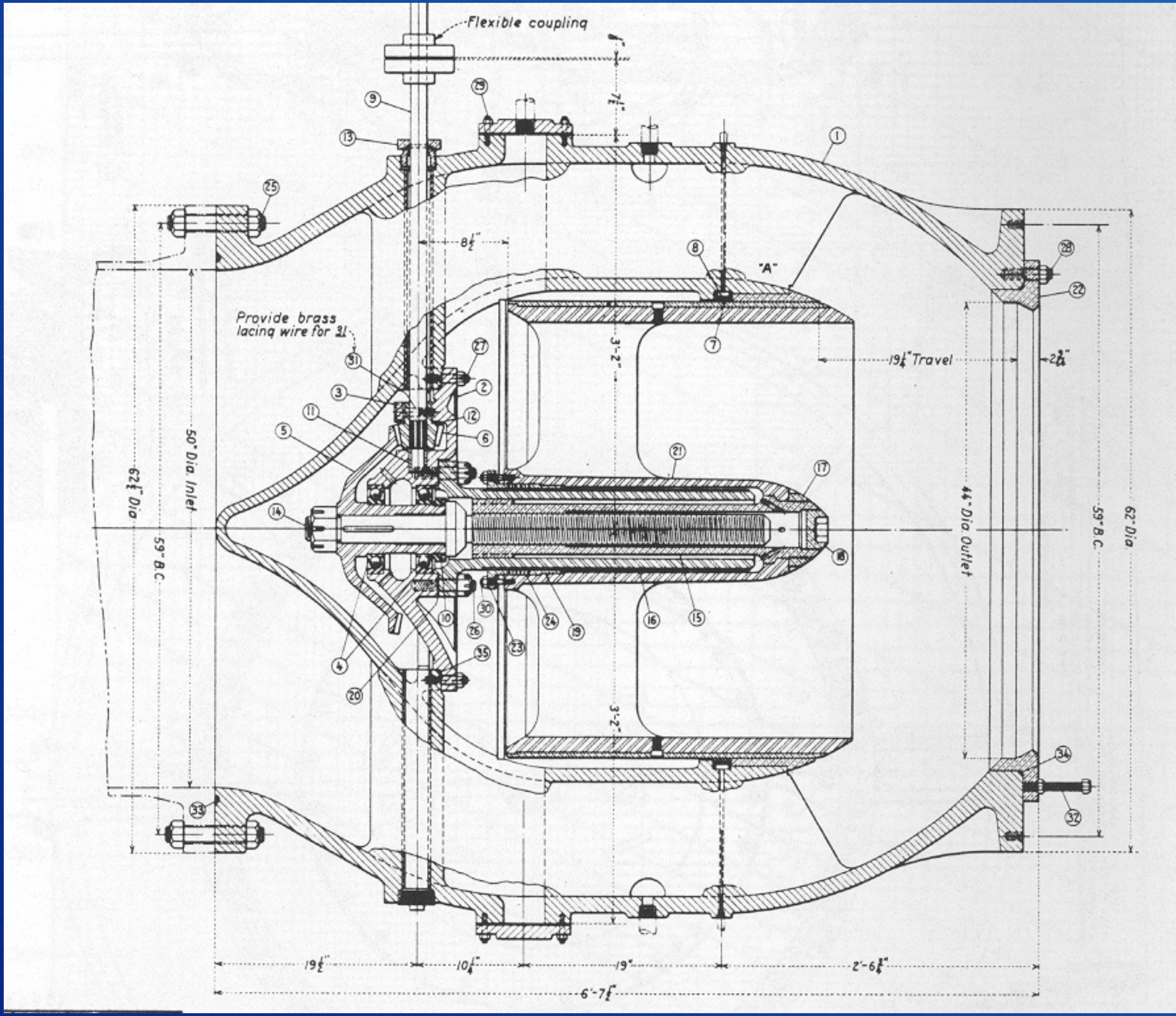
Tube Valve



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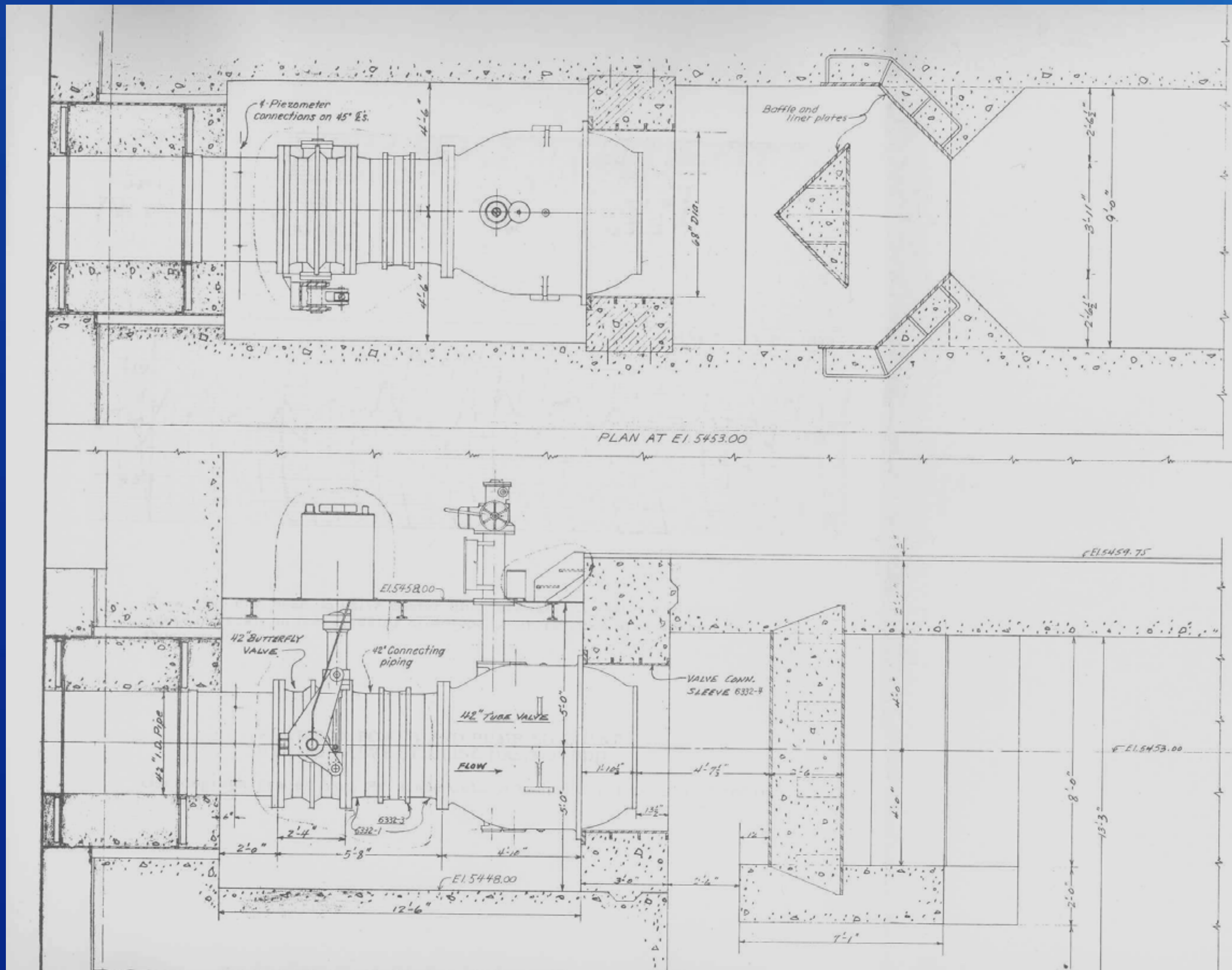
Flatiron Tube Valve

- The 42-inch tube valve is located in the pump-turbine bypass at the Flatiron end of the manifold of the Flatiron-Carter Lake Aqueduct
- The valve was tested in the early 1950’s by Jim Ball who had performed a hydraulic model study that helped design the stilling chamber
- Cavitation is definitely present in the stilling chamber.



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Flatiron Tube Valve

- Initial recommendations stated that air should be admitted through a 2-inch air valve for any short-term operations, however if long-term operation is needed, two 10-inch vent pipes should be installed.
- Sometime during the subsequent years, an operating restriction of 20-percent maximum opening was placed on the valve.

Data Acquisition System

- Wavebook 516
- WBK14 – Dynamic Signal Conditioning
- Dell Laptop

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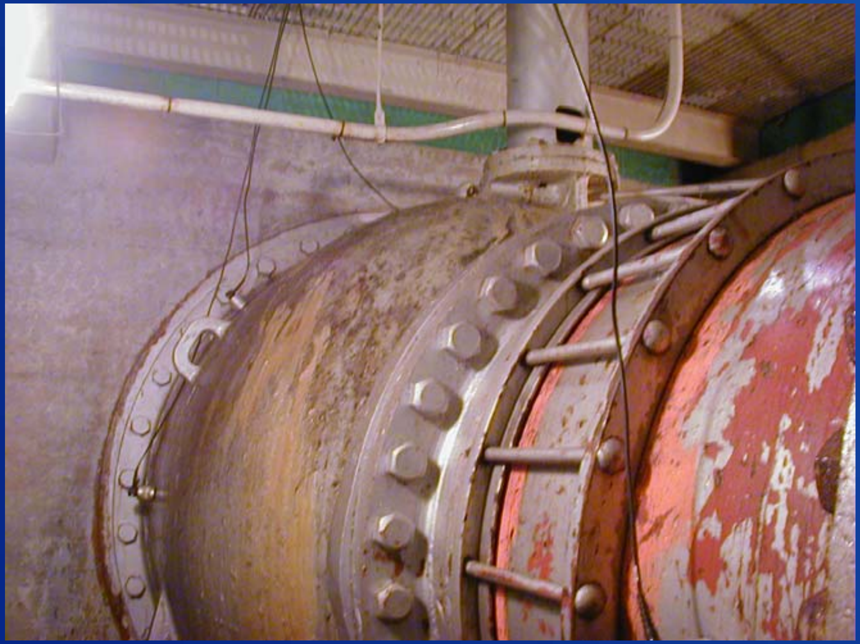
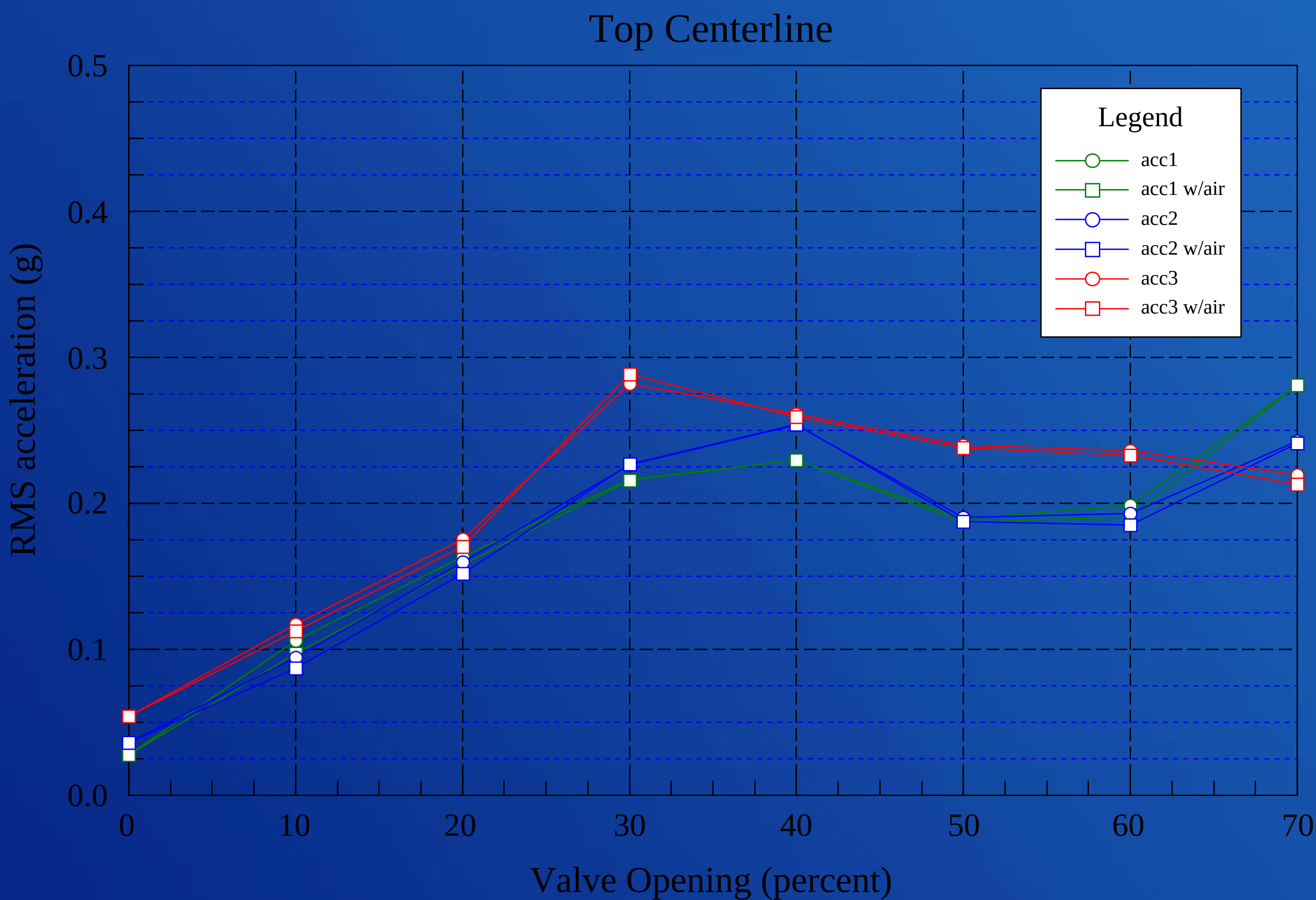
Accelerometer Locations



- 8 – accelerometers
- 7 on the tube valve and exposed piping
- 1 on the concrete floor above the baffle in the stilling chamber



- **RMS vertical acclerations, with and without air injection**

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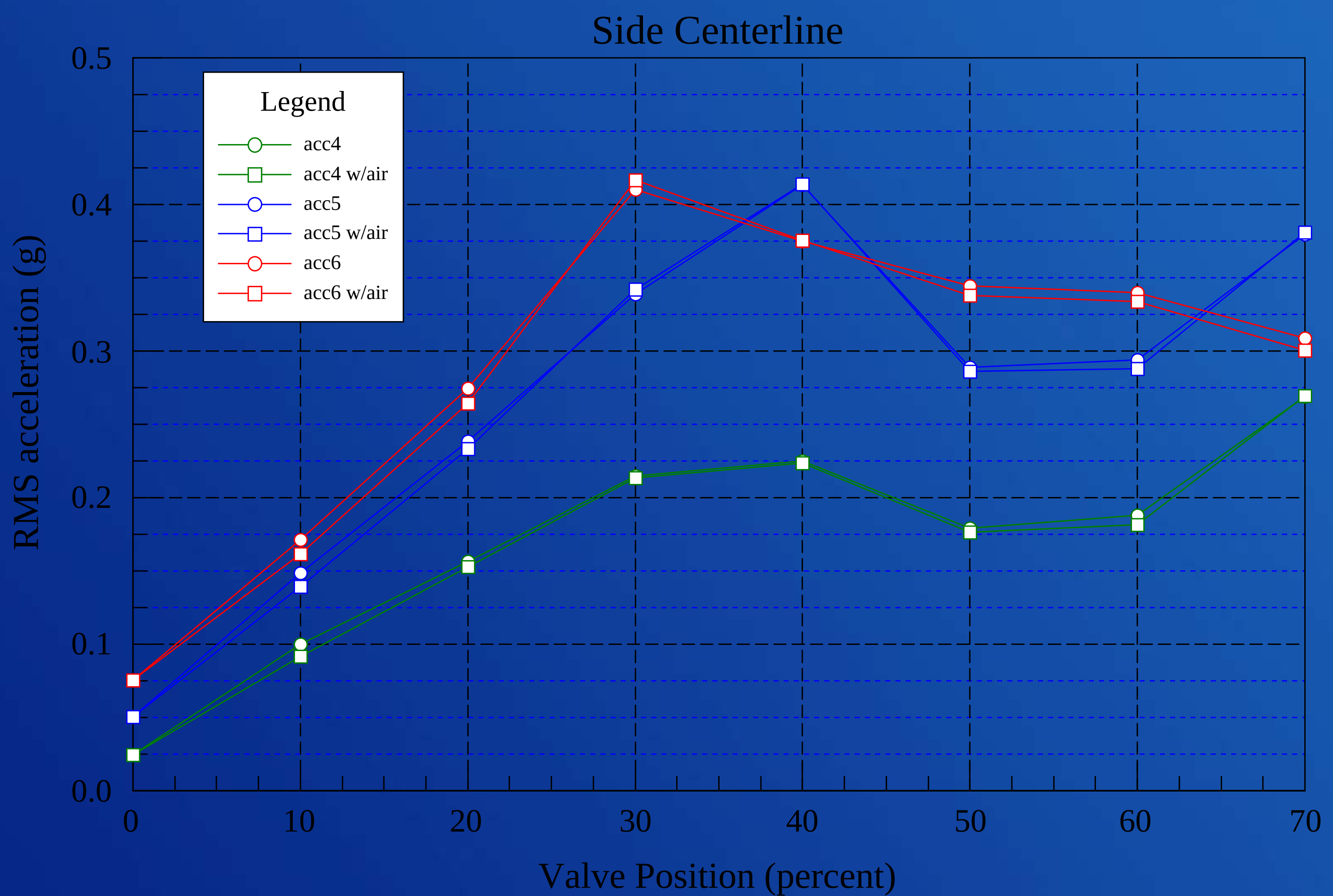

- **RMS horizontal acclerations, with and without air injection**

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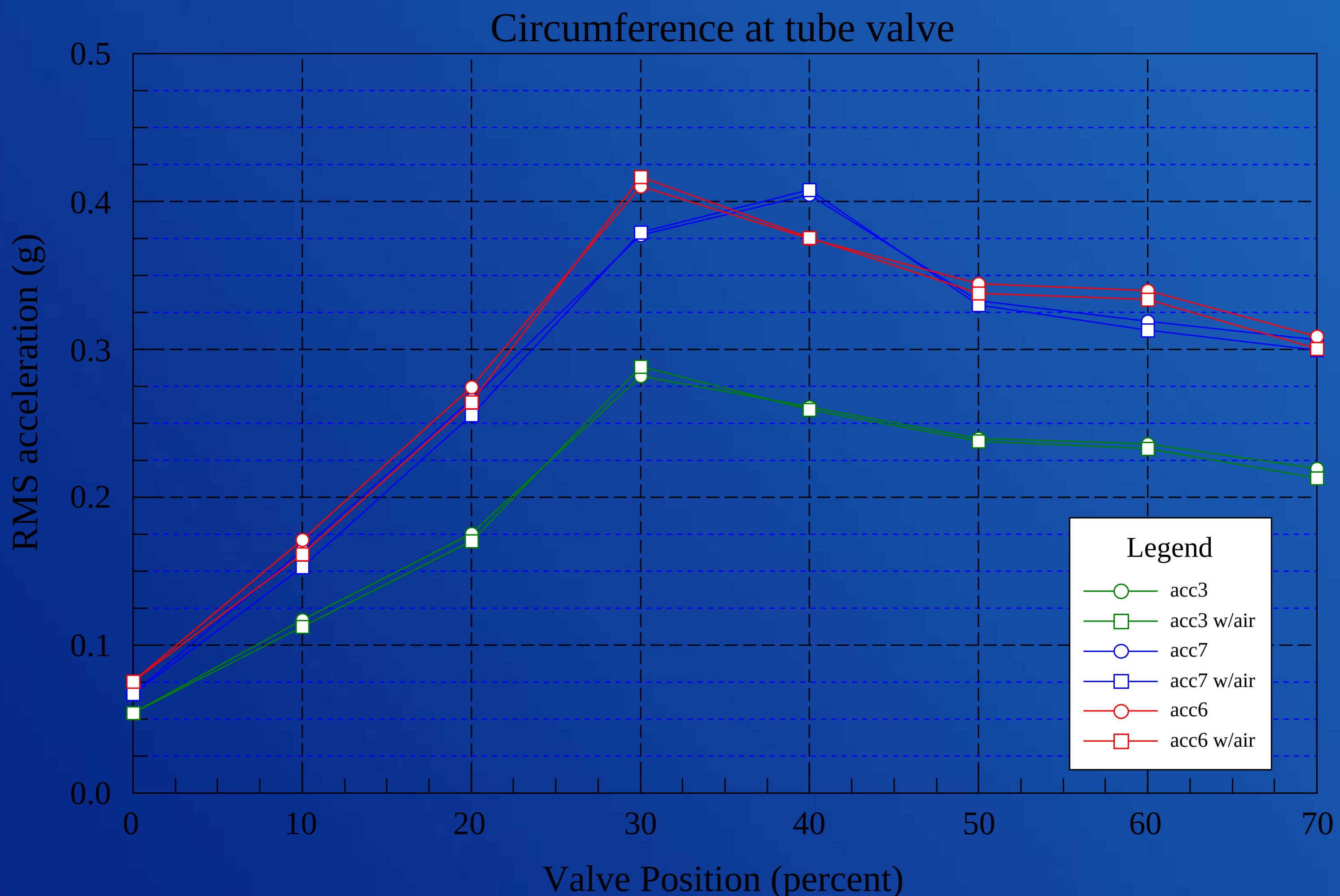

- **RMS acceleration on circumference of the tube valve**

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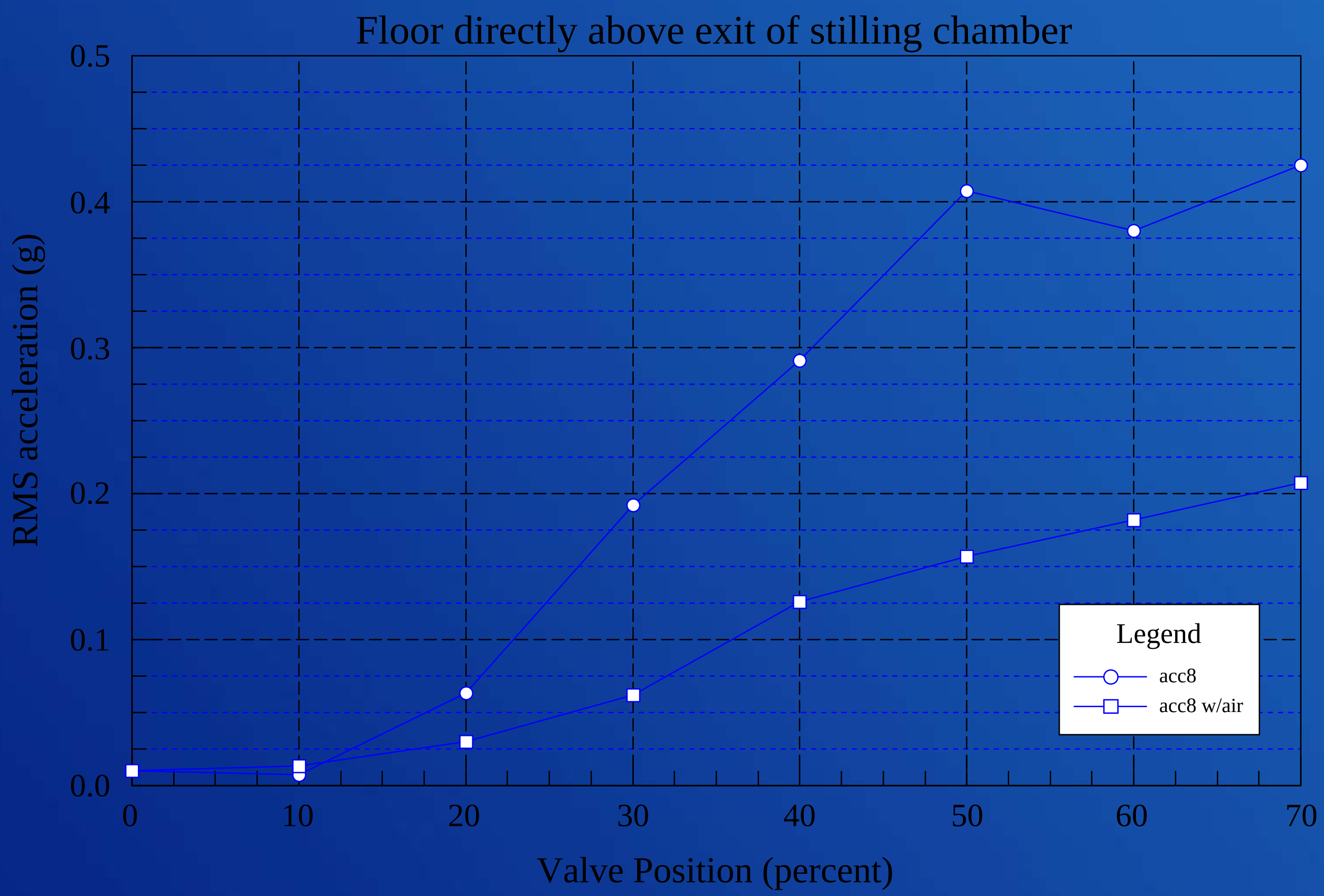

- **RMS acceleration at the floor directly above baffle**

Tailrace area

- Tube valve at 10% open
- Left: no air injection, Right: 2” compressed air line open
- Discharge about 70cfs

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Tailrace area

- Tube valve at 30% open
- Left: no air injection, Right: 2” compressed air line open
- Discharge about 260 cfs

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Conclusions

- Vibration levels were not severe, especially on the valve body itself
- Noise levels during operation were high
- Admission of air, even in the small amounts capable from the 2” compressed air line were helpful in quieting the noisy operation and most likely somewhat effective in affecting the cavitation in the stilling chamber.

Recommendation

- Operating restriction limiting the valve opening to 20-percent can be lifted.
- 2" inch compressed air line should always be open during valve operation.
- If long-term operation above 20-percent is necessary, follow recommendations from the original tests in 1954&55 for the installation of two 10-inch air vents.

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End of Overhead Walkway Self-Guided Tour
Please proceed south to Door 2402 (on the right) for stairway to the laboratory floor