

# Validating xStream for Air Hammer Analysis in a Transonic Wind Tunnel

PLATINUM PIPE AWARD WINNER

## CHALLENGE

North Wind Test LLC needed to evaluate air hammer effects caused by rapid valve actuation in a supersonic wind tunnel's complex supply piping system. The organization had historically used the legacy GTRAN (developed by NASA) code to model these transients but sought a more modern, user-friendly platform for future work.

Before transitioning, they needed to validate that xStream could accurately replicate legacy GTRAN results—particularly during sudden valve openings that produce significant transient pressure spikes. The test scenario involved tanks initially at 440 psia, transient events from 0–2 seconds, and critical valves whose behavior drives the air hammer phenomenon.

## SOLUTION

North Wind engineers constructed an xStream model of the entire wind tunnel supply system, including storage tanks, manifold, upstream valves, and the PES and sleeve valves. Several methods were evaluated to determine appropriate Cv values for the critical valves—including catalog scaling, back-calculations based on GTRAN results, and adopting GTRAN RESIST values as Cv.

The piping network was iteratively refined, beginning with coarse pipe sectioning for rapid trial runs and increasing resolution for accuracy. The model's Mach number and temperature settings were adjusted per solver recommendations to ensure stability and accuracy during transient analysis.



- **Industry:** Aerospace
- **Region:** US
- **Focus:** Hydraulic design of an air tunnel

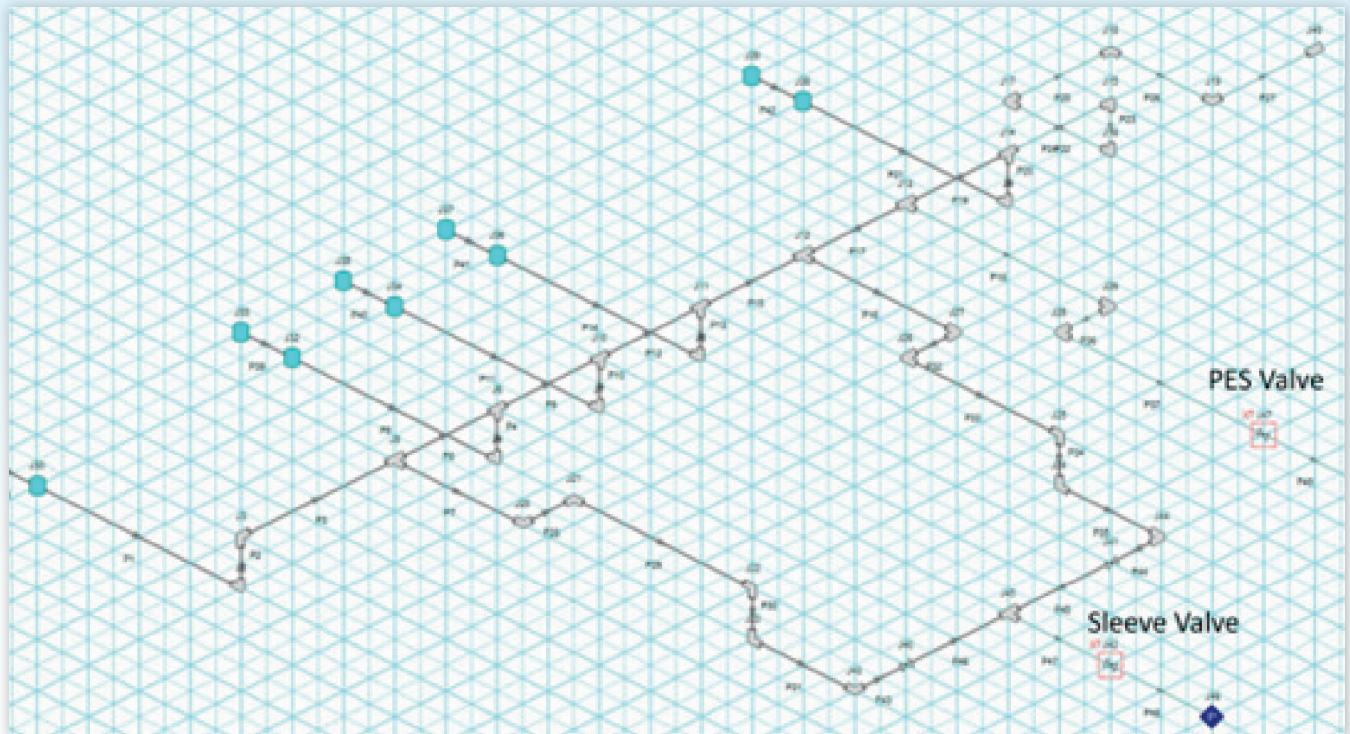
## RESULTS

The comparison between xStream and GTRAN demonstrated excellent agreement, with xStream matching GTRAN's mass-flow and pressure-fluctuation magnitudes within approximately 5%. Timing alignment of pressure spikes and troughs was nearly exact across the 0–2 second transient.

This strong correlation provided confidence for North Wind to adopt xStream as their primary tool for future air hammer analyses.

## TANGIBLE BENEFITS ACHIEVED

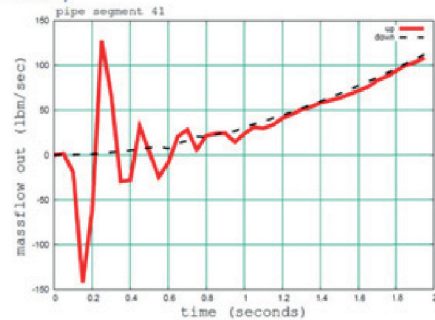
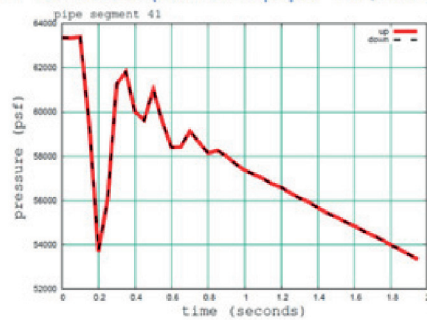
- **Validated xStream accuracy within ~5%**, proving it can reliably replace legacy GTRAN for air hammer modeling.
- **Enabled transition away from legacy code**, allowing North Wind to standardize on a modern, user friendly AFT toolset.
- **Improved modeling efficiency**, with easier system setup and faster coarse to fine iteration workflows.
- **Enhanced understanding of transient behavior**, including revealing unique tank to tank ringing behavior.
- **Increased operational confidence**, providing accurate prediction of pressure spikes and safer wind tunnel operation planning.



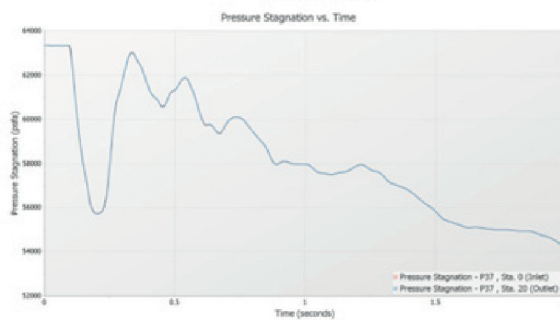
xStream Model Developed for the System

### Pipe US of PES valve (GTRAN pipe 41 / xStream pipe P37)

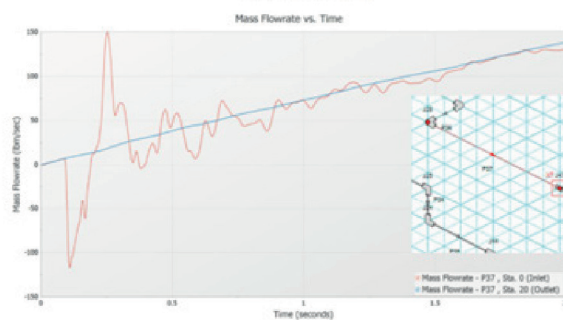
GTRAN



xStream



Pressure



Mass flow

Transient Behavior

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