TANK PRESSURE CONTROL EXPERIMENT
(TPCE)

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OVERVIEW

- Tank Pressure Control Experiment (TPCE) is a small self-contained STS payload
- Objective is to test jet mixer for cryogenic fluid pressure control
- Flown on STS-43 in August 1991
- Demonstrated reliable pressure control with low-energy mixer
- Reflight scheduled for late October on STS-52

PROJECT ORGANIZATION

- Sponsored by In-Space Technology Experiments Program (In-STEP)
- Managed by NASA Lewis Research Center
- Design, fabrication, flight data analysis by Boeing Defense & Space Group
- STS integration managed by NASA Goddard Space Flight Center

PROJECT PHILOSOPHY

- Quick-response, relatively low-cost experiment
- GAS carrier chosen for ease of integration, manifesting
- Class D Modified approach used for hardware development
  - minimum cost
  - commercial-grade components
  - reduced product assurance requirements (except safety)
  - extra system-level testing to assure of flight readiness

RISK MANAGEMENT APPROACH

- Designed with redundancy where most beneficial
- Designed for minimal requirements on Orbiter and crew
- Based designs and components, where possible, on those used on prior payloads
- Tested prototype in low-g on Lewis Learjet Microgravity Test Facility
- Performed five complete Mission Simulation tests prior to delivery

TANK PRESSURE CONTROL EXPERIMENT

PROBLEM AND OBJECTIVES

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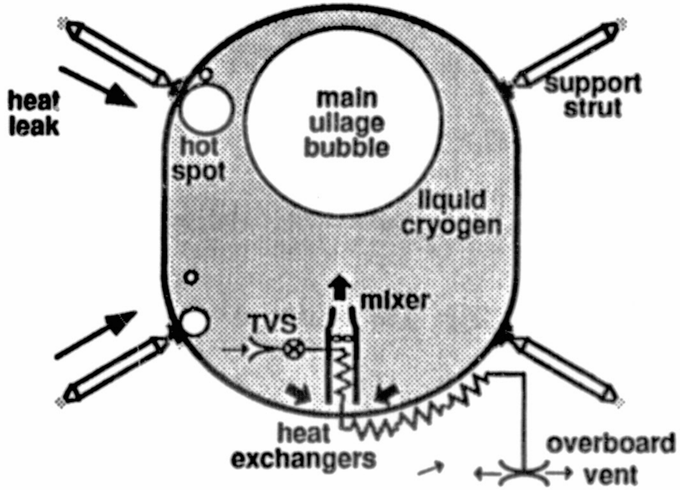
Problem:

Storage of cryogens for long durations in low-g requires efficient and reliable control of tank pressure.

Active jet mixing is leading candidate for pressure control but energy addition results in boiloff penalty. Low-energy mixing requires in-space test.



Objectives:

- Determine jet mixing effectiveness in realistic low-g environment, as measured by ability of jet to:
  - penetrate vapor bubbles and reach all tank regions
  - reduce pressure in minimum time / minimum energy
  - equilibrate fluid temperatures

- Provide data for development of analytical models

APPROACH

- Refrigerant 113 simulates cryogens
- 0.5 cu-ft tank filled to 83% level
- Pressure raised by heating, then reduced by mixing
- 38 test runs to determine effect of flow rate, acceleration environment, heater location
- Packaged as an autonomous STS payload using GAS carrier

TANK PRESSURE CONTROL EXPERIMENT

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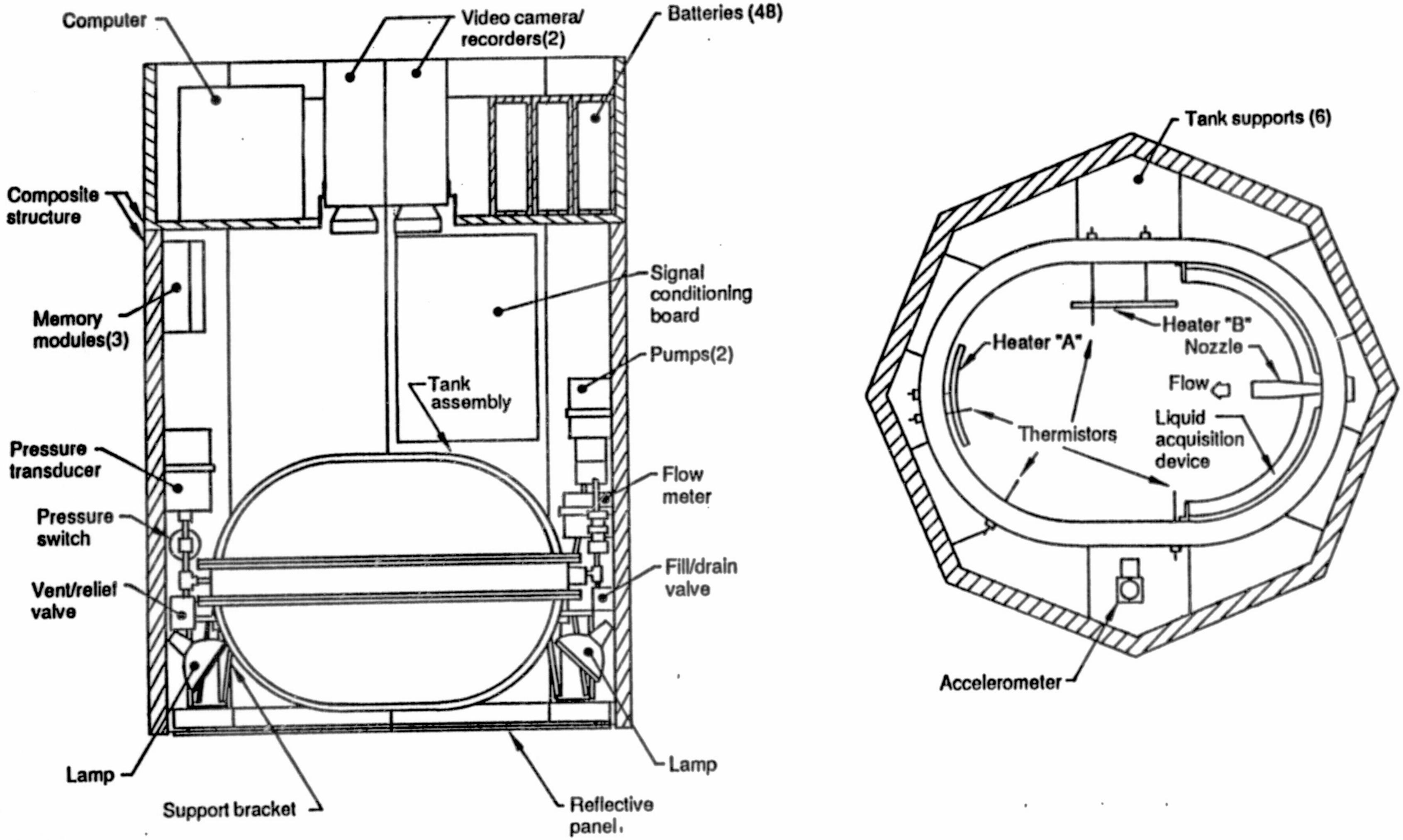
PAYLOAD CONCEPT

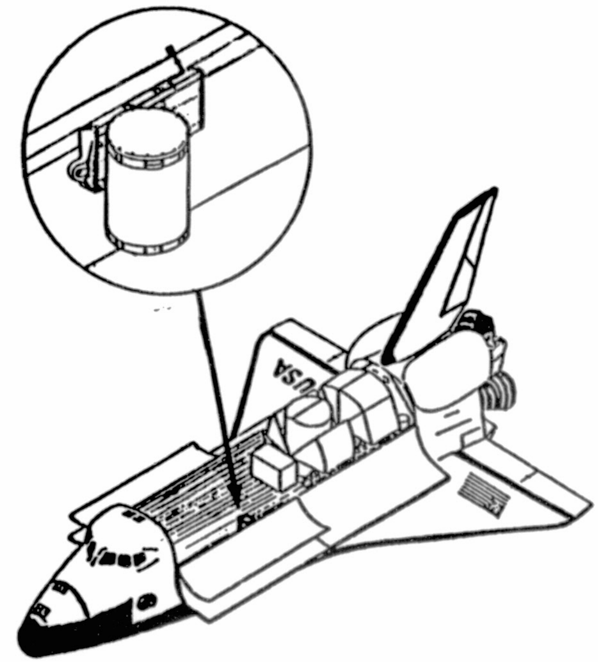


Cutaway View

Note: For clarity, some components are not shown in their true orientations

STS MISSION PLAN

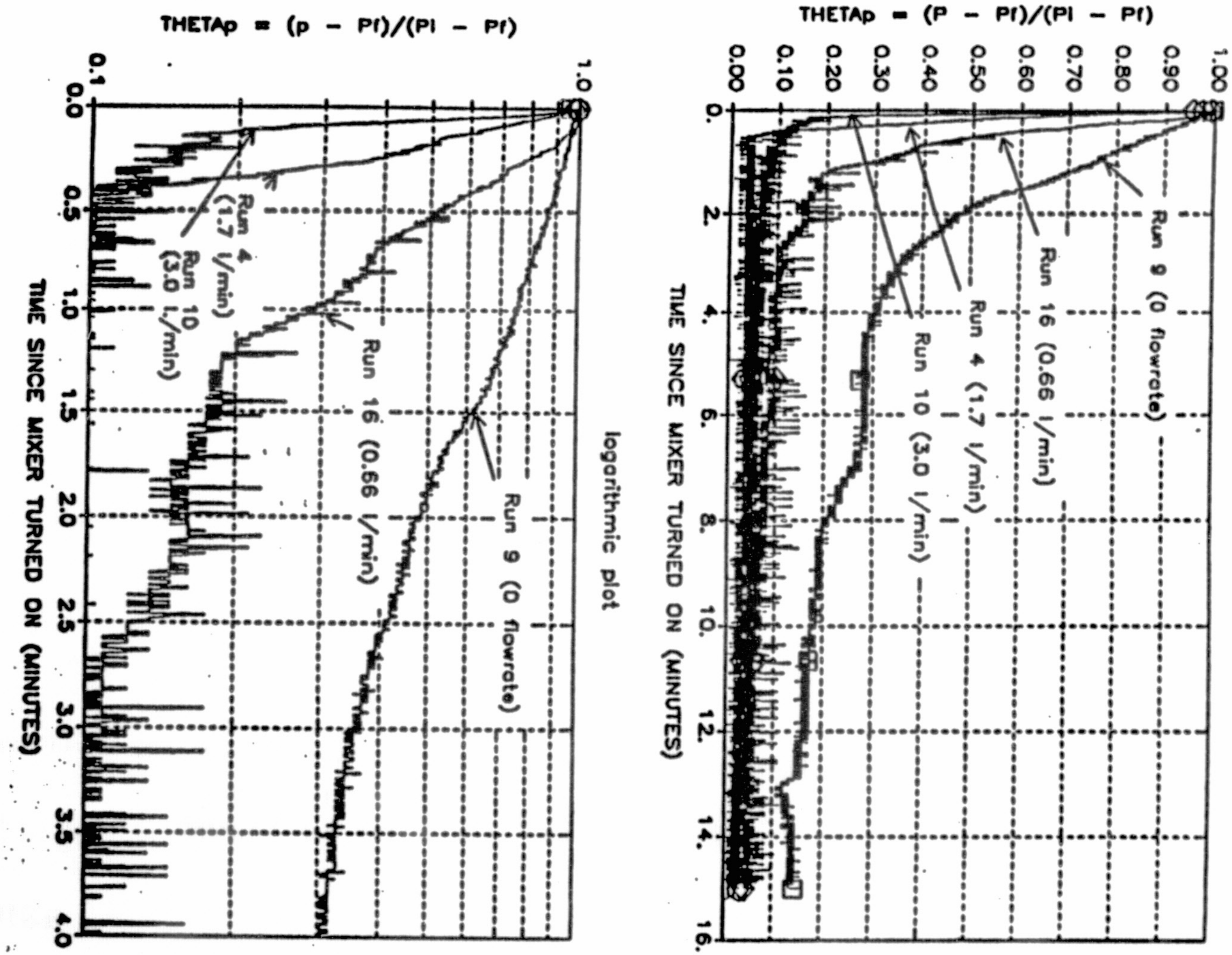
- Secondary payload using Get-Away Special carrier
- Payload size: <200 lbm, 5.0 cu-ft
- Tank major axis aligned with Orbiter X-axis, mixer nozzle at aft end
- OMS burns will settle liquid at mixer end
- Tail-first Orbiter orientation during first sleeping period (8 hours)
- Payload activation by baroswitch during launch
- Test duration: approximately 27 hours



SUMMARY OF DATA - VIDEO

- Effects of acceleration environment
- Heating (pressure rise) phase
- Self-mixing behavior
- Mixing flow patterns

NORMALIZED PRESSURE HISTORIES - FOUR TYPICAL RUNS



TANK PRESSURE CONTROL EXPERIMENT

PRESSURE REDUCTION TIME VERSUS WEBER NO. & FLOW PATTERN

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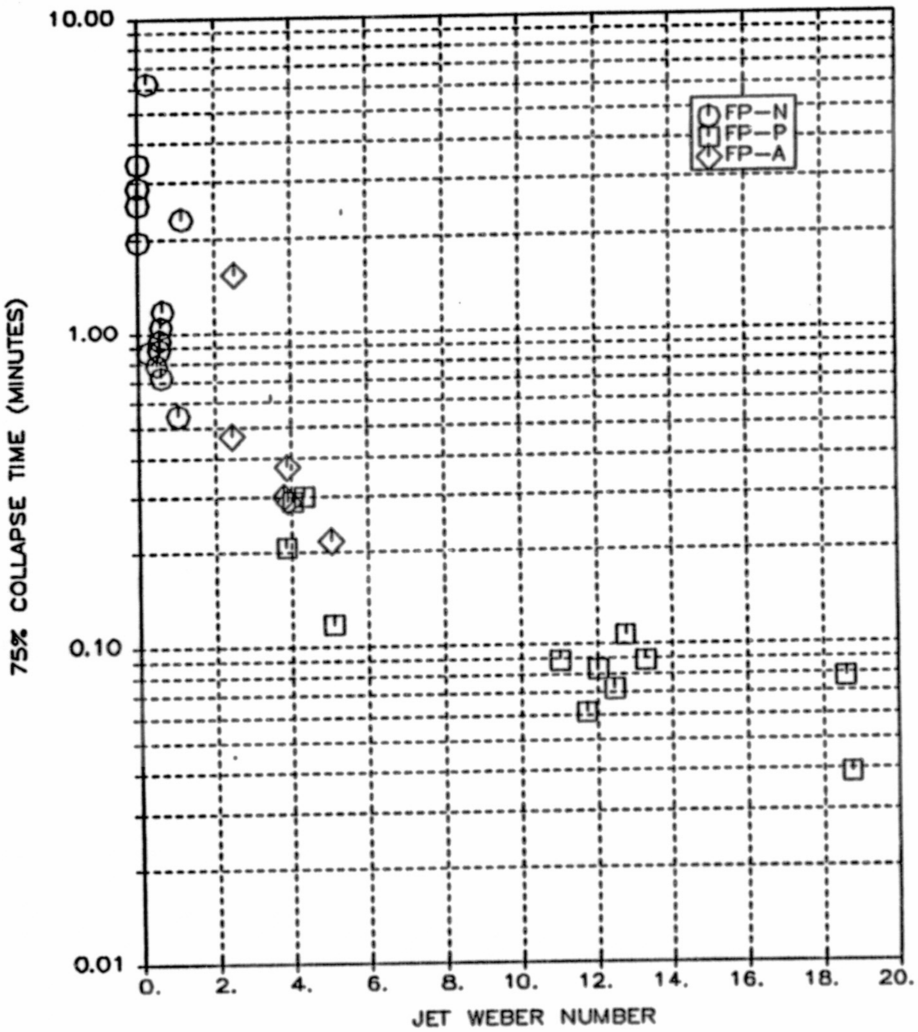

RESULTS AND CONCLUSIONS

- All objectives met or exceeded, no failures
- Data support thesis that low-energy jet is efficient pressure control device
  - Moderate velocities cause complete circulation, rapid pressure drop
  - Low velocities also cause reliable pressure drop with ~80% less energy added
  - Identified ranges of dimensionless jet momentum to be avoided
  - Generated large amount of digital and video data to support model development
- Identified potentially significant pressure rise phenomena requiring further study
- Payoff: - Cryogen pressure control shown to be manageable problem
  - Boiloff mass due to mixing can be reduced to insignificant level