36th AIAA/ASME/SAE/ASEE
Joint Propulsion Conference and Exhibit

July 16-19, 2000

NASA Fastrac Engine Gas Generator Component Test Program and Results

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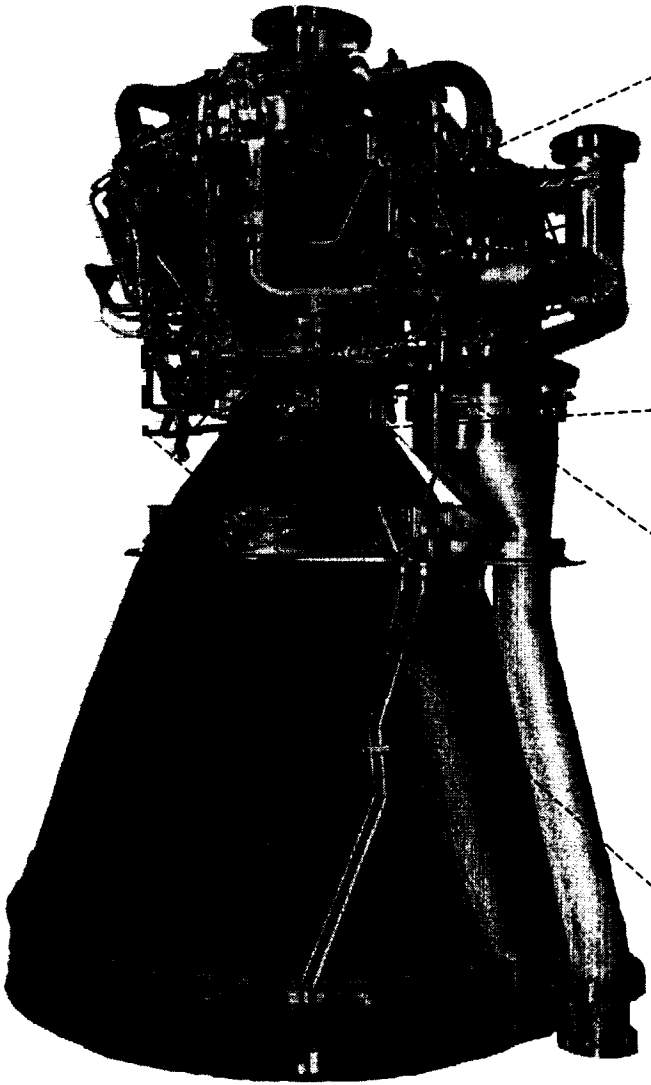
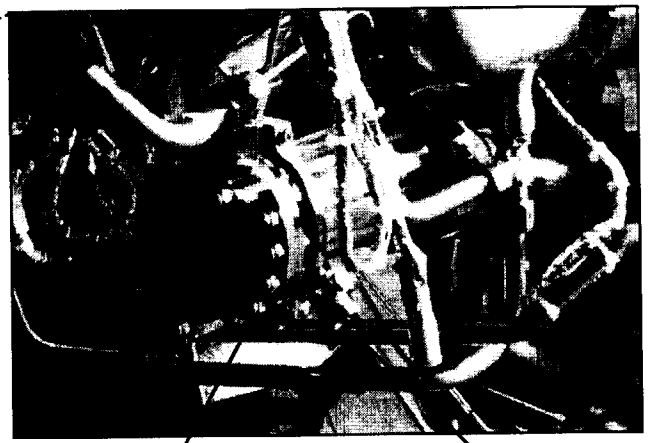
Fastrac (MC-1) Engine and Gas Generator



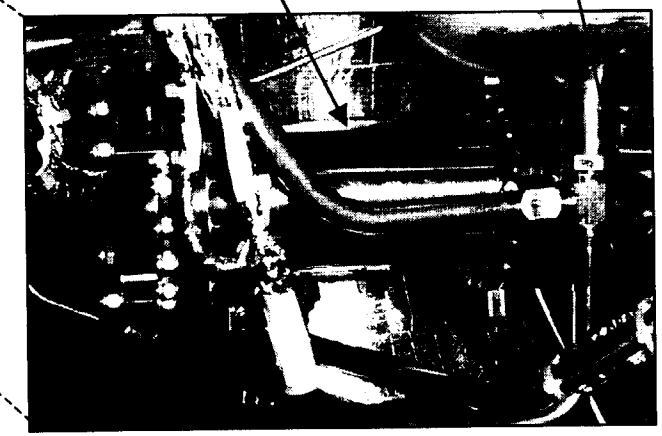


Injector

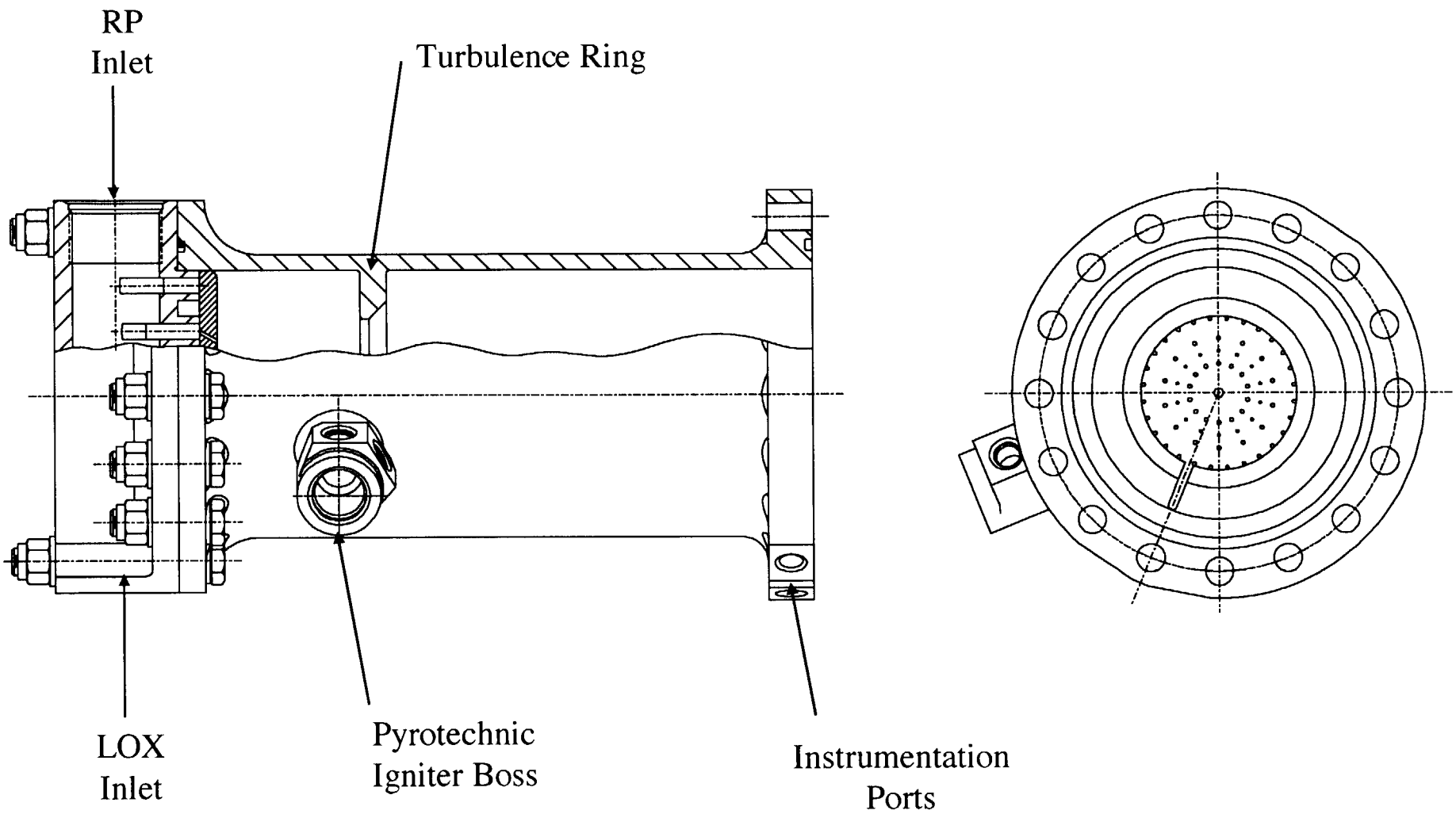
Igniter

Chamber

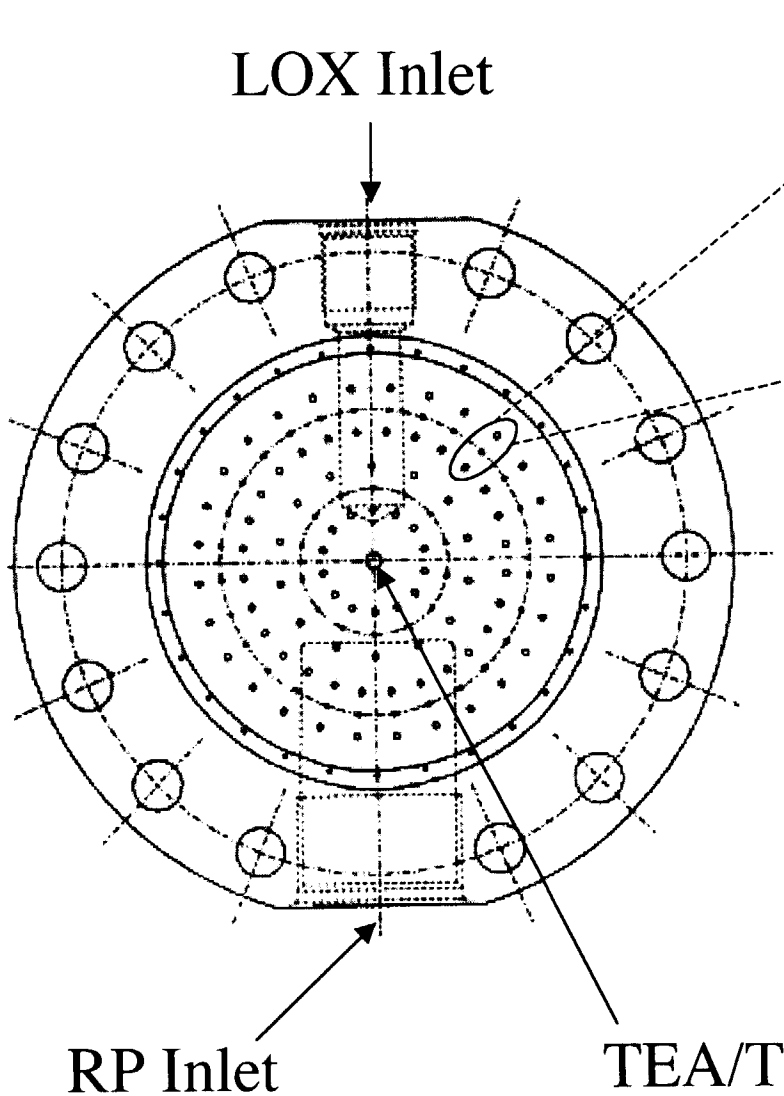
Turbine Inlet

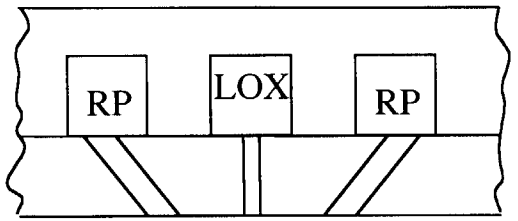


Flight Configuration



Injector Assembly



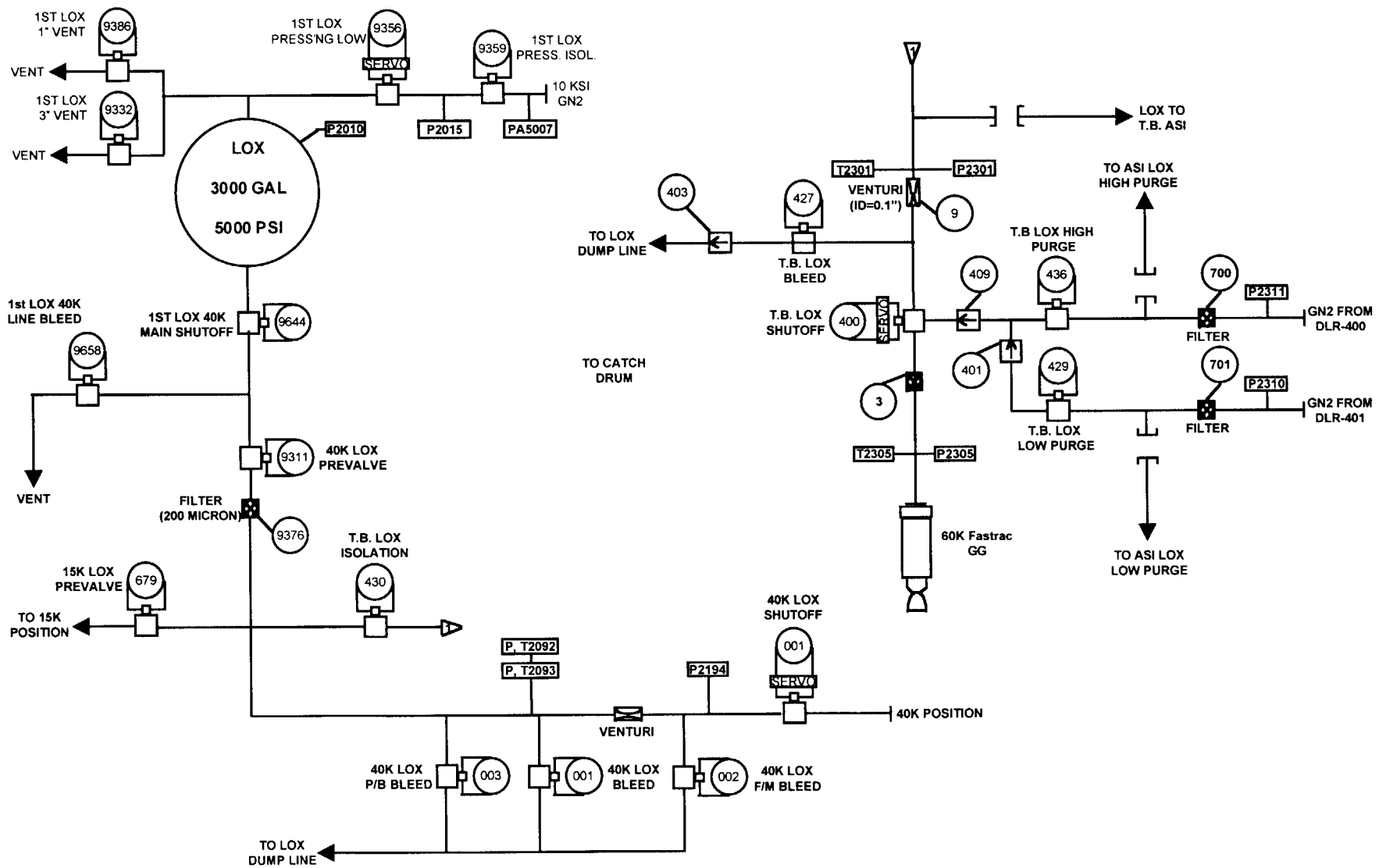


LOX/RP-1 F-O-F Triplet Injector Design Parameter Summary		
Faceplate		
Primary Elements (42)	LOX Side	RP-1 Side
Number of Orifices	42	84
Orifice Diameter	0.033 in.	0.047 in.
Impingement Angle	n/a, showerhead	60°, incl. angle.
28 Film Coolant Holes, 0.025 in. Dia. (40° Biased to Wall), 8.8% Fuel Flow (0.48 lbm/sec)		

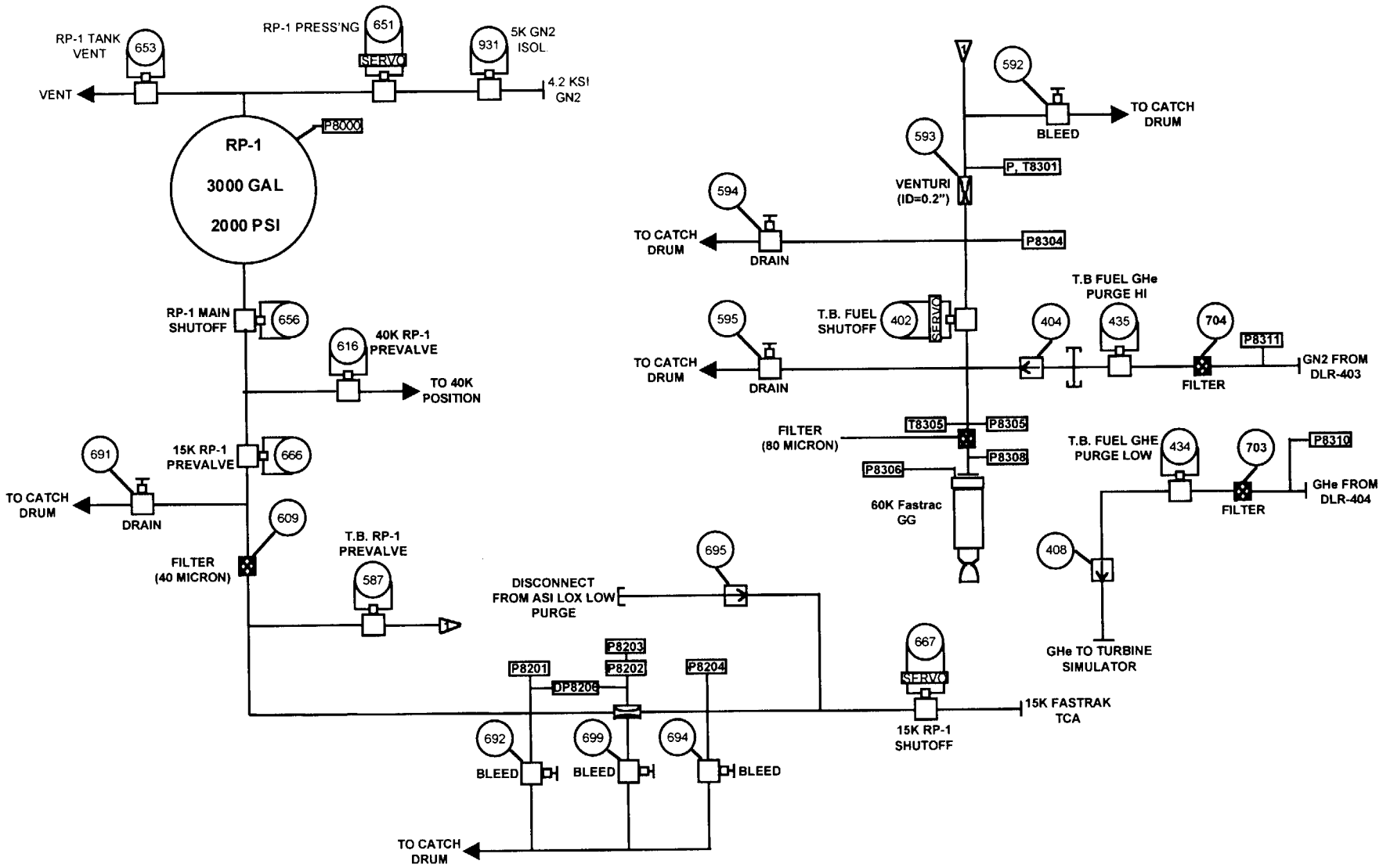
Nominal Operating Parameters

Chamber Pressure -	575 psia
Total Flowrate -	7.1 lbm/sec
Oxidizer Flowrate -	1.64 lbm/sec
RP Flowrate -	5.46 lbm/sec
Mixture Ratio -	0.30 O/F
Combustion Gas Temp. -	1600 +/- 50 °R

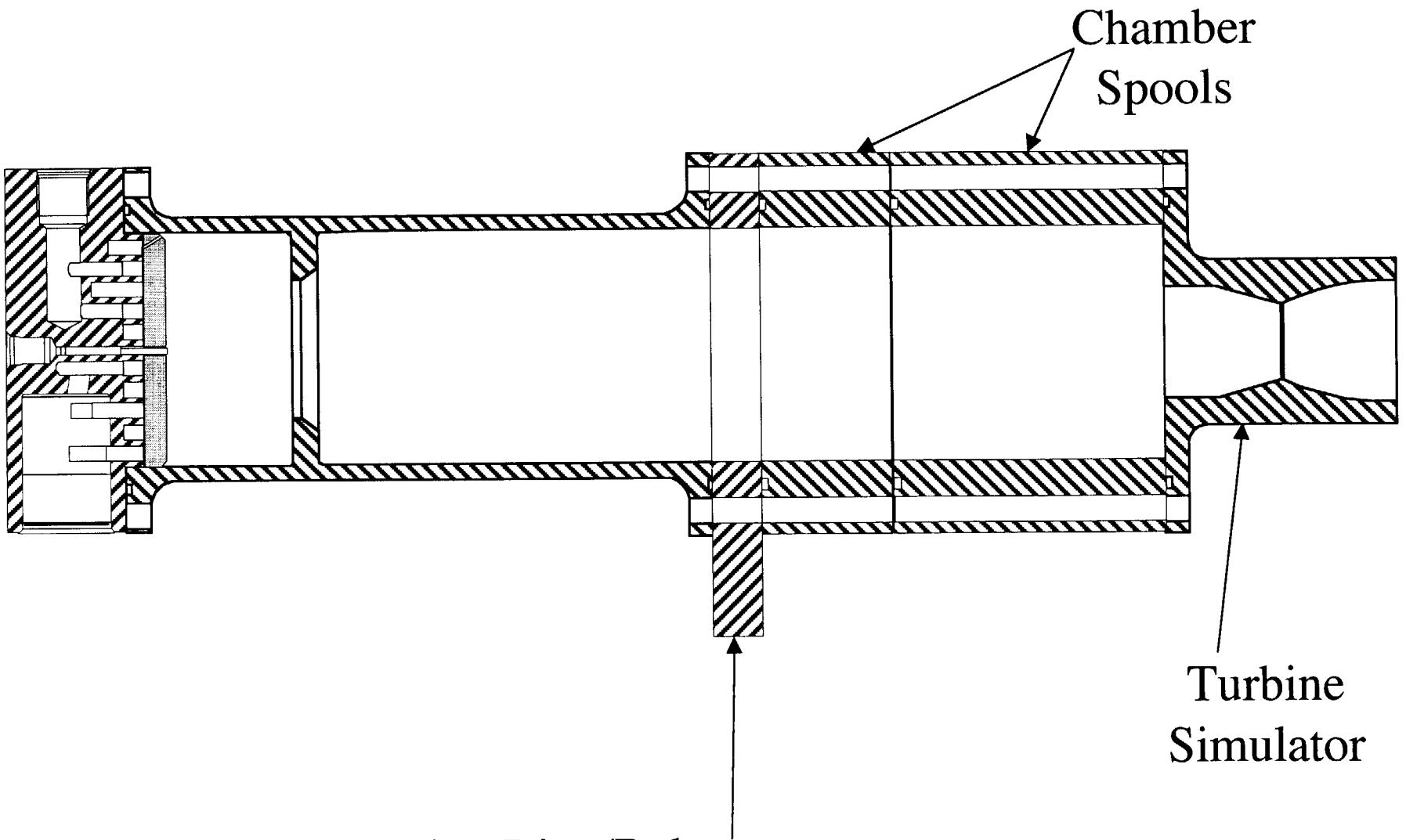
60K Fastrac GG at TS116: LOX System



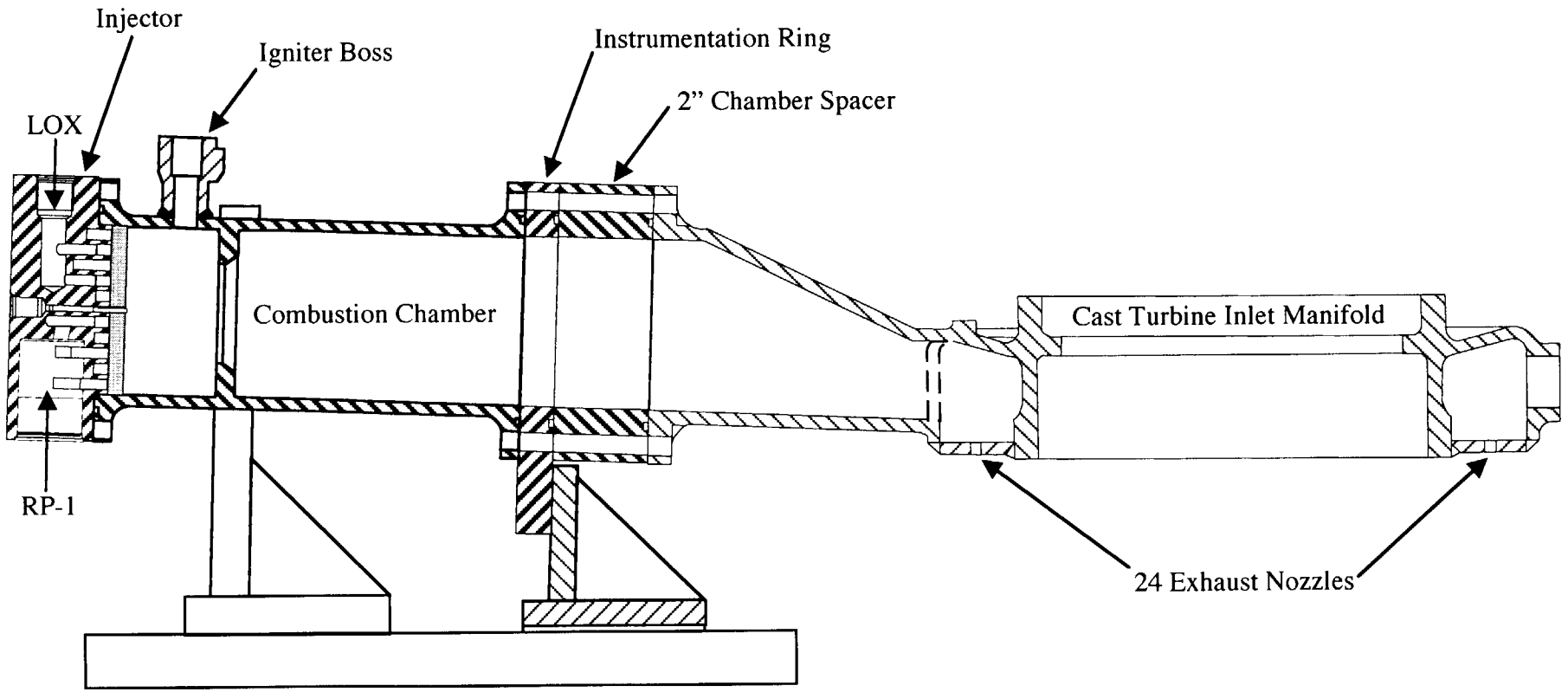
60K Fastrac GG at TS116: RP-1 System



Component Test Configuration (Typical)



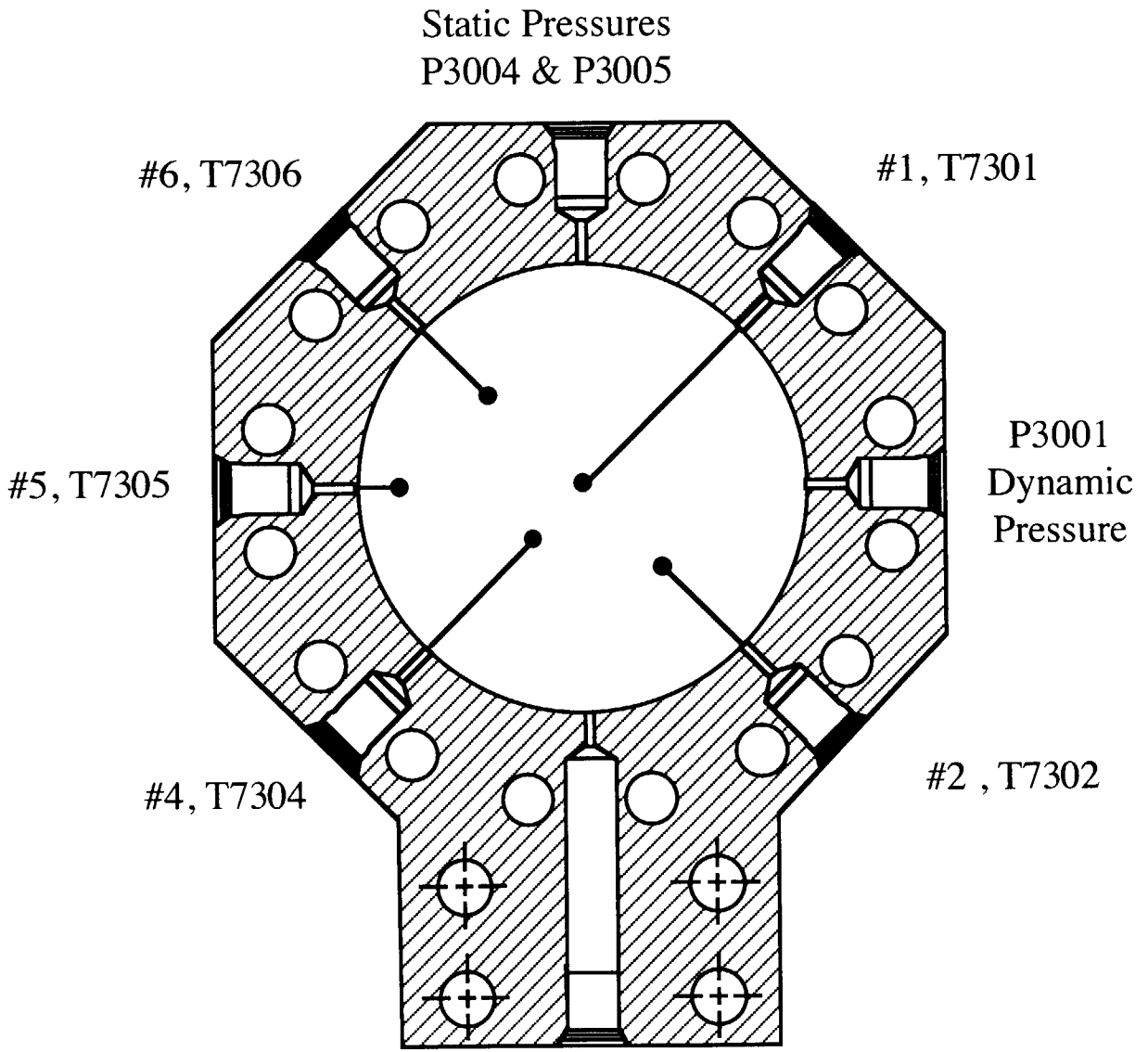
Test Configuration with Turbine Inlet Manifold



Test Instrumentation

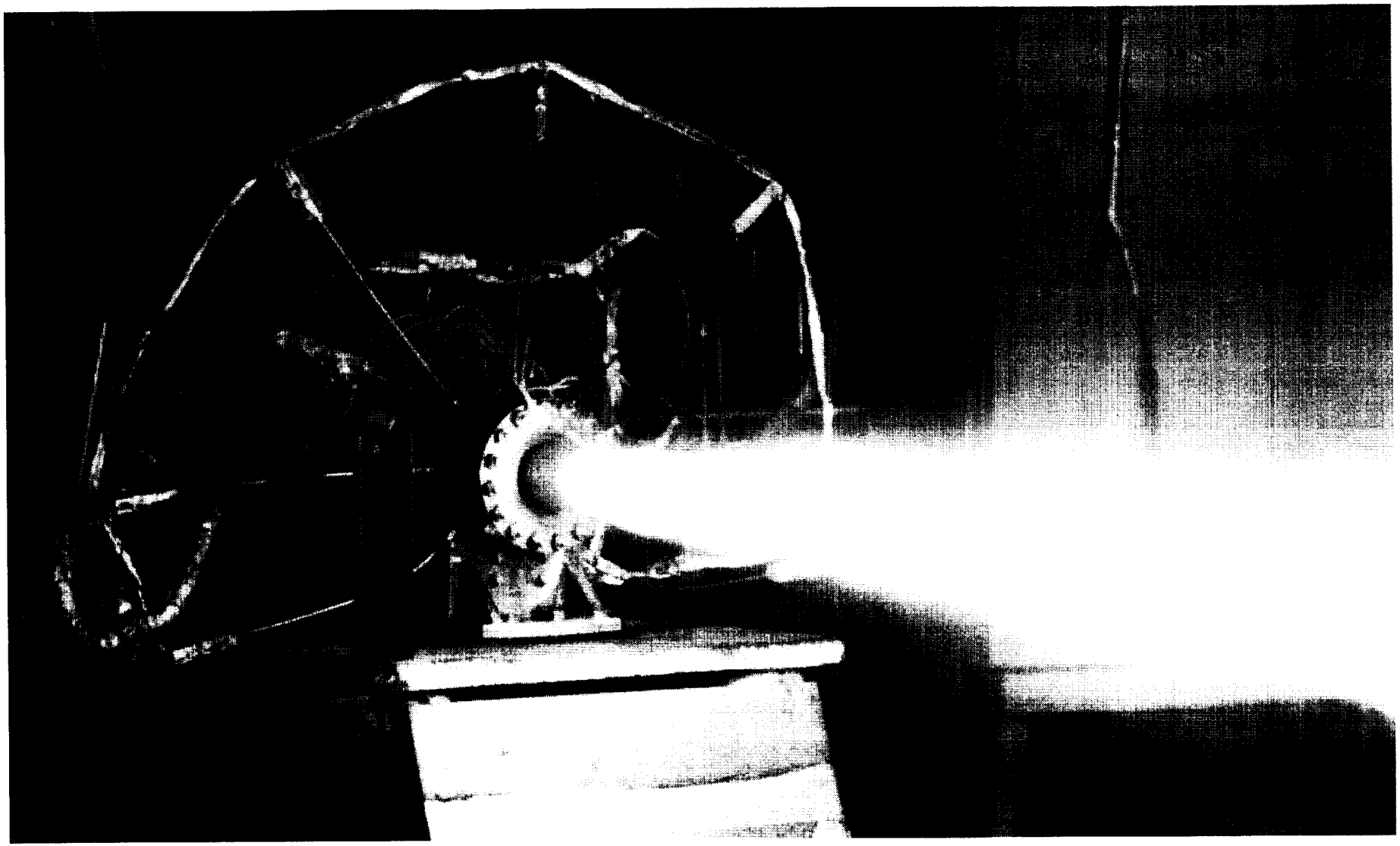
- Chamber Pressure
- Combustion Gas Temperature Profiles (Rake)
- Accelerometers
- Injector Fuel Manifold Pressure and Temperature
- Chamber Skin Temperatures
- Propellant Flowrates (Cavitating Venturis)
- Facility/Tank Pressures and Temperatures

Instrumentation Rake Configuration (Typical)

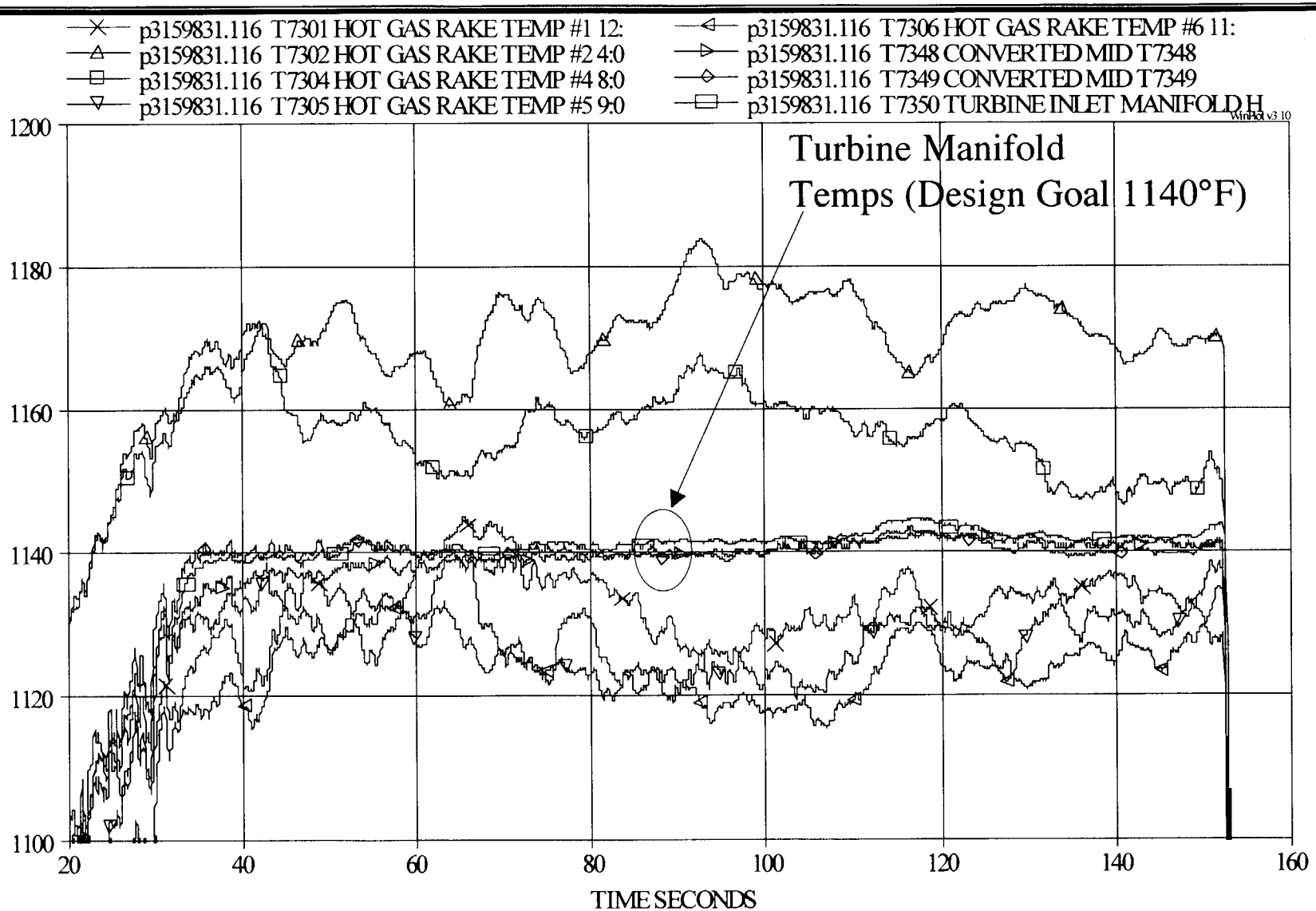


T/C No.	Insertion Depth
1	1.7 in.
2	0.9 in.
3	none
4	1.3 in.
5	0.4 in.
6	0.9 in.

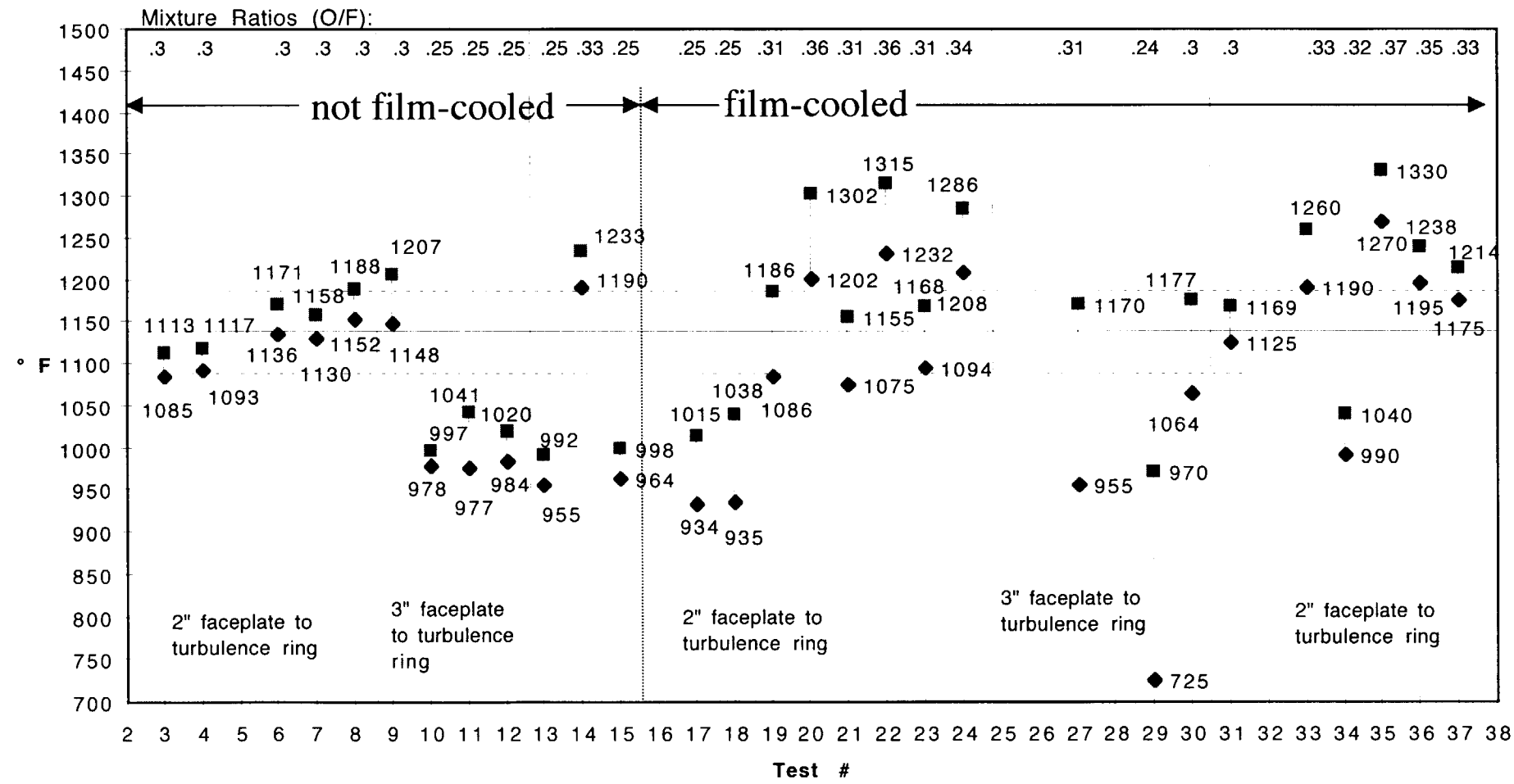
Component Test Fire



Hot Gas Temperature



Fastrac GG Component Test Temperature Profiles



Component Level Testing Summary

GG Component Level Testing:

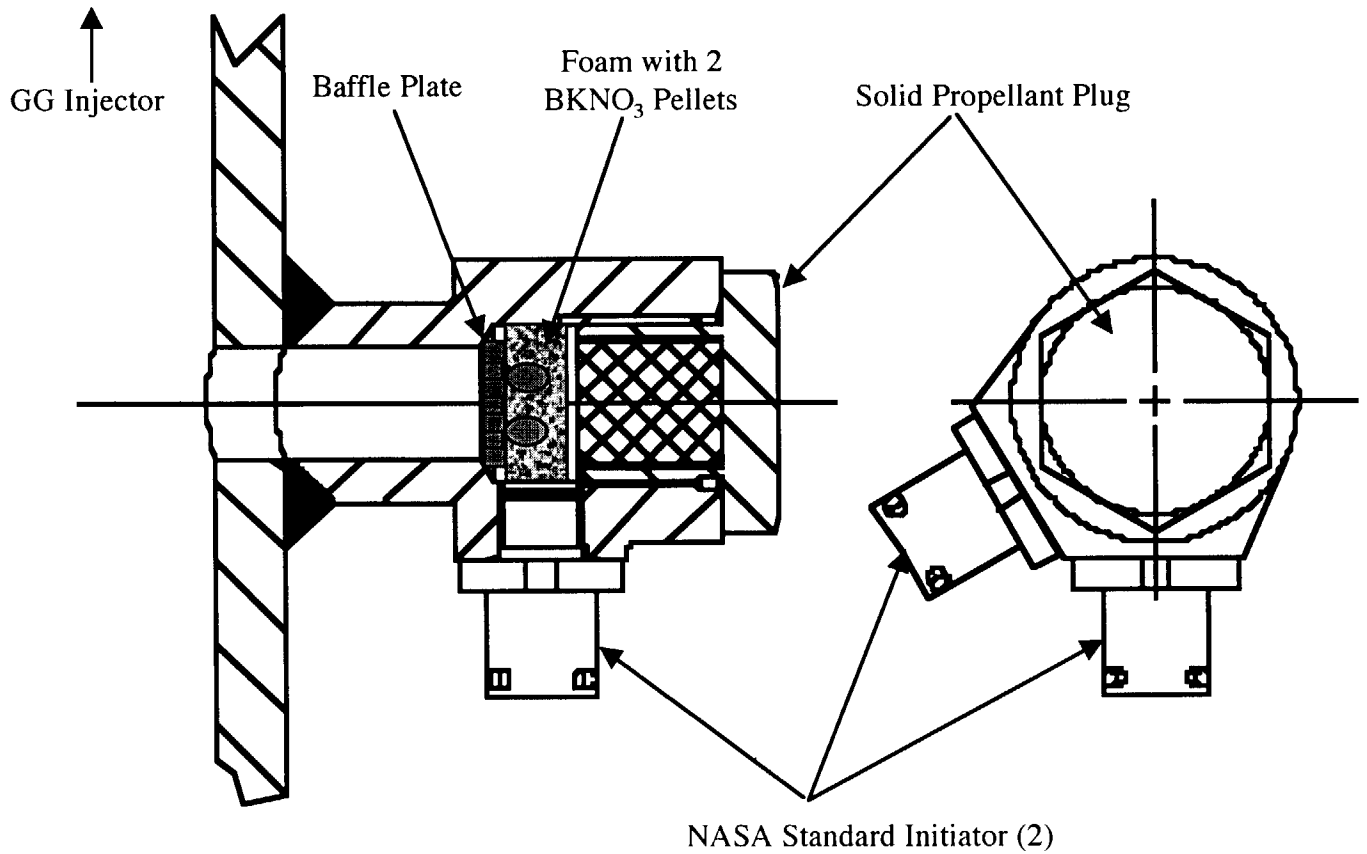
- 37 hot-fire tests under 4 test series (pressure-fed TS116 component test position).
- Demonstrated nominal hot gas temperature profile of 1600 +/- 50 °R.
- Total test time 2223 seconds with 2 injectors and 2 combustion chambers
- Demonstrated a minimum of 25 starts and 1600 seconds on a single unit (design minimum is 9 starts and 1200 seconds).
- LOX-rich TEA/TEB ignition and fuel-rich pyrotechnic ignition.
- Testing ranged from short-duration ignition tests to 150 sec. full power durations.
- GG tested in all operating conditions expected at engine level with O/F ratios ranging from 0.25 to 0.35 and chamber pressures ranging from 225 to 675 psia.

Turbopump Component Level Testing:

- 11 hot-fire tests to date (TS116 turbopump test position).
- Total GG hot-fire test time 65 seconds.
- O/F range from 0.25 to 0.30 and chamber pressures ranging from 575 to 600 psia.
- Testing is on-going.

Backup Charts

Pyrotechnic Igniter Assembly



GG Combustion Stability

- Stability requirements:
  - No spontaneous instabilities in development or flight hardware tests
  - 50 stable tests to mainstage pc at engine level
    - Pressure oscillations greater than 10% peak-to-peak must damp within 30 milliseconds

- To date, the GG has completed:
  - 23 full Pc component level tests with no spontaneous instabilities
  - 14 full Pc engine level tests with no spontaneous instabilities

- Due to low mixture ratio of GG, stability problems were not expected or seen.
  - During component GG tests, sustained low-level frequency levels of 1-2% RMS/Pc were seen. Levels as high as 8% were seen during off-design low Pc tests.
  - No anomalous frequencies have been seen during turbopump level component tests or engine level tests.

Chamber Overheating