GENERAL DYNAMICS
Armament and Technical Products

Qualification Testing of High Rate of Fire Gun Systems

Presented by:

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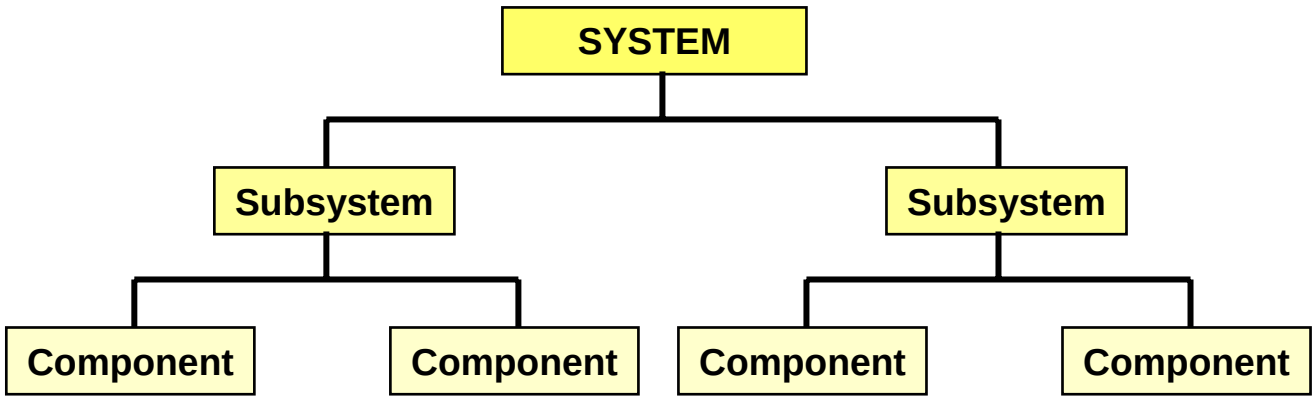
Presentation Outline

- Qualification Methodology
- Gun System Qualification Test Approach
- JSF CTOL Qualification Results
- Conclusions

What is Qualification?

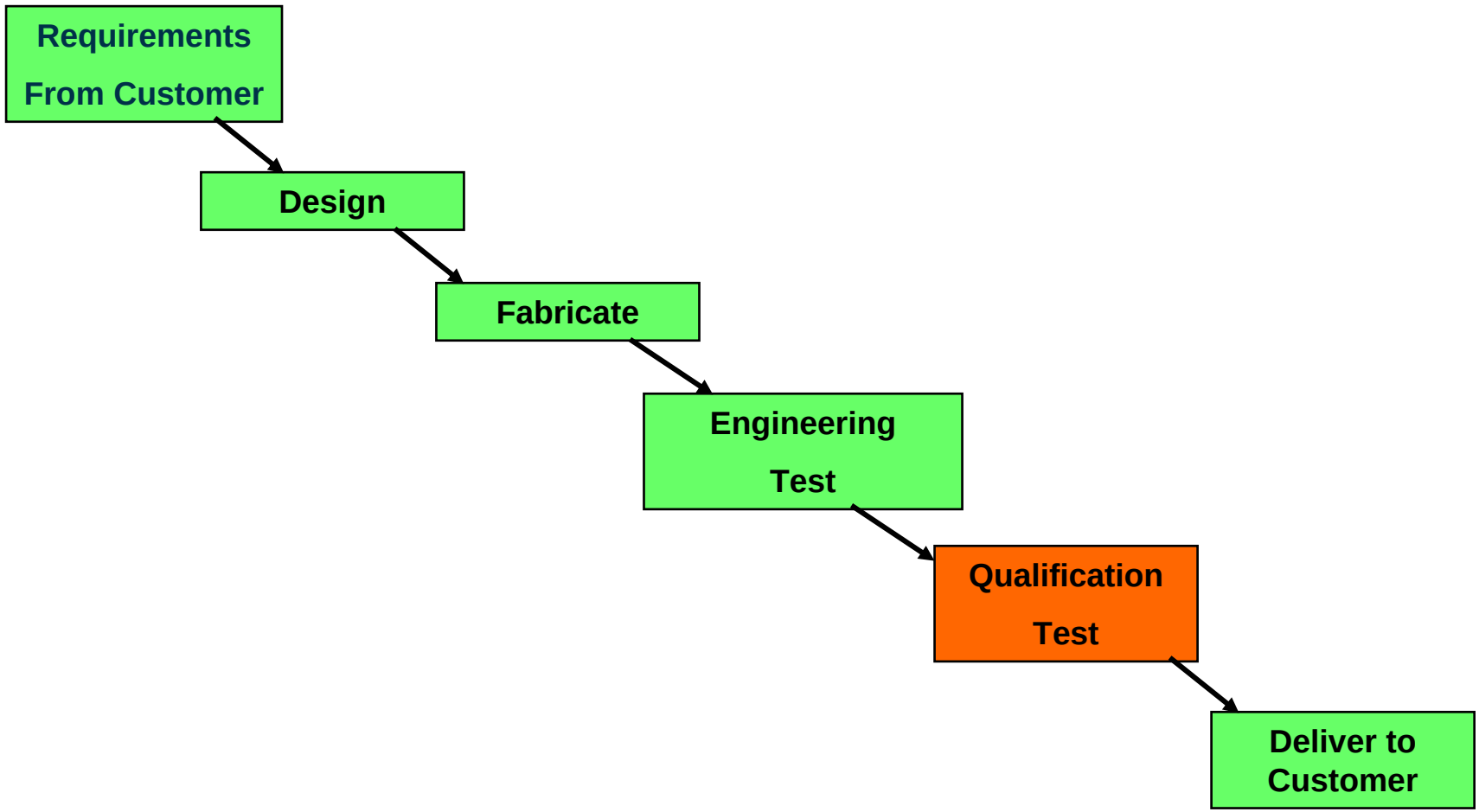
- Qualification is a process of verifying that a design meets its allocated requirements.
- Qualification is usually done in a systematic manner, starting with lower level components and subsystems, and working up to the system level.



System Perspective

The distinction between a system and a subsystem is a matter of perspective

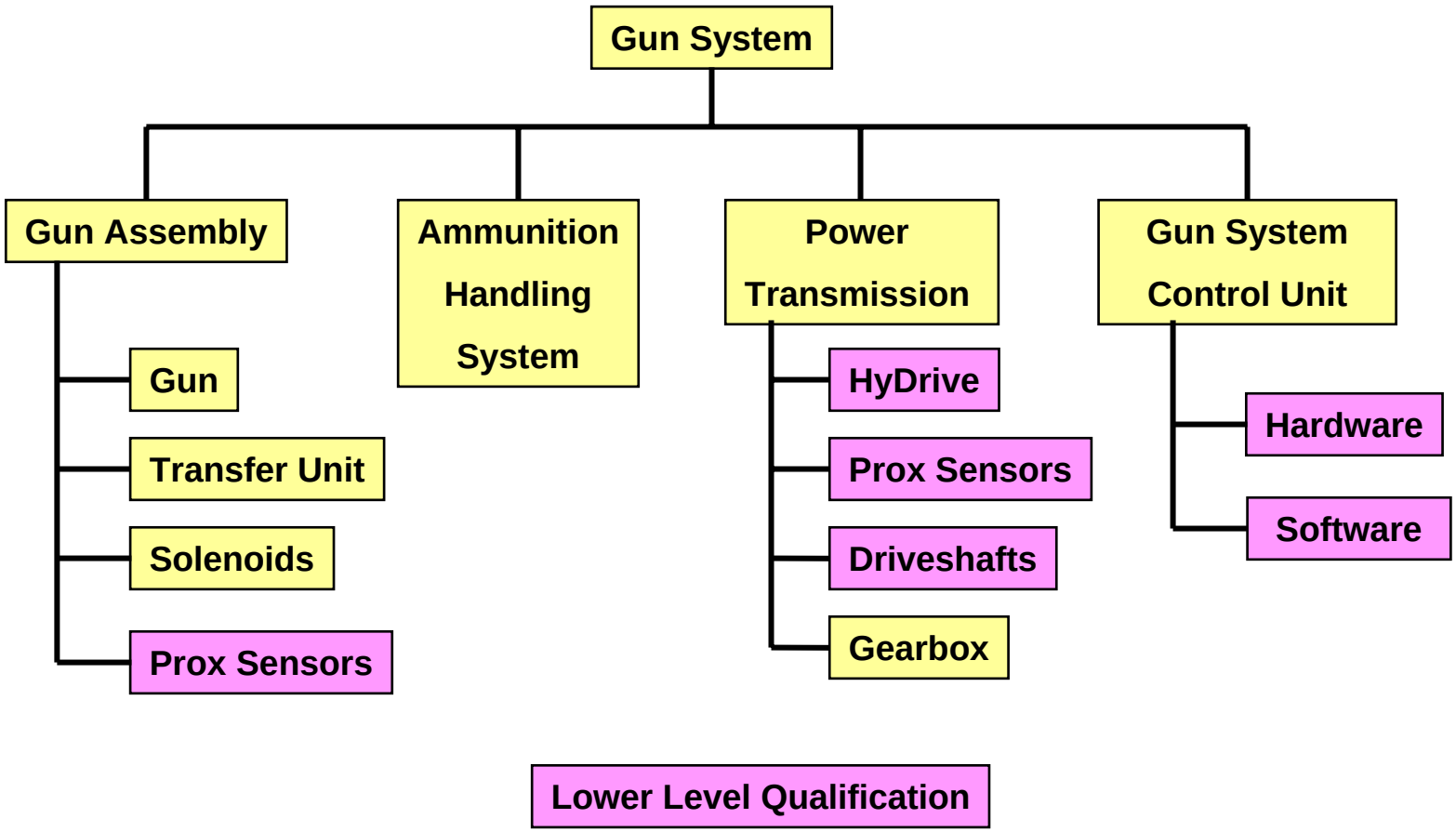
Where does Qualification fit?



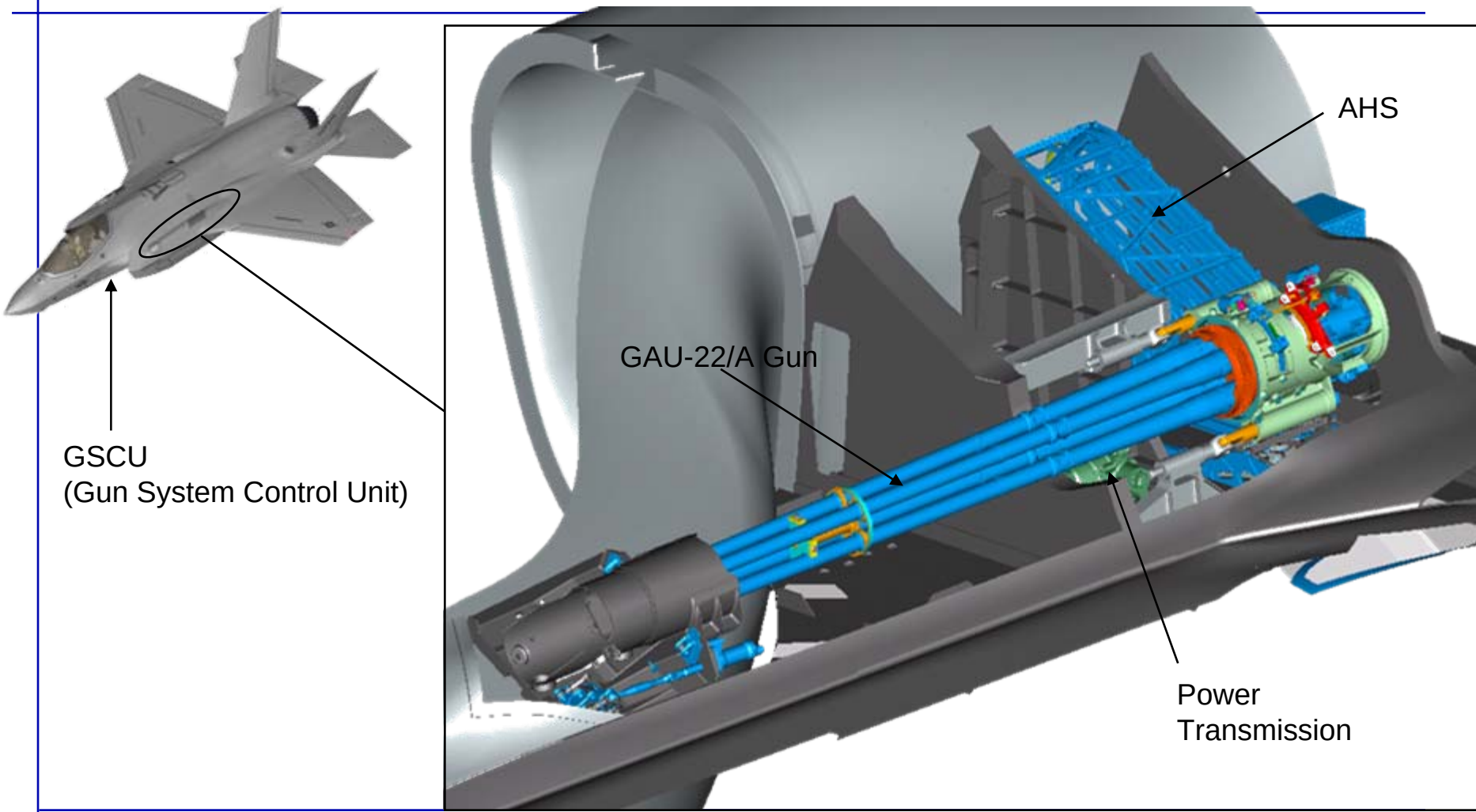
Qualification Methods

- Analysis – Technical assessment using detailed calculations, including computer modeling.
- Demonstration – Simple, uninstrumented go-no go result
- Examination – Visual inspection
- Similarity – Based on qualification results of a similar product in a similar environment .
- Test – Measurement of performance while operating the system

Typical Gun System Architecture

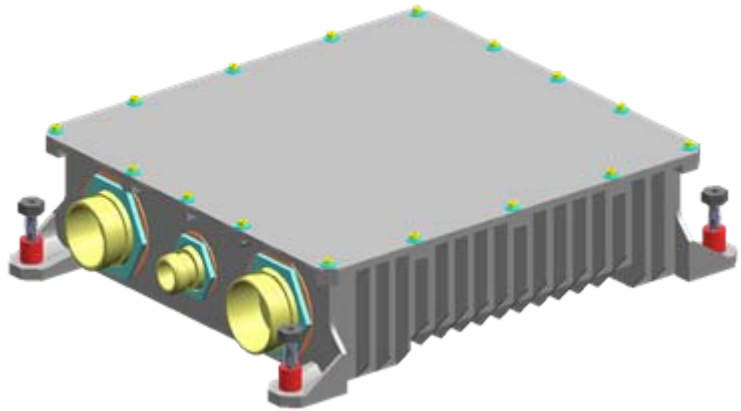


JSF CTOL Example



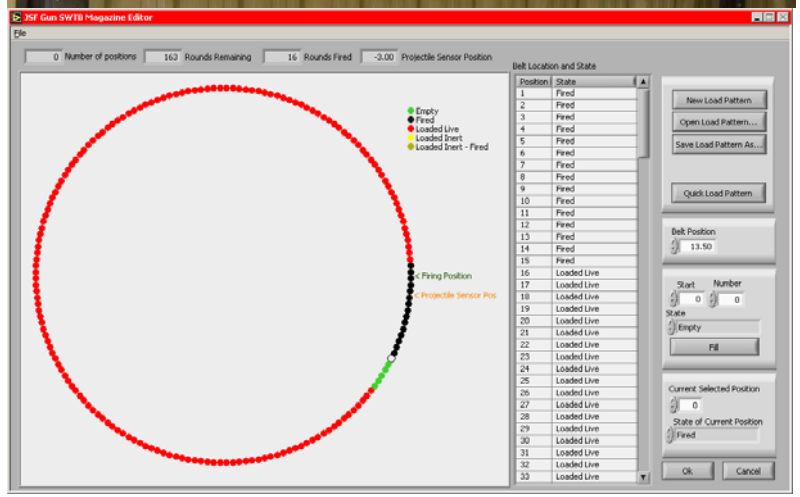
GSCU HW Qualification Tests

- Electrical Characteristics
- Electromagnetic Interference
  - Conducted Emissions and Susceptibility
  - Radiated Emissions and Susceptibility
  - Electrostatic Discharge
- Mechanical
  - Shock and Vibration
  - Humidity, Rain, Ice
  - Altitude and Air Pressure
  - Corrosion



GSCU Software Qualification

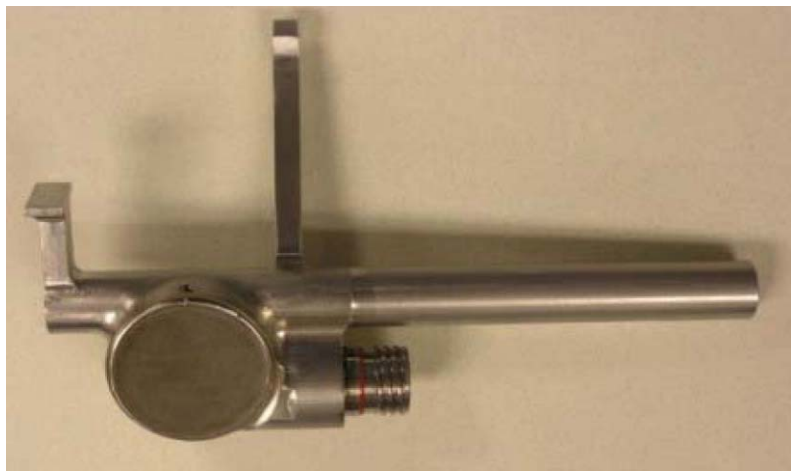
- All Software Requirements Verified
- Tests conducted with prototype GSCU and “Software Testbed” that emulates the Gun System.
- Testing conducted independently.



Proximity Sensors

- Electrical / Functional Characteristics
  - Sensing Range
  - Temperature
  - Voltage Levels
- EMI
  - Conducted Emissions and Susceptibility
  - Radiated Emissions and Susceptibility
  - Electrostatic Discharge

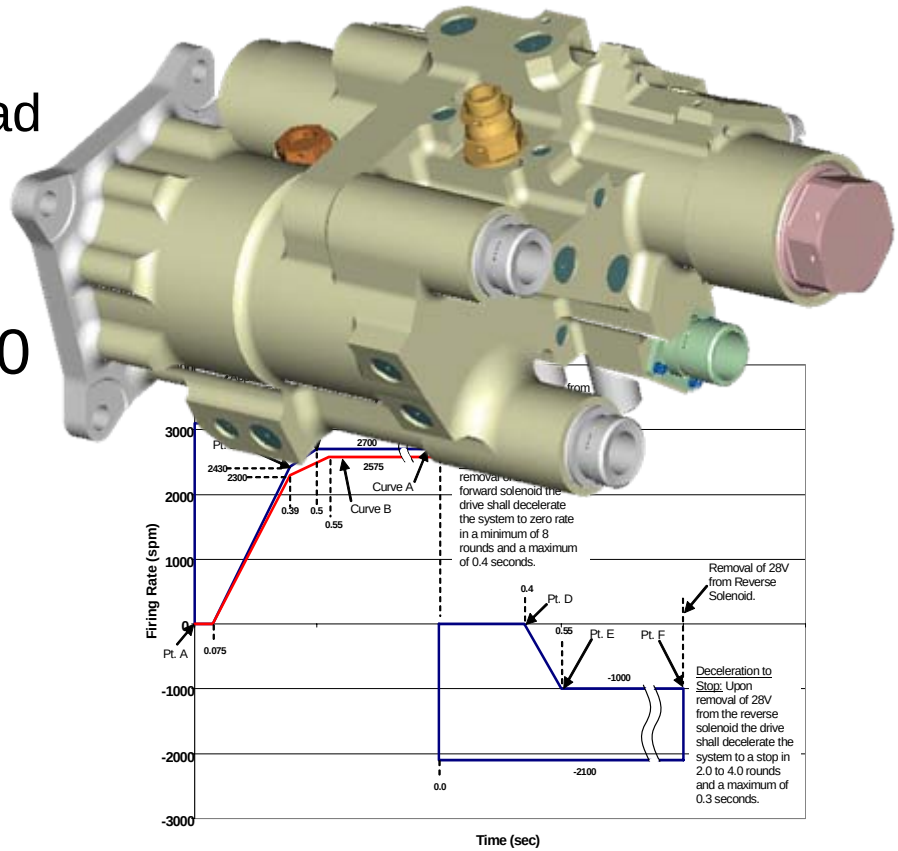
Gun Motion Sensor



Projectile Sensor

Hydraulic Drive Motor Qualification Tests

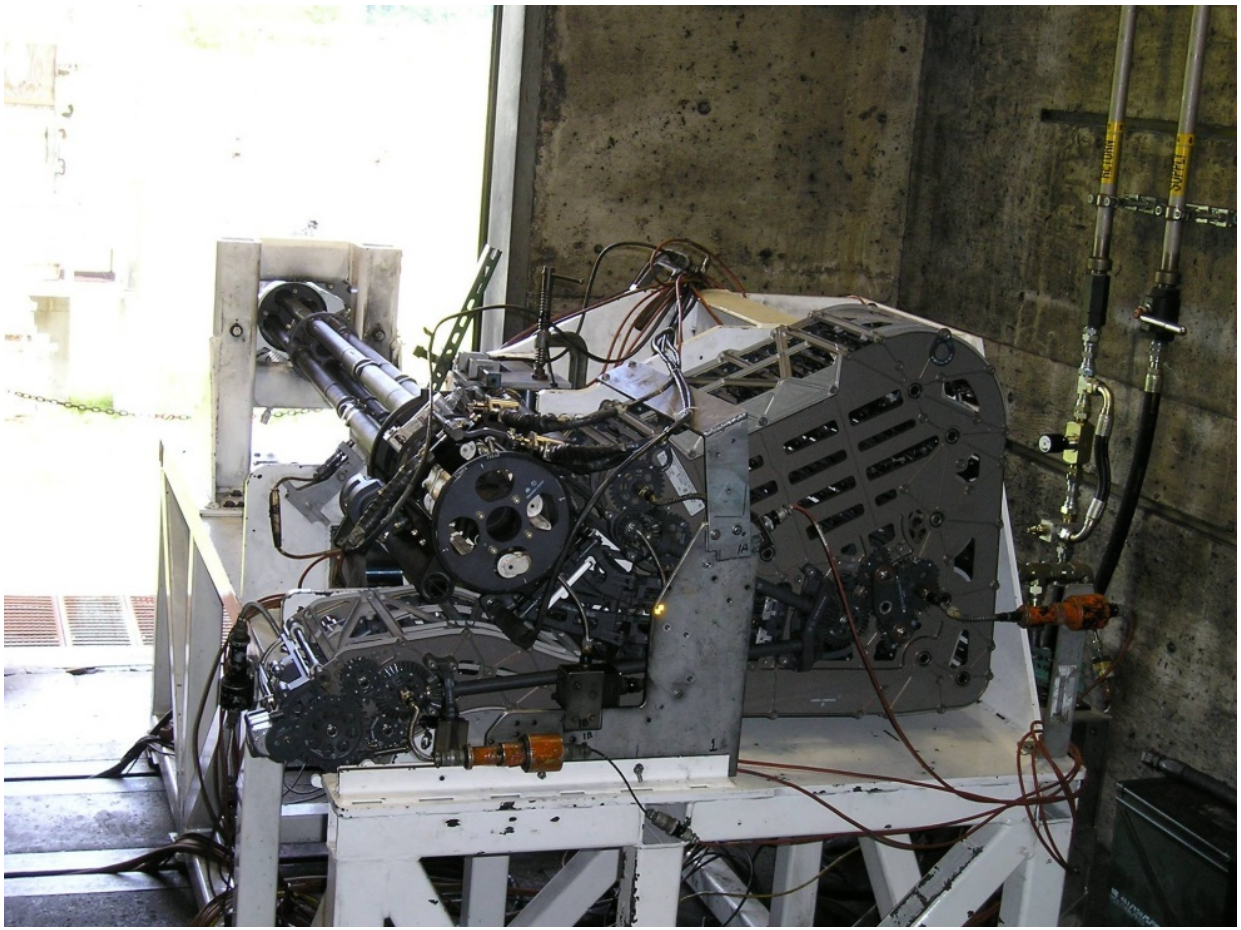
- Performance Mapping
  - Temperature, Pressure, Load
  - Speed and Power
  - Rounds to Stop
- Impulse Pressure (100,000 cycles)
- Burst Pressure
- Warming Flow
- Shock and Vibration



JSF System Level Qualification Tests

- 36,000 Round Durability Test (2X Life)
  - Fatigue
  - Wear
  - Barrel Performance
  - Hot and Cold Temp
  - Clearing
  - Dispersion
- Environmental Test
  - Shock,
  - Vibration
  - Limit Load (centrifuge)

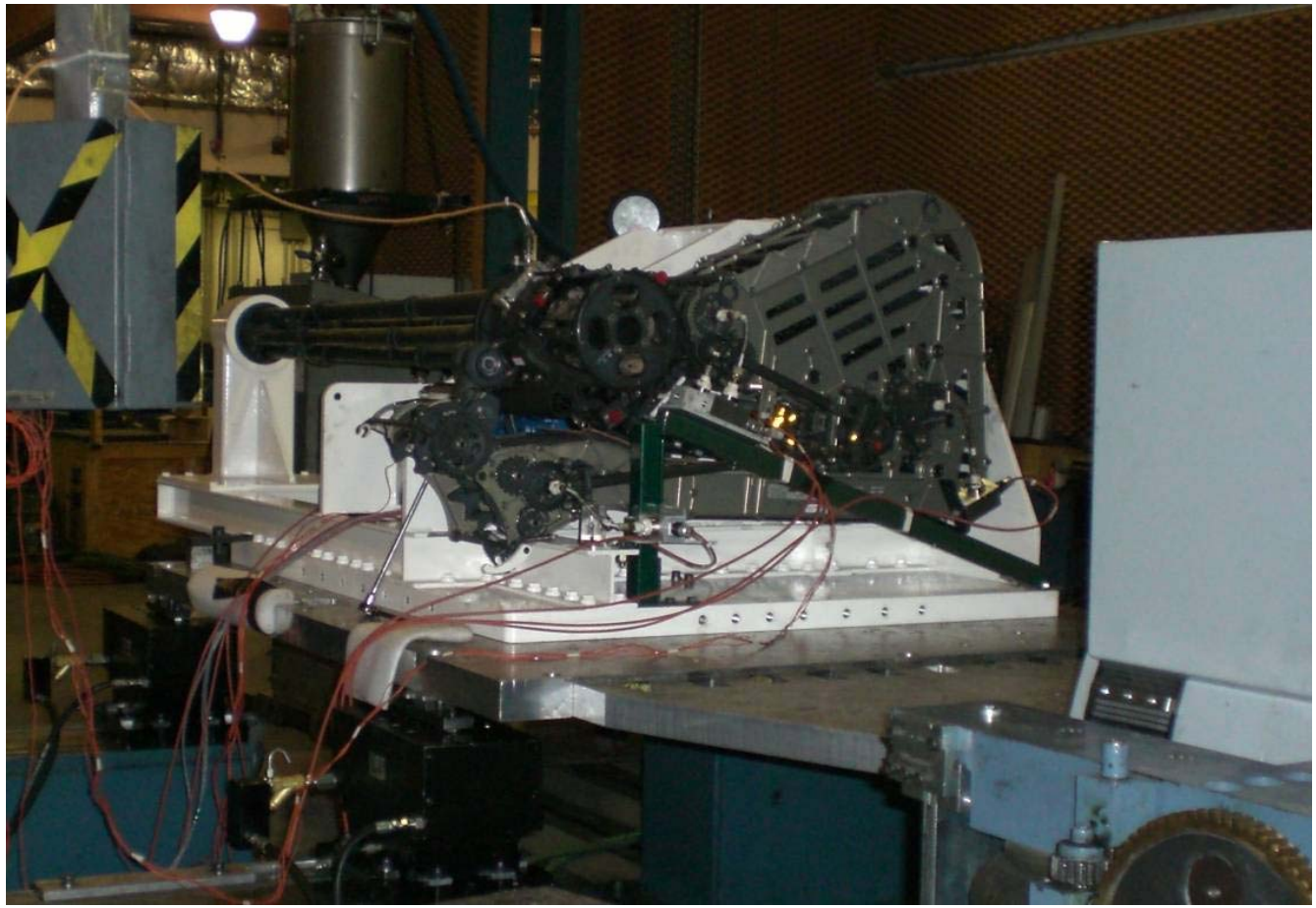
JSF CTOL Fire Test Set-Up



36,000 Round Endurance Test – Key Results

- Outstanding reliability demonstrated.
- No gun jams occurred in over two lifetimes of fire testing.
- No significant increase in dispersion after two lifetimes.
- No broken parts
  - Fatigue cracks were found on some parts, but none were beyond acceptable limits.
  - Where possible, design changes were implemented to eliminate cracking.

Environmental Test Set-Up



Environmental Test – Key Results

- JSF CTOL Gun System passed all environmental test requirements.
- Dummy ammunition failure (separated nose cone) damaged Ammunition Handling System.
- Stronger spring implemented in Load Access door latch.
- Pin in slot mounting interface strengthened to reduce fretting wear.
- Internal parts modified to eliminate minor cracking.

Conclusion

- A systematic approach resulted in a highly successful qualification test, as a prelude to flight test.
- Results of qualification testing frequently lead to design improvements.
- Overall, the JSF CTOL Gun System demonstrated exceptional reliability during qualification testing.
- Lessons learned are being applied to the Missionized Gun System, scheduled to begin qualification testing later this year.

A rigorous qualification program results in a better design and reduces risk at the next level of test.

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