



# Hard and Soft Verifications

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# Introduction

- The definition of verification is: establishment of the correctness of a theory, fact, etc.; evidence that provides proof of an assertion, theory, etc. or, 2. (Law) *law*; (formerly) a short affidavit at the end of a pleading stating the pleader's readiness to prove his assertions or confirmatory evidence.
- In the Space Flight world verifications are used to provide evidence that the system meets the requirements and is what was requested

# Introduction

- Verifications are used to:
  - Prove the product is up to standards and contains no defects before release – it is safe
  - Understand the product to define maintenance/upgrades, improve future products, avoid failures – it will continue to be safe
- Verifications can be:
  - Tests
  - Analysis
  - Inspections
  - Demonstration

# Definitions

- A hard safety verification is datum which demonstrates how a safety control is enacted
  - An example of this is relief valve testing
- A soft safety verification is considered a “nice to have” but not necessary (?) to prove safe operation
  - An example of a soft verification is the recovery and inspection of the Solid Rocket Booster (SRB) casings

# Hard Verifications

- Federal regulations must be verified before the product is allowed to be sold or used in many cases
  - Some are on every product
    - SSME – green run
    - Automobile – brakes
    - Aircraft- non-destructive inspection
  - Some are on qualification (set aside) units
    - SSME – life test
    - Automobile – test track
    - Aircraft – lightning test



# Soft Verifications

- New regulations post sale for safety
  - Flight Data Recorders
  - Event Data Recorders
    - Trucks
- Insurance companies
  - Progressive “Snapshot”: How often you make hard brakes, how many miles you drive each day and how often you drive between midnight and 4 a.m. can all impact your potential savings
  - Used to verify you are a safe driver

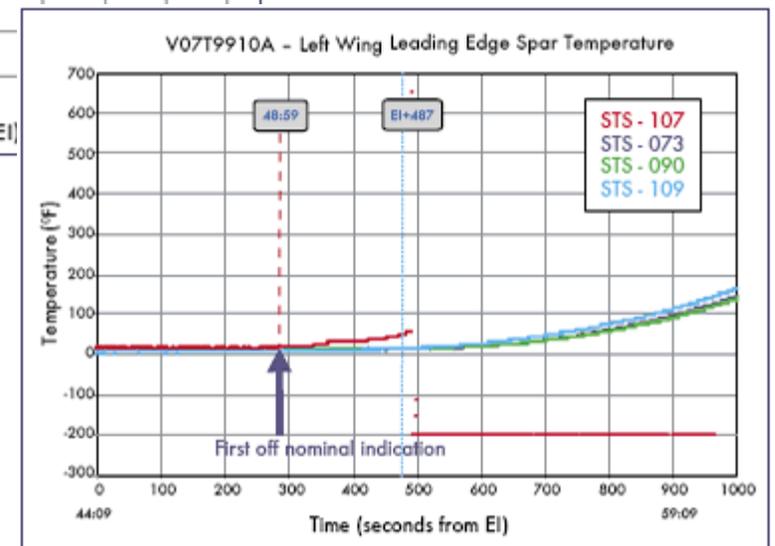
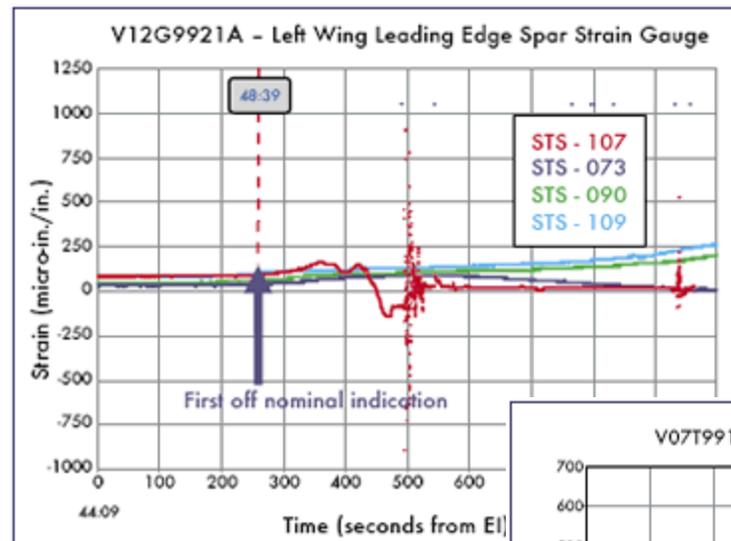
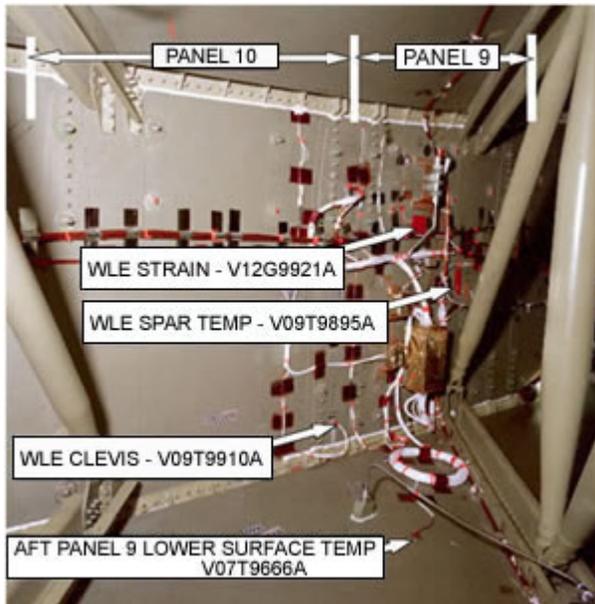


# Soft Verifications

- Imagery and instruments on Launch Vehicles demonstrate it “flew like we expected”
  - Film canisters recovered from Saturn V confirmed that potential failure modes that could not be simulated had not occurred
  - Stress/strain instrumentation on Shuttle helped define future launch profiles
  - Can be used to anchor models
  - Can be used to verify the actual environments experienced

# Shuttle Post Deploy Soft Verifications

- Shuttle instrumentation on flight units for understanding environment



# Accident Investigation

- Instrumentation can be used after an accident for investigation
  - Some of the same instrumentation used for flight environment can be used
  - It can provide the real cause of the accident
  - It can provide information to understand how to better withstand failures

# Conclusion

- Launch Vehicles use post deployment verifications to improve safety
- With the falling cost and increasing capability of sensors and data recording combined with product liability more post sale “verifications” may become more prevalent
- Consider using soft verifications which may not be a “nice to have”, but necessary to improve safety