TEST/ANALYSIS PROGRAM

TO DEMONSTRATE

IMPROVED VIBROACOUSTIC TEST SPECIFICATION & PRACTICE

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Outline

- OBJECTIVES
- DAMAGE POTENTIAL APPROACH
- TEST PROGRAM
- INITIAL RESULTS
- PLANS

OBJECTIVES

- DEMONSTRATE DEGREE OF CONSERVATISM IN TRANSLATING NONSTATIONARY FLIGHT DATA INTO A STATIONARY TEST SPECIFICATION
  - CONVENTIONAL *MAXIMAX* PRACTICE (*MM* TEST)
  - PROPOSED *DAMAGE-POTENTIAL* PRACTICE (*DP* TEST)
- INVESTIGATE OPTIMIZATION OF *DP* TEST DURATION
- DETERMINE FLIGHT-FLIGHT VARIABILITY
  - BASIS FOR STATISTICAL ESTIMATES OF ACCEPTANCE & QUALIFICATION TEST LEVELS

IMPORTANCE OF A DAMAGE POTENTIAL TOOL

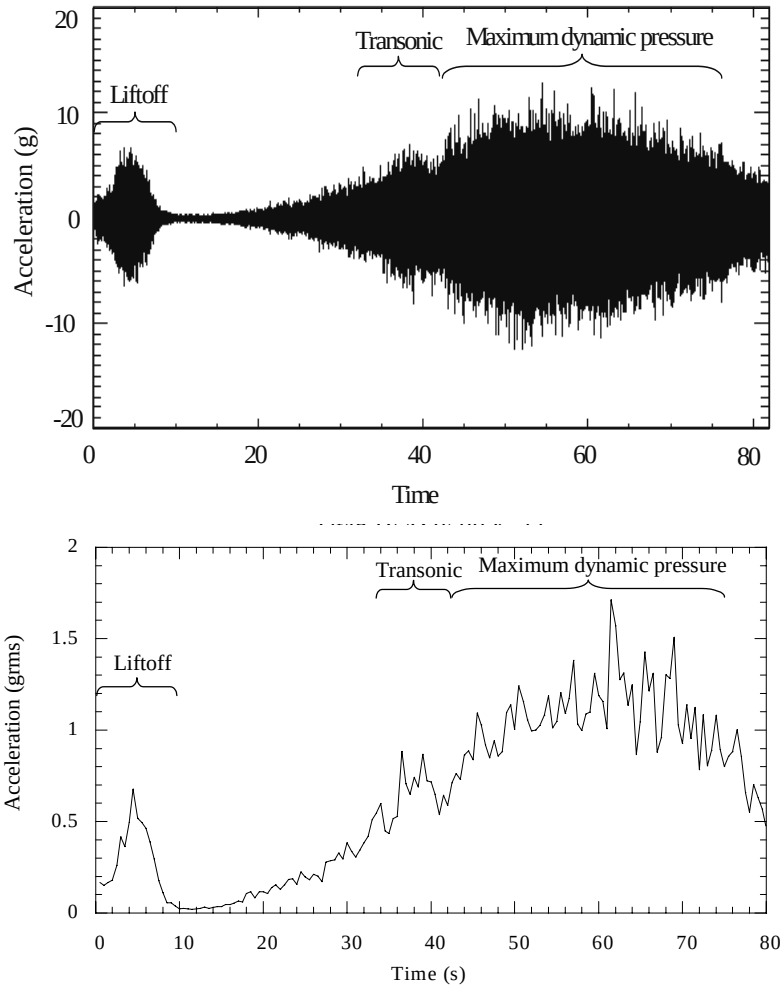
- ENABLES PERCEPTIVE RISK MANAGEMENT REGARDING QUALIFICATION ADEQUACY
  - WHEN CONVENTIONAL DATA ANALYSIS (*MM*) YIELDS MUCH HIGHER THAN EXPECTED LEVEL
  - WHEN VEHICLE CHANGE OR HARDWARE RELOCATION LEADS TO INCREASED VIBRATION
  - WHEN USING COTS HARDWARE
- IMPROVES ABILITY TO ESTABLISH MORE REALISTIC TEST REQUIREMENTS
  - ENABLES QUANTIFICATION OF MARGINS DEMONSTRATED BY TEST

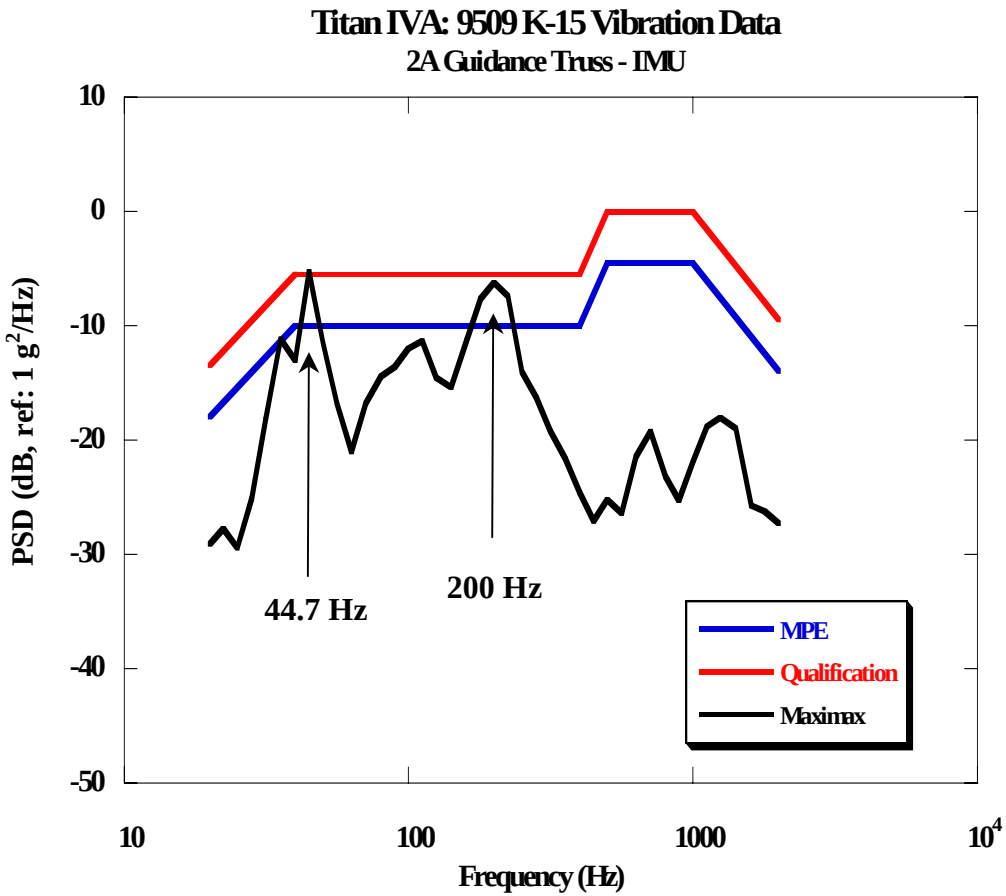
DAMAGE POTENTIAL CONCEPT

- PYROSHOCK
  - *SHOCK RESPONSE SPECTRUM* (*SRS*) INTRODUCED IN 1962
  - RATIONALE: DAMAGE POTENTIAL RELATES TO PEAK RESPONSE OF HARDWARE RESONANCES

- NONSTATIONARY RANDOM VIBRATION
  - MOTIVATION: BELIEF THAT *MAXIMAX PSD* IS UNREASONABLY CONSERVATE (TITAN IV EXPERIENCE)
  - *DAMAGE POTENTIAL* (*DP*) INVESTIGATION BEGUN ABOUT 10 YEARS AGO
  - RATIONALE: EXTENSION OF *SRS* TO INCLUDE FATIGUE POTENTIAL & UNCERTAINTIES IN DAMPING & FATIGUE LAW

EXAMPLE OF CONVENTIONAL APPROACH





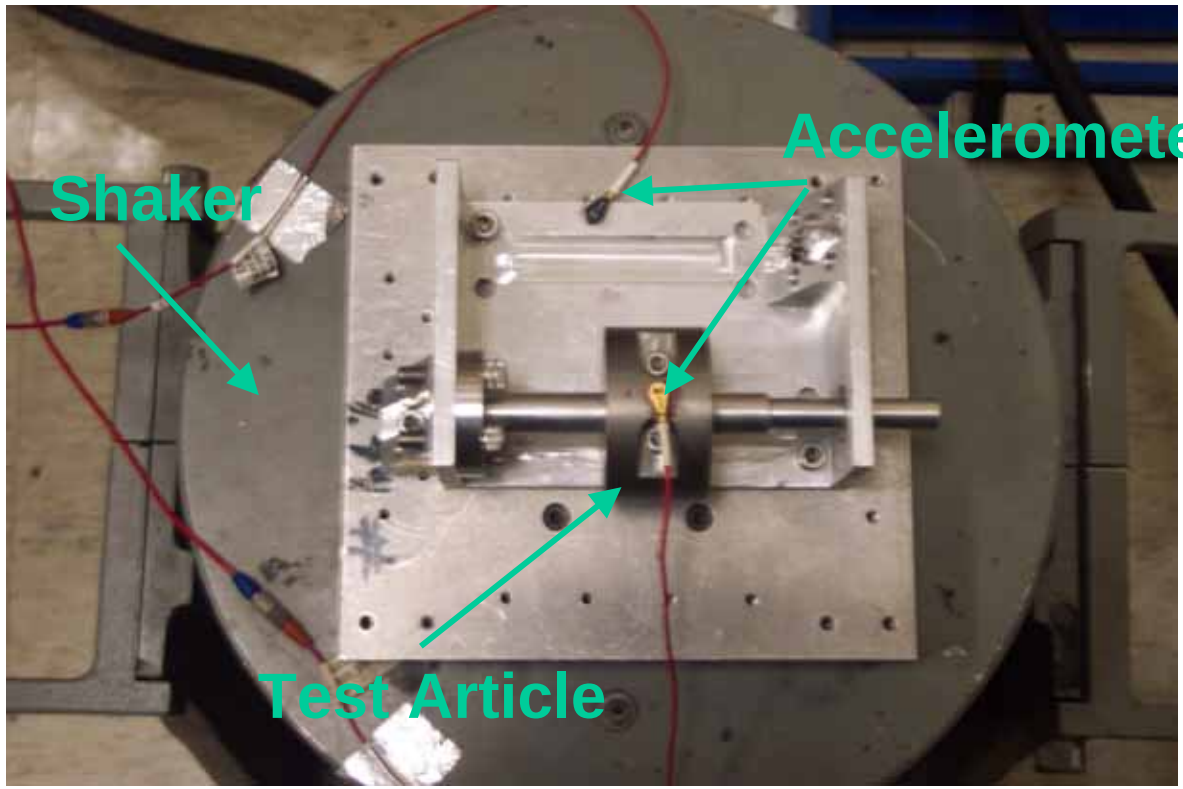
DP APPROACH STATUS

- DATA ANALYSIS TECHNIQUE DEVELOPED
  - OPERATIONAL AT AEROSPACE CORP.
  - INCORPORATED IN VISPERS (demo in June at Workshop)
- JOURNAL PUBLICATION IN 2003
  - THEORY AND RESULTS OF APPLICATION TO TITAN VIBRATION AND ACOUSTIC DATA (AIAA J. SPACECRAFT & ROCKETS, vol. 40, no. 2, 2003)
- TEST PROGRAM BEGUN IN LAST QUARTER OF 2004

TEST PROGRAM

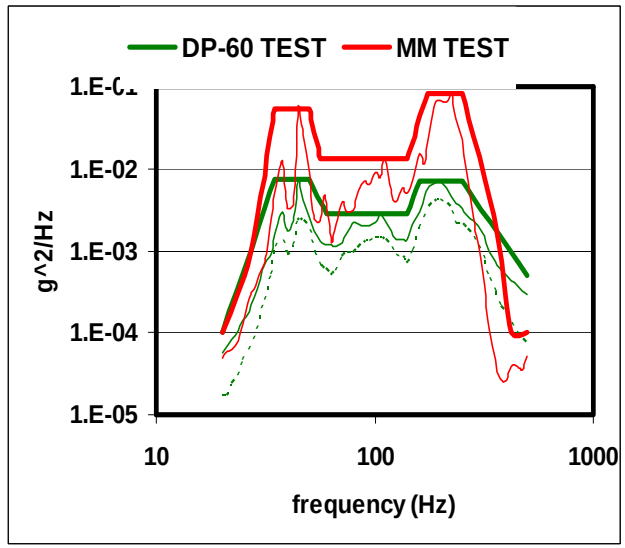
- TEST SURPLUS FLIGHT HARDWARE
- INPUT NONSTATIONARY (FLIGHT) VIBRATION & CORRESPONDING STATIONARY TESTS
  - BASED ON *MAXIMAX* & PROPOSED *DAMAGE POTENTIAL* PRACTICE
  - INSTRUMENT INTERNAL RESPONSES & RELATE TEST TO FLIGHT SEVERITY
- INVESTIGATE OPTIMIZATION OF *DP* TEST DURATION

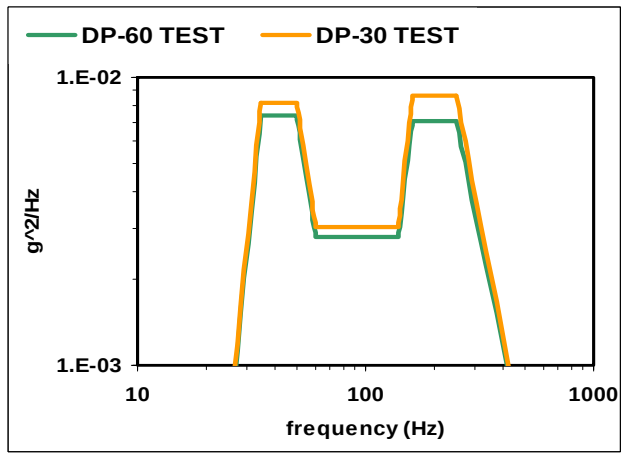
INITIAL TEST ARTICLE



TEST SPECTRA FOR A COMMON NONSTATIONARY INPUT

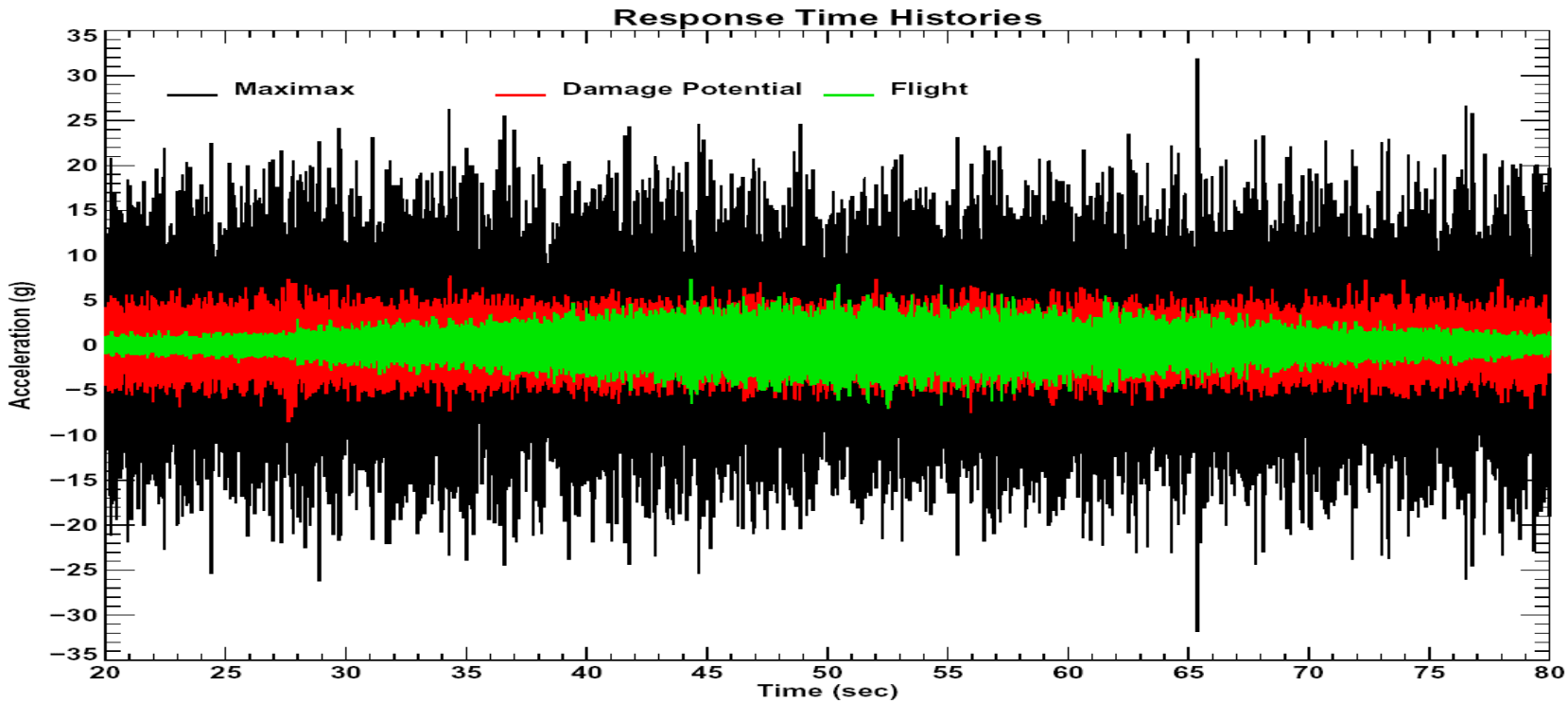
- *DP* TEST SPECTRUM ENVELOPES UNCERTAINTIES IN *Q* & FATIGUE LAW
  - **FOR A SELECTED TEST DURATION**
  - ***MAXIMAX* TEST SPECTRUM INDEPENDENT OF TEST DURATION**
- *DP* SPECTRUM FOR 60-SEC TEST WELL BELOW THE *MM* SPECTRUM
  - **11 dB HIGHER AT 200 Hz**
- *DP* SPECTRUM FOR 30-SEC TEST SLIGHTLY HIGHER THAN 60-SEC TEST
  - **0.9 dB HIGHER AT 200 Hz**
  - **EVALUATION OF DAMAGE POTENTIAL IS IN PROCESS**





RESPONSES DURING 60-SECOND STATIONARY TESTS VS RESPONSE TO FLIGHT INPUT

- MAXIMUM RESPONSE FOR *DP*-60 CLOSE TO THAT FROM FLIGHT INPUT
- MUCH HIGHER RESPONSE DUE TO *MAXIMAX BASED* INPUT



FUTURE WORK

- OBTAIN SURPLUS FLIGHT UNITS FROM TITAN PROGRAM
  - IDENTIFY MAJOR INTERNAL RESONANCES
  - PLACE ACCELEROMETERS AT A HIGH RESPONSE LOCATION FOR EACH RESONANCE
  - PERFORM NONSTATIONARY AND STATIONARY TESTS
  - MEASURE RESPONSES, EVALUATE *DP & MM* BASED TESTS FOR DEGREE OF CONSERVATISM
- CURRENT STATUS
  - FIRST FLIGHT UNIT ON HAND & IN PREPARATION FOR TEST
  - PLAN REPORT OF RESULTS AT *SPACECRAFT & LAUNCH VEHICLE DYNAMIC ENVIRONMENTS WORKSHOP* (JUNE 2005)
- PLAN TO TEST SECOND FLIGHT UNIT BY 30 SEP 2005