MODEL-ASSISTED PROBABILY OF DETECTION

Introduction and Review of Charter

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Background

- Motivation: Reduce the time and cost of determination of Probability of Detection (POD), a key input to the determination of remaining service life
- Approach: Reduction of sample preparation and empirical experimentation by the introduction of insights from controlled experiments and/or physics-based simulation tools

MAPOD Working Group

General Objective: To promote the increased understanding, development and implementation of model-assisted POD methodologies.

Membership: 94 members, including many international, who voluntarily devote time and energy

Meetings: 1 or 2 meetings per year in conjunction with national technical meetings

Model-Assisted POD Working Group Initial Charter (9/2004)

- Discuss strategies for model-assisted POD determination
  - Empirical approaches, refined to with insight from physics-based models
  - Model-assisted methodologies based on flaw response
  - Model-assisted methodologies based on image data
- Discuss requirements for models to be used in POD studies
  - Accuracy expected of models
  - Extent of validation required
  - Strategies/requirements for determining input parameters

Model-Assisted POD Working Group Prospectus Summary

- Identify gaps that need to be addressed between state of the art physics-based models and real world problems
  - Accuracy expected of models
  - Extent of validation required
  - Strategies/requirements for determining input parameters
- Provide input regarding examples of specific problems that would demonstrate the utility of model-assisted POD activities
  - How models can be used to establish the acceptability of replacement inspection techniques, e.g., transition from single frequency eddy current methods to transient eddy current methods
  - Use of models to assist in the transfer the results of assessments under one set of conditions to a related set of conditions
  - Full POD determinations as required to meet lifing requirements

Model-Assisted POD Working Group Prospectus Summary

- Communicate the results of model-assisted POD demonstrations
  - The working group would not be expected to do the detailed work in these areas but rather serve as a sounding board and provide general input

MAPOD Meetings

- Consortium Planning, 11/18-10/03, Austin
- MAPOD 1: 9/23-24/04, ATA NDT Forum, Albuquerque
- Sub-team: 11/17/04, ASNT Annual Meeting, Las Vegas
- MAPOD 2: 2/4/05, Aging Aircraft 2005, Palm Springs
- MAPOD 3: 6/9-10/05, AeroMat 2005, Orlando
- MAPOD 4: 9/22-23/05, ATA NDT Forum, Orlando
- MAPOD 5: 3/9-10/06, Aging Aircraft 2006, Atlanta
- MAPOD 6: 10/19/06, ATA NDT Forum, Ft. Worth
- MAPOD 7: 10/26-27/06, ASNT Annual Meeting, Houston
- MAPOD 8: 4/10/07, Aging Aircraft 2007, Palm Springs
- MAPOD 9: 11/16/07, ASNT Annual Meeting, Las Vegas
- MAPOD10: 11/14/08, ASNT Annual Meeting, Charleston

Phase I MAPOD Accomplishments

- MAPOD strategies developed
- Draft protocols developed
  - Technical publications
  - Appendix H of draft update of MIL HNDK 1823 update
- Key technical issues (“Totem Pole”) addressed
- Demonstrations conducted
- Results broadly communicated via internet
  - http://www.cnde.iastate.edu/MAPOD/index.htm

Technical Issues
"TOTEM POLE"

- Probe Calibration
- Model Validation
- Transfer Function Validation
- Specimen Design
- Relative Responses of Cracks and Notches
- Required Number of Specimens
- Treatment of Noise
- Validating the Procedure (how to know it is right)
- Lessons Learned from Concurrent Programs

Demonstrations

- Pratt and Whitney & ISU: UT of engines
- Pratt and Whitney: EC of engine fatigue cracks
- DSTO (Australia): UT of lower wing skin of F111
- NRC (Canada): Generic bolt hole EC
- QinetiQ Ltd (UK): UT in cold worked holes
- AFRL: EC of wing lap joints
- Pratt and Whitney & ISU: EC of engine fatigue
- Cessna & ISU: EC of wing lap joints
- Others not yet reported

Future Directions

- In the fall 2008 meeting, it was decided that
  - Initial objectives had been met
  - There is benefit to the group to continue work
- Accordingly
  - MAPOD Phase I will be concluded with a final report
  - MAPOD Phase II will be initiated with today's meeting

Phase II Objectives

- Document Cost Benefits
  - Case studies
- Develop Engineering Practice/Formal Protocols
- Simplify procedures
- More broadly communicate results

Phase II Objectives (cont.)

- Address a number of advanced technical issues
  - How to determine input parameters for models
  - Fully accounting for uncertainties (what variabilities are you trying to capture?)
    - Model accuracy
    - Input parameters
  - How to make use of “pretty good but imperfect” models
  - Issues associated with effect of crack growth conditions on POD
  - Moving to more complex physical situations and other modalities
  - Dealing with SHM and sparse data applications
  - Application to the determination of POD based on images