

RELIABLE FPI / PROCESS CONTROL

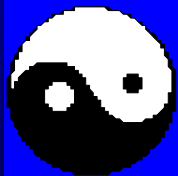
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SPECIALIZING IN:

Nondestructive Inspection Engineering
Materials Science and Industrial Processes
Quality Assurance and Failure Analysis

OVERVIEW

- **Need**
- **Approaches**
- **TAM / KDS Panels**
- **Use**
- **Care**
- **Expectations**
- **Summary**

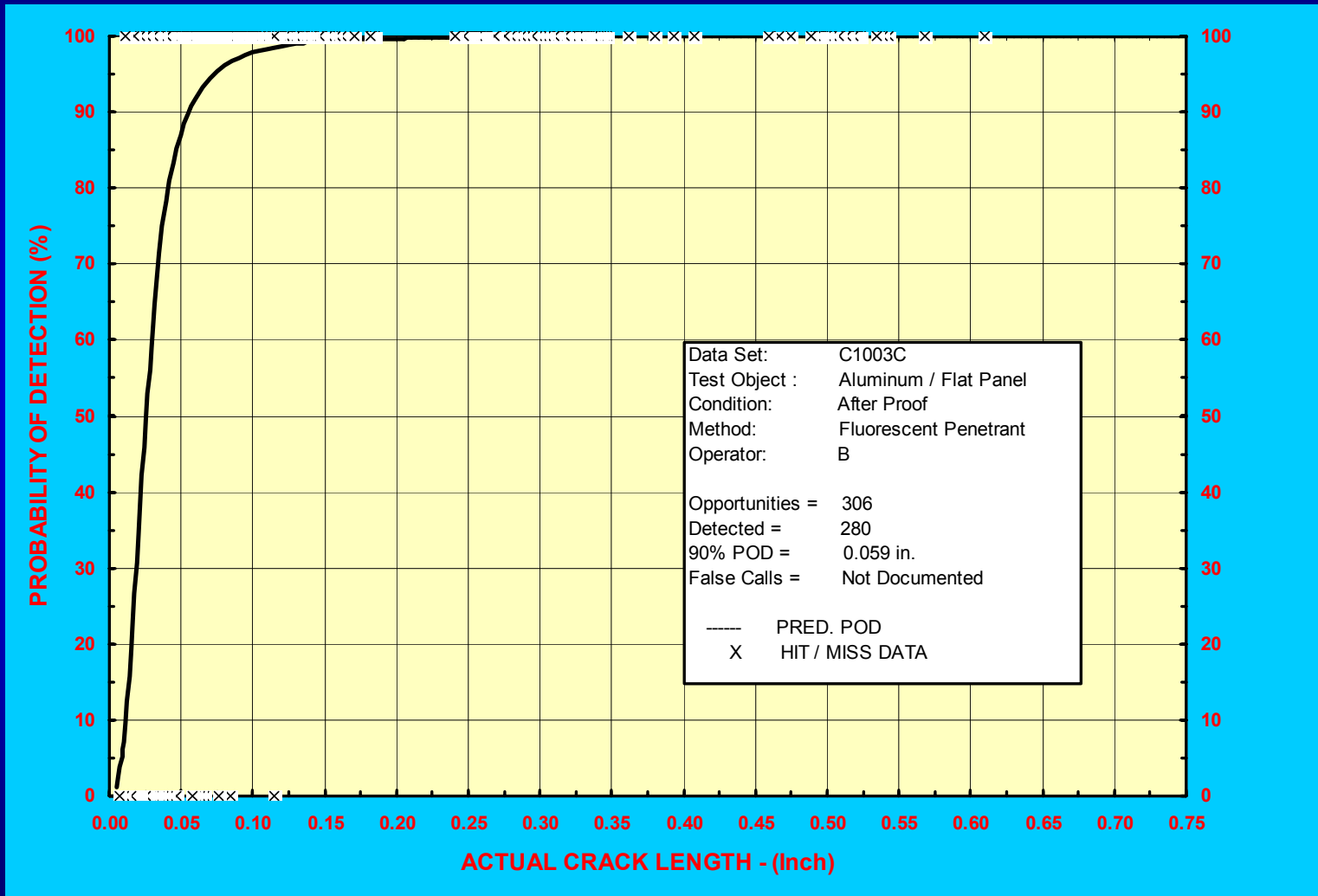
FPI Process

- **Fluorescent penetrant inspection WITHOUT process control is an expensive parts washing ceremony**
- **In-Line inspection cost is the same WITH or WITHOUT process control**
- **Resulting cost to the end product may be significant**

FPI Reliability

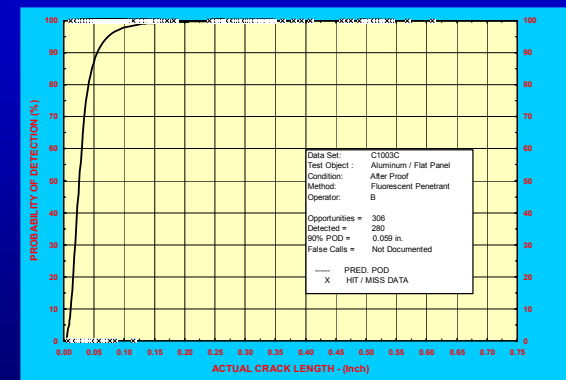
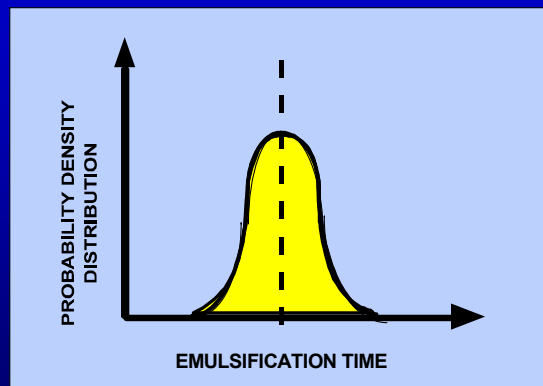
- **CAPABILITY** - Is it the right inspection tool?
- **REPRODUCIBILITY** - “Calibration” / Procedure parameter development and variances (tolerances)
- **REPEATABILITY** - Process Control

CAPABILITY



REPRODUCIBILITY

- Process established on representative defects to be detected
- Variances / tolerances in process parameters; i.e. emulsification time, wash time/temperature, etc.



REPEATABILITY / PROCESS CONTROL

Process Materials Control

- **Penetrant Materials**
- **Processing Fluids**

Process Parameters Control

- **Times**
- **Temperatures**
- **Pressures**

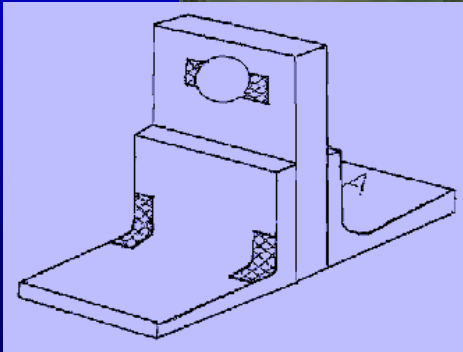
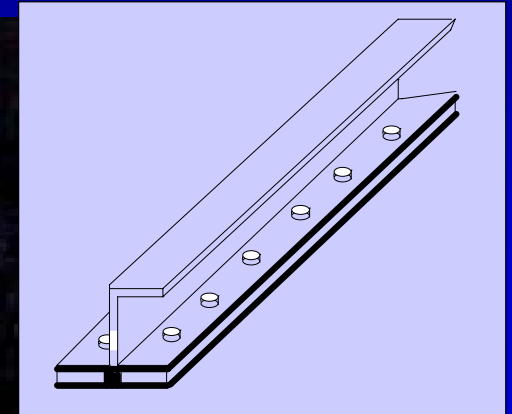
Procedures Control

- **Sequence**
- **Reference Specimens**

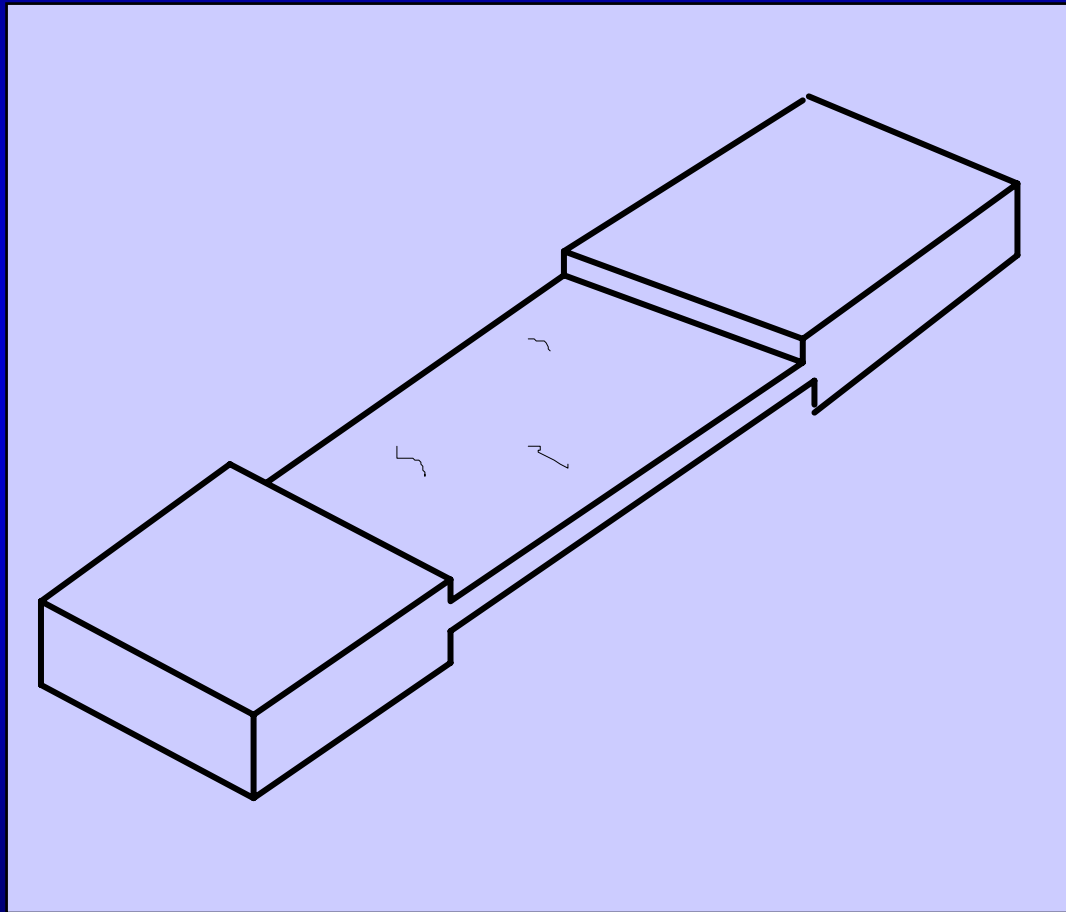
REFERENCE SPECIMENS

- Selected material defects
- Fatigue cracks
- Quench cracked panels
- Chrome / Nickel plated panels
- TAM / KDI panels

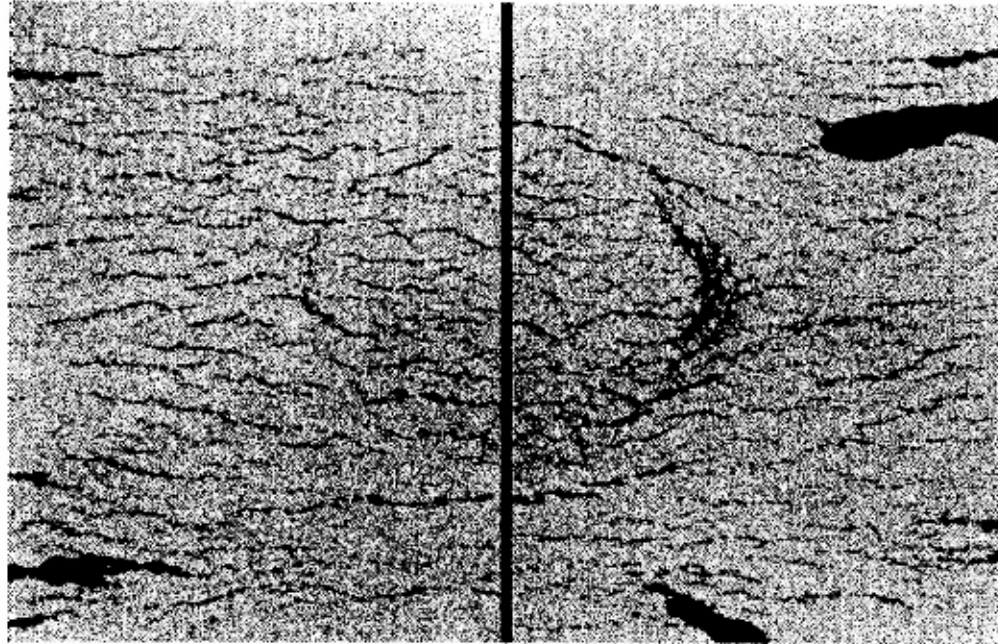
SELECTED MATERIAL DEFECTS



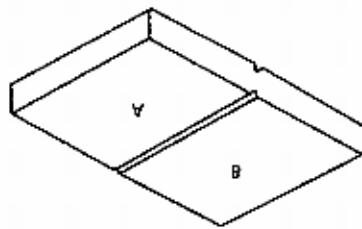
FATIGUE CRACKS



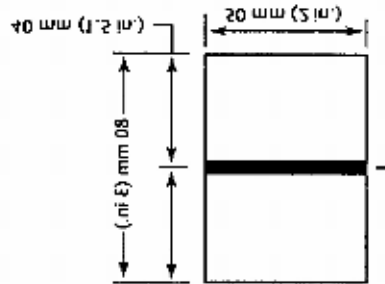
QUENCH CRACKS



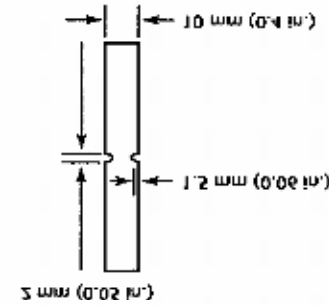
(q)



(a)



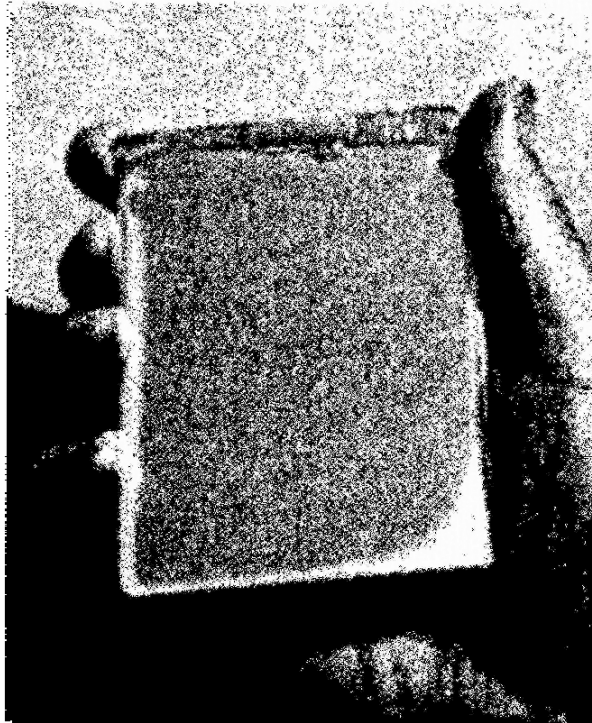
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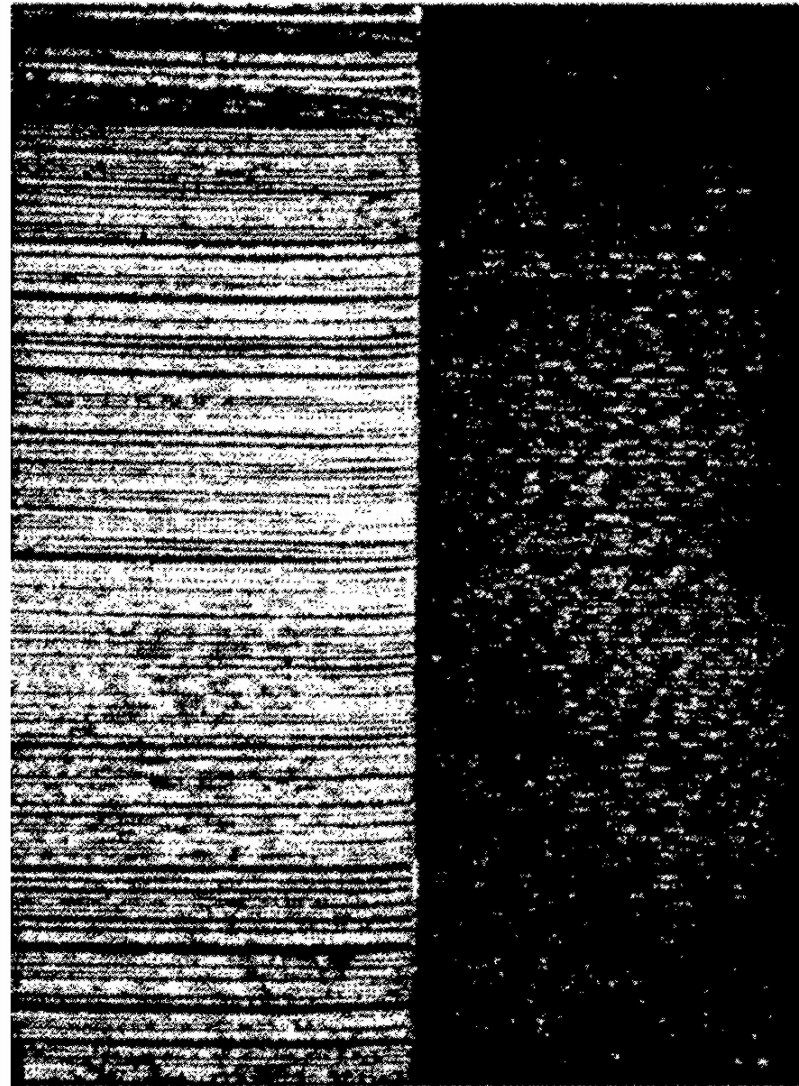
(c)

CRACKED CHROME / NICKEL

(a)

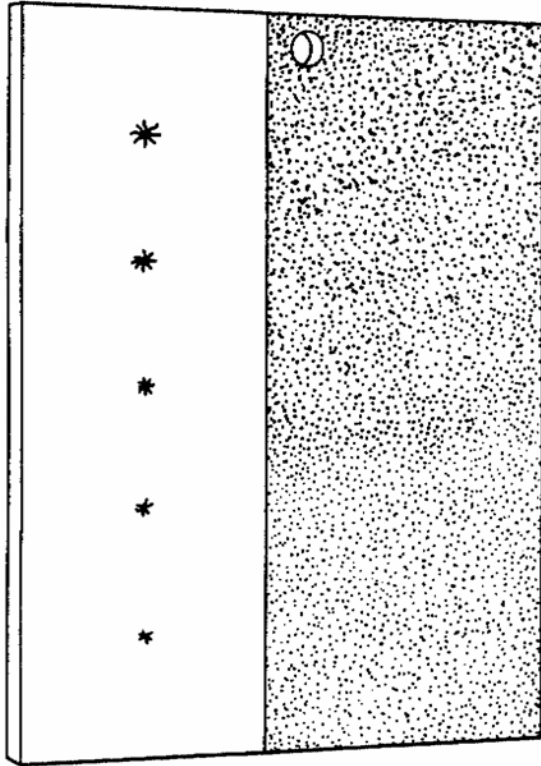


(b)

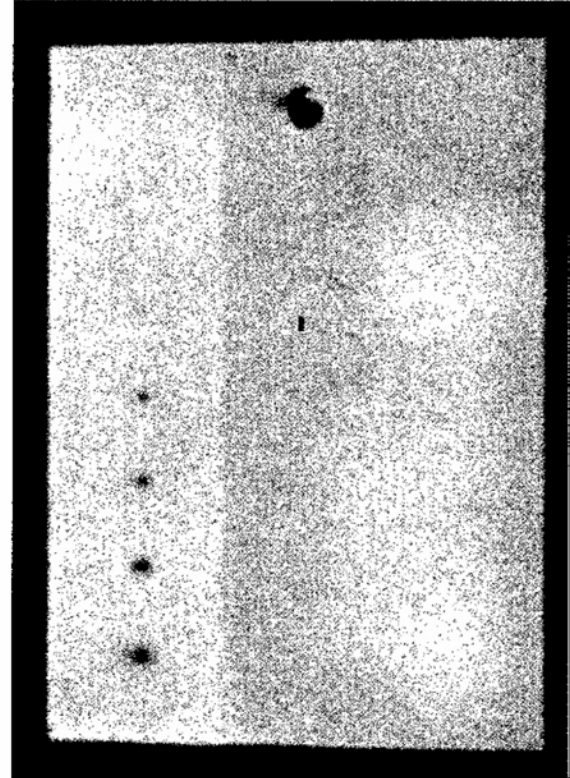


PSM-5 (TAM) / KDS Panels

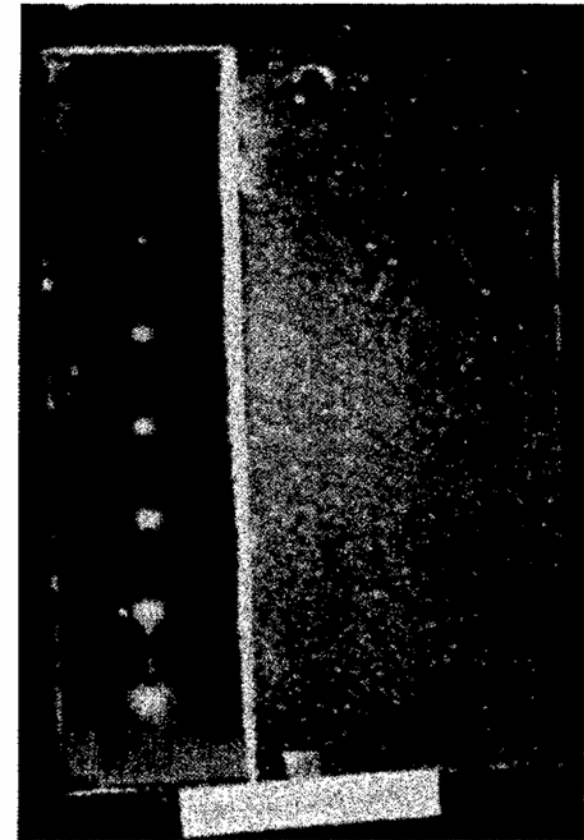
(a)



(b)



(c)



PSM-5 (TAM) / KDS Panels

- **Penetrant composition (or contamination)**
- **Emulsifier / remover composition (or contamination)**
- **Developer composition and contamination**
- **Penetrant dwell time and mode**
- **Emulsifier / remover dwell time and mode**
- **Water wash pressure, temperature, dwell and mode**
- **Oven temperature, dwell and mode**

PSM-5 (TAM) / KDS Panels

The effectiveness of a monitor panel is directly dependent on the skill of the operator using the panel

Each panel has a characteristic “signature” and variances in that signature are indications of process variance

Panel patterns as well as brightness are indicators of process consistency or variance

Panel Care and Cleaning

- Panel handling to avoid damage
- Effective cleaning is mandatory
 - Recommend hot water clean to remove developer
 - Ultrasonic cleaning to remove penetrant
 - Test with developer to verify penetrant removal
 - Reclean
- **NEVER USE ABRASION / “SCOTCH BRITE”**
- Store in a suitable solvent (usually isopropyl alcohol)

Panels Will Degrade with Use

- **Loss of impact (star) crack pattern**
- **Blue “halo” around impact cracks**
- **Blue hue on blasted surface**
- **Mechanical damage (scratches, etc)**
- **Varies with penetrant materials and cleaning practices**

CHEMICAL / SOLUTION PROCESS CONTROL

- **Penetrant concentration / surfactants / brightness**
- **Residue in penetrant tank**
- **Emulsifier remover concentration / contamination**
- **Water temperature / pressure / quality**
- **Air temperature / pressure / dryness / quality**
- **Developer concentration / contamination**

PERIODIC VALIDATION

- **Process fatigue cracked panels**
- **Process representative components**
- **Give special attention to developer coverage and texture**
- **Attention to bleed back procedures**
- **Attention to use of added (usually NON-AQ) developer**
- **Black light / white light/ and general condition of viewing areas**

EXPECTATIONS

- **Fluorescent penetrant is capable of reliability detecting cracks greater than 0.050 inch length when used under very controlled conditions**
- **Typical penetrant performance in an industrial environment is at a level of 0.100 to 0.200 inch crack length**
- **Performance may vary with varying levels of process control**

Summary

- Penetrant inspection can be a reliable inspection method
- Attention to process control is mandatory
- Process control indicators such as TAM / KDS panels are only effective when used by skilled operators
- Attention to cleaning and part handling is essential to success