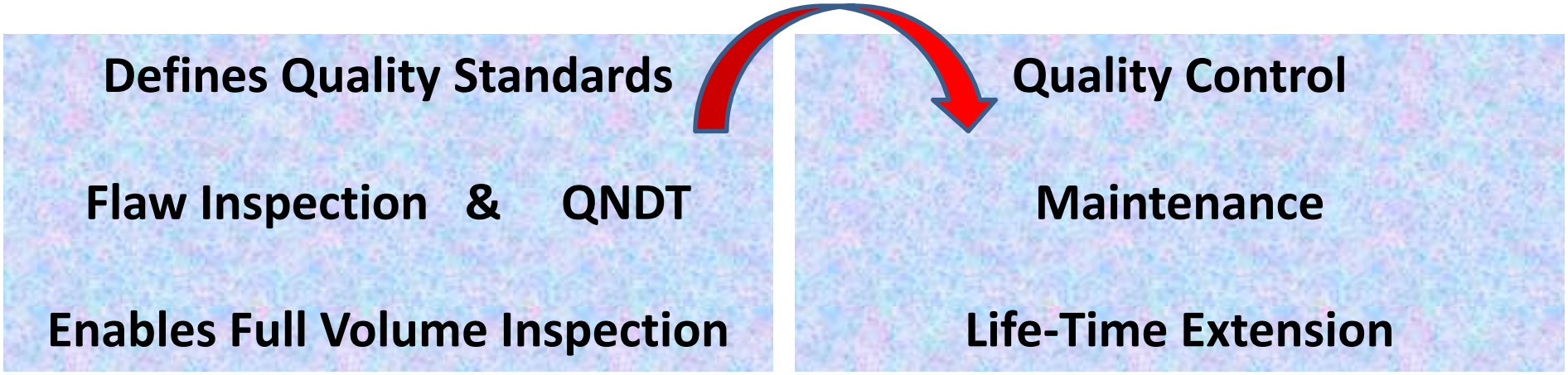
Application of NDT and Limits

MATERIAL CHARACTERIZATION

4.	**Mitigation Strategies – The world is never perfect**
4.1.	Structure Design and NDT
4.2.	Application of NDT
4.3.	Limits of NDT
4.4.	Quantitative NDT
4.5.	Material Characterization
4.6.	Case Study – Inspection by Cause

Application of NDT and Limits

Nondestructive Testing



IT IS MANDATORY
Regulations – Codes - Procedures

WE MUST ASSURE THE QUALITY
WE MUST CONTROL THE STRUCTURAL STATE

BY

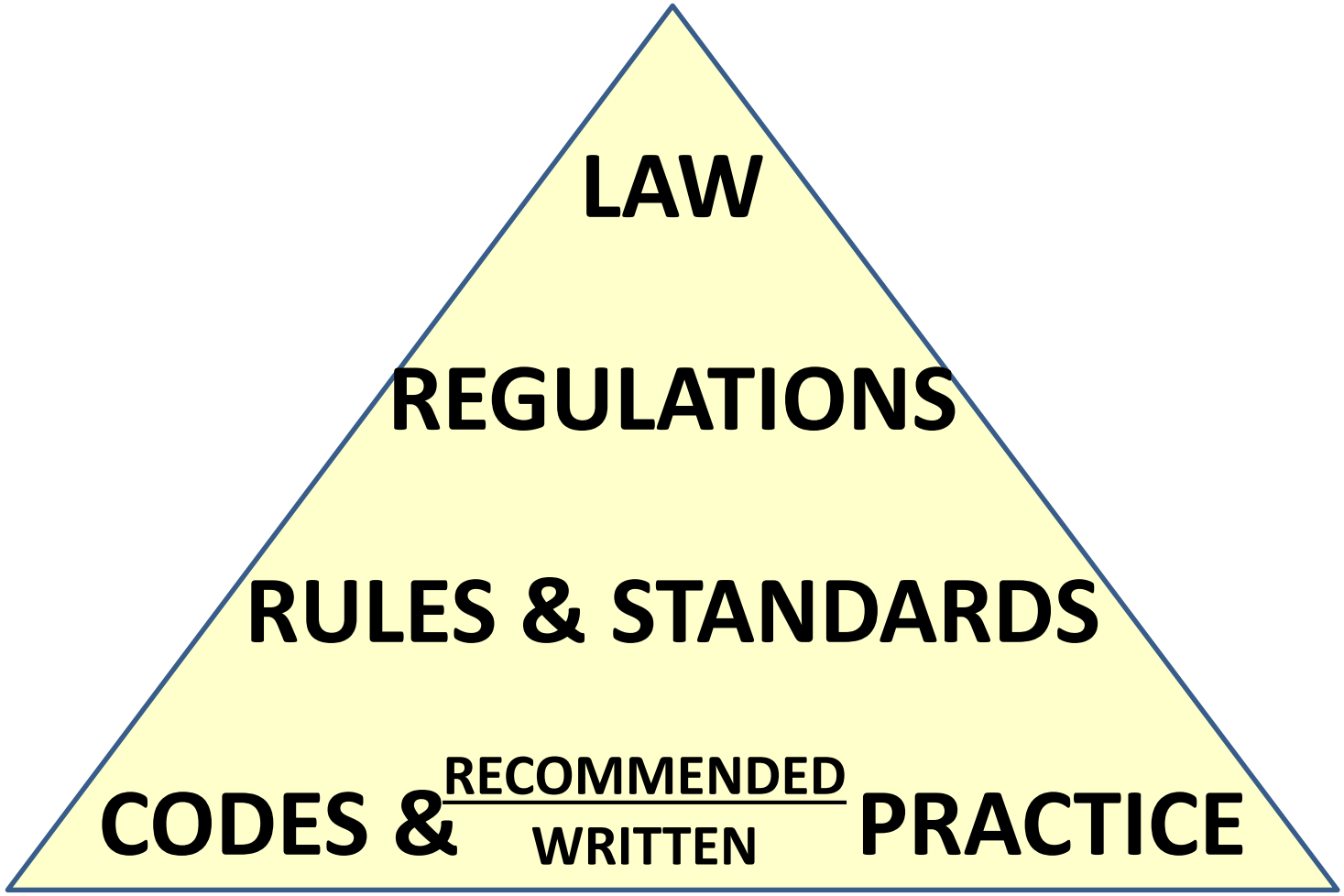
- **NONDESTRUCTIVE FLAW EVALUATION (NDT&E)**
- ***NONDESTRUCTIVE MATERIAL CHARACTERIZATION (QNDT & NDMCh)***
  is a development task

We see some progress!
However,

CAN WE EVALUATE FLAWS QUANTITATIVELY?
CAN WE CHARACTERIZE MATERIAL PROPERTIES?

THERE ARE MANY CHALLENGES
FOR YOUNG SCIENTISTS
&
PIONEERS

HIERARCHY OF RESPONSIBILITY



TERMS

REGULATION

A principle, rule, or law designed to control or govern conduct.

A governmental order having the force of law.
Also called *executive order*.

An authoritative, prescribed direction for conduct, especially one of the regulations governing procedure in

STANDARD

The goals of standardization is: compatibility, interoperability, safety, repeatability, or quality.

It is an authoritative, prescribed direction for conduct, especially one of the regulations governing procedure

RULE

An authoritative, prescribed direction for conduct, especially one of the regulations governing procedure

CODE

A system of principles or rules
How to behave or conduct

Codes and Standards Bodies Involved in NDT Industry

Standards Bodies
develop and publish technical industrial standards.

There are many organizations:

National & International
Governmental & Non-governmental

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ASTM INTERNATIONAL (American Society for Testing and Materials)
AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN)
AEROSPACE INDUSTRIES ASSOCIATION (AIA)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

www.iso.org

The International Organization for Standardization, the world's largest developer and publisher of International Standards, is a non-governmental organization located in Geneva, Switzerland.

ISO is a network of the national standards institutes of 161 countries, one member per country. Many of the ISO member institutes are part of the governmental structure of their countries, or are mandated by their government. Other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

www.iso.org

ISO 9712, *Non-destructive testing –*
Qualification and certification of personnel

This International standard, revised in 2012,
provides the requirements for the NDT certification of NDT personnel
by an accredited third-party certification body
that conforms to the requirements of ISO/IEC 17024, *Conformity assessment — General requirements for bodies operating certification of persons.*

ISO/IEC 17024, *Conformity assessment –*
***General requirements for bodies operating certification of persons*.**

This international standard was developed with the objective of
achieving and promoting a globally accepted benchmark
for organizations operating certification of persons.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

www.asme.org

The American Society of Mechanical Engineers
is a not-for-profit professional organization that enables
collaboration, knowledge sharing and skill development across all engineering disciplines,
while promoting the vital role of the engineer in society.

ASME codes and standards, publications, conferences,
continuing education and professional development programs
provide a foundation for advancing technical knowledge and a safer world.

The “ASME Boiler & Pressure Vessel Code” (BPVC). The 2010 edition of the BPVC with 2011 addenda was made available in July 2011. This code is made up of 12 sections, or “books,” covering the following subjects:

The "ASME Boiler & Pressure Vessel Code" (BPVC)

The 2010 edition of the BPVC with 2011 addenda was made available in July 2011.
This code is made up of 12 sections covering the following subjects:

I Power Boilers
II Materials
III Rules for Construction of Nuclear Facility Components
IV Heating Boilers
V Nondestructive Examination
VI Recommended Rules for the Care and Operation of Heating Boilers
VII Recommended Guidelines for the Care of Power Boilers
VIII Pressure Vessels
IX Welding and Brazing Qualifications
X Fiber-Reinforced Plastic Pressure Vessels
XI Rules for In-service Inspection of Nuclear Power Plant Components
XII Rules for Construction and Continued Service of Transport Tanks

ASTM INTERNATIONAL (www.astm.org)

ASTM International provides technical standards for materials, products, systems and services. Over 180 ASTM NDT standards are published in the ASTM Annual Book of Standards, Vol 03.03, Nondestructive Testing. ASTM defines three of their document categories as follows:

•A **"guide"** is a compendium of information or series of options that does not recommend a specific course of action. A guide increases the awareness of information and approaches in a given subject area.
•A **"practice"** is a definitive set of instructions for performing one or more specific operations or functions that does not produce a test result. Examples of practices include, but are not limited to: application, assessment, cleaning, collection, decontamination, inspection, installation, preparation, sampling, screening and training.
•A **"test method"** is a definitive procedure that produces a test result. Examples of test methods include, but are not limited to: identification, measurement and evaluation of one or more qualities, characteristics or properties.

Application of NDT and Limits

Some of the more commonly used ASTM NDT standards

ASTM E165: *Standard Practice for Liquid Penetrant Examination for General Industry*

ASTM E1417: *Standard Practice for Liquid Penetrant Testing*

ASTM E1209: *Standard Practice for Liquid Penetrant Testing using the Water-Washable Process*

ASTM E1210: *Standard Practice for Liquid Penetrant Testing using the Hydrophilic Post-Emulsifiable Process*

ASTM E1219: *Standard Practice for Liquid Penetrant Testing using the Solvent-Removable Process*

ASTM Volume 03.03 (2012)

ASTM E114: *Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*

ASTM E164: *Standard Practice for Contact Ultrasonic Testing of Weldments*

ASTM E1213: *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

ASTM E2375: *Standard Practice for Ultrasonic Testing of Wrought Products*

ASTM E1962: *Standard Practice for Ultrasonic Surface Testing using Electromagnetic Acoustic Transducer (EMAT) Techniques*

Some of the more commonly used ASTM NDT standards

ASTM E94: *Guide for Radiographic Examination*

ASTM E1742: *Practice for Radiographic Examination*

ASTM E1000: *Guide for Radioscopy*

ASTM E1255: *Practice for Radioscopy*

ASTM E1030: *Test Method for Radiographic Examination of Metallic Castings*

ASTM E268: *Electromagnetic Testing*

ASTM E426: *Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys*

ASTM E709: *Standard Guide for Magnetic Particle Testing*

ASTM E1444: *Standard Practice for Magnetic Particle Testing*

ASTM Volume 03.03 (2012)

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN)
www.cen.eu

The European Committee for Standardization is a business facilitator in Europe, removing trade barriers for European industry and consumers.
Its mission is to foster the European economy in global trading, the welfare of European citizens and the environment.

CEN is a major provider of European Standards and technical specifications.
It is the only recognized European organization according to Directive 98/34/EC for the planning, drafting and adoption of European Standards in all areas of economic activity with the exception of electro-technology and telecommunication.

31 National Members work together to develop voluntary European Standards (ENs).
Standards (Norms) developed by CEN are considered “harmonized standards” that are required to be accepted by all member nations in the European Union.

HARMONIZATION

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN)
www.cen.eu

The following two ENs are NDT certification standards:

EN 473/ EN ISO 9712, *Non-destructive testing – Qualification and certification of NDT personnel - General principles*.

This European Standard established principles for the third-party ("central") qualification and certification of personnel who perform industrial non-destructive testing (NDT) by an accredited third-party certification body. Under EN 473, certification bodies had to administer procedures for certification according to the requirements of EN 473 and must fulfill the requirements of EN ISO/IEC 17024.

EN ISO 9712, replaced EN 473 as the European harmonized standard (Norm) for NDT central certification effective 1 January 2012. EN ISO 9712 and ISO 9712 are identical except that EN ISO 9712 has been approved as a harmonized standard for use under the European Pressure Equipment Directive 97/23/EC.

EN 4179, *Aerospace series , Qualification and approval of personnel for non-destructive testing*.

This employer-based certification standard is the European version of NAS 410,

AEROSPACE INDUSTRIES ASSOCIATION (AIA)
www.aia-aerospace.org

The Aerospace Industries Association is a trade association with more than 100 major aerospace and defense member companies. These companies embody every high-technology manufacturing segment of the U.S. aerospace and defense industry from commercial aviation and avionics, to manned and unmanned defense systems, to space technologies and satellite communications. The AIA publishes multiple aviation and aerospace-related standards.

AEROSPACE INDUSTRIES ASSOCIATION (AIA)
www.aia-aerospace.org

NAS 410, *NAS Certification & Qualification of Nondestructive Test Personnel*.

This employer-based certification standard establishes the minimum requirements for the qualification and certification of personnel performing nondestructive testing (NDT), nondestructive inspection (NDI), or nondestructive evaluation (NDE) in the aerospace manufacturing, service, maintenance and overhaul industries.

In 2002, NAS 410 was harmonized with European Norm 4179 (listed in the CEN section), so that the requirements in both documents are identical.

NAS 999, *Nondestructive Inspection of Advanced Composite Structures*.

This specification establishes the requirements for non-destructive inspection (NDI), NDI standards, NDI methods, and NDI acceptance criteria.

Certification of NDT Personnel

COMPETENCY

NDT personnel have the proper training,
have passed written and practical examinations,
and have enough experience
to properly perform NDT tasks
using the applicable test method or technique.

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

TERMS

Certification Standard:

National or international documents describing the requirements for the qualification and certification of NDT personnel.

Certification System:

The combination of the standard or recommended practice governing the certification requirements, the third-party certification program (if applicable) or the employer's written practice, and additional employer documents used in the administration of their certification program.

Recommended Practice:

A formal document that provides nationally or internationally recognized guidelines, and describes the qualification and certification process for NDT personnel.
If mandated by governing codes, standards, specifications or contract documents, these guidelines become requirements for the specified project

Certification Program:

The documented employer's or certification body's procedures and processes based on a standard or recommended practice, which defines the requirements of that specific program.

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

NDT Certification Systems

The employer has the ultimate responsibility

Employer-based

- **administration**

of the training and the qualification examinations of their own employees

- **documentation**

of the required training, examinations and experience in accordance with an employer-based standard or recommended practice.

(described in the employer's Written Practice)

Central

An independent 3rd-party certification body administers the qualification examinations based on a central certification standard.

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

Application of NDT and Limits

		2006 CP-106 & SNT-TC-1A[a]			ACCP 8/9/09			ISO 9712:2005[h]		EN 473:2008[i]	
Method	Cert. Level	Training Hours	Experience Hours		Training Hours	Experience Hours		Training Hours[e]	Exp.[e] (Months)	Training Hours[(1,2,5,7)]	Exp. Months[(5,7)] (40 hrs/wk)
			In Method	Total in NDT		In Method	Total in NDT				
MT	I	12	70	210	-----	-----	-----	16	1	16	1
	II	8	140	400	40[f]	265	530	24	3	24	3
	III	[b]	[d]	[d]	[d]	[d]	[d]	20	12	32	12
PT	I	4	70	130	-----	-----	-----	16	1	16	1
	II	8	140	270	40[f]	200	400	24	3	24	3
	III	[b]	[d]	[d]	[d]	[d]	[d]	20	12	24	12
RT	I	40	210	400	-----	-----	-----	40	3	72	3
	II	40	630	1200	120[f]	800	1600	80	9	80[(6)]	9
	III	[b]	[d]	[d]	[d]	[d]	[d]	20	18	72[(3,4)]	18
UT	I	40	210	400	-----	-----	-----	40	3	64	3
	II	40	630	1200	120[f]	800	1600	80	9	80	9
	III	[b]	[d]	[d]	[d]	[d]	[d]	40	18	72[(3,4)]	18
ET	I	40[g]	210[g]	400[g]	-----	-----	-----	40	3	40	3
	II	40[g]	630[g]	1200[g]	80[f]	800	1600	64	9	40	9
	III	[b]	[d]	[d]	[d]	[d]	[d]	46	18	40	18
VT	I	8	70	130	-----	-----	-----	16	1	16	1
	II	16	140	270	24[f]	200	400	24	3	24	3
	III	[b]	[d]	[d]	[d]	[d]	[d]	24	12	24	12
										Basic knowledge (direct access to level 3)	80

ASNT "Certification Systems":

NDT CERTIFICATION TRAINING & EXPERIENCE REQUIREMENTS COMPARISON

Recommended Practice Personnel Qualification

NDT Level I

"An NDT Level I individual should be qualified
to properly **perform** specific calibrations, specific NDT
and specific evaluations for acceptance or rejection determinations
according to written instructions and to record results.

The NDT Level I should receive the necessary instruction and supervision
from a certified NDT Level II or III individual."

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

Recommended Practice Personnel Qualification

NDT Level II

"An NDT Level II individual should be qualified
to **set up and calibrate equipment** and to **interpret and evaluate results**
with respect to applicable codes, standards and specifications.

The NDT Level II should be thoroughly familiar
with **the scope and limitations of the methods** for which he is qualified
and should exercise assigned responsibility
for **on-the-job training and guidance** of trainees and NDT Level I personnel.

The NDT Level II should be able to **organize and report the results** of NDT tests."

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

Recommended Practice Personnel Qualification

NDT Level III

An NDT Level III individual should be capable of
developing, qualifying and approving procedures,
establishing and approving techniques,
interpreting codes, standards, specifications and procedures,
as well as **designating the particular NDT methods, techniques and procedures** to be used.

The NDT Level III should be **responsible for the NDT operations**
for which he is qualified and assigned
and should be **capable of interpreting and evaluating results**
in terms of existing codes, standards and specifications.

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

Recommended Practice Personnel Qualification

NDT Level III

The NDT Level III should have sufficient practical background
in applicable materials, fabrication and product technology
to establish techniques and to assist in establishing acceptance criteria
when none are otherwise available.

The NDT Level III should have general familiarity with other appropriate NDT methods,
as demonstrated by an ASNT Level III Basic examination or other means.

The NDT Level III, in the methods in which he is certified, should be capable
of training and examining NDT Level I and II personnel for certification in those methods.

ASNT "Certification Systems"
2006 edition of the ASNT Recommended Practice No. SNT-TC-1A.

NDT Procedure for Ultrasonic Inspection

A Nondestructive testing (NDT) Procedure suitable for General Ultrasonic Inspections. This is a sample UT procedure and may be required to be modified as per specific requirements.
NDT Procedure No: TNE-DOC-UT-01 Rev '0'

4. Responsibilities:

• The NDE Examiner shall be responsible for conducting and reporting the results of examination in accordance with the applicable Code and Client's specifications, whichever is more restrictive.

5. Personnel Qualifications:

• All personnel involved in Ultrasonic Examinations shall be qualified to Level II in accordance with the requirements of Trinity NDT, Written Practice (Training, Qualification & Certification for NDE Personnel).

• When the written practice is revised, the certification of NDE personnel remains valid to the requirements of the previous revision until the expiry date of the personnel qualification certificate; then, recertification to the requirements of the new revision is required.

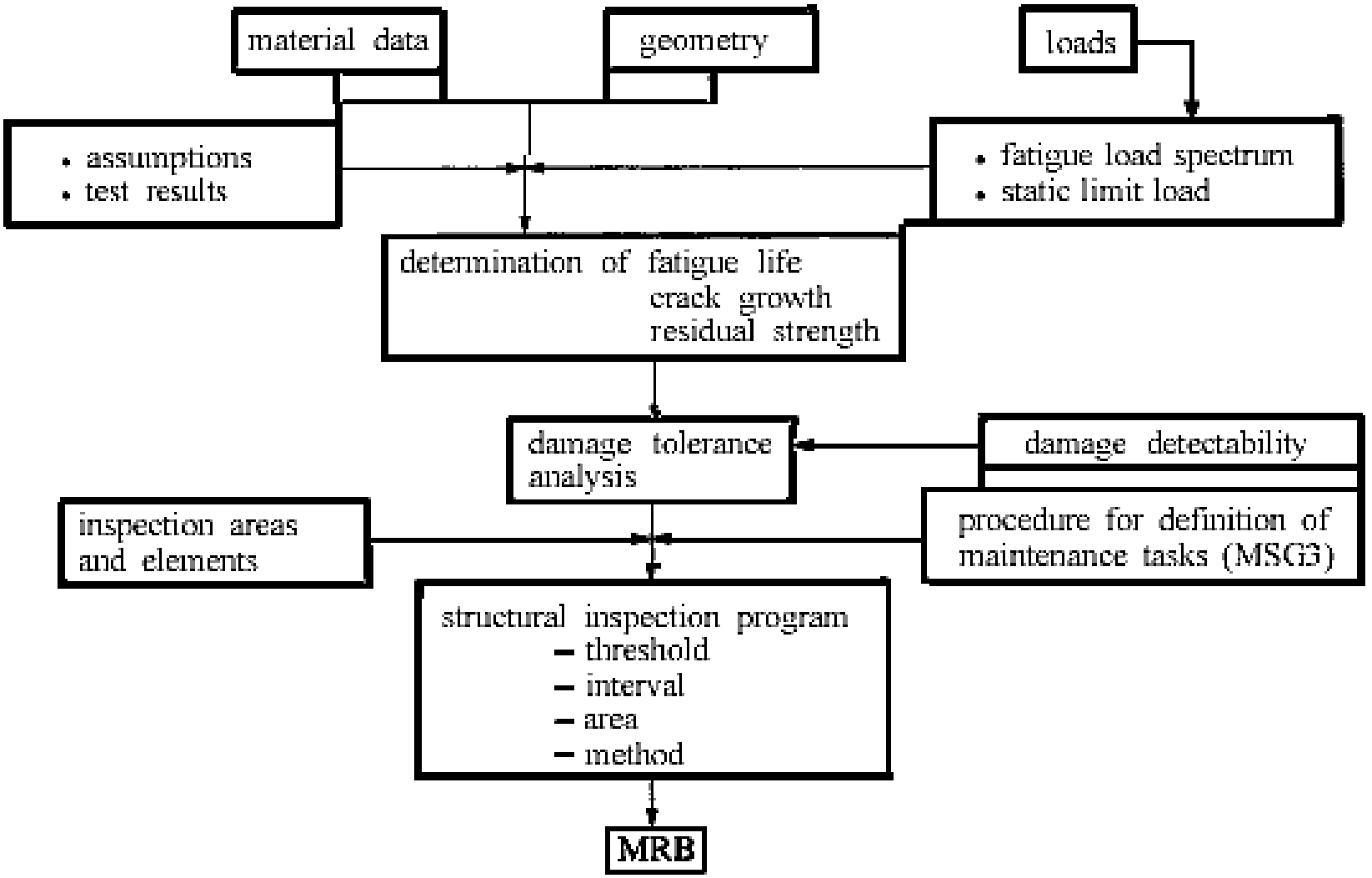
• Subcontractor's personnel involved in Ultrasonic Examinations shall be qualified to Level II in accordance with the requirements of subcontractor's written practice which shall be reviewed and accepted by Trinity NDT QA/QC Manager.

• The certification of personnel shall be checked by the QA/QC Manager or NDE Level III prior to work commencement.

2.	Degradation of nuclear structures during operation
2.1.	**Aging, Neutron Embrittlement, Structural Material Parameters**
2.2.	Stress Corrosion Cracking
2.3.	Fatigue
2.4.	(Unexpected events)

2.	Degradation of airplane structures during operation
2.1.	**Fatigue Life (Endurance)**
2.2.	**Damage Tolerance Capability**
2.3.	**Corrosion Resistance**
2.4.	(Unexpected events)

Development of Structure Inspection Program



Damage Tolerance Evaluation

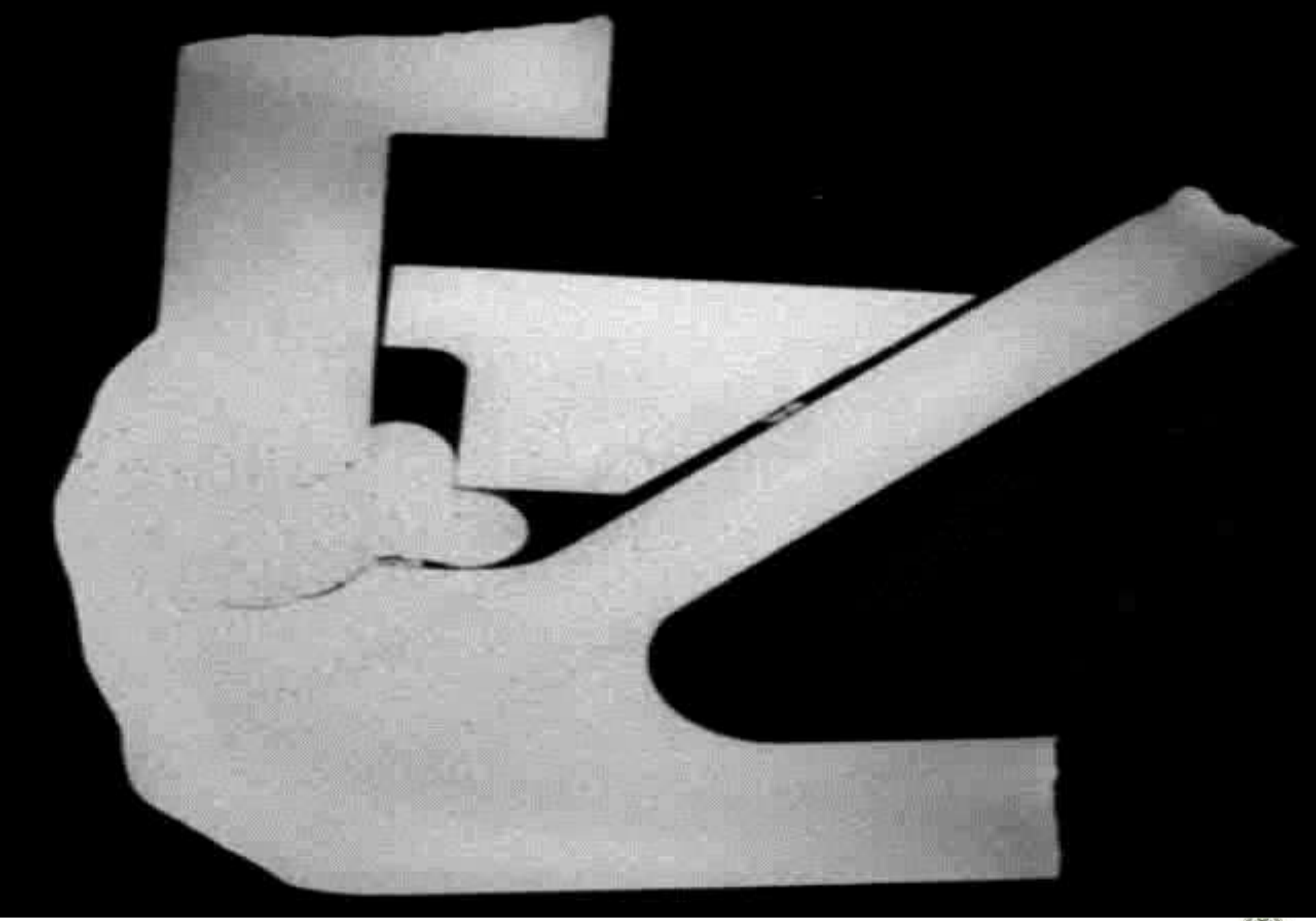
"The ultimate purpose of the damage tolerance evaluation
Is the development of a

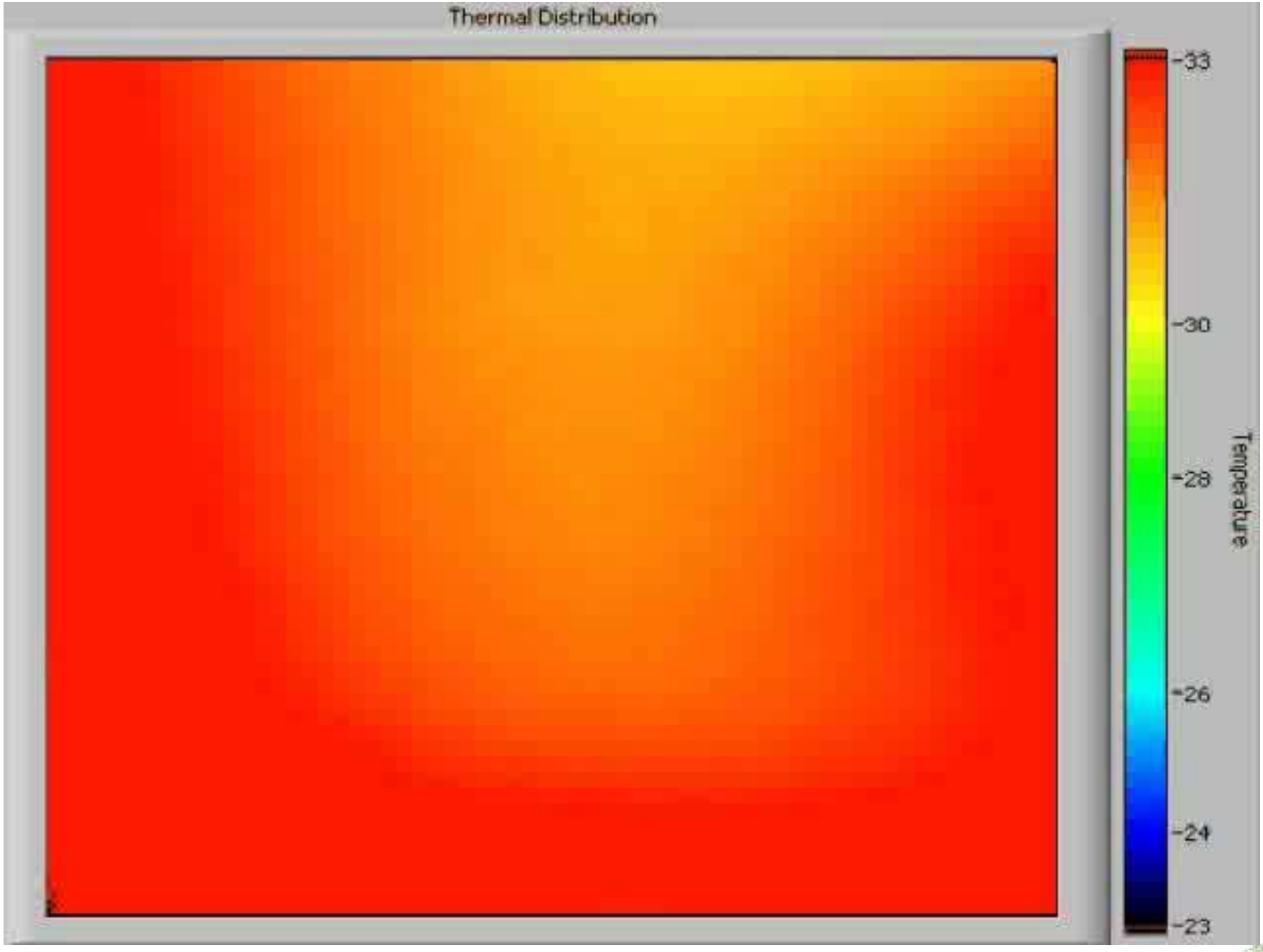
recommended structural inspection program

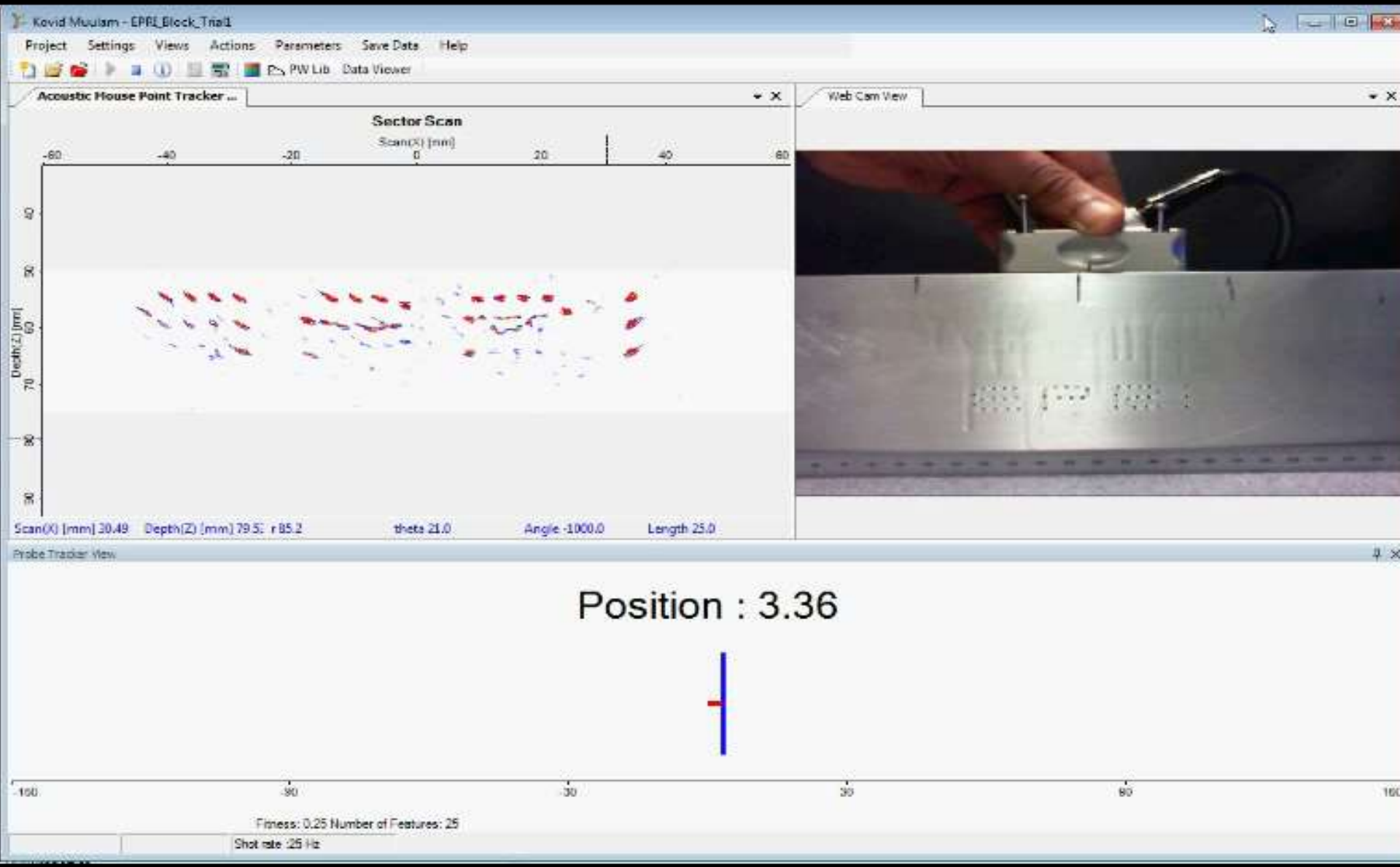
considering

probable damage locations,
crack initiation mechanisms,
crack growth time histories,
and crack detectability"


Made by intelligeNDT




Thermal Distribution
-33
-30
-28
-26
-24
-23
Temperature


Kovid Muulam - EPRI_Block_Trial1
Project
Settings
Views
Actions
Parameters
Save Data
Help
PW Lib
Data Viewer
Acoustic House Point Tracker ...
Sector Scan
Scan(X) [mm]
Depth(Z) [mm]
Web Cam View
Probe Tracker View
Position : 3.36
Fitness: 0.25 Number of Features: 25
Shot rate :25 Hz

Literature

1. www.asnt.org./en/