Establishing a New ISI Strategy for Paks NPP

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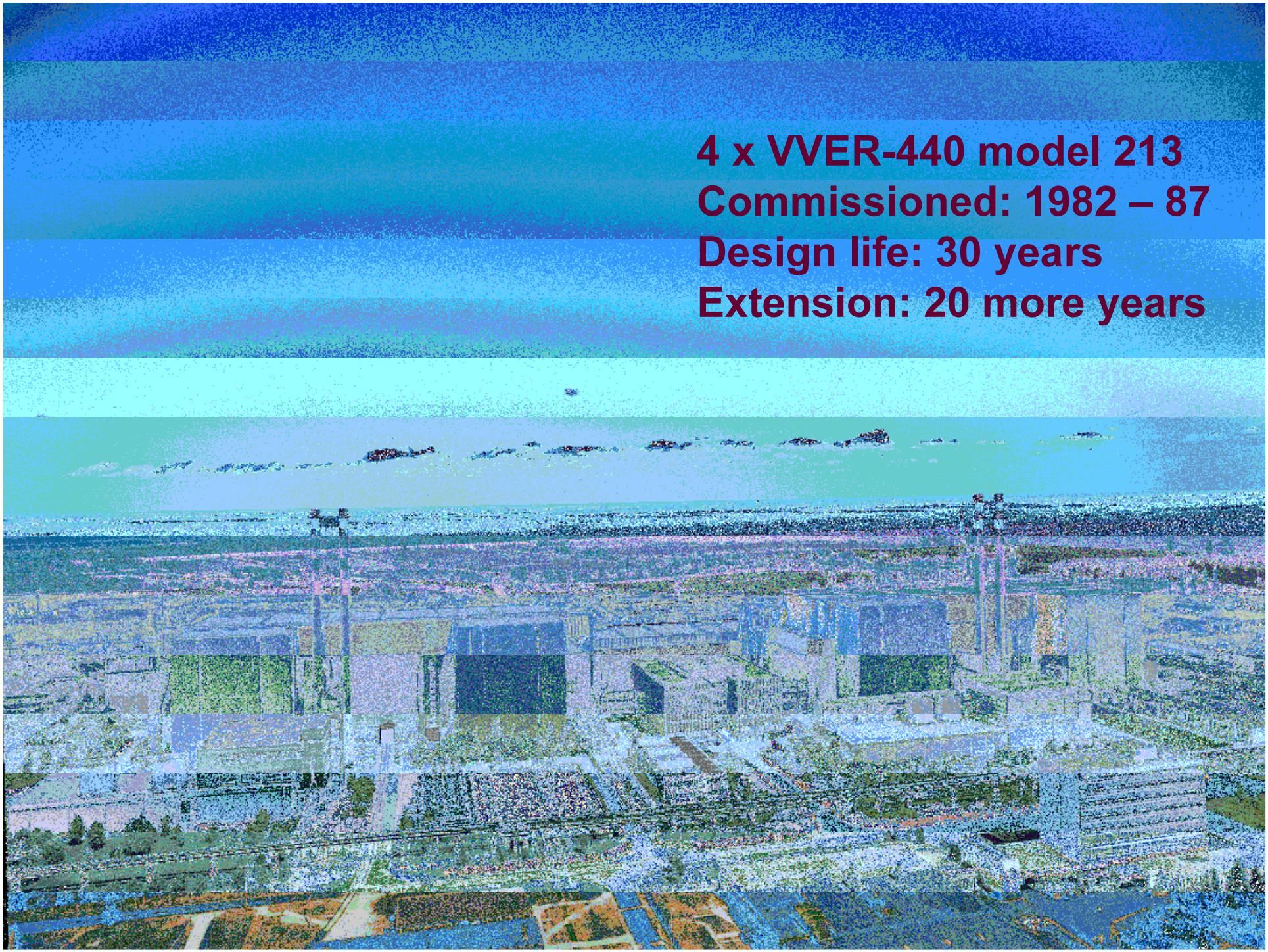
4 x VVER-440 model 213
Commissioned: 1982 – 87
Design life: 30 years
Extension: 20 more years

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Hungarian ISI Program (1)

Origin: former Soviet nuclear regulation

- OPB-82: Basic Regulations on NPP Safety Assurance

  (equivalent to Appendix A to 10 CFR Part 50)

- Normative Technical Documents (NTDs)
  - Rules for Construction and Safe Operation of NPP Pressurized Components
    - „Structural Examination” *(equivalent to VT-3)*
    - System Pressure Test
    - Control of periodic NDE results
  - PK 1514-72: Inspection Code (for construction!)
    - NDE acceptance standards

Hungarian ISI Program (2)

- Import (i.e. translation) of the NTDs
  - Valid from 1979 to 1996
- New set of Hungarian Safety Rules
  - Since 1997 (periodic upgrading)
- No detailed requirements for ISI
  - for periodic NDE:

    „…program has to be based on *authoritative* codes and standards.
  - for pressure test:

    „Structural Examination" and pressure test must be performed (Technical Inspection Plan)
- NPP's ISI program is being approved by the Regulator

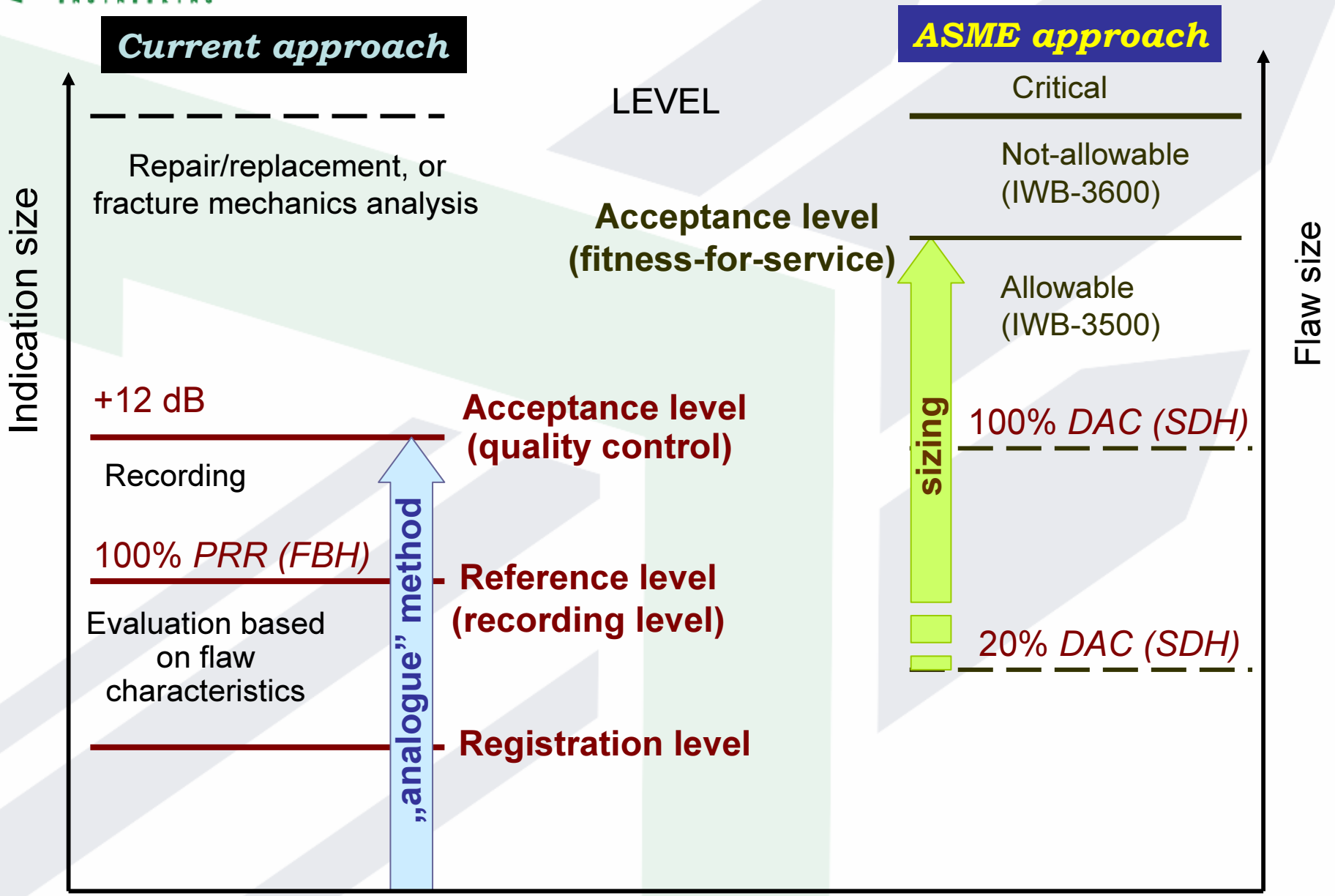
Main Features of the ISI Program

- NDE acceptance standards do not serve FFS
  - Expressed in FBH equivalents
- Test pressure of reactor coolant pressure boundary
  - 192 bar (now 164 bar) – operational pressure: 123 bar
- Inspection interval (for Safety Class 1 components)
  - 4 years (NDE + Pressure Test)

Consequences:

- Component overloading (hydrotest, fatigue)
- Unnecessary repair works (construction criteria)

Acceptance Standards



Evolution of the ISI Program

NTDs had no periodic revision

Continuous improvement from the beginning:

- Ensuring completeness
  - Inclusion of emerging items (e.g. UT of austenitic welding, ET of SG tubing)
  - Introduce RPV OD inspection
- Strengthening ISI character
  - Decrease pressure test pressure (supported by AE during the test)
  - Increase of PRR level *(appr. ASME XI)*
  - Introduction of flaw analysis *(similar to IWB, C, D-3600)*

Life Management Context

- Former Soviet codes are not *authoritative*
- The Regulator's statement places a responsibility on the licensee, and
- Provides an opportunity for safety and efficiency improvement (LM goals)

Decision:

Adaptation of ASME Code requirements

Paks NPP's Objectives

Overall objective:

- Adaptation of a comprehensive standard, i.e. ASME requirements for
  - ISI,
  - maintenance (repair, replacement),
  - strength analysis

  of pressurized components where appropriate

Specific objectives:

- Extend the current 4-year ISI interval up to an 8-year one
- Provide an opportunity to compare ISI environment with worldwide acceptable safety requirements
- Strengthen a consent across Europe for Paks NPP operational life extension

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Implementation (1)

- ISI program development according to ASME XI
  - Comparison of the scope
    ~90% coverage
  - Assessment of acceptance criteria
    - „two-level" evaluation concept
  - Adapting ASME pressure test parameters
  - Development of repair / replacement plan
- Rewriting NDE procedures according to ASME V
  - UT procedure handbook (FBH vs SDH)
- IST: on the basis of OM Code
- Design review of selected components
  - Justification of compliance with ASME III requirements
  - Inspection interval: 8 years (<10 y)

Justification of compliance with ASME III requirements

Substantial issue

- Preparation of a load catalogue
- Design review of selected components (according to ASME III)
  - Strength calculation
  - Fatigue calculation
  - Brittle fracture resistance
  - Over-pressure protection
  - Operational monitoring parameters

Implementation (2)

- Basis: Technical Inspection Plans
- Activities show conformity with ASME XI in
  - content,
  - format,
  - consistency
- **Ageing management** function strengthened
- Transition: validity of licensing conditions must be kept permanently
- **Delicacy: plant is constructed by different code as in-service inspected**
  - Comprehensive assessment of
    - legislative bases
    - code sections
    - regulatory guides
    - standards referred

    in both USA and Hungary

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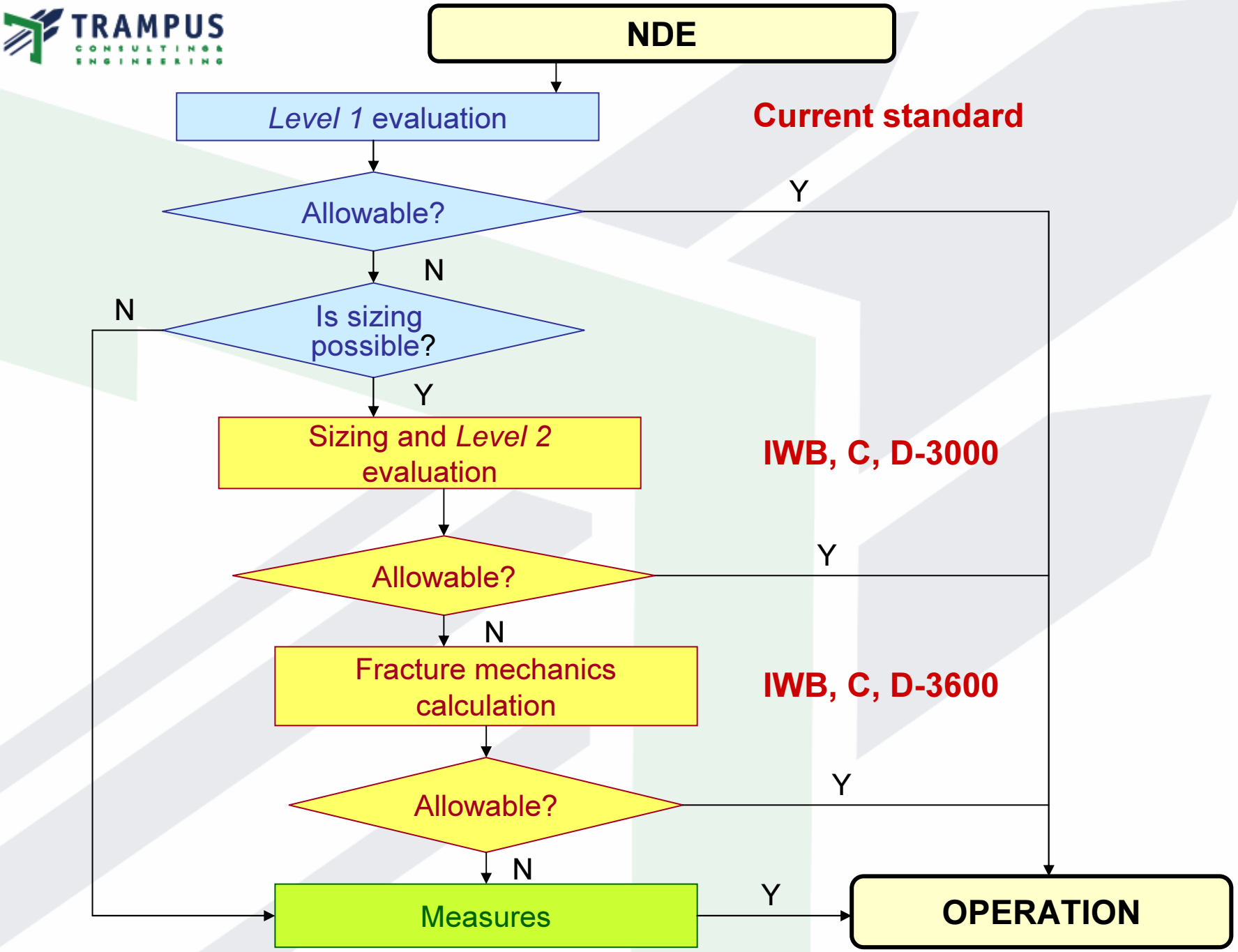
Two-level Evaluation Concept

- Further use of current criteria
  - Feasible
  - **Ensures continuity**
- FBH-SDH conversion

$$D_{FBH} = 0{,}67\sqrt{\lambda\sqrt{D_{SDH} * s}}$$

- Validation via experiments
  - *Level 1*: 100% PRR (FBH)
  - Good conformity with ASME XI


NDE
Level 1 evaluation
Current standard
Allowable?
Y
N
Is sizing possible?
N
Y
Sizing and Level 2 evaluation
IWB, C, D-3000
Allowable?
Y
N
Fracture mechanics calculation
IWB, C, D-3600
Allowable?
Y
N
Measures
Y
OPERATION

Conclusions

- Internationally acceptable level in structural integrity assessment of pressurized components
- Major contribution to Paks NPP operational life extension project