

Nigel TAYLOR

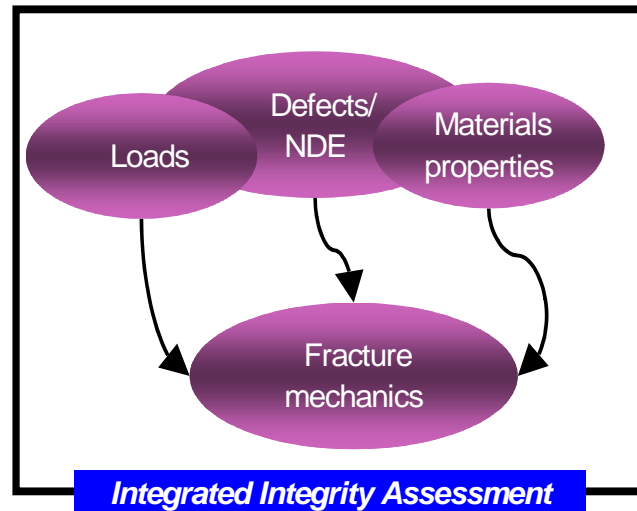
JRC - Commission Européenne



Improving Structural Integrity Assessment Techniques

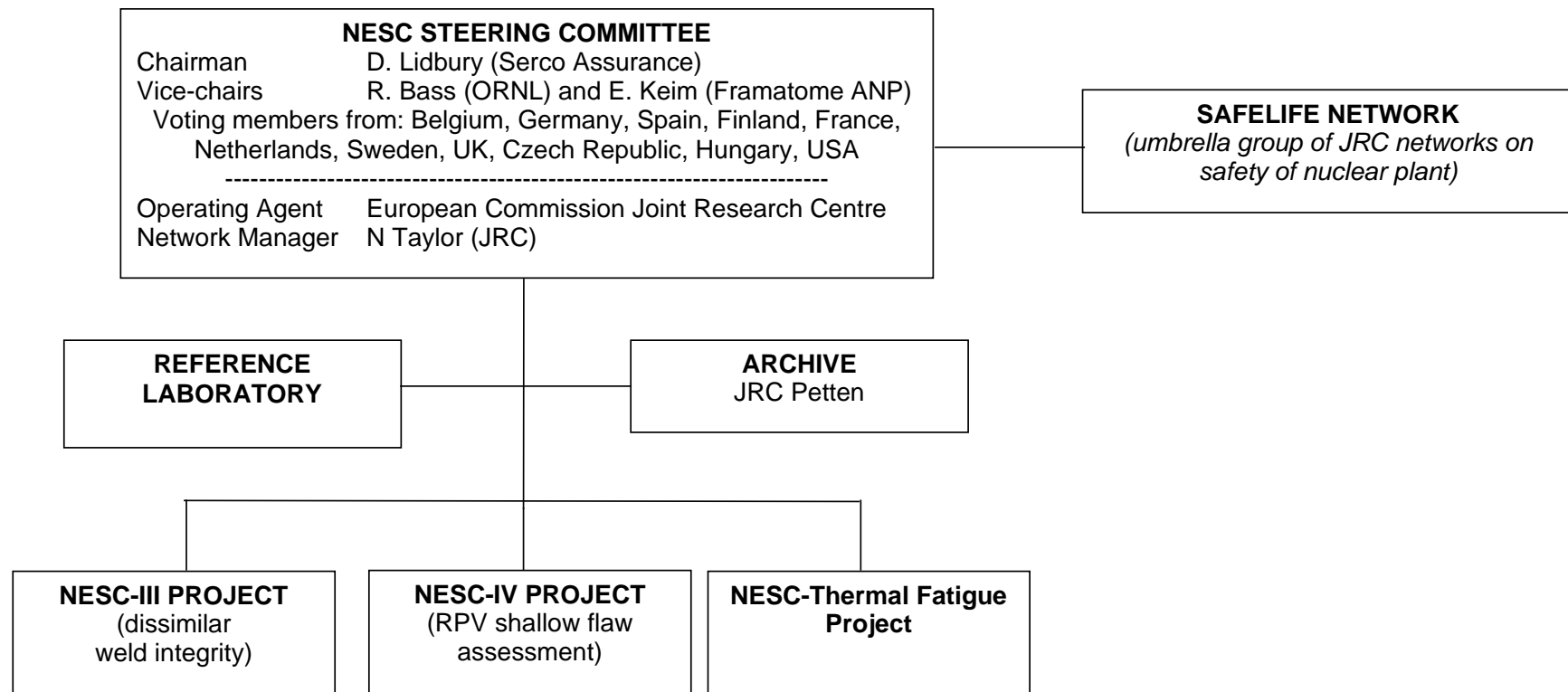
N.G.Taylor (European Commission Joint Research Centre)
and D.P.G. Lidbury (Serco Assurance)

NESC: Network for Evaluating Structural Components

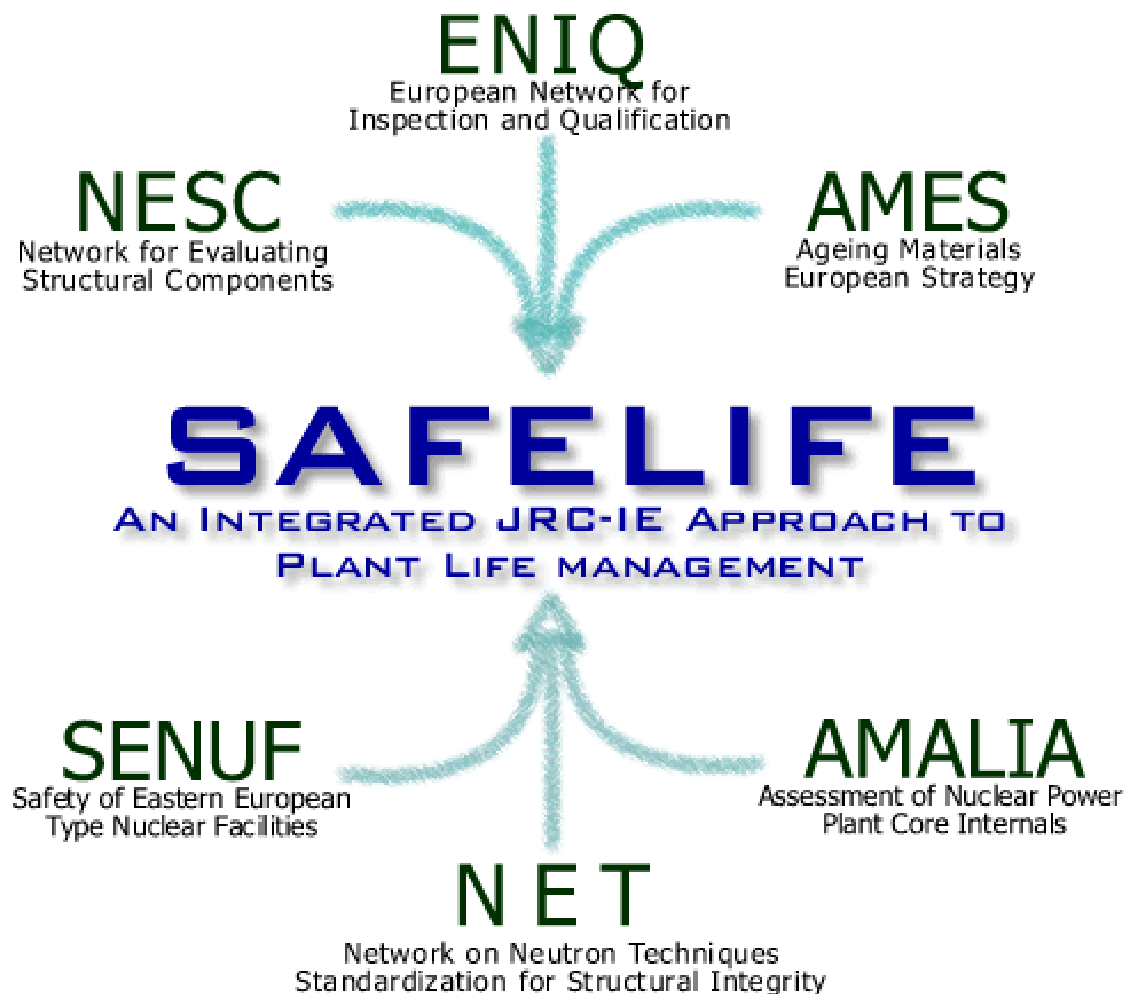


- *How do we deal with the real or postulated cracks in critical components in nuclear power plants?*
- *Integrity assessment is a complex process, and large-scale experimental benchmarks have a crucial role to play as validation and training tools.*
- *The NESC network exploits the concept that such projects work best by grouping all the key players to combine fragmented R&D, to promote best practices and to safeguard expertise.*
- *The JRC' acts as independent Operating Agent, as well as contributing its technical competence in selected areas.*

NESC Network Structure

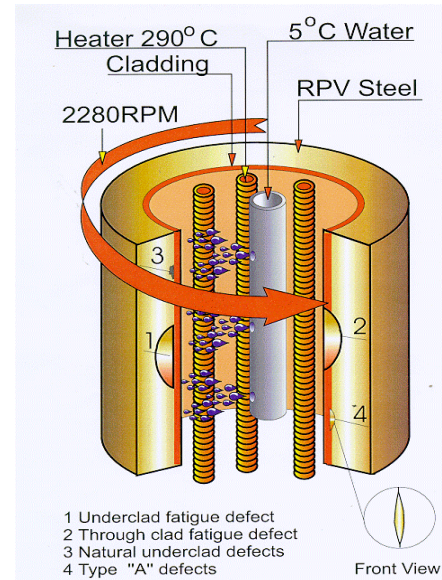


NESC is one of the
JRC's European
Networks, grouped
under its internal
SAFELIFE project

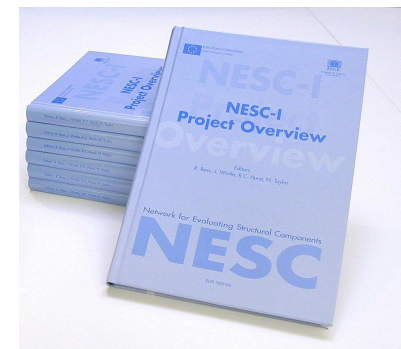
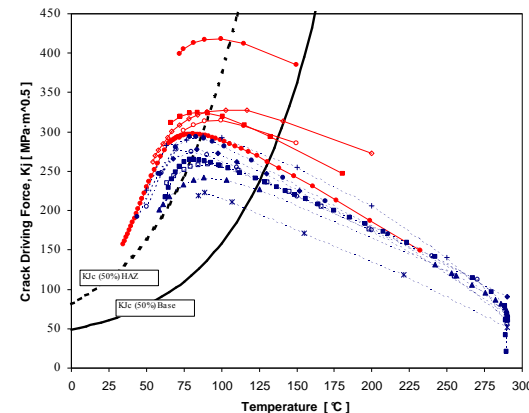


NESC-I spinning cylinder test

- The NESC-I test realised a planned cleavage run-and-arrest event at the large through-clad defect (74 mm). This results confirmed the safety margins of national nuclear safety codes (RCCM, R6, SKIFS, KTA, ASME) which predict allowable defects of 1 to 9 mm deep.
- Advanced analysis methods proved capable of predicting the event with a good degree of accuracy, by taking account of variations in material toughness, constraint effects and effect of cladding.
- The comprehensive documentation includes a book and 19 peer-reviewed technical reports.

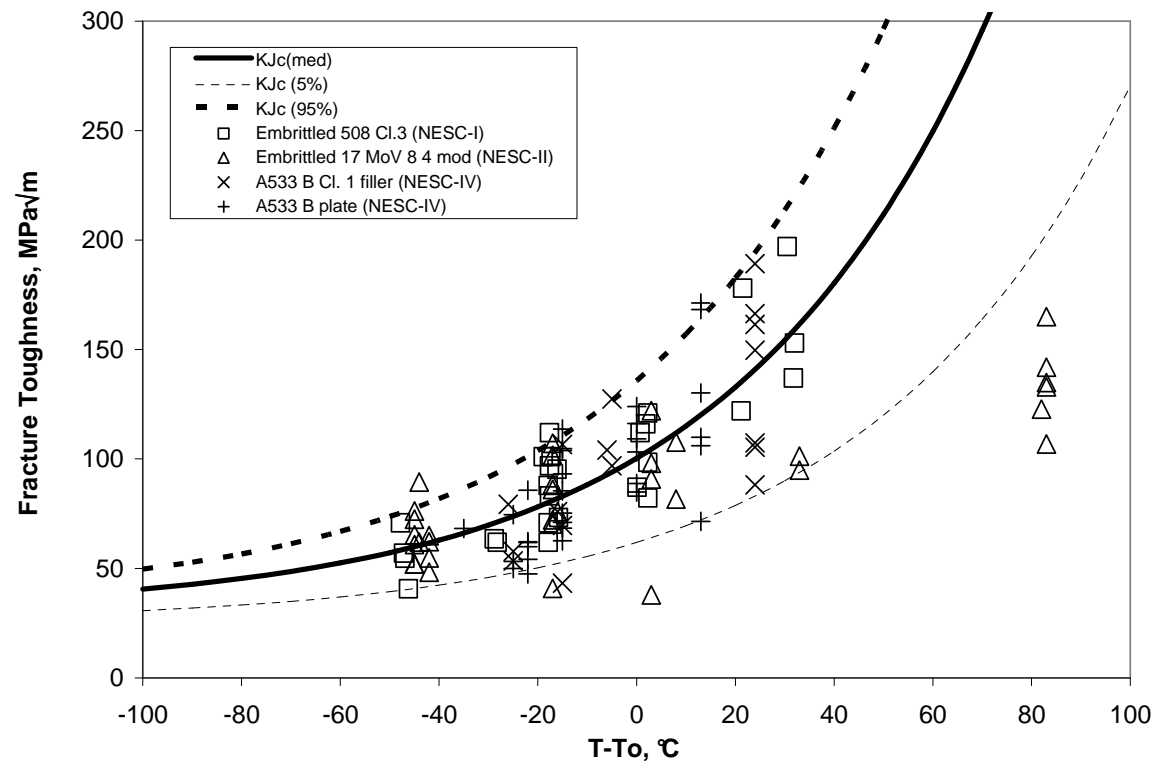


The cleavage event location

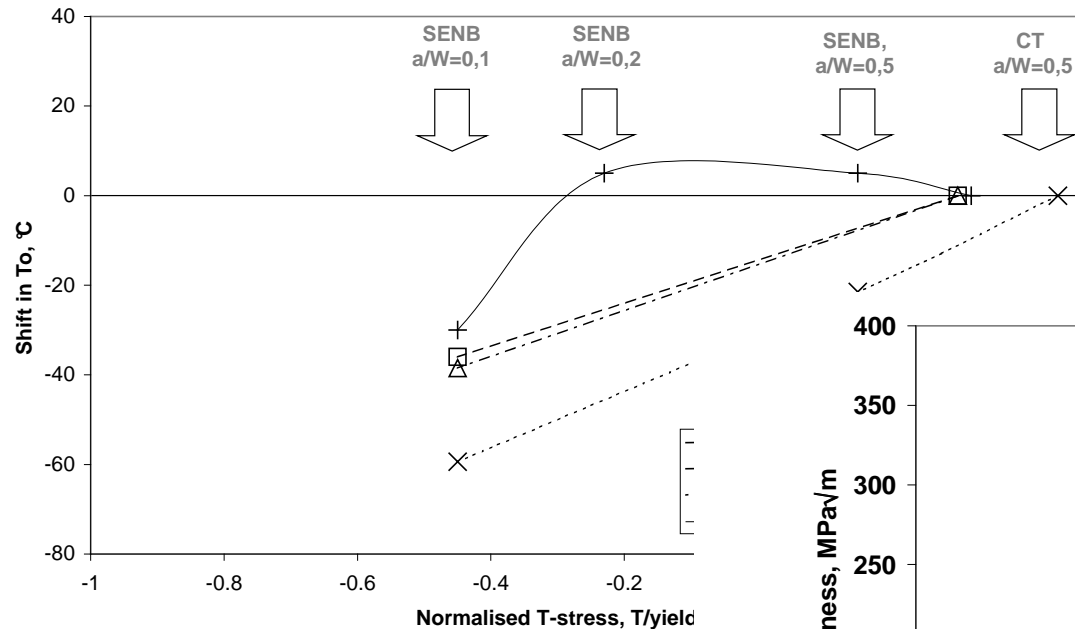


Fracture testing on RPV steels

- Artificially embrittled A508 Cl. 3, used for the NESC-I cylinder
- Artificially embrittled 17 MoV 8 4 mod, used for the NESC-II cylinders
- A508 B weld (SAW, Class 1 filler), used for the NESC-IV biaxial tests
- A508 B plate, used for the NESC-IV embedded flaw tests

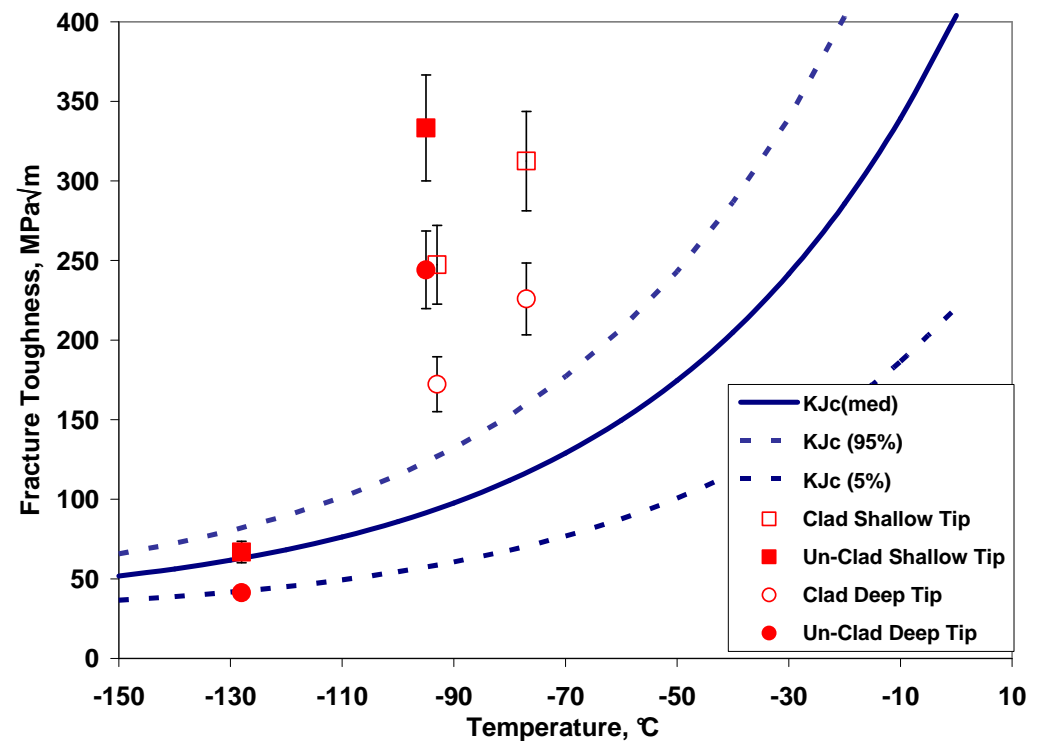


Constraint-loss effects



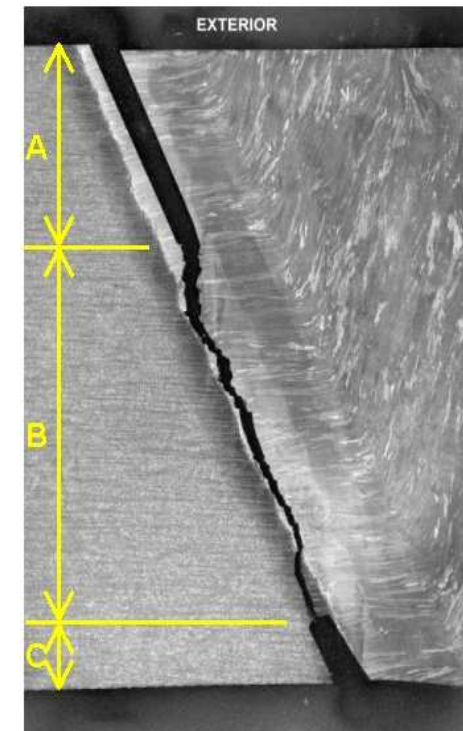
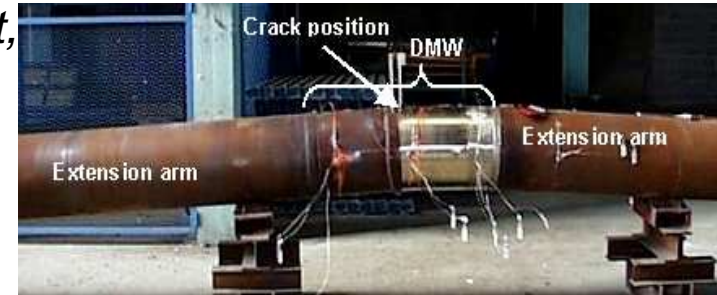
NESC projects have systematically included fracture tests on shallow-flaw specimens for calibrating advanced fracture models

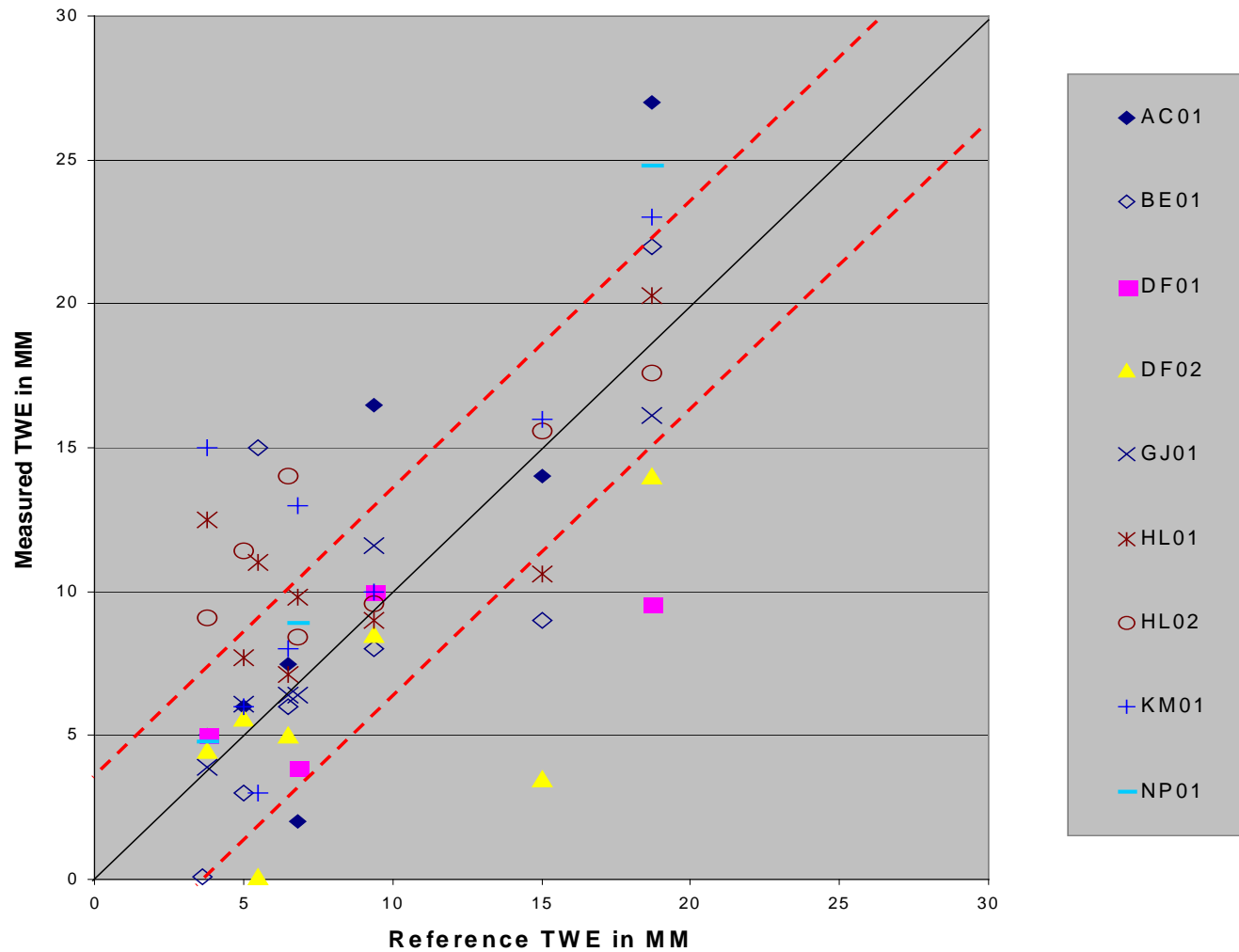
The NESC-IV tests on 100x100 mm beams under uniaxial loading containing embedded flaws produced evidence of strong constraint loss effects



NESC-III Dissimilar Weld Integrity

- *NESC-III was set up around the ADIMEW test, performed by EDF in 2003.*
- *Substantial progress in several areas:*
 - *Completion of an independent ISI performance trial with 7 teams*
 - *Additional materials tests: micro-hardness profile, new tensile tests on 316 SS and notch-tensile tests on butter-layer specimens*
 - *Six new post-test fracture analyses*
 - *Four FE simulation studies of the welding process and residual stresses*
 - *Study on applicability to VVER designs*
 - *NESC-III final report with overall evaluation (including Adimew results where appropriate)*





Results from the NESC-III ISI performance trials, showing measured vs. reference through wall extent for all defects in weld A (308L filler)

NESC Thermal Fatigue

European Methodology

- Identify the most important parameters that control thermal fatigue on NPP components by analysis of operational experience
- Develop a thermal fatigue evaluation procedure (primarily HCF)
- Verify the procedure by analysis of cases from operational experience and from features tests

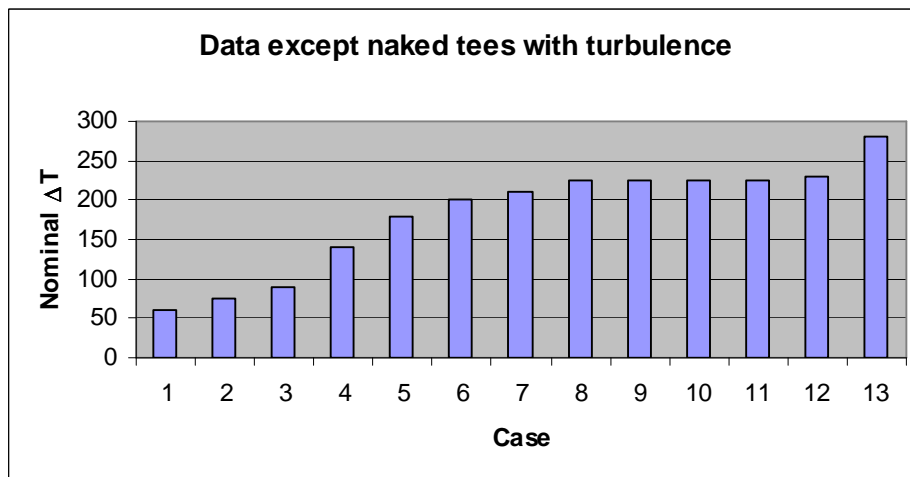
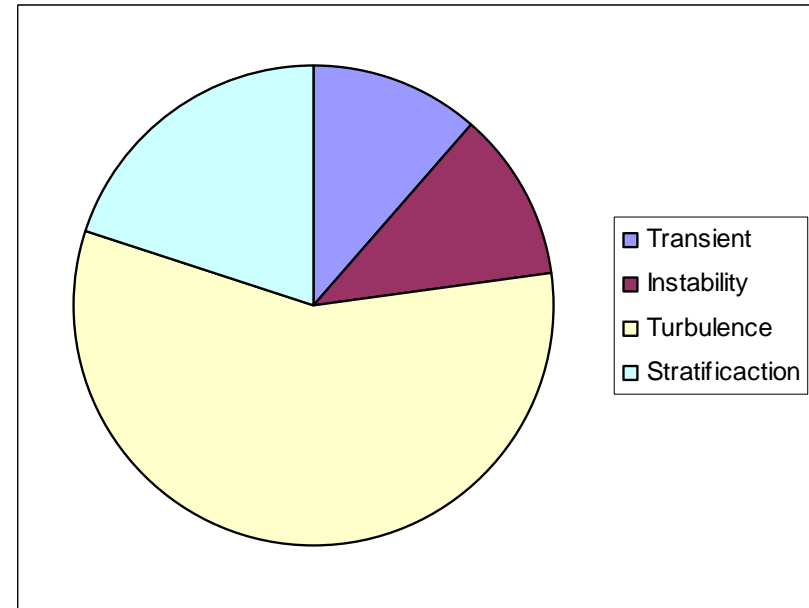
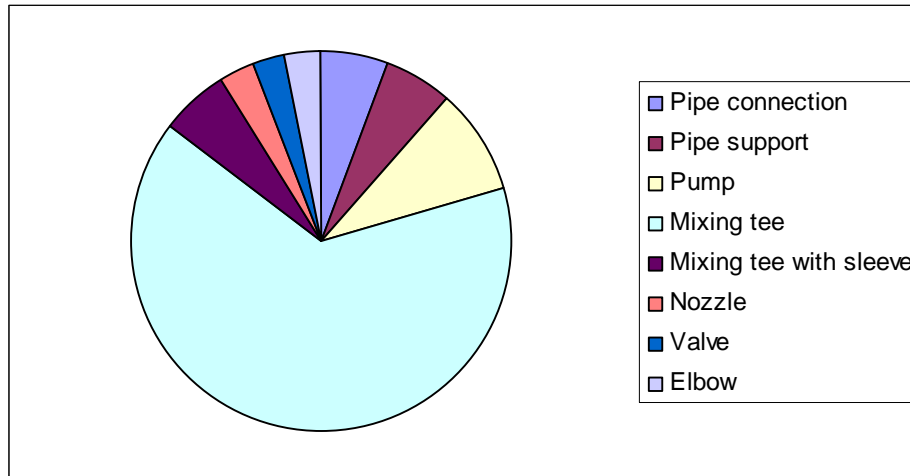
NESC Thermal Fatigue Project

International activities

DG-RTD Funded THERFAT project

In-kind contributions

Analysis of the NESC-TF Component Database

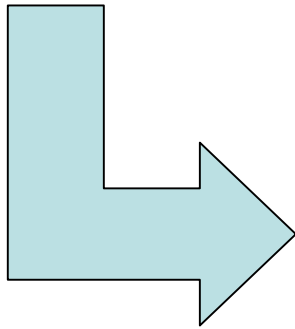


- A common screening criterion on the nominal ΔT seems possible.
- Welds do not dominate as sites for crack initiation.
- Through-wall cracking dominates for stratification.
- Models for stratification should be considered.

Future directions ...

Proposed SIReNet Network of Excellence

Sustainable Integration of European Research in Residual Lifetime Prediction Methodologies



- *Need R&D to support long term safe operation of nuclear reactors*
- *Need to create a single organisational structure capable of working at European level to providing innovative R&D services to end users.*

Disciplines

- Relevance of materials ageing mechanisms
- Availability of material properties data
- Parametric analyses of material properties data
- Reliability of materials ageing methodology
- Reliability of NDE
- Reliability of structural analysis methodology
- Consistency of fracture assessment methodology
- Large scale benchmarks

•Knowledge management

•Personnel qualification and training

Target

European
R&D Forum for
Residual Lifetime
Methodologies
(SIRENET)

Technical basis of
qualified and harmonised
set of procedures
(tools, best practices)
for
plant life time predictions

Dissemination

Design

Manufacturers

PLIM

Utilities

PSR

Regulators

Conclusions

- NESC has demonstrated its capability to execute collaborative projects aimed at developing best practice for structural integrity assessment procedures
- It has provided a series of large-scale experimental benchmarks and reference analyses, which are essential to verifying integrity assessment procedures and which would have been beyond the scope of single organisations acting independently.
- Comprehensive details of the test conditions and results are made available to promote development of advanced techniques and for training purposes.
- The future impact of NESC-type activities can be maximised by their integration in a dedicated European organisation, such as the proposed SIRENET Network of Excellence for residual life methodologies.