

STRUCTURAL INTEGRITY ASSESSMENT METHODS

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NUSAC SCR September 2005



CONTENTS OF PRESENTATION

- The R6, R5 and R3 Procedures
- Work Programmes
 - Recent achievements
 - Current challenges/key drivers
 - Planned programmes
- Collaboration
 - Within the UK
 - International

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THE R-CODES

R6 - Assessment of the Integrity of Structures Containing Defects

R5 - Assessment of Structural Integrity at High Temperature

R3 - Impact Assessment Procedures

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R6 PROCEDURE

Defect assessments at low temperature

- First issued 1976
- Revision 4 in 2001
- Parts of R6 in BS 7910
- Continuing development led by BE

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R5 PROCEDURE

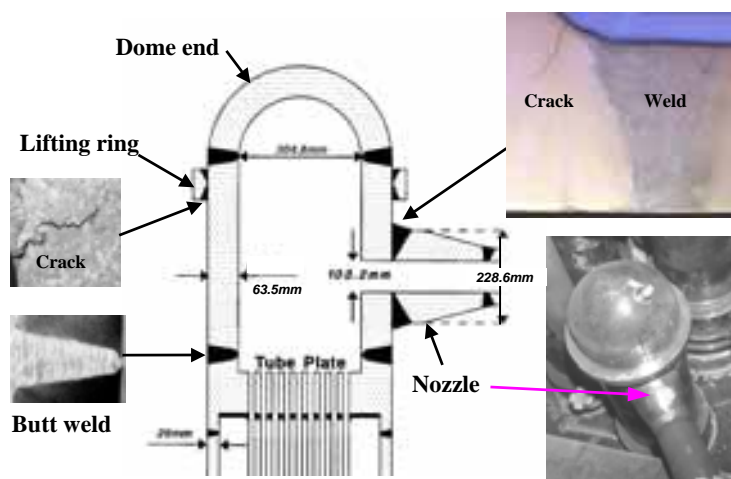
Creep assessments with and without defects

- First issued 1990
- Issue 3 in 2003
- Simplified parts of R5 crack growth method in BS 7910
- Continuing development led by BE

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REHEAT CRACKING



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R3 PROCEDURE

Impact assessment (Missiles, blast, pipewhip)

- First parts issued in 1991
- Revision 2 in 2004
- Continuing development led by BNFL

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RECENT R6 ACHIEVEMENTS

Updates to Revision 4

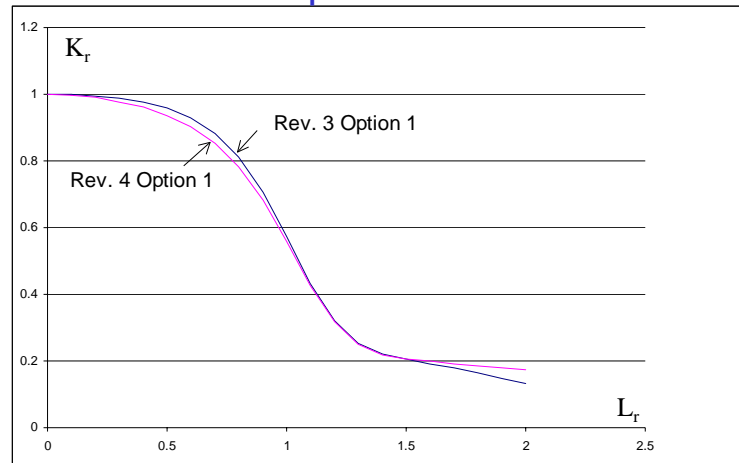
- Residual Stress
 - More realistic profiles for stainless steel pipe butt welds
- Stress Intensity Factor Solutions
 - Revised Section with updated cylinder solutions
- Sustained Loading Advice
 - New data, showing when sustained loading negligible
- Validation revised in a number of areas.

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FAILURE ASSESSMENT DIAGRAM

New Option 1 FAD



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R6 Challenges/Key Drivers

- Open NRI Issues
- Residual stress effects
- Maintain capability

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R6 Planned Work Programme

Addressing NRI Issues

- Residual stress treatment
- Stress classification
- Leak-before-break
- Load-history effects
- Validation

Non-NRI Issues

- Residual stress simulation

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RECENT R5 ACHIEVEMENTS

Updates at Issue 3

- Calculation of creep damage under triaxial stress
- Creep-fatigue initiation in weldments
- Creep-fatigue crack growth under secondary loads
- Advice on creep-fatigue crack growth interactions
- Validation revised in a number of areas.

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 **British Energy**

R5 Challenges/Key Drivers

- Open NRI Issues
- Maintain capability
- Creep damage in weldments

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R5 Planned Work Programme

Addressing NRI Issues

- Constitutive models
- Creep-fatigue in weldments
- Negligible creep cracking
- Multiaxial creep ductility
- Creep-fatigue crack growth

Non-NRI Issues

- Failure of cracked components
- Reheat cracking development
- Validation

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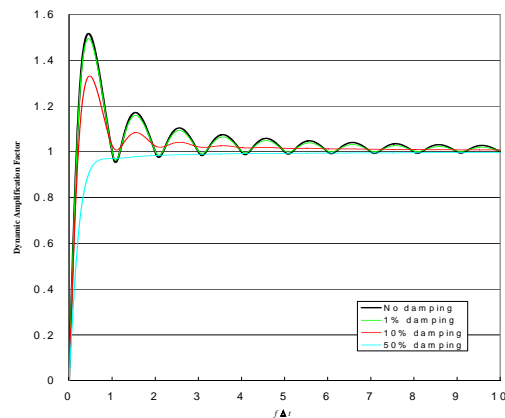
RECENT R3 ACHIEVEMENTS

- Pipe-on-pipe impact
- Local damage to concrete targets
- Dynamic amplification factors

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Dynamic Amplification Triangular Pulse



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R3 Challenges/Key Drivers

- Maintain capability
- Concrete impact

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R3 Planned Work Programme

Non-NRI Issues

- Concrete impact
- Pipe-on-pipe impact for reinforced concrete beams
- TAGSI peer review

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R6 UK LINKS

- Collaborative programme involving BE, Serco Assurance and Rolls-Royce.
- NII attend R6 Panel as Observers
- BS7910 fracture and residual stress sub-groups.
- University contracts
 - Imperial/Bristol

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R6 INTERNATIONAL LINKS

- European projects
 - SMILE (warm pre-stressing)
 - VOCALIST (constraint/validation)
 - ENPOWER (residual stress)
 - NESG (large-scale validation)
 - FITNET (overall European procedure)

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R5 UK LINKS

- Collaborative programme involving BE, Serco Assurance and Rolls-Royce.
- NII attend R5 Panel as Observers
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- University contracts
 - Imperial/Leicester

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R5 INTERNATIONAL LINKS

- European FITNET project
- European Creep Collaborative Committee
- European CRETE project

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R3 LINKS

- Collaborative programme involving BNFL and BE
- University contracts
 - Manchester

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SUMMARY

A number of industry-led procedures are used in structural integrity assessments

Procedures are particularly used for defect tolerance arguments

The procedures continue to be developed, linked to external standards and wider programmes

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