# R5 & R6 Newsletter

Number 56, December 2024
Issued by the R5 and R6 Panels

This latest issue of the R5 & R6 Newsletter contains articles on:

- Current R5 and R6 Panel membership;
- Current status of the R5 procedures;
- Current Status of the R6 procedures;
- Future development of the R5 procedures;
- Future development of the R6 procedures;
- Sales process for the R5 and R6 procedures;
- Information about a R5 introduction Course;
- Information about a R6 introduction course;
- Information about a structural integrity course;
- Closure.

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## CURRENT R5 AND R6 PANEL MEMBERSHIP

### R5 Panel

The function of the R5 Panel, which meets biannually, is to provide the Panel members with an approved assessment procedure for the high temperature response of structures (R5) and to provide technical governance and oversight of the R5 Development Programme. Each organisation that is eligible to sit on the R5 Panel nominates a Panel member.

The R5 Panel currently consists of the following members:

| | |
|---|---|
| J G Johns | EDF Energy (Chair) |
| D W Dean | EDF Energy |
| M J Chevalier | EDF Energy |
| R A Ainsworth | Independent |
| S K Bate | Amentum |
| M Martin | Rolls-Royce |
| L Bortolan Neto | ANSTO |

Observers of the R5 Panel include a representative from the UK Office for Nuclear Regulation (ONR).

### R6 Panel

The function of the R6 Panel, which meets biannually, is to provide the Panel members with an approved procedure for the assessment of the integrity of structures containing defects (R6) and to provide technical governance and oversight of the R6 Development Programme. Each organisation that is eligible to sit on the R6 Panel nominates a Panel member.

The R6 Panel currently consists of the following members:

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| D W Dean | EDF Energy (Chair) |
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| M J Chevalier | EDF Energy |
| R A Ainsworth | Independent |
| P J Budden | Independent |
| J K Sharples | Amentum |
| B Pellereau | Rolls-Royce |
| F Brigante | NRG PALLAS |
| C M Sellers | Kinectrics UK |
| M Tran | ANSTO |

Observers of the R6 Panel include a representative from the UK Office for Nuclear Regulation (ONR).

## CURRENT STATUS OF THE R5 PROCEDURES

The R5 procedures provide an assessment of the continuing integrity of a component, where the operating lifetime might be limited by one of the following mechanisms:

(1) excessive plastic deformation due to a single application of a loading system;
(2) creep rupture;
(3) ratchetting or incremental plastic collapse due to a loading sequence;
(4) excessive creep deformation enhanced by cyclic load;
(5) initiation of cracks in initially defect-free material by creep and creep-fatigue mechanisms;
(6) the growth of cracks by creep and creep-fatigue mechanisms.

R5 is an established methodology, first produced in 1990. In 2003, the former Volumes 2 and 3 of R5 were combined into a single procedure for assessing defect-free structures and the former Volumes 4 and 5 were combined into a single procedure for assessing defects in structures. There are now 5 volumes in R5 in total:

| | |
|---|---|
| Volume 1: | The overview |
| Volume 2/3: | Creep-fatigue crack initiation procedure for defect-free structures |
| Volume 4/5: | Procedure for assessing defects under creep and creep-fatigue loading |
| Volume 6: | Assessment procedure for dissimilar metal welds |
| Volume 7: | Behaviour of similar weldments: guidance for steady creep loading of ferritic pipework components |

Volume 1 provides an overview that indicates the overall scope and restrictions of R5 by reference to the other volumes, provides a route for following the detailed procedures given elsewhere in R5 and compares R5 with other approaches.

Volumes 6 and 7 are essentially specialised applications of the creep-fatigue damage calculations of Volume 2/3 and the creep and creep-fatigue crack growth calculations of Volume 4/5 respectively, to particular weldments and operating conditions found in AGRs.

Since Issue 3 (2003), there have been three major revisions to R5.

Issue 3 Revision 001 (2012) included the following significant changes to Volume 4/5:

- The procedures for combined primary and secondary loading in Appendix A3 were extended to allow inclusion of the relaxation of the reference stress associated with significant crack growth and to allow estimation of the C(t) parameter for elastic-plastic-creep behaviour.
- The sigma-d approach for predicting creep, fatigue and creep-fatigue incubation in Appendix A6 was modified, following a review by the UK Technical Advisory Group on the Structural Integrity of High Integrity Plant (TAGSI). It is now explicitly recommended that the incubation crack growth increment should be 0.2mm for the characteristic distance d=50μm, and additional validation of the approach has been included for Type 316H and Esshete materials.

Issue 3 Revision 002 (2014) included the following significant changes to Volume 2/3:

- Introduction of an improved approach for assessing weldments in Appendix A4, in which the previous Fatigue Strength Reduction Factor (FSRF) has been replaced with a Weld Strain Enhancement Factor (WSEF), which is lower than the FSRF, together with a reduced fatigue endurance.

- Addition of a new option to use a stress-modified ductility exhaustion approach in the creep damage calculations.
- A revised approach for the treatment of cycles with compressive dwells, in which the creep damage per cycle is taken as zero and the endurance used in the fatigue damage calculations is reduced by removing the cycles to nucleation.

The current version of R5, Issue 3 Revision 003 (2021), included the following additional significant changes to Volume 2/3:

- Provision of updated advice on $K_s$ factors, including new advice for Type 321 steels.
- Introduction of a new method for calculating the elastic follow-up factor that prevents the dwell stress from dropping below the steady state stress. This uses a new parameter, $Z_s$, that differs from the existing parameter Z by separating the creep strain contributions due to relaxation of secondary stresses and forward creep deformation caused by primary loading.
- Addition of a new Appendix A15 describing a probabilistic approach for assessing creep-fatigue crack initiation.
- Addition of a new Appendix A16 outlining an approach that accounts for the effects of carburisation on creep-fatigue crack initiation behaviour

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## CURRENT STATUS OF THE R6 PROCEDURES

The R6 procedures provide elastic-plastic fracture mechanics approaches for assessing the integrity of cracked structures. R6 can be used to determine whether or not a given structure, containing either a known or a postulated crack-like defect, is liable to fail, either by fracture or by plastic collapse, when subjected to relevant loadings.

R6 is an established methodology, first produced in 1976. Since then, the document has been through a number of major revisions. The most recent of these major revisions was Revision 4, which was issued in 2001. R6 contains five chapters:

- Chapter I presents the basic R6 procedures;
- Chapter II provides guidance on the input data required to follow the basic procedures set out in Chapter I;
- Chapter III sets out alternative approaches to the basic route of Chapter I;
- Chapter IV contains five compendia, three of which relate to the basic R6 procedures of Chapter I, with the remaining two relating to alternative approaches presented in Chapter III;
- Chapter V sets out material relating to validation of the basic and alternative approaches together with worked examples.

Since Revision 4 (2001), a number of amendments to R6 Revision 4 have been produced. The most recent of these was Amendment 13 (2023). This included the following significant changes:

- Section II.4 on plastic limit load analysis has been updated as follows:-
  - Sub-section II.4.4 has been revised to provide guidance on the use of elastically calculated stresses in the three recommended plate local limit load models (noting that use of the “Connors model” is no longer recommended).
  - A major revision to sub-section II.4.6.2.1 includes new validation for the use of plate global limit load

solutions (summarised in Table II.4.1) and plate local limit load solutions (summarised in Table II.4.2).
    - A major revision to sub-section II.4.6.2.2 includes new validation for the use of cylinder global limit load solutions (summarised in Table II.4.1) and cylinder local limit load solutions (summarised in Table II.4.2).
    - Sub-section II.4.6.2.3 has been updated to include guidance from recent FE analyses of cracked branches.
    - Sub-section II.4.6.2.4 has been significantly updated to include the newly developed guidance on pipe elbow assessments. Validation for the use of elbow global limit load solutions and plate local limit load solutions is summarised in Tables II.4.1 and II.4.2 respectively.
- Section II.5 on stress intensity factor solutions has been updated as follows:-
    - In the previous version of this section, only $K_I$ was discussed. In this update, stress intensity factor K, incorporating contributions from $K_I$, $K_{II}$ and $K_{III}$, is used to describe the calculation methods and solutions. In addition, some explicit guidance for calculating $K_{II}$ and $K_{III}$ is now included in the updated section.
    - Guidance has been added for using the new stress intensity factor solutions for pipe elbows in new sub-section IV.3.7.
    - Sub-section II.5.2 now includes advice for determining influence coefficients using the recently developed interpolation method.
    - Sub-section II.5.6 on finite element methods has been updated for consistency with current practice.
    - The title of sub-section II.5.8 has been changed to Through-thickness flaws with through-wall completely self-balancing stress distributions. The previous stress intensity factors have been removed and the sub-section now refers to sub-section IV.3.3.6 for updated advice on stress intensity factors for completely self-balancing secondary stresses.
    - The reference list has been updated by removing out-of-date references and adding relevant new references.
- In order to maintain consistency in R6 advice, Section II.6 was also modified so it refers to sub-section IV.3.3.6 for updated advice on stress intensity factors for through-thickness cracks subjected to completely self-balancing secondary stresses. This included minor changes to sub-sections II.6.6 and II.6.9, updating of reference [II.6.29] and removal of Figure II.6.3.
- Section II.7 on treatment of welding residual stresses has been updated as follows:-
    - Sub-section II.7.6.1 was revised to remove the previous 55 MPa advice for PWHTd SA508 welds and the associated reference [II.7.36]. There has also been some updating of other references.
    - The 60 MPa advice for PWHTd C-Mn steel welds has also been removed.
    - It now refers to BS 7910:2019 for advice on PWHTd C-Mn and 2.25Cr1Mo steel welds.
    - It now refers to Section II.6 and sub-section IV.3.3.6 for updated advice on stress intensity factors for through-thickness cracks subjected to completely self-balancing secondary stresses.
    - Table II.7.1 and reference to Table II.7.1 in the Figure II.7.1 flow chart have been removed.
- Section III.7 on allowance for constraint effects has been updated as follows:-
    - Inclusion of a method published by Seal and Sherry for estimating the constraint dependent toughness based on mechanistic modelling.
    - A change in notation, with 1/N being used instead of N.

- A corrigendum to reference [III.7.40] has been issued and this has been added to reference [III.7.40].
- Further illustration of Method III has been published and this has been referenced in the Status Notes and a new reference [III.7.48] has been added with later references re-numbered.
- References [III.7.24] and [III.7.28] have been updated to refer to the latest versions of BS7910 and BS8571, respectively.

- A new Section III.17 on assessment of non-sharp defects has been added to Chapter III; this can account for the greater resistance to fracture of components containing non-sharp defects (having a non-zero radius of curvature at the tip) rather than sharp cracks. Two alternative, but equivalent, assessment procedures are given that can account for the improved fracture resistance of non-sharp defects.
- Section IV.1 on limit load solutions for homogeneous components has been updated as follows:-
  - Sub-section IV.1.6 on embedded rectangular and elliptical defects in plates has been updated to include new global and local limit load solutions in sub-sections IV.1.6.1 and IV.6.1.2 that include the effect of membrane stress parallel to the crack plane.
  - Sub-section IV.1.7 on surface rectangular and semi-elliptical defects in plates has been updated to include new global and local limit load solutions that include the effect of membrane stress parallel to the crack plane (sub-section IV.1.7.1) and membrane and bending stress parallel to the crack plane (sub-sections IV.1.7.2 and IV.1.7.3).
  - A new sub-section IV.I.9.4 has been added that gives new local and global limit load solutions for axial rectangular and semi-elliptical defects in cylinders subjected to pressure and global bending.
  - A new sub-section IV.I.11 has been added that gives new local and global limit load solutions for defects in pipe elbows.
- Section IV.3 on stress intensity factor solutions has been updated as follows:-
  - Sub-section IV.3.1 has been updated to include guidance on polynomial fitting and interpolation of tabulated influence functions.
  - A new sub-section IV.3.3.6 has been added giving updated advice on stress intensity factors for through-thickness cracks subjected to completely self-balancing secondary stresses.
  - A new sub-section IV.3.7 has been added that gives new stress intensity factor solutions for defects in pipe elbows.
- Section V.2 sub-section V.2.10, which summarises validation of methods that account for load history effects, has been updated to include additional warm pre-stressing data from EDF report E/REP/BBGB/0222/GEN/18. Previous validation data for a range of steels and a weld metal are supplemented by additional validation data for C-Mn and A533B-1 steels. Validation is provided for the above materials based on predictions using the Wallin and ACE approaches.
- Two new sub-sections have also been added to Section V.2:-
  - Sub-section V.2.16 summarises validation of the Section III.16 procedure for assessing strain-controlled loads based on a TWI report that compares J predictions using Section III.16 with those using other codes and standards and some pipe test data.
  - Sub-section V.2.17 summarises validation of new Section III.17 approaches for treating non-sharp defects. Experimental validation is presented for cleavage fracture using

specimens containing defects with defect tip radii up to 32% of the defect size. Validation based on the use of micromechanistic modelling is also presented for cleavage and ductile fracture.

- A new sub-section V.5.6 has been added to Section V.5 summarising validation of methods for predicting residual stresses in ferritic (SA 508) weldments; this uses two autogenous edge-welded SA 508 beams (produced as part of the NeT Task Group 5 round-robin) as benchmark specimens. This new validation is useful for analysts that need to estimate residual stresses in ferritic (SA 508) weldments where a limited number of weld passes (e.g. 1-2) are applied, given solid-state phase transformations in ferritic material during welding can significantly affect the post-weld residual stress profile under such conditions. However, the applicability of these residual stress prediction methods to multi-pass ferritic (SA 508) weldments has not yet been validated.

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## FUTURE DEVELOPMENT OF THE R5 PROCEDURES

### R5 Volume 2/3 – Creep Fatigue Damage

Hysteresis loop construction is key to evaluating the creep-fatigue damage per cycle by estimating the strain range (for fatigue) and the starting stress and creep strain during dwell periods (for creep). Traditionally this has assumed a single, stabilised cycle for simplicity and R5 contains relatively simple rules for positioning the cycle. The use of the Neuber rule, although simple to implement, is considered to be unrealistic and overly conservative in many cases so there is a desire to replace this. Moreover, the simple assumption of a stabilised cycle is unrealistic for many components since they may not encounter enough cycles for the cyclic hardening (or softening) to fully stabilise and the presence of creep dwells can also affect cyclic hardening or softening. Therefore, a more realistic hysteresis construction approach, capturing the evolution of hysteresis loop shape and position, is desirable. The influence of creep re-priming and how this is affected by cyclic plasticity is also significant as the degree of creep re-priming assumed can significantly affect the prediction of creep damage.

The aim of these developments is to provide more advanced techniques to capture these effects. These are expected to be used mainly in conjunction with finite element models as this is seen to be advantageous for more complex loading and stress distributions that may be relevant, particularly for new reactor designs if they are subjected to more severe cyclic loading. These approaches can also more accurately account for the detailed variation of the tri-axial stress state through the operating history.

Alternative means of providing a more realistic estimation of the creep and fatigue damage in conjunction with the existing, simplified R5 Volume 2/3 approaches are also being explored in parallel. Creep-fatigue damage models have been developed, focusing on the Option 3 (Stress Modified Ductility Exhaustion) approach in which creep ductility is a function of both stress and strain rate as well as temperature. This is considered to be a more reliable (less pessimistic) damage model than Option 1 or Option 2 ductility exhaustion approaches and has been validated against a large test data set and also some plant components. Models for a number of high temperature materials are available. There will be a revision to the Sections of R5 Volume 2/3 to clarify the advice on creep-fatigue and creep rupture damage, including the use of multi-axial stresses.

Environment effects, specifically the impact of carburisation for AGR component operation in a pressurised $CO_2$ environment, are being evaluated. Testing has been undertaken over several years to establish properties and provide pragmatic, conservative advice. More recent testing covering different steel grades and different temperatures has consolidated the advice for the creep ductility observed in carburised materials. This confirms the lower monotonic creep ductility values for the carburised layer compared with those for base parent material. However, the current, simple approach advised in R5 Volume 2/3 Appendix A16 to account for the potentially detrimental environmental effects of carburisation is recognised as being quite conservative as it does not take benefit from the changes in other properties in the carburised layer. Cyclic creep-fatigue tests with load-controlled dwells on carburised specimens have demonstrated that much greater effective creep strains can be tolerated than are predicted by the current conservative approach. These have been modelled using analytical approaches to explain the lower creep strain developed in the carburised layer and hence the greater endurance. These findings have implications for other environments which could have similar effects. No changes to the R5 procedure have yet been proposed for these environment effects but the findings provide evidence of the conservatisms in the current approach.

**R5 Volume 4/5 – Creep-Fatigue Crack Growth**

Improvements are being explored in the R5 Volume 4/5 Appendix A3 combined loading methodology. It is recognised that the current approach for C(t) could be usefully modified to better capture the behaviour of general materials where the creep rate and plastic strain indices differ substantially. This is continuing from previous developments to account for the effects of local crack tip plasticity. Improved validation is being carried out making use of a wide set of FEA results, looking at different combinations of loading, different creep rate and plastic strain indices and how different levels of constraint influence the results.

Long-term creep crack growth testing continues to consolidate the crack growth rate parameters for key high temperature materials (predominantly 316H). The work is also investigating the benefits of lower levels of constraint. Creep crack growth rates in thin components are considered to be very conservatively predicted by the current creep crack growth laws, which are based on tests on thick, high constraint specimens. Although there is currently insufficient information to allow less conservative creep crack growth laws to be recommended for thin components, there is sufficient information to demonstrate that constraint effects on creep crack growth can be significant for plant components.

Environment effects on creep crack growth are of interest and the effects of carburisation on creep crack growth are already being investigated. The limited, relatively short-term tests carried out so far suggest that, although there might be a small detrimental impact, this is likely to be within the current scatter band for creep crack growth tests in air. Longer-term tests are needed before firm conclusions can be dawn on the effects of carburisation on creep crack growth. However, the use of bounding data from high constraint thick specimens is expected to remain bounding for thin carburised plant components. This has implications for other environments and a programme of tests in a Helium environment are being prepared. It should be recognised that the effects may not become apparent in short-term tests, so a full investigation of these effects needs much longer-term testing.

## Long Term Development

A review of the medium and long-term requirements for development areas has been conducted, particularly considering the need for use of R5 in new designs of high temperature Advanced Modular Reactors (AMRs), in particular high temperature gas reactors. As an initial screening we are currently progressing creep, creep-fatigue and environmental testing on Alloy 800H. There is a need to link the procedure development with the requirements of the design codes. The key areas likely to need development have been ranked, based on benefit, cost and risk, to give a priority for the next phases of the R5 development programme. In addition to the on-going work above, we would aim to:

- Expand on the hysteresis loop developments. This will involve a review of the positioning methods, examination of the effect of displacement-controlled conditions on hysteresis loop construction and replacement of the Neuber approach, work to improve positioning of the hysteresis loop and a review of R5 Volume 2/3 for conditions where fatigue dominates creep.
- Review the materials needs for potential Advanced Reactors in the UK, including identification of the additional test requirements for new materials.
- Address the influence of multi-axial stress components on the damage via a review of existing knowledge followed by a plan for development of techniques which capture this.
- Review the creep-fatigue damage approaches for weldments and plan developments to improve these.
- Revisit and validate the appropriate use of C(t) in creep crack growth laws.
- Review the creep crack growth in weldments and develop the assessment methods.

## Future Revision Updates

The next revision of the R5 procedure is expected to include updates in the following Sections:

- Revised R5 Volume 2/3 sections incorporating the latest creep damage models that account for the effects of multi-axial stress state.
- Revised R5 Volume 2/3 Appendix A7 incorporating improved hysteresis loop construction techniques.
- Consolidated advice in R5 Volume 2/3 Appendix A16, including recognition of conservatisms, for assessing the effects of carburisation on creep-fatigue damage.
- Updated R5 Volume 4/5 Appendix A1 on creep crack growth testing, measurement and analysis.
- Revised R5 Volume 4/5 Appendix A3 with improved methods for predicting creep-crack growth for combined loading.
- New R5 Volume 4/5 Appendix A10 giving advice on finite element analysis.
- Updated R5 Volume 4/5 Appendix A7 on probabilistic assessments to capture current best practice.

## FUTURE DEVELOPMENT OF THE R6 PROCEDURES

### R6 Revision 4 Amendment 14

It is intended to produce the next update of R6, Revision 4 Amendment 14, in late 2024-early 2025. This will include updates to Section II.6 (see below) and any other updates that are ready for inclusion at that time.

### Updates to R6 Section II.6 – Treatment of Primary and Secondary Stresses

R6 Section II.6 presents guidance on the treatment of combined primary and secondary stresses and is of fundamental importance to the R6 approach. The new Section IV.3 included in R6 Revision 4 Amendment 13 gives updated advice on calculating SIFs for completely self-balancing through-wall secondary stresses in Section IV.3.3.6. This advice supersedes the advice in Section II.6.7. In order to maintain consistency in R6 advice, Section II.6 was also updated in R6 Revision 4 Amendment 13 (see above).

It is proposed to carry out a more significant revision of Section II.6 for inclusion in a future R6 Revision 4 Amendment 14. This will involve:-

i. A fundamental re-structuring of Section II.6 with a more logical ordering of sub-sections that will allow the flow chart to be simplified.
ii. Incorporation of advice on the relationship between elastic follow-up factor, $Z^s$, and $K_J^s$.
iii. Incorporation of updated equations used in the simplified V approach that are based on the R6 Revision 4 Option 1 Failure Assessment Diagram (FAD).
iv. Incorporation of advice describing how values of the parameter V for the detailed approach can be evaluated using any FAD rather than using the special case currently presented in Section II.6.4.3.

The following supporting documents will be required to support this revision of R6 Section II.6:-

i. A report describing the background to the changes to be incorporated in a future R6 Revision 4 Amendment 14 Section II.6.
ii. A report summarising the experimental and finite element validation of the approaches to be included in a future R6 Revision 4 Amendment 14 Section II.6.
iii. Compendium of elastic follow-up factors for cracked structures.

### Updates to R6 Section II.7 – Treatment of Welding Residual Stresses

The update to sub-section II.7.6.1 of Section II.7 in R6 Revision 4 Amendment 13 included removing the previous 55 MPa advice for PWHTd SA508 welds and the associated reference together with other minor modifications (see above). Subsequently EDF have proposed a residual stress test programme which involves measuring residual stresses in a number of PWHT'd SA508 welds. In addition, EDF and Amentum are performing additional material testing on relevant materials. These data will be fitted to suitable material models in 2025 to simulate the welding process (including the effects of solid-state phase transformation behaviour if required) and to creep models to simulate stress relaxation behaviour during PWHT.

EDF and Amentum will monitor all of these activities and consider how they impact on the current residual stress advice in R6

Revision 4 Amendment 13. In particular:

1. Section III.15 will be updated to provide improved advice on modelling the material behaviour of ferritic steels to account for solid-state phase transformation behaviour (if required).
2. Section II.7 will be updated to give improved advice on the treatment of residual stresses in low alloy steels following post weld heat treatment.

**Improved Methods for Assessing Cracks in Complex Structures**

The limit load of a cracked structure is one of the key parameters when understanding R6 fracture assessments. The limit load is important as it not only specifies the load at which plastic collapse occurs but itis also a key parameter (along with the stress intensity factor, K) in J-integral evaluation using the reference stress based R6 methodology. Advice on the determination of K and limit load for use in R6 assessments of cracked elbows was recently included in R6 Revision 4 Amendment 13.

Work undertaken by Amentum within the R6 development programme since 2019 has involved carrying out 3D finite element analyses of cracked branches to determine K and J values. This work has considered a range of branch geometries, loadings and semi-elliptical defect sizes and locations.

The results of these finite element analyses are being used by EDF to develop advice on the determination of K and limit load for use in R6 assessments of cracked branches. Preliminary advice has recently been developed on the determination of K and limit load for external defects in the main pipe of branch connections. Future work at EDF will extend the advice to cover external defects in the branch pipe and internal defects in the main and branch pipe.

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## SALES PROCESS FOR THE R5 AND R6 PROCEDURES

The current versions of the R5 and R6 procedures can be purchased:

- R5: Assessment Procedure for the High Temperature Response of Structures, Issue 3, Revision 003 (2021)
- R6: Assessment of the Integrity of Structures Containing Defects, Revision 4, Amendment 13 (2023)

**Costs**

Copies of R5 and R6 can be purchased individually, or together at a discounted cost. The following charges apply to industry:

- R5: £1,500 + VAT
- R6: £1,000 + VAT
- R5 + R6: £2,250 + VAT

Universities can purchase the procedures for 20% of the above industry costs.

The revenue that EDF Energy receives from sales goes directly into funding the production and distribution of digital copies of the procedures. Future revisions of R5 Issue 3 and future amendments of R6 Revision 4 will be sold separately in order to fund their production (i.e. the copy holder is not given a perpetual licence that grants access to future updates of the procedure).

No direct technical support will be provided to subscribers.

**Distribution**

Digital copies (in pdf format) of both R5 and R6 procedures will be made available. These copies will be sent to the registered copy holder via email and passwords will be sent to the copy holder separately via email. The copies may be distributed within the copy holder's organisation, noting that the copy holder is responsible for maintaining the security of the document, as per the signed disclaimer.

**Contact Details**

If you are interested in purchasing either or both of these procedures, please register your interest with us via:

**robin.over@edf-energy.com**
and
**atgrprocs@edf-energy.com**

## R5 INTRODUCTION COURSE

R5 Introduction training courses have been previously run by Peter James of Amentum, who has extensive experience in the development and application of R5 procedures. The course has not been run for a few years. However, as a result of recent interest, the delivery of the course in 2025 is being considered.

Specific course details are being reviewed, but at a high level the course would provide a basic background to both R5 Volume 2/3 and Volume 4/5, and provide attendees with the opportunity to be able to undertake calculations involving these volumes of the procedure.

Anyone who may have an interest in attending such a course during 2025 should please contact Peter James by email:

**peter.james2@global.amentum.com**

## R6 INTRODUCTION COURSE

R6 Introduction training courses have traditionally been run by John Sharples and Peter James of Amentum, both of whom have extensive experience in the development and application of the R6 procedures. In recent years, such a course has been held over two days and has been organised through the UK Forum for Engineering Structural Integrity, FESI, or through a direct contractual arrangement with Amentum.

Provided there is a sufficient level of interest, the course can be held again in 2025 (note that this course can be provided to an individual organisation if there is sufficient demand).

The aim of the two-day training course is for the participants to gain a good appreciation and understanding of R6 and to be able to undertake calculations involving the main basic aspects of the procedures. The R6 course comprises a combination of presentations by John and Peter and the participants undertaking calculations on benchmark modules on lap-top computers using EXCEL software. The course is structured along the following lines:

- The first day concentrates on the concepts of fracture mechanics and the basics of the R6 procedure.
- The second day incorporates the more advanced aspects of R6.

This course will be of interest to engineers and scientists who wish to learn about R6 and apply the methodology to plant components. It will also be of interest to middle and senior technical managers who wish to gain an appreciation of the methodology and how it may be applied in their area of responsibility.

Anyone who may have an interest in attending the two-day course during 2025 should please contact John Sharples by email:

**john.sharples1@global.amentum.com**

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## STRUCTURAL INTEGRITY COURSE

The next Structural Integrity Course will be held in the Wills Memorial Building, Bristol University from 12-16 May 2025. The course covers fracture mechanics, creep deformation and failure, creep fracture, corrosion and environmentally assisted cracking from fundamental aspects to structural integrity assessment following procedures such as R5 and R6.

Anyone who may have an interest in attending the course during 2025 should please contact Bob Ainsworth by email:

**robert.ainsworth@manchester.ac.uk**

**CLOSURE**

We hope you have found this Newsletter interesting and useful. If you have any queries arising from the articles, or about other applications of R5 or R6, please let us know. Articles relevant to R5 and R6, for possible publication in this Newsletter, are also welcome. Please contact:

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**robin.over@edf-energy.com**
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**atgrprocs@edf-energy.com**