

ECCC RECOMMENDATIONS VOLUME 1 [Issue 6]

OVERVIEW

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ECCC RECOMMENDATIONS - VOLUME 1 [Issue 6]
CREEP DATA VALIDATION AND ASSESSMENT PROCEDURES
OVERVIEW

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APPROVED


On behalf of ECCC

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ABSTRACT

Working group 1 of the European Creep Collaborative Committee (ECCC-WG1) was formed towards the end of 1992 to develop and recommend the procedures to be used by ECCC for the generation, collation and assessment of creep deformation, stress rupture and stress relaxation data. More recently, as the scope of ECCC activity has broadened, other working groups have contributed to the suite of recommendation volumes, of which there are now eight. ECCC Recommendations Volume 1 introduces the eight technical volumes and provides an overview of their content.

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FOREWORD

ECCC Volume 1 overviews the recommendations contained in eight technical volumes providing guidance on terminology, data generation, information-collation/exchange, and data assessment relating to creep deformation and rupture in uniaxial and multi-axial loaded testpieces/components, both without and with pre-existing defects.

VOLUME 2 - Terms and terminology

VOLUME 3 - Recommendations for data acceptability criteria and the generation of creep data

VOLUME 4 - Guidance for the exchange and collation of creep data

VOLUME 5 - Guidance for the assessment of uniaxial creep data

VOLUME 6 - Residual life assessment and microstructure

VOLUME 7 - Guidance for the assessment of creep crack initiation in testpieces and components

VOLUME 8 - Guidance for the assessment of multi-axial creep test data

VOLUME 9 - High temperature component analysis

The suite of volumes has been specifically prepared for use within ECCC. Nevertheless, they represent the state-of-the-art for industrial creep data acquisition and manipulation, and their content is therefore of interest and is recommended to a much broader spectrum of user beyond ECCC.

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The availability of a comprehensive English-language terminology document and data-exchange template spreadsheets is providing the means by which scientists and engineers can work in a co-ordinated way in other collaborative research programmes. The data generation recommendations contain the distilled experience of several European research institutes and industrial creep laboratories and provide an excellent starting point for other creep laboratories wishing to attain the same high standard. In the area of data assessment, recommendations for the first time provide objective, unequivocal tests for the results of an assessment. The approach is finding direct use outside of ECCC and is being adopted for the evaluation of other material property data.

It is intended that the Volumes will continue to be updated at appropriate intervals to reflect (i) further progress made in the development of creep testing and data assessment, and (ii) the user feedback received from within ECCC and from external sources.

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INTRODUCTION

The European Creep Collaborative Committee (ECCC) was founded in 1991 to co-ordinate the generation, collation and analysis of creep data for metals commonly used for high temperature plant within Europe [1]. Four specific aims were:

- i)* to co-ordinate the generation of creep data throughout Europe,
- ii)* to interact with, and supply information to the formal European Standards organisations and their technical committees,
- iii)* to mutually exchange technical information relating to current and future activities on material developments, and
- iv)* to develop rules for data generation, collation/exchange and assessment.

The organisation was established by a group of European industrialists as an independent body to be free to detail its own work programmes. A prime objective was to use the collective knowledge of those belonging to ECCC to influence the content of European Product, Design and Testing Standards relating to high temperature materials. To this end, a close collaboration with the European Committee for Iron and Steel Standardisation (ECISS) was established.

The ECCC Memorandum of Understanding was initially signed by representatives of industry from Austria, Belgium, Denmark, Finland, France, Germany, Holland, Italy, Portugal, Sweden, Switzerland and the UK. More recently, it has been signed by the Czech Republic, Petten (1997-2001) and Slovakia.

During the four year period, from the beginning of 1993, the activities of ECCC were supported by the Brite-Euram Concerted Action *CREEP* project [BE-5524]. Support between 1997 and 2001 was provided by the Brite-Euram *WELD-CREEP* Thematic Network [BET2-0509]. The third phase of activity (2001-2005) is being supported by the *ADVANCED-CREEP* Thematic Network.

The defined aims continue to be achieved through the efforts of a number of working groups whose activities are steered by the ECCC Management Committee (Fig. 1). The ECCC-WG3x groups co-ordinate and execute the generation, collation and assessment activities directed towards influencing European Standards and Codes (Fig. 2). The WG3x structure is flexible to enable available effort to be focused on current objectives. Areas of responsibility have included:

- Special Welds (including dissimilar metal joints), (WG3.1, 1997-2001)
- Ferritic Steels and Weldments (currently WG3A)
- Austenitic Stainless Steels and Weldments (currently WG3B)
- Bolting Alloys (WG3.4, 1993-2001)
- Nickel Alloys and Weldments (currently WG3C)

The WG3x working groups are responsible for producing the ECCC Creep Property Data Sheets [2].

WG4 is a new working group, formed at the start of the *ADVANCED-CREEP* phase of activity to focus on the assessment of high temperature components and multi-axial features. When ECCC was first formed, its main activity was driven by the requirements of alloy producers and plant manufacturers. More recently, the requirements of plant operators have become increasingly important. This is reflected by the creation of PEDS (now WG1.1) in 1997 and in particular now by the formation of WG4 to provide support for plant design and assessment functions (as shown in Fig. 2).

The development of guidelines to enable the WG3x working groups to exchange and assess creep data in a common way is the role of WG1. While the membership of WG3x is predominantly industry based, WG1 was set up to be composed of specialists from academia, the institutes and industry to ensure a broad based state-of-the-art input to the

recommendations to be made. An additional feature is that group members from 11 countries, representing the interests of alloy producers, plant manufacturers and the utilities have participated in WG1. In 1997, the scope of WG1 was expanded through formation of the PEDS sub-group to prepare guidelines relating to post service exposed creep data. In 2001, PEDS became known as WG1.1, with a new sub-group WG1.2 being convened to prepare guidelines relating to creep crack initiation (from pre-existing defects).

ECCC-WG1

During the period of activity covered by the *CREEP* Concerted Action, WG1 prepared a suite of four technical volumes [3b-e], introduced by an overview volume [3a]. The guidance in these volumes focused on generic issues relating to creep data generation, collation/exchange and assessment, with particular emphasis on information relating to virgin parent steels and uniaxial testing. Moreover, the data assessment guidelines were specifically directed at the large full-size datasets typical of those being collated to provide strength values for Product and Design Standards. The subjects covered by the four original technical volumes were:

VOLUME 2 - Terms and terminology

VOLUME 3 - Recommendations for data acceptability criteria and the generation of creep data

VOLUME 4 - Guidance for the exchange and collation of creep rupture, creep strain-time and stress relaxation data for assessment purposes

VOLUME 5 - Guidance for the assessment of uniaxial creep data

The way in which the four volumes relate to the various stages of creep data generation, collation and assessment is depicted in Fig. 3.

Since 1997, WG1 focus has been on *i*) maintenance of the original ECCC Volumes, *ii*) co-ordination of the preparation of guidelines relating to weld creep data, post service exposed material data, and the assessment of sub-size datasets in general, and more recently *iii*) advanced creep data. Technical contributions to the latest issues of ECCC Volumes have not only originated from WG1, but also from WG1.1 [4d,5c,6a,7d,8], WG1.2 [4e,5d,6b,9], WG3.1 [4b] and WG4 [4f,5e,6c,6d,10,11]. In particular, the contributions of WG1.1, WG1.2 and WG4 have led to the preparation of:

VOLUME 6 - Residual life assessment and microstructure

VOLUME 7 - Guidance for the assessment of creep crack initiation in testpieces and components

VOLUME 8 - Guidance for the assessment of multi-axial creep test data

VOLUME 9 - High temperature component analysis

The current scope of each of the existing technical volumes is summarised in the following sections.

VOLUME 2

ECCC Recommendations Volume 2 provides guidance for common terms and terminology to be used within the working group structure of the European Creep Collaborative Committee [4]. Its main purpose is to provide an English language nomenclature listing to overcome the difficulties which could arise from the use of inconsistent terminology and alternative interpretations being made of the same terms by specialists with different native languages. Extensive use has been made of the most commonly used terminology world-wide, and this has been accomplished by first performing comprehensive reviews of the nomenclature employed in leading national/international Standards and database thesauri.

The scope of Volume 2 has now been expanded to cover:

- Part I General terms and terminology and items specific to parent material [4a]
- Part IIa Terms and terminology for welding processes and weld configurations [4b]
- Part IIb Terms and terminology for weld creep testing [4c]
- Part III Terms and terminology for post service exposed creep data [4d]
- Part IV Terms and terminology for creep crack initiation testing and data assessment [4e]
- Part V Terms and terminology for multi-axial features and components [4f]

The original Volume 2 [3b] is now Part I [4a]. Terms and symbols are defined in sections covering material details, test type descriptions, testing details, data collation, data storage and data assessment. Parts I to III are essentially concerned with uniaxial testing and data. Part IV covers terminology for fracture mechanics specimen testing and data assessment. Part V covers terminology relating to the testing and assessment of multi-axial feature specimens and components.

Document Controllers for each Part collate feedback from the WG3.x working groups and issue amendments when necessary.

VOLUME 3

Prior to the assessment of creep data there is a need to confirm the integrity of the analysis input data, both in terms of the pedigree of the material used and the testing practices adopted to generate the information. ECCC Volume 3 defines the minimum material pedigree and testing practice information required to accompany (a) existing test data and (b) results generated in new testing programmes [5]. The general philosophy has been to set the minimum requirements to ensure the acceptability of existing data that has traditionally been regarded as reliable, and to recommend more precise acceptability criteria for test data generated in the future. With the latest technology, it is feasible to effectively gather and evaluate more information in an advanced way and to exert tighter controls in testing. The recommended acceptability criteria for the future have therefore been set to take full advantage of these developments.

The scope of Volume 3 has now been expanded to cover:

- Part I Data acceptability criteria and data generation: Generic recommendations for creep, creep rupture, stress rupture and stress relaxation data [5a]
- Part II Data acceptability criteria and data generation: Creep data for welds [5b]
- Part III Recommendations for creep testing of PE (ex-service) materials [5c]
- Part IV Testing practices for the generation of creep crack initiation data [5d]
- Part V Testing practices for multi-axial features and components [5e]

The original Volume 3 [3c] is now Part I [5a].

Material Pedigree

Data acceptability criteria covering material pedigree are an integral part of Volume 3 [5]. Material pedigree parameters within the document are classed as 'mandatory', 'recommended' or 'optional'. Data are only acceptable for assessment if the information classed as 'mandatory' is available to confirm, for example, that the cast of material to which it relates conforms to the requirements of the alloy specification under consideration, *i.e.* in terms of chemical composition, product form and heat treatment details.

Testing Practice

Unlike material pedigree for which target requirements may be set by the instigator of the assessment, the data acceptability criteria covering testing practices are influenced by existing national/international Standards and the actual practices adopted by the leading European

creep testing laboratories. The available creep rupture and stress relaxation testing Standards, and current testing practices are comprehensively reviewed in Appendices 1 and 2 of Part I [5a]. These reviews form the basis of tables listing the important testing practice parameters and acceptability criteria (a) for existing results and (b) for test data to be collected in the future.

The Part I appendices also supply the background knowledge for the comprehensive list of recommendations presented in the main text. The original issue of these in [3c], identified the need for new European testing Standards for:

- (i) uninterrupted creep rupture testing,
- (ii) interrupted creep rupture testing,
- (iii) uniaxial stress relaxation testing, and
- (iv) model bolt stress relaxation testing,

and provided the information on which such documents could be founded. As a consequence, Brite-Euram SMT (Standards, Measurement and Testing) programmes covering (i) and (ii) [12] and (iii) and (iv) [13] were initiated. The recommendations in [3c] and the findings of [12] have had a direct influence on the new European Creep Testing Standard [14]. Similarly, the recommendations in reference 3c and the findings of reference 13 have had a direct influence on the new European Stress Relaxation Testing Standard [15].

Volume 3 Part I focuses on generic recommendations relating to creep and stress relaxation testing practices, with particular emphasis on parent steels. In Part II, the recommendations concerning weld creep testing practices are based on state-of-the-art reviews covering (i) actual weldments and (ii) simulated HAZ structures. These form the basis of the two Part II appendices [5b].

Part III covers testing practice recommendations relating to post service exposed material [5c]. The guidance is based on the results of a questionnaire leading to responses from 18 European organisations (*i.e.* utilities, plant manufacturers, engineering institutes/consultants, universities). The results of the questionnaire are included in an appendix. Part III has been expanded with a review of specific testing techniques for post (service) exposed material creep behaviour investigation.

Part IV proposes testing practices for the generation of creep crack initiation data [5d]. CCI properties may be determined as part of a creep crack growth test. However, while the ASTM E1457 standard adequately covers the procedures for CCG testing, it does not provide all the necessary guidance to fully characterise CCI behaviour. Part IV has been prepared to provide the additional guidance required.

Part V covers practices for the testing of multi-axial testpieces and components [5e]. The guidance given for components is based largely on the results of a WG4 survey of the practices adopted by European laboratories with established high temperature component testing facilities.

VOLUME 4

ECCC Volume 4 defines the recommended approach for the collation and exchange of creep rupture and stress relaxation data within ECCC [6]. It introduces working tools for the digital collation and exchange of data in the form of an Excel workbook containing several spreadsheets (the workbook files are contained on the Volumes CD). In addition, it recommends a standard procedure for data handling within ECCC and provides general guidelines for the manipulation of data by donors and receivers (*i.e.* for up-loading and down-loading data, to and from local data banks).

During development, it was recognised that there were a number of ways in which data may be exchanged. The Excel spreadsheet option provides a pragmatic and proven vehicle for data transfer, which anyone with access to a PC can use. An important consideration is that this

application software allows data files to be saved in other common spreadsheet and database formats and in ASCII format, and is therefore an extremely flexible solution.

It has never been the intention to develop an ECCC database. The objective has been 'simply' to devise a data file structure, which would enable results to be transferred from one existing database to another. As a consequence, the spreadsheet layout has been constructed to be compatible with a number of recognised European database structures. Nevertheless, it became obvious as the feedback from ECCC members was being accommodated that the product under development was required not just for exchange purposes, but also for storage for those without existing PC databases. Moreover, there has been a requirement for sheet layouts to be conducive to hard copy reporting. The end-product is a flexible, user-friendly utility for the collation and exchange of creep rupture and stress relaxation test data and its associated material pedigree data. The workbooks continue to be revised in response to user feedback.

Volume 4 Issue 6 has been expanded to become four parts. Issue 5, which only covered guidance for the exchange and collation of uniaxial creep data, becomes Part I of Issue 6 [6a]. The contents of Volume 4 are now:

- Part I Guidance for the exchange and collation of creep rupture, creep-strain time and stress relaxation data for assessment purposes [6a]
- Part II Guidance for the exchange and collation of creep crack initiation data for assessment purposes [6b]
- Part III Guidance for the exchange and collation of multi-axial creep test data for assessment purposes [6c]
- Part IV CREESTY database user manual [6d]

Four workbooks are attached to Part I (in Appendix A) to provide the means to exchange/collate data (including the associated material pedigree data) from creep-rupture tests (*CREEPDAT.XLS*), stress relaxation tests (*RELAXDAT.XLS*), weld creep tests (*WELDDAT.XLS*), and post exposed (*CREEPPE.XLS*) tests [6a]. Each has been constructed to serve the requirements of a wide range of users. In this respect, they have the capability to store a comprehensive package of material pedigree and testing practice information in addition to test data, and consequently the scope of individual worksheets is extensive. There is an inbuilt capability for users to customise the apparent extent of the spreadsheets to suit individual requirements without compromising the exchange capability. Part I provides the supporting documentation for the workbook/spreadsheet utilities and helpful guidance for the collation and exchange of creep data.

Single workbooks are respectively attached to Part II (*CCIDAT3.XLS*) [6b] and Part III (*MULTIAXIAL3.XLS*) [6c] for the exchange and collation of creep crack initiation and multi-axial creep test data.

Part IV provides a user manual for the ISPESL CREESTY database which is accessed via the internet. This database provides the opportunity to collate and compare component in-service performance observations [6d].

VOLUME 5

ECCC Volume 5 provides guidance for the assessment of uniaxial creep-rupture and stress-relaxation data [7].

In the first three issues of Volume 5, recommendations were specifically concerned with the assessment of large multi-cast, multi-temperature, inhomogeneously distributed datasets, typical of those to be considered by the WG3x working groups for the determination of strength values for European Product and Design and Standards. The original Volume 5 [3e] has now become Part Ia of the following structure:

- Part Ia Generic recommendations and guidance for the assessment of full-size creep-rupture datasets [7a]
- Part Ib Recommendations and guidance for the assessment of creep strain and creep strength data [7b]
- Part Ic Recommendations for the assessment of full-size stress relaxation datasets [7c]
- Part Id Recommendations for the assessment of creep ductility data [7d]
- Part IIa Recommendations for the assessment of sub-size creep-rupture datasets [7e]
- Part IIb Recommendations for the assessment of weld creep-rupture data [7f]
- Part III Recommendations for the assessment of post exposure (ex-service) creep data [7g]

In reviewing the creep data assessment practices adopted for large datasets [3e], it became apparent that there was no single universally accepted methodology adopted within Europe. National groups were generally committed to their own specific methods and reluctant to change their allegiance without good reason. The ECCC strategy is therefore to allow flexibility in the choice of the main assessment procedures (with the proviso that it is well defined), and to strongly promote (i) rigorous pre-assessment and (ii) the use of effective post assessment tests (PATs). The PATs were formulated to independently check the ability of the results of the main assessment to characterise the creep rupture behaviour of the alloy under investigation on the basis of the available data. This is achieved through tests for physical realism, within-data-range fit, and extrapolation repeatability/stability. The use of PATs is an original WG1 concept, and their application is shown to be effective in reducing the uncertainties associated with creep strength predictions at the longest test durations, and beyond, to more acceptable levels. Not only are the ECCC PATs now commonly used in their own right, but they have been integrated into a new state-of-the-art UK creep rupture data assessment procedure [16] (also see App. D3 of Part I [7a]).

Part I is now split into four, respectively covering the assessment of large sets of (a) creep-rupture data, (b) creep strain data, (c) stress relaxation data and (d) rupture ductility data. A relatively new feature of Part Ia is a revision to the recommendations for the minimum requirements for datasets to be used for the determination of strength values for Product and Design Standards.

The most significant outcome of the original creep rupture data assessment evaluation exercise was a greater appreciation of the potential levels of uncertainty in predicted strength values for long durations and the consequent recommendations to reduce this risk.

Parts IIa, IIb and III extend the assessment recommendations to '*small*' datasets, and in particular those for *i*) new alloys, ripe for early commercial exploitation, *ii*) welds, and *iii*) post exposed (ex-service) material. Various approaches are evaluated, including the complementary use of reference data. Such is the usefulness of this technique for certain types of small datasets that it has now been used to form the basis of an additional post assessment test. Guidance for the use of 'comparable' data to expand the scope of small datasets is also provided.

Although originally developed for full-size datasets, the PATs are also recommended for use with the types of sub-size dataset considered in Parts IIa, IIb and III [7e,f,g]. In such cases, the guidance is to use the PATs to define the boundaries within which predicted strength values can be applied with confidence.

The Volume 5 recommendations are supported in appendices by reviews of assessment methods, details of the assessment evaluation exercises, comprehensive assessment procedure documents and worked examples.

VOLUME 6

Volume 6 was produced by WG1.1 and reviews existing knowledge relating to the characterisation of microstructure and physical damage for remaining life assessment [8]. The comprehensive review considers available methods for quantifying metallurgical change and physical damage accumulation during service, and ways of applying this information to the reliable assessment of remnant life.

VOLUME 7

Prepared by WG1.2, Volume 7 is concerned with the assessment of creep crack initiation in testpieces and components [9]. The onset of creep crack development from a pre-existing defect may be determined using an experimentally determined $t_{i,x}(C^*)$ correlation, critical crack tip opening displacement or a 2-criteria failure assessment diagram. In particular, the document focusses on the background, application and effectiveness of the R5-TDFAD (time dependent failure assessment diagram) and the German 2-CD (2-criteria diagram) approaches.

VOLUME 8

Volume 8 reviews assessments of the multi-axial rupture strength and ductility characteristics of a low alloy ferritic steel, a martensitic stainless steel and an austenitic stainless steel [10]. These form the basis of recommendations for the assessment of multi-axial testpieces.

VOLUME 9

Volume 9 is concerned with the assessment of high temperature components and comprises four parts:

- Part I High temperature component analysis: Overview [11a]
- Part II Overview of assessment and design procedures [11b]
- Part III Database of component tests and assessments [11c]
- Part IV Vessel assessment case studies [11d]

Part I overviews the WG4 component assessment activity leading to the preparation of the Volume and, based on the findings, offers recommendations for the analysis of high temperature components. Part II provides a comprehensive overview of 12 assessment and design procedures available for the defect-free analysis or defect analysis of high temperature components [11b].

Part III is a catalogue of summary details for 36 high temperature components tests with an indication of the assessment route(s) performed, where appropriate [11c].

Four WG4 assessors were involved in the evaluation of 5 component cases, with each case being assessed by at least one analyst. Summary details of these case studies are given in Part IV [11d].

SUMMARY

ECCC Volume 1 introduces and provides an overview of eight technical ECCC Recommendation Volumes:

VOLUME 2 - Terms and terminology

VOLUME 3 - Recommendations for data acceptability criteria and the generation of creep data

VOLUME 4 - Guidance for the exchange and collation of creep data

VOLUME 5 - Guidance for the assessment of uniaxial creep data

VOLUME 6 - Residual life assessment and microstructure

VOLUME 7 - Guidance for the assessment of creep crack initiation in testpieces and components

VOLUME 8 - Guidance for the assessment of multi-axial creep test data

VOLUME 9 - High temperature component analysis

ACKNOWLEDGEMENTS

The ECCC Volumes are the product of intensive activity by a small group of enthusiasts, and the Editor acknowledges the mostly unfunded efforts of individual members of WG1 (1992 to present), WG1.1 (1997 to present), WG1.2 (2001 to present), WG3.1 (1997-2001) and WG4 (2001 to present). The feedback and helpful comments from members of the ECCC Management Committee and the WG3x working groups are duly acknowledged. Particular mention is given to the support efforts of Dr I A Shibli and Dr D G Robertson (ETD, ECCC Secretariat) who prepared the individual parts for publication.

The funding provided by the European Commission through the BRITE-EURAM BE-5524 *CREEP* Concerted Action, BET2-0509 *WELD-CREEP* Thematic Network and *ADVANCED-CREEP* Thematic Network initiatives in support of travel to meetings and the development work performed by EC institutes is also gratefully acknowledged.

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(b) Part IIa, 'Terms and terminology for welding processes and weld configurations', Issue 2
(c) Part IIb, 'Terms and terminology for weld creep testing', Issue 2
(d) Part III, 'Terms and terminology for post service exposed creep data', Issue 4
(e) Part IV, 'Terms and terminology for creep crack initiation testing and data assessment', Issue 2
(f) Part V, 'Terms and terminology for multi-axial features and components', Issue 1
- 5 ECCC Recommendations Volume 3, 2005, 'Recommendations for data acceptability criteria and the generation of creep data', eds. Holdsworth, S.R., Granacher, J., Theofel, H., Klenk, A., Buchmayr, B., Gariboldi, E., Brett, S., Müller, F., Gengenbach, T., Dean, D. & Brown, T.B. publ. ETD,

- (a) Part I, 'Data acceptability criteria and data generation: Generic recommendations for creep, creep rupture, stress rupture and stress relaxation data', Issue 5,
 - (b) Part II, 'Data acceptability criteria and data generation: Creep data for welds', Issue 3
 - (c) Part III, 'Recommendations for creep testing of PE (ex-service) materials', Issue 4
 - (d) Part IV, 'Testing practices for the generation of creep crack initiation data', Issue 2
 - (e) Part V, 'Testing practises for multi-axial features and components',
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- (a) Part I, 'Guidance for creep rupture, creep strain-time and stress relaxation data', Issue 6
 - (b) Part II, 'Guidance for creep crack initiation data', Issue 1
 - (c) Part III, 'Guidance for multi-axial creep test data',
 - (d) Part IV, 'CREESTY database user manual', Issue 1
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 - (b) Part Ib, 'Recommendations and guidance for the assessment of creep strain and creep strength data', (Issue 3)
 - (c) Part Ic, 'Recommendations for the assessment of full-size stress relaxation datasets', Issue 2
 - (d) Part Id, 'Recommendations for the assessment of creep ductility data', Issue 1
 - (e) Part IIa, 'Recommendations for the assessment of sub-size creep-rupture data', Issue 1
 - (f) Part IIb, 'Recommendations for the assessment of weld creep-rupture datasets', Issue 2
 - (g) Part III, 'Recommendations for the assessment of post exposure (ex-service) creep data', Issue 2
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- (a) Part I, 'Overview',
 - (b) Part II, 'Overview of assessment and design procedures', Issue 1
 - (c) Part III, 'Database of component tests and components', Issue 1
 - (d) Part IV, 'Vessel assessment case studies',
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Fig. 1 Current structure of ECCC

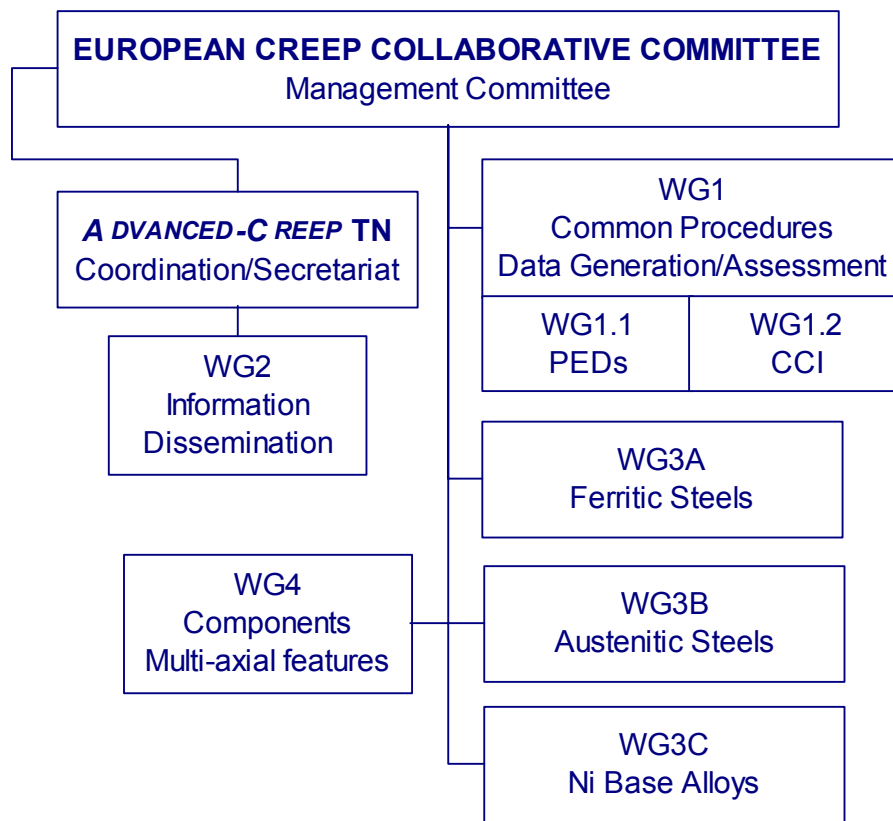


Fig. 2 Relationship between ECCC, the *ADVANCED-CREEP* Thematic Network (TN) and external organisations

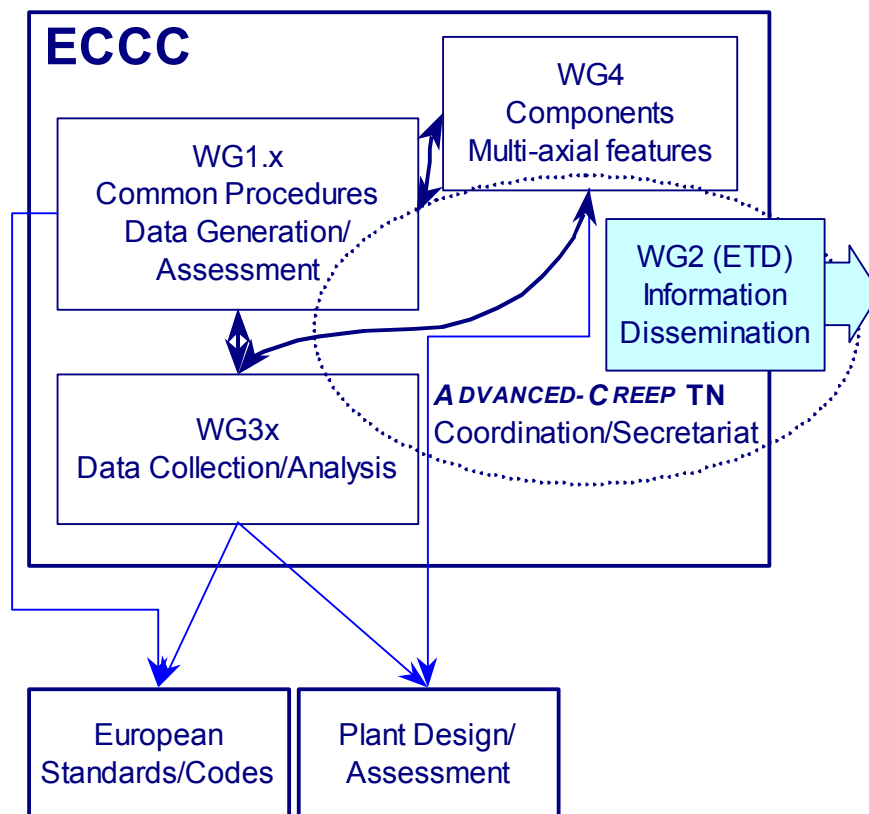


Fig. 3 The Role of the ECCC Volumes in creep data assessment

