

Non-Destructive Examination in Relation to Structural Integrity

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Non-Destructive Examination in Relation to Structural Integrity

Proceedings of the 1st International Seminar on 'Non-Destructive Examination in Relation to Structural Integrity' held at the International Congress Center Berlin, Berlin (West), Germany, 22nd August 1979, in conjunction with the 5th International Conference on Structural Mechanics in Reactor Technology. Organizational Support: Bundesanstalt für Materialprüfung (BAM), Berlin; ICC Department of Organization and Operation.

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Dedication

The meeting of which this volume is the proceedings was one of several specialist meetings held in Berlin immediately after the 5th International Conference on Structural Mechanics in Reactor Technology, colloquially and affectionately known as SMIRT5. The very concept of these SMIRT Conferences and the effective realisation of them into the successful technical contributions that they undoubtedly are arises essentially from the vision, vigour and enthusiasm of Professor Tom Jaeger. He and his wife Brunhilde have the ability to make busy experts the world over find time to work for him, to gather around him and to enjoy the friendship, social goodwill and technical interchange that they so much catalyse. It is to Professor and Mrs Jaeger that I dedicate this volume, for without their efforts it would not have existed.

R. W. NICHOLS

Preface

An important aspect of the assessment of structural integrity, particularly of such high integrity structures as are associated with nuclear reactor pressure circuits, is that of determining the influence of those flaws which may remain in a fabrication, even one made to the highest standards of quality and of quality assurance. These aspects of the assessment of reliability, of the use of fracture mechanics to determine the effect of possible flaws, and the probabilistic and statistical aspects associated with such approaches form part of all the discussions of structural mechanics in reactor technology, particularly those related to pipework and pressure vessels.

Some aspects of such work require specialist input which we considered could best be achieved by arranging specialist seminars immediately after each SMIRT Conference, which could be attended not only by the interested delegates of the Conference itself but also by others coming for the Seminars especially.

One topic particularly appropriate for such treatment is that of Non-Destructive Examination (NDE) which by the use of such tools as visual examination, radiography, eddy currents and ultrasonics (especially ultrasonics) sets out to determine what flaws are in a finished structure, what is their size and where they are located. The use of such procedures has long formed part of the quality control of every high integrity fabrication, and together with the use of manufacturing techniques chosen and demonstrated to have a very low rate of flaw production, provide the required assurance of quality. The development of fracture mechanics has changed the role of NDE somewhat from that of being a watchdog on production procedures to that of detecting any significant flaws before they can lead to failure in service. This aspect has been extended by the use of such

techniques on the completed reactor structure before commissioning and at intervals throughout its service life in the so-called in-service inspection procedures on which the ASME Boiler & Pressure Vessel Code Section XI gives considerable detailed guidance. It is against this background that I willingly agreed to organise this post-conference seminar on 'Non-Destructive Examination in Relation to Structural Integrity', intending to cover reports on recent relevant experience and developments.

On this occasion however, one particular aspect became of overriding importance. The use of NDE as a tool for detecting flaws in relation to fracture mechanics calculations raises the question of how reliable is NDE in such detection. The development of probabilistic fracture mechanics in particular makes it desirable to have more quantitative information on this reliability in actual application—a very different matter from the sensitivity or the potential detection ability of particular NDE techniques. Information of this type is very difficult to obtain as was indicated in the UK report on its study of the integrity of PWR pressure vessels (the 'Marshall' report), which had to make do with estimates that that Study Group had obtained from experienced operators. The difficulty of getting really relevant information on this subject is that it can only really be obtained by the comparison of the results of non-destructive examination with those of a comprehensive destructive examination in which the subject component is dissected until all the flaws are revealed and characterised, an operation that can rarely be afforded in practice. It is most convenient then for such work to be done on specially prepared representations of components into which deliberate but real flaws are introduced, these components being subjected to a round-robin of non-destructive examinations and subsequently with great care and precision examined destructively. Several such programmes have recently been initiated—in particular by the US Pressure Vessel Research Council (PVRC/HSST), by the US Electric Power Research Institute (EPRI), by the UK Welding Institute (WI) and by the Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency and the Commission of the European Communities. A major part of this seminar was therefore devoted to receiving status reports on each of these programmes. In particular there was presented a series of final reports on the CSNI Plate Inspection Steering Committee (PISC) work in which more than 30 European NDE testing institutions participated. This seminar and this proceedings volume thus became the medium for publication of an exceptionally important set of results from what is at present a unique and particularly relevant and extensive piece of collaborative research.

The attendance at the seminar was notable for the expertise of the delegates and for the good international coverage which was achieved. Vigorous discussion took place both in the meeting and between smaller groups outside. That in the meeting was, by agreement, recorded on tape, and I have used the transcripts of these tapes to produce the edited discussions presented in this volume. For practical reasons it was agreed that the transcripts would not be sent back to the speakers, with the result that the written version here given is my own responsibility and interpretation. I hope that I have recorded the most important points of general interest, that I have interpreted the comments correctly and that I have given them correct attributions. If not, I apologise for any errors. I hope that readers of this volume will find the discussion adds to their appreciation of the interesting and important papers which are given in the order of presentation. The first four papers cover recent developments in general survey methods and the following four papers cover aspects of recent development and experience with ultrasonic examination techniques. After these presentations on technique developments there are two papers on the assessment of the reliability of flaw detection by ultrasonics, the last one (Paper 10) being in five sections representing different aspects of the PISC trial. Finally there are two papers covering other reliability trials now in progress which have emphasis on flaw sizing and characterisation and the use of advanced NDE techniques.

I will close this preface by thanking all those responsible for writing, presenting and making these papers available for publication, and to the many people behind the scenes who helped in the seminar and in the preparation of these proceedings.

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SESSION I
Review of Methods Available