Abstract
The OECD Nuclear Energy Agency has 28 Member countries. In 2004 the NEA issued its Strategic Plan covering the period 2005-2009. The plan identifies six sectorial arenas of work for the NEA, including as the first arena “Nuclear Safety and Regulation”. In this arena the NEA operates through two senior standing technical committees. The Committee on Nuclear Regulatory Activities (CNRA) deals with regulatory aspects, and the Committee on the Safety on Nuclear Installations (CSNI) deals with technological aspects.

Under the CSNI, the Working Group on the Integrity and Aging of Components and Structures (IAGE) is responsible for conducting studies, research projects and sharing information and reaching consensus on issues related to the integrity and aging of nuclear power plant.

The IAGE Working Group has been actively working mainly in two areas: Aging management programmes, and External Hazards. Recently, as recognition of the worldwide nuclear “renaissance”, the mandate of the IAGE Working Group was changed to capture also the design aspects of SSCs. In the area of the aging management programmes, efforts have been devoted to address the environmental effects on the integrity of components, the reactor pressure vessel lifetime, passive components failure rates and structural behaviour, risk informed in service inspections and non destructive examinations, and the assessment of the containment integrity. In the area of external hazards, the work of the IAGE group has been focused on the seismic behaviour of SSC.

The paper provides background on the Agency itself, the results of the joint CNRA/CSNI strategic plan in terms of the main challenges that regulators and the safety research community will face in the near term and the strategy that both committees follows to address these challenges and to identify and perform the work that will contribute to the resolution of these issues. It presents the accomplishments of the IAGE working group in addressing issues related to the regulatory aspects of long term operation and plant life management, and also provides recommendations in the areas where efforts should be pursued.

1. Introduction
The Nuclear Energy Agency (NEA) is one of bodies that make up the Organisation for Economic Co-operation and Development (OECD), located in Paris, France. The Members of the OECD/NEA are a group of 28 like minded, developed countries which at the start of 2007 operated 346 reactor units in 17 OECD countries, with 10 more under construction: four in Korea, three in Japan, two in the Slovak Republic and one in Finland. NEA Member countries account for approximately 85% of the world's installed nuclear capacity. In the OECD area, nuclear energy represents nearly a quarter of the electricity supply [Ref 1].

The mission of the OECD/NEA is to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and its sustainable development.

The broad direction of the programme of work of the OECD/NEA is set by the Steering Committee for Nuclear Energy. This Committee is assisted by a number of specialised standing committees such as the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA).
The NEA programme of work covers a very full range of topics, with nuclear safety and regulation as the top priority in the Agency’s 2005-2009 Strategic Plan. Currently, 15 international joint projects are conducted under NEA auspices on nuclear safety matters. The technical fields of nuclear reactor safety interest into which the CSNI has designated specific Working Groups are: risk assessment, analysis and management of accidents, integrity and aging of components and structures, fuel cycle safety, human and organisational factor, and fuel safety.

This paper will focus specifically on those activities of the Working Group on Integrity and Aging (IAGE) of components and structures relevant to long term operation and plant life management. IAGE WG deals with the integrity of structures and components, and has three sub groups, dealing with the integrity and aging of metal structures and components, integrity and aging of concrete structures, and the seismic behaviour of structures.

The IAGE working group has dealt with issues related to thermal fatigue in piping by sponsoring: round robins or benchmarks on fatigue crack growth in plates and pipes under mechanical loading, on crack opening behaviour and leak rates in pipes, on pipe leak and break probabilities, and NDE in a range of components (the former PISC project, jointly with the CEC); Specialists meetings or workshops on Leak Before Break, reactor coolant system leakage and failure probabilities and experience with thermal fatigue in LWR piping caused by mixing and stratification; and a series of reports on risk informed in-service inspections.

NEA works in co-ordination with other international organisations such as the CEC, IAEA and WANO to avoid duplication and to ensure the appropriate participation. This co-ordination takes the form of liaison between the secretariats, joint sponsorship of meetings or projects, and exchange of future programmes of work.

2. Challenges for regulators and safety researchers

The CSNI is an international committee made of senior scientists and engineers with broad responsibilities for safety technology and research programmes, and representatives from regulatory authorities. It was set up in 1973 to develop and co-ordinate the activities of the NEA concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations.

The CSNI’s purpose is to foster international co-operation in nuclear safety amongst OECD member countries. The Committee focuses primarily on existing power reactors and other nuclear installations; it also considers the safety implications of scientific and technical developments of new reactor designs.

The CNRA is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations.

The CNRA is responsible for the programme of the NEA concerning the regulation, licensing and inspection of nuclear installations with regard to safety. The Committee’s purpose is to promote co-operation among member countries to use the feedback from experience to develop measures to improve safety, to enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field.

Recognising that there are many common areas of interest and the need for close co-ordination and co-operation between the two committees, it was decided to develop a joint CSNI/CNRA strategic plan. One of the main purposes of the joint strategic plan was to identify the main challenges for nuclear safety in the next five years and outline the focus areas to properly respond to those challenges.

In developing the joint CSNI/CNRA Strategic Plan it was important to recognise the current status of the nuclear power industry and, in particular, the main challenges that regulators and safety researchers will face in the next five years. These will likely determine the focus of CNRA and CSNI activities and include:
Shrinking nuclear infrastructure:

Increased public expectations regarding safety in the use of nuclear energy:

Industry initiatives to improve economics and safety performance in the production of nuclear power:

Necessity to ensure safety over the plant life cycle:

New reactors and new technology:

The strategy to be employed by CSNI is to work closely with CNRA in addressing these challenges and identify and perform work that will contribute to the resolution of related issues. To be useful, such work will need to be technically relevant and timely and clearly communicated to potential users. To help ensure that the work performed by CSNI is relevant to the challenges listed above, a list of Safety Issues and Topics (SIT) has been developed to define the areas in which CSNI activities are to be focused.

Recognizing the safety significance of the long term operation and plant life management, the CSNI has included two SITs to focus the activities of the CSNI on these aspects. The first one is Long Term Safety Management aimed to demonstrate that the safety level of an aged plant is high enough compared with its original design basis as well as with new regulatory rules or standards posed after the plant initiation of operation. The second one is Degradation by Aging intended to develop an understanding of aging mechanisms in order to ensure a safety in old plants. The use of qualified methods and procedures for the monitoring, maintenance and replacement of aged components and structures is essential both for authorities and industry.

3. IAGE WG mission statement

The main mission of the IAGE Working Group is to advance the current understanding of those aspects relevant to ensuring the integrity of structures, systems and components, to provide for guidance in choosing the optimal ways of dealing with challenges to the integrity of operating as well as new nuclear power plants, and to make use of an integrated approach to design, safety and plant life management.

The specific mandate should be as follows:

1. The Working Group shall constitute a forum to exchange views, information and experience on generic technical aspects of integrity and aging of components and structures, and review, as necessary, national and international programmes concentrating on research, operational aspects and regulation.

2. The Working Group shall stimulate, in relevant technical areas, new research and recommend possible international co-operative projects.

3. The Working Group shall develop common technical positions on specific integrity issues of operating and new nuclear power plants, and identify areas where further work is needed.

4. The Working Group shall discuss the potential impact of aging and other challenges to integrity on the safety, regulation, and operability of operating and new nuclear power plants.

4. IAGE recent activities related to aging management, material degradation and long term operation

4.1 Structural integrity

4.1.1 Thermal fatigue

Thermal fatigue is widespread and there are recurring problems in nuclear power plants worldwide. Several incidents with leakage of primary water inside the containment challenged the integrity of the primary system of nuclear power plants although no release outside of containment occurred. Some complex thermal loads are not taken into account at the design stage of some operating plants (i.e. stratification, mixing). Regulatory bodies, utilities and researchers have to address them for operating plants and design of future plants. There are complex phenomena that involve and link thermal hydraulic, fracture mechanics, materials and plant operation.
In consequence, the CSNI requested the IAGE working group to prepare a program of work on thermal cycling to provide information to NEA member countries on operational experience, regulatory policies, countermeasures in place, current status of research and development, and to identify areas where research is needed both at national and international levels.

Thermal cycling is connected either to operating transients (low cycle fatigue) or to complex phenomena such as stratification, vortex and mixing (low and high cycle fatigue). The former is covered by existing rules and codes. The latter is partially addressed by national rules and constitutes the major effort needed.

The working group proposed a 3 fold program that covered:

1. Review of operating experience, regulatory framework, countermeasures and current research. A questionnaire was completed by Member countries with the objective to find out how widespread a problem thermal fatigue is, to learn what kind of countermeasures have been taken by countries and to obtain a detailed view of countries’ actions and regulations, if any, and to identify adequate corrective actions. Results and assessment of the members countries responses were published in 2005 [Ref 2];

2. Benchmark to assess calculation capabilities in NEA member countries for crack initiation and propagation under a cyclic thermal loading, and ultimately to develop screening criteria to identify susceptible components. The benchmark was focused on mixing problems in which, for high flow rate and extensive discontinuities, the mixture becomes turbulent and a wide range of turbulence frequencies and thermal fluctuations are encountered. The consequence for structures is multiple or isolated cracks which, in some cases, may not be very deep but which in others can cause perforation of the structure. Results of the benchmark were published in 2005 [Ref 3];

3. An active program of information exchange between experts worldwide through: a biennial Conference on Fatigue of Reactors Components in association with the EPRI and the USNRC, and a review of the member countries related information in the annual meeting of the metal subgroup of the IAGE working group.

As a result of the 2007 round table discussions at the annual metal meeting, a proposal for a new activity was agreed, in order to assess the fatigue data transferability from standard specimen to structures and components. After a long process, mainly in Japan and USA, on fatigue of standard specimen, the remaining question will be: how to transfer these results to industrial components and structures. All type of fatigue will be considered, high and low cycle fatigue, mechanical and thermal fatigue, without or with environmental effects. The results of this activity are: confirmation of Code practices to analyze fatigue of components (different codes will be considered); proposal of a synthesis of existing fatigue tests done on components and structures; and, selection of a set of reference tests to check different proposed rules in different countries. The proposal will be submitted to the CSNI for approval at its December 2007 meeting.

In addition, a large number of NEA member countries are participating in the OECD Piping Failure Data Exchange Project (OPDE) to collect field experience on piping degradation [Ref 4, 5]

4.1.2 Reactor pressure vessel and PTS

One of the key issue of aging of nuclear power plants is the radiation effect on the reactor pressure vessel that leads to material embrittlement and can reduce the safety margins in case of pressurized thermal shock. Pressurized thermal shock is still a relevant issue for lifetime extension, and its analysis needs a large number of data with their uncertainties: transients, material properties and flaw distribution. Deterministic approach is too conservative and probabilistic methodologies are used or under development in many countries (USA, Japan, France and Korea). However, there is concern, that calculations performed with the same tool and generally similar data lead to very large discrepancies. Consequently, there is a need to clearly understand how calculations are performed and what improvements or common basis could be adopted.
The NEA CSNI has approved a Round Robin proposal (PROSIR) aimed to assess the calculation capabilities in member Countries and to evaluate methods and hypothesis used. The main objectives of this round robin is to confirm performance of probabilistic approaches for reactor pressure vessel, compare and improve probabilistic fracture mechanics tools, and identify the major uncertainties that play role in these approaches. It is a complementary step to FALSIRE [Ref 6, 7] and ICAS [Ref 8] program on RPV integrity. Nine countries (USA, Japan, Korea, Sweden, Germany, Czech Republic, Spain, EC and France) have been involved in the round robin defined in 2 phases:

- **Deterministic approach.** A deterministic approach based on mean value of each random parameter has to be done as a pre-requisite to assure a perfect fitting at this level of all interested participants. The crack will be located in a longitudinal weld, 2 types of cracks will be considered: surface and under-clad cracks.

- **Probabilistic approach.** It is composed of various analysis involving RR1 : Toughness property distribution versus aging; RR2: Probability of crack initiation versus time for a given transient; RR2-a : Surface crack initiation versus time for a given transients and RR2-b : Probability of under-clad crack initiation versus time for a given transient; RR3: probability of arrest of a surface crack for 2 given transients; RR4: probability of crack initiation for 1 crack in a crack size distribution; and RR5 : Parametric studies for consideration of: other transients, crack type, crack location, base metal / welds, plasticity correction, residual stress, master curve or other random variable are welcome.

The phase 1 (deterministic approach) conclusions are: in general there is a good agreement on temperature; there are some differences between material property variation with temperature (fixed or connected to the temperature variations); there are some differences in K computation of surface crack that is connected mainly to the K estimation scheme; there are some differences in K computation of under-clad crack that is connected to the K estimation scheme or the plastic zone size correction; there are some difficulties with the RTNDT evaluation at the crack tip due to the problem statement not completely clear. All the difficulties have been discussed and finalized before the second phase of PROSIR Round Robin.

The phase 2 (probabilistic approach) conclusions are: for RTNDT estimation there is very good agreement for toughness uncertainties propagation with vessel age (10, 20, 40, 60 years), less than few degree on RTNDT; no major influence of the fluence uncertainties on RTNDT estimation, at least in our case; for crack initiation for 1 defect (Probability of Crack Initiation), less than 1 order of magnitude including all the differences in participant models (see phase 1 results); around 2 orders of magnitude in PCI for under-clad crack due to criteria: with / without plasticity effects; for crack initiation for a flaw distribution (PCI) larger scatter in the results, up to 3 orders of magnitude.

General conclusions of the PROSIR benchmark are that a simple thermal shock evaluation needs a large number of very precise data and method definitions. For similar data and similar methods the results can be strongly different. The type of initial defect (surface crack or embedded crack) is an important hypothesis. The need of determinist approaches based on mean value of each parameter is a key issue to compare probabilistic methods and results.

After PROSIR phase 1 on deterministic analysis of pressurized thermal shock (PTS) on a cracked RPV, and phase 2 on probabilistic approach of crack initiation on a cracked RPV, a proposal has been submitted to the CSNI to approve a phase 3, which will focus on probability of crack arrest in order to have a complete round robin exercise on RPV integrity.

### 5. Environmental effects

Nickel-based alloys are used in several primary pressure boundary components. Degradation of these components could lead to significant loss of safety margins as well as potential loss of coolant accidents (LOCA). For example, circumferential cracks discovered in the CRDM nozzles could result in a small to medium LOCA. The leakage of primary water could lead to significant degradation of the pressure boundary as seen in the wastage of low alloy steel at
the Davis-Besse plant. Both the regulators and industry need data and information to develop effective inspection, repair, and mitigation strategies to avoid significant degradation and loss of safety margins. This is needed for alloys used in the existing components as well as alloys used for the replacements.

The IAGE working group, based on presentations made by the US NRC and CSN representatives at the 2003 meeting, highlighted the large concerns about Primary Water Stress Corrosion Cracking (PWSCC) in nickel based alloys used in the reactor vessel head penetrations and other components, in particular Alloy 600 and its associated welds. It was agreed that a questionnaire be prepared to collect information to help and identify the common needs and area of potential co-operative activities based on the experience, status of existing data and research, and regulatory practices in the various member countries. While considerable research work has been ongoing for the steam generator tubing, there is still incomplete understanding of susceptibility of the thick sections. In addition to the understanding of degradation mechanisms, data is needed on crack initiation, crack growth rates, stress analysis of welded assemblies of nickel-based components, and efficacy of NDE techniques. This is vital for defining appropriate inspection techniques and frequency to avoid potential breach of the primary pressure boundary. This information is also essential for consideration of probability of crack detection, leak-before-break concepts, leakage detection requirements, and risk assessments.

Results and analysis of the responses are documented in [Ref 9]. It is clear from the questionnaire that many of the older pressure vessel heads with Alloy 600/182 head penetrations have been replaced and that more replacements are anticipated in the future. The majority of replacement heads have or will have Alloy 690/152 head penetrations. The reason for the choice is given as either recommendation from others, literature, or the good experience with Alloy 690 as a steam generator tube material. In addition laboratory testing has shown that Alloy 690 is much more resistant to PWSCC than Alloy 600. In most of the few cases when Alloy 600/182 has been chosen for the head penetrations no reason for the choice has been given, probably because that particular question was missing in the questionnaire. In one case, Davis Besse, the choice was opportunistic; there was a head available on short notice.

Several questions dealt with crack initiation. It is clear from the answers that nobody attempts to predict crack initiation as such, except perhaps in a small number of cases. However the American approach of calculating EDY, effective degradation years, is an indirect way of expressing the probability that cracks might have initiated and it is based on an Arrhenius approach. It does not contain any stress dependence. Therefore as a general rule, residual stresses do not play a role in estimates of crack initiation. However residual stresses are often calculated but then perhaps for the purpose of flaw tolerance analysis or risk informed inspection.

6. Risk informed ISI and non-destructive examination

The CNRA and the CSNI agreed to prepare a state-of-the-art report addressing the present situation and regulatory aspects in NEA member countries on: risk informed in-service inspections developments and qualification of NDT system to be used for the inspections.

In order to get a good basis for compiling the report with an overview on the present situation in OECD/NEA countries and regulatory aspects on the further developments of RI-ISI and NDT qualification approaches a questionnaire was prepared. A workshop organized to complement the questionnaire was held in Stockholm, Sweden on April 2004 and hosted by SKI. In addition to regulators, licensees, manufacturers and researchers, this workshop gathered international organisations (i.e EC, IAEA) and the main organisations worldwide developing RI-ISI methodologies. The proceedings of the workshop were published in [Ref 9].

The synthesis report [Ref 10] compiles information from the questionnaire, the workshop and from discussions held at the IAGE WG meetings. It was concluded that major changes of ISI approaches have been introduced during the last decade. The evolution of PSA methodology has provided an enhanced understanding of the consequences of component failures. This
The concepts of RI-ISI have successfully been implemented in several countries and are now along with NDT qualification providing improved ISI that both reduce plant risks and radiation exposure to inspection personnel. These benefits have been achieved at the end of a long period of development and implementation.

The concept of NDT qualification has been implemented in most countries. Implementation experience to date indicates that NDT qualifications have contributed to more reliable NDT systems for ISI. Qualified NDT-systems, in general, performs well. There is confidence in their capability and reliability. Decision making during the NDT process have become more transparent and convincing.

Implementation experience to date and results of pilot studies show however that further evaluations and developments of RI-ISI and NDT qualification approaches are needed. It was recommended that a comparative RI-ISI method performance study were conducted, applying several of the existing qualitative and quantitative methods to the same specific scope of piping in one or two plants, and comparing the results in terms of the extent, the number and the locations of inspection sites.

In consequence the OECD/NEA in coordination with the EC JRC initiated in 2005, a 2 year Benchmark on Risk-Informed In-service Inspection methodologies (RISMET). The objective of the benchmark is to assess both the impact of RI-ISI methodologies on reactor safety and how the main differences influence the definition of the inspection programme by applying various RI-ISI methodologies to the same nuclear power plant piping systems.

7. Aging management and material degradation

The aspects of plant aging management gained increasing attention over the last ten years. Numerous technical studies have been performed to assess the impact of aging mechanisms on the safe and reliable operation of nuclear power plants. National research activities have been initiated or are in progress to provide the technical basis for decision making processes. The long-term operation of nuclear power plants is influenced by economic considerations, the socio-economic environment including public acceptance, developments in research and the regulatory framework, the availability of technical infrastructure to maintain and service the systems, structures and components as well as qualified personnel. Besides national activities there are a number of international activities in particular under the umbrella of the IAEA, the OECD and the EU.

The NEA has been actively working in this area and has issued documents related with the technical and regulatory aspect of long term operation [Ref 11, 12]. Also, an active program of information exchange regarding aging management programmes at the member countries has been taken place at each annual meeting of the IAGE working group. Based on the wealth of information collected, a proposal has been approved at the 2007 IAGE meeting to produce a synthetic programmatic document to develop an Aging Management Program taking into consideration experiences collected by member countries during implementation of their own AMP. This proposal will be submitted to the CSNI for their approval at its 2007 December meeting.

One of the necessary elements for plant aging management is the knowledge of aging related damage mechanisms including benchmarking of the consequences of damage mechanisms into macroscopic behaviour of materials and structures under applicable conditions. The NEA has been actively working in sharing the knowledge of aging related damage mechanism developed in different projects, such as the OECD Piping Failure Exchange Project (OPDE), and the OECD Stress Corrosion Cracking and Cable Aging Project (SCAP). A new research project is under discussion on the Zorita NPP internals.

Several OECD Member countries have agreed to establish the OECD project to collect pipe failure data including service-induced wall thinning, part through-wall crack, pinhole leak, leak, and rupture/severance (i.e., events involving large leak rates up to and beyond the
9. Aging of concrete

In mid nineties, the CSNI approved a proposal to set up a Task Group under its Principal Working Group 3 (renamed as the IAGE Working Group) to study the need for a programme of international activities in the area of concrete structural integrity and aging and how such a programme could be organised.

The Task Group found that a number of national and international programs were addressing aging issues associated with these structures and recommended a medium-to-long term CSNI program of work that included holding a series of workshops that address specific issues associated with aging. As a result of this recommendation, the CSNI convened a series of Workshops and published related reports as shown in the table below. Most of these reports summarize the findings derived from the workshops.

<table>
<thead>
<tr>
<th>WORKSHOP TOPIC</th>
<th>LOCATION AND DATE</th>
<th>OECD REPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestress Loss</td>
<td>Poitiers, FR; August 1997</td>
<td>NEA/CSNI/R(97) 9</td>
</tr>
<tr>
<td>NDE in Concrete</td>
<td>Risley, UK; November 1997</td>
<td>NEA/CSNI/R(97) 28</td>
</tr>
<tr>
<td>FE Analysis of Degraded Concrete Structures</td>
<td>Upton, NY; October 1998</td>
<td>NEA/CSNI/R(99) 1</td>
</tr>
</tbody>
</table>

The issues of aging of concrete structures for current NPPs and nuclear facilities discussed by the IAGE sub-group on concrete in the past ten years are not totally closed. The pre-stress loss has been addressed in a workshop held in Civaux (France) in August 1997. One of the conclusions of the workshop was that research has so far failed to formulate a universal and reliable model for predicting both short and long term loss of pre-stress in actual concrete structures.
There is a general lack of confidence in the Non-Destructive-Examination (NDE) techniques because there is very little independent advice on their applicability, capability, accuracy and reliability. The information obtained by these techniques appears qualitative rather than quantitative and there is concern that NDE procedures lack the necessary qualification to permit their use on safety critical structures. There is no authoritative international guidance or standard for NDE of concrete structures. This topic has been addressed in a workshop held in Risley (UK) in November 1997. Recommendations issued at the end of the workshop advice CSNI to review this topic after 3 years.

The capability of current instrumentation and monitoring systems to describe the actual state of structures and detect aging problems should be assessed. Technologies of this domain are quickly evolving. This topic has been addressed in a workshop held in Brussels (Belgium) in March 2000. Extended life time of NPP should bring the concrete sub-group to revisit this domain.

Current practices and state of the art with regard to the evaluation of defects, repair criteria and methods of repairs for concrete structures on NPP should be reviewed with a view to determining the best practices and identification of shortfalls in the current methods. This topic has been addressed in a workshop held in Berlin (Germany) in April 2002. The concrete sub-group should review how recommendations issued by the workshop participants are taken into consideration.

Experience to date suggests that some structures will suffer local degradation during the life of the plant that could require an assessment of the significance of the damage and a determination of the actual margin against the effects of internal accidents or extreme environmental events. Finite Element analysis is a still evolving approach that offers promise in that domain. This topic has been addressed in a workshop held in Brookhaven (USA) in October 1998. Recommendations issued at the end of this workshop asked for future action/research in order to improve validation of models.

At the 2007 meeting of the IAGE concrete sub-group, a proposal was made to hold a workshop in early 2008 on aging management of thick walled concrete structures including ISI, maintenance and repair – instrumentation, methods and safety assessment in view of long term plant operation. The objective of this workshop is to present state of the art techniques for the integrity assessment of concrete structures, and to recommend areas where further research is needed. Special emphasis will be given to performance-based ISI based on NDE methods (such as impact echo, ultrasound and high frequency radar) and instrumentation. Limits of applicability will be extensively discussed. The management of aging programs based on suitable structural monitoring will be addressed also in the framework of a safety assessment of the installations in the long term. Probabilistic methods oriented to the reliability structural assessment will be compared and suggestions will be issued for consistent management of the integrity assessment of civil structures, both repairable and not.

9. **Seismic evaluation of aged components**

A joint workshop between the three sub-groups of the IAGE working group was held during the 2007 annual meeting. The objectives of the meeting were: to increase the synergistic communication and interaction among the IAGE sub-groups; and to identify cross-cutting issues of interest to the three sub-groups on existing and new reactors designs. One of the important issues discussed at the meeting were different member countries assessment of the seismic behaviour of degraded piping. Japan presented several experiments to address the piping failure mode, the vibration characteristics change as well as the seismic margin change.

10. **Conclusion**

The CSNI and CNRA have identified the necessity to ensure safety over plant life cycle as one of the main challenges for nuclear safety that regulatory authorities and the research community will face. The management of plant aging, life extension and license renewal are of direct interest to all member countries. The physical and mechanical properties of most materials and components change with age and these changes are often exacerbated by
environmental factors. It is important to develop methods for identifying, testing and modelling the aging mechanisms that affect materials and components important to the safety of nuclear power plants.

This paper has outlined some of the CSNI/IAGE activities aimed: to develop an understanding of the aging degradation mechanisms; to identify appropriate methods for in-service inspections; and to generate and assess the capability to model the aging mechanisms. This could significantly improve the member countries aging management programmes required for a safe long term operation of nuclear power plants. The IAGE working group will continue addressing the technical aspects of aging for long term operation in close cooperation and coordination with the IAEA and the European Union.

References

[7] NEA/CSNI/R(96)1 CSNI project for Fracture Analysis of Large-Scale International Reference Experiments (FALSIRE) Phase II.
[10] NEA/CSNI/R(2005)9 Review of International Developments and Cooperation on Risk-Informed In-Service-Inspection (RI-ISI) and Non-destructive Testing (NDT) Qualification in OECD-NEA Member Countries