SEANCES PLENIAIRES / PLENARY SESSIONS
Débats / debates and discussions

Le contrôle de la sûreté des équipements sous-pression nucléaires / Control and supervision of safety of nuclear pressure equipment

Tribune ASN France / ASN France panel : Alain SCHMITT, Sophie MOURLON, Laurent FOUCHER
Sophie MOURLON – ASN France, Susanne SCHULZ – HSK Switzerland, Karen GOTT – SKI Sweden,
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Sophie MOURLON - Notre première séance plénière va traiter du contrôle de la sûreté des équipements sous pression nucléaires. Nous allons tenter de dresser un panorama général des pratiques et des approches en matière de sûreté et de gestion du vieillissement.

Nous avons voulu des panels variés et nous avons fait en sorte que des approches différentes soient représentées dans chaque panel. L'Autorité de sûreté nucléaire française sera représentée à la tribune par Alain Schmitt, directeur général adjoint en charge des réacteurs de puissance à l'ASN, par Laurent Foucher, adjoint à la sous-direction chargée des réacteurs de puissance à l'ASN et qui est également ancien chargé d'affaires du BCCN, par moi-même, et par Dominique Arnaud, mon adjointe.

This first technical introduction is about control and supervision of safety of nuclear pressure equipment. I will try to present the French position on this matter.

Ageing issues for nuclear pressure equipment are numerous. Among them, and very important, is the degradation of many mechanical properties of materials. For instance, thermal ageing and irradiation embrittlement are issues for pressure equipment because they degrade their mechanical properties over time. We also have the degradation of the equipment itself, for example through stress corrosion, fatigue, and other kinds of corrosion. Very important and not to be forgotten: the loss of skills and know-how and the obsolescence of materials. This loss of skills and know-how is important because it affects engineering teams of utilities and also manufacturers and sub-contractors. This is all a challenge for the safe operating lifetime of nuclear power plants. As Mr Borchardt said, it is very important to take this into account now in order not to meet any problems in the future with current power plants or future power plants.

What is specific to France? In France, 58 pressure water reactors are operated by one utility. They are all similar in design. They were built by Framatome. The oldest one is Fessenheim – it started operations in 1977 – and the most recent is Civaux, which started operations in 1996. We have quite an important fleet of reactors with similar design and very close in age, because they all started in a period of less than 20 years. This has advantages because we have a large fleet to have feedback experience. That is a good advantage for ageing management but it also has drawbacks. In particular, any problem that might affect one reactor might, in fact, affect all reactors at just about the same time because they are all so close in age. This is taken into account in the French regulatory approach to ageing management.

It is important to say that, in France, the regulatory approach to ageing management does not set any licensing lifetime. There is no lifetime introduced in the licensing process. Of course, there are hypotheses on lifetime which are taken into account in design studies, but the operator is responsible for maintaining the safety of the plant and the plant may operate as long as safety is ensured. I said the operator is responsible for the safety of the plant. It is responsible for safe operation, of course, but also surveillance in operation which includes in-service inspection, repairs and replacements in time, and provision of safety demonstrations. The Nuclear Safety Authority may require a comprehensive review of safety at any time and may also stop a reactor if safety is challenged at any time.

In fact, this comprehensive safety review is done every ten years. It is a periodic safety review every ten years during decennial outage. The utility, during this safety review, is required first to check that safety requirements are still met although the reactor is ageing and degradations are appearing on the reactor. This includes improvements in safety demonstration if necessary. Of course, improvements in the demonstration are not improvements in safety. At this point, it is only checking that safety requirements are still met throughout the lifetime of the plant. The second point, and very important, is that the utility is expected to implement technical improvements on equipment and operation to update reactors to state-of-the-art technology and design. This is improvement of safety. The utility is supposed to take into account, in particular, the new technologies that are designed for new reactors. The programme of the periodic safety review is designed by the utility but has to be approved by the French Safety Authority.

For nuclear pressure equipment, there is an extended number of regulatory texts. One of them is very important: it is the order of November 10, 1999 for Main Primary System and Main Secondary System of PWRs. This text is oriented towards ageing management. All the requirements that are found in this text are, in fact, oriented towards ageing management. It uses a 'defence-in-depth' approach with requirements on design, on surveillance operations, on maintenance and on feedback experience that we are going to detail now.

For design and fabrication, the designer and future utility are expected to study materials and their fabrication with respect to ageing issues and ageing problems. Materials have to be chosen and manufacturing processes have to be chosen and studied with respect to ageing management. They are supposed to be qualified to known ageing degradations. The mechanical properties that have to be taken into account for design are expected end-of-life mechanical properties. At the design stage, it is expected that the safety of the plant be demonstrated for the expected lifetime of the plant. It is also required that the designer did what is necessary to prevent fatigue. This means taking into account the possibility of fatigue in design and also in future operation. Measures to prevent fatigue can be taken as well for the design of the equipment as for the operation of the plant. It is also expected, it is required, that the designer did what is required to favour in-service inspection. At the design stage, the reactor must be designed so that the utility may perform thorough in-service inspection. No limit on in-service inspection should be introduced at the design stage.

About design and fabrication, there are other texts. For example, there is a 1974 order on construction and fabrication of power plants. There is now a new order in preparation on this matter to take into account a recent European Directive on pressurised equipment. The present reactors in operation in France were built under the 1974 order. The French Safety Authority has also issued technical rules for construction that are to be applied for new reactors, in particular the European pressurised water reactor (EPR) that is currently being designed in France and built in Finland. For France, these technical rules for construction that were issued officially by the French Safety Authority have to be taken into account.

The utility, EDF, and the designer Framatome in association wrote the RCCM code to codify the regulatory requirements. The French Safety Authority has examined the RCCM code in its first version and is looking at the newer versions of the code. We do not approve it but by looking at it we check that what is written in the code helps in meeting the regulatory requirements. When instruction is finished, we issue a letter to give a decision, to say that the French Safety Authority is okay with the RCCM code and this should be the reference of the design and construction of nuclear pressure equipment.

In the defence-in-depth approach there are many important features for operation; in particular, a good surveillance of the plant should be done by the utility. It has to monitor the relevant parameters – pressure, temperature, chemistry – and to do a transient book-keeping to check that operating conditions are consistent with design hypotheses, and also to perform in-service inspection to detect degradations and flaws. In France, we require the utility to do its in-service inspection in order to detect the flaws before they challenge integrity and before they lead to a leak. This is to check that materials behave as anticipated. They are designed with hypotheses on operation that have to be checked during operation. The design conclusions on the behaviour of the materials during operation are to be checked throughout operation of the plant.

The order of 1999 requires that, for each degradation mode, there be an ageing surveillance programme that is designed by the utility and that has to be approved by the Safety Authority. The degradation modes, for instance, are irradiation embrittlement for the reactor pressure vessel, and thermal ageing. Any degradation mode that is linked to ageing and that is identified is supposed to be addressed through a specific surveillance programme.

To design in-service inspection programmes, the utility is expected to analyse expected degradations and to adapt NDE techniques to flaws. We require performance demonstration systems, called qualification, that we will present tomorrow during another plenary session on ISI. The NDEs have to be adapted to the flaws that are expected – known or expected. Also, the definition of the frequency of the examinations has to be defined depending on the expected degradation and on the growth rate of the expected flaws. But not only that – we consider that it is not enough and that sample checks should be performed on top of those examinations that are done to search for expected degradation and expected flaws. As I said in my introductory address: nature and physics are always more imaginative than men and engineers. To try and meet nature and physics, we require these sample checks to find degradations that were not expected in case they happen. Also, of course, we require the utility to take feedback experience into account for its in-service inspection programmes. In-service inspection programmes are expected to be revised at least every ten years to take into account feedback experience – national and international.

As I said, nature is more imaginative than engineers so we require sample tests and also hydraulic tests that are performed every ten years on pressurised equipment. This hydraulic test is a global test that allows us to find – if it should happen – important degradations that were not expected. It proved useful in 1991 when, during a hydraulic test at Bugey 3, the reactive pressure vessel head showed a small leak. This started a whole set of issues about reactor pressure vessel heads that we will talk about in one of the workshops this afternoon.

For us, for the French approach, it is very important for sample tests and hydraulic tests to be performed. Although we are trying, through feedback experience, through analysis, through studies, through research, to know what is going to happen, we do not know everything. At some point, we must have another type of test, of global test, just to check that nothing else that we did not expect is actually happening in the plants. This shows also the importance not only of national experience but also of international experience because the age of the reactors from one country to another may be different. The operation of the reactor may be different. Also it allows a bigger statistical set if we look at international experience to find what degradations are appearing here and there.

I must also insist on the influence of operation procedures: the same reactor, operated differently, may develop different degradations. In France, 80% of the electricity is produced with nuclear power plants. This means that some of the power plants follow the electricity network so they are not operated on a basic operation but there are fluctuations to follow the electricity network. This means that operation in some of the plants is a bit different and may create new degradations or different degradations or accelerate the process of degradation.

Maintenance: a defence-in-depth approach is also very important. The utility must make sure that repair techniques and repair equipment are available. This means that technical skills have to be created and maintained, that they have to check that the contractors will be available with the right skills at the right time, and the right number of contractors – this is very important in France with 58 very similar reactors – and that the industrial capacity is still there for repair equipment. The utility is expected – it is in the order of 1999 – to repair cracks as soon as they are detected. Also, we often require that utilities perform research on replaced elements: when equipment is taken away from the reactor and replaced by other equipment, it is a good opportunity to perform research on the equipment that was taken away.

With respect to ageing management, the position of the ASN is as follows. The ASN considers that operation of the French reactors for 30 years is possible with adequate surveillance in operation and considering relevant safety cases, of course. With what we know, what we have looked at, and what the utility is doing, we consider that operation for 30 years is possible. Beyond, a thorough analysis is required. The condition of the plant with respect to ageing phenomena has to be addressed and the demonstration has to be made that operation may proceed safely for ten more years. The utility is submitting operation continuation aptitude cases – in French, DAPE – and a very comprehensive review programme will have to be performed at the third decennial outage when the reactor has reached 30 years. Only after that will we know if operation may go on beyond 30 years.

In conclusion, for the French Safety Authority, ageing management requires good design, thorough surveillance and in-service inspection – because design and fabrication are very important but not every degradation can be prevented at the design stage and we have to check that everything is happening the way we thought it would happen – and also the capacity to repair and replace in time. Managing ageing is one thing; more interesting is to anticipate. Anticipation requires experience feedback, requires sample checks and hydraulic tests to find the degradations that were not expected, and, of course, research that can find new degradations that will happen or may happen on the reactors, and international experience. Thank you.

Ulla EHRNSTEN, VTT Finland - I have two questions. I do not know whether they should be put to you or somebody else in this audience. My first one is that you said that not all French plants operate on steady-state operation with full power all the time. Is that seen in the degradations, in that the more you have fluctuations in capacity, the more you have degradation?

Sophie MOURLON - This is under study. Of course, we think right away about fatigue but fatigue degradations have shown that they are not linked only to this kind of operation. One of the main examples of fatigue in France is the Civaux event, when a crack appeared at the very beginning of operation at Civaux. This was not linked to non-steady operation of the plant. The question is under study. Maybe the utility will tell us a bit more about that tomorrow.

Ulla EHRNSTEN - My second question concerns the internals for the EPRs. The design basis is 60 years. You said that for all the ageing modes that you might have, you need a surveillance. How are the internals of the pressure vessel going to be surveyed for the EPR?

Sophie MOURLON - I am sorry, I cannot answer that. BCCN only deals with pressurised equipment : the internals are not in our scope.

Alain SCHMITT, ASN France - Maybe just one complementary remark about the influence of load variations. In fact, up until now we have not seen any effect on ageing of load variations compared to baseload production. The licensee has decided to study this issue in more depth and to concentrate on baseload production on some reactors and load following on the others. Maybe, in some time, we will have new things to say about this topic but, for the time being, we have not seen any influence on the ageing of pressurised equipment.

Dominique ARNAUD, ASN France – Susanne Schulz, physicienne, inspecteur de l'Autorité de sûreté nucléaire suisse HSK, va nous présenter le programme de surveillance du vieillissement ainsi que les documents émis dans ce cadre en Suisse.

Susanne SCHULZ, HSK Suisse - Thank you very much for giving me the opportunity to introduce the Swiss Federal Nuclear Safety Inspectorate's guidelines for ageing surveillance for mechanical and electrical equipment in civil structures in nuclear installations. In Switzerland, we have four nuclear power plants with five reactors that cover about 40% of the electric energy production in Switzerland. We have three quite old reactors : an old Westinghouse pressurised water plant with two reactors at Beznau and an old General Electric boiling water reactor at Mühleberg. Somewhat newer is a Siemens pressurised water reactor at Gösgen and then another General Electric pressurised water reactor at Leibstadt. The three oldest blocks have accumulated already over 250 000 operating hours on the net. If we look at the world statistics of nuclear power plants we see that our reactors are all in the second half.

The history of the Swiss Ageing Surveillance Programme dates back to the early 90s when already some damage had been found. In 1991, a letter was sent to the Swiss nuclear power plants with the requirement to establish ageing surveillance programmes. In response to that, a working group of the Swiss nuclear power plant operator, GSKL, has developed a basic programme for that task, that was acknowledged by HSK. Since about ten years, the elaboration of plant-specific Ageing Surveillance Programme procedures and documentation is underway. Some of the documentation has already been revised several times. At the end of last year, HSK issued guidelines on ageing surveillance of mechanical and electrical equipment in civil structures in nuclear installations. It has 51 guidelines. It is only in German because all of our nuclear power plants are in the German-speaking part of Switzerland. At nearly the same time, the Federal Law on Nuclear Energy in Switzerland was renewed. The new Federal Ordinance on Nuclear Energy now has a separate article that requires ageing surveillance, Article 35. You can see it on the internet in German, French and Italian.

Some recent ageing issues in Swiss nuclear power plants are, for instance, the core shroud cracking in Mühleberg. This was found in 1990 and Mühleberg decided not to replace the core shroud but they installed reinforcement. In recent years, there were efforts to slow down the crack growth and crack initiation by modification of the primary water chemistry of this boiling water reactor but it has not been successful so far. This will be an issue in the future. The stress corrosion susceptibility of this Inconel 600 penetration that we already mentioned is also an issue, although luckily no cracks have been found in Swiss nuclear power plants up to today. Beznau nuclear power plant, with the Westinghouse reactors, recalculated the reactor pressure vessel head temperature last year and found it was higher than they had thought before. This reassessment led to an enhanced ISI programme in the last few years. I think the next test will be in fourteen days or so.

Another issue is steel containment corrosion that resulted from temporary leakages. It has been found in recent years and occurs mostly on inaccessible areas of the containment and a local loss of wall thickness of more than 10% has already been detected. We think it is not a very severe condition at the moment but, in the future, there shall be additional inspections and examinations in order to stop these leakages that cause that corrosion. A single ageing issue was the finding of cracks in a safe end of a reactor pressure vessel nozzle in Mühleberg, that was caused by thermal stratification. It was interesting because this nozzle was in the ageing programme and the mechanism of thermal stratification was mis-judged because the temperature distribution was calculated with the design flow which was not true any more for operation. There is a lesson to be learned from this.

Our guidelines give a definition of ageing, that is, cumulative time-dependent change in physical or chemical properties. The guidelines deal only with material ageing. We define ageing surveillance as all measures of timely recognition, evaluation and mitigation of the condition of ageing. The ageing surveillance programme is the systematic procedure to do so and close gaps if the analysis shows gaps in ageing surveillance.

The whole service life of our nuclear equipment is covered by several guidelines. The ageing surveillance guidelines cover the whole service life from design to removal of the component. The ageing surveillance shall not only take into account normal operation and ageing by normal operation but also single damaging events and flaws from fabrication that are left in place and may influence the process of ageing.

The basic requirements of ageing surveillance are the identification of the ageing mechanisms with the help of catalogues of ageing mechanisms; the component-specific identification of possible ageing mechanisms and the documentation of these assessments; the inventory of existing methods of ageing surveillance; evaluation of inspection methods and techniques and, if necessary, lists of supplementary actions; and, of course, an interface regulation between the different technical departments so that no orphan components between the technical departments are left over in ageing surveillance.

There are several requirements for the systematic procedure that is to consider all known and possible ageing mechanisms, to check the qualification and application of ageing surveillance methods, to identify and treat possible deficiencies and open questions, to evaluate trends from maintenance and operating experience, and to evaluate the knowledge from research and technical and industrial experience. Then we have the tasks to determine the values of risk relevance for components – I will come to this later – with the help of probabilistic safety assessment studies. Last but not least, to document the results and proofs of ageing surveillance.

The component-specific evaluation of ageing has to take into account, on one hand, the generic ageing information and the specific local data of the component or system, such as material information, water chemistry, environment transients and so on. The assessment shall end with a list of positions where possible ageing mechanisms have been identified, the main method that is implemented as an ageing surveillance method, and references to established programmes and, if a gap is found, then a reference to the action plan that is necessary to close that gap.

In our guidelines we have specific instructions for civil structures but because of the lack of time I will skip them. Then for electrical equipment and mechanical equipment let me mention that we look mostly at the classified equipment; of course, all the pressure retaining boundary of the primary coolant system and so on. There may be important components for the safety of the nuclear power plant that are not classified; we try to cover these components by the evaluation of risk values from probabilistic safety assessment studies because these studies are done independently of the safety classes.

I think we have already heard lots of these with the previous speaker so I come to HSK's supervision of ageing surveillance, that consists in: assessment of the ageing surveillance programme documents, catalogues and technical reports; the review of regular and event reporting of the plant operators' inspections; plant walk-downs; technical and regulatory meetings to discuss ageing issues; if necessary, requirements for further assessments; and, like in most countries, the assessment of ageing surveillance activities as part of the periodic safety review every ten years.

Let me come to the conclusion. With our ageing surveillance programmes, we now have a systematic procedures established to determine the current state of ageing of our components and support the planning and maintenance in this respect. Although our ageing surveillance aims at material ageing, it has useful side effects because the historical information is made available from the archives during the assessment so it counteracts document ageing. Young people learn about the history and operating experience of the old components and systems so it counteracts personnel ageing. The recent periodic safety review reflects successful experience with our ageing surveillance programmes. There have been periodic safety reviews for Gösgen, for Mühleberg, and for both blocks of Beznau in the last few years. The next one will be for Leibstadt. The slogan is 'Ageing under control?', but there is a question mark because it is a permanent struggle. Thank you.

Dominique ARNAUD - Spécialiste de la physique des métaux à l'Autorité de sûreté suédoise SKI, Madame Gott a travaillé sur la chimie des réacteurs et possède une grande connaissance des différents aspects du contrôle. Elle va nous présenter la position suédoise vis-à-vis des problèmes de vieillissement, ainsi que la base de données STRYK qui a été élaborée pour son suivi.

Karen GOTT, SKI Sweden - Good morning, ladies and gentlemen. I am going to give a short background, and to explain a little bit about the regulatory situation in Sweden, which has a political aspect to it which you may or may not know about. After that I will talk about what I think is a useful tool in the following of materials degradation and, thus, materials ageing problems. At the end, I am going to give you some concluding remarks.

Bosenbeck One was shut down for political reasons. It resulted from a change in the law, passed after the 1978 referendum, to phase out nuclear power by 2010. A second consequence of this law was that Bosenbeck II was shut down on 31 May this year. The current situation following the realignment of the political situation is that nuclear power may now be used and operated as long as it is technically viable and it is considered safe.

SKI is a small organisation. We regulate, react to safety, non-proliferation, and nuclear waste. We do not have any responsibilities except on a collegiate basis with our sister authority on radiation protection. The full and undivided responsibility for safety lies with the licensee. SKI, being small and using the traditional approach of issuing prescriptions and regulations – not 'cookery book' regulations – has adopted a regulatory strategy in which we ensure that the licensee has the organisation, both with respect to quality assurance, documentation and systems and also sufficient competent personnel, to handle their responsibilities, as defined both by the Act of Nuclear Activities and SKI's regulations. Following the changes in the law, the Swedish utilities are currently planning power upgrades of up to 130% and also an operational life of up to 60 years.

Following the recent changes in the law, the prescriptive regulations that we originally issued, known as SKIFS 1998 : 1, have been reissued as SKIFS 2004 : 1. They became effective on 1 January this year. These regulations are basically editorial changes and the major difference is that we have introduced a stipulation that the utilities must provide SKI with an ageing management programme by the end of this year for us to review. We have also issued complementary regulations – 2004:2 – which stipulate that utilities must modernise their plants so that they comply with current safety and design standards. These regulations were issued after extensive discussions with utilities and have their acceptance. They are, in fact, seeing this as a reason for future investment and have extensive investment plans over the next ten to fifteen years.

SKI's regulations may not have required ageing management programmes as such, but for many years they have required maintenance programmes which should be based on the results of plant-specific probabilistic safety analyses and risk-oriented inspection programmes.

The oldest SKIFS is, in fact, that concerning mechanical components. SKI was first formally allowed to issue regulations in 1992 – one of my first jobs at SKI was to help formulate these regulations. We modernised them in 2000, to comply with the 1998 regulations. The mechanical component regulations are more specific than the overall regulations. They require inspection and testing and other programmes to ensure structural integrity. We have, since 1994, required that only qualified inspection and repair procedures are permitted. All degradation must be reported and also investigated so that we have an assured root cause report. If you find any degradation then you have to expand the inspection sample to cover 100% of similar components – similar either because they have the same material or because they have the same operational situation.

We have been using this risk-based inspection rule for a long time and it is based on a consequence index and a damage index. This combination will give you :

- 100% in the area that is designated "A" ,
- a sampling in the areas designated "B",
- and in "C" you must have your own non-reportable inspection programmes.

The damage index is assigned on a component-by-component, weld-by-weld basis and depends on anticipated degradation mechanisms. The utilities now have guidelines on, for example, carbon count content, temperature for thermal fatigue and such like, to designate the damage index. We also have a consequence index. This is both a more global approach but it is also associated with the PSA results. The larger the consequence, the higher the risk, the faster you go up into 100% sampling for your inspection.

In the mid-90s we realised that we had collected information from the beginning of the nuclear power operation in Sweden from the 70s and we started to try to get this organised into a database. We have not limited it to piping; we have extended it to include all mechanical components that are regulated by SKIFS. To date, there are about 1 900 entries, which are set for cracks, and these cover 1 300 different events. This is what the interface looks like. I would like to point out that when you have a database, you have to be careful how you analyse it – what you actually put in and what you can actually get out. You can only put in what people will give you as information. All countries suffer from the fact that reporting level requirements have changed over the years, so that older information is not necessarily exactly equivalent to current information. This means that you may not even have information about some events because people were not required to report it in the early days.

The time entered for an event is always the time at which you discover the crack – it is not the time when the crack appeared. If you have a ten-year cycle, you could have a ten-year-old crack or you could have a one-year-old crack or you could have a two-day-old crack: you do not know. Another problem is that system numbering varies between plants. This may sound like a minor detail but it is, in fact, a problem. I have cases where not even the utility knows which system they are actually reporting on, so some reports have one system number and exactly the same event on another report will have another system number. You have to make a decision as to which system you are going to report this event under. This can also give you discrepancies when you are doing the analysis for inspection procedures for the inspection programme. You can see that there are some years in which there were a large number of events. 1986 was a year when Ringhals I and Oskarshamm I found a lot of stress corrosion cracking. This was following the events in the United-States. We had one or two leaks and they decided to just replace a lot of piping and went into the lab and looked at this piping and these events are recorded as 1986 stress corrosion cracking events. In the early 90s – 1993 and 1994 – Oskarshamm I did an inspection and found a major problem with its feedwater system. That is, in fact, unique in that the feedwater system goes in at the bottom of the reactor vessel and is, in fact, an internal pipe in the final stage of that system. That resulted in a major renovation of the plant. They worked for about 18 months, finding more and more cracks and problems as they proceeded and had permission to restart on the condition that they replaced their core shroud and the header of the internals – a lot of internals have been replaced there. This started a trend in Sweden and several of the power plants have replaced their core shrouds to avoid cracking problems in the future. The PWR core shrouds in Sweden are bolted in place rather than welded so it is a slightly easier operation.

Around 2000 we have another example of a generic problem. Inconel X750, with the wrong heat treatment is a well-known problem for stress corrosion cracking. The improved inspection procedures that were implemented in 1999-2000 found a large number of cracks in some internals. You also have a problem that you may not be finding things because you have the wrong inspection procedure: even though you think it was qualified it may not have had sufficient resolution to find the cracking. This is just the same information in a different scale.

Since we have had this inspection programme in place, detection methods have found almost 90% of cracks. The major degradation mechanisms do not differ in Sweden from anywhere else in the world. You can use a database to see if your root causes are the same as in other countries. Again, this is always a subjective analysis, it is a personal analysis – this is my personal analysis based on reading as many reports as have been made available to me. You will notice that it is not, in fact, weld sensitisation that is the major problem in Sweden but it is cold work. Cold work due to manufacturing practices but not least cold work due to grinding and scratches on the internal surfaces of the components. This continues to be a problem and I think it is a problem that is not recognised sufficiently around the world. Cold work and sensitisation are an ongoing problem on our plants, as Inter Granular Stress Corrosion Cracking is a function of operational time. It is a continuing problem despite the fact that several of our reactors have been running on hydrogen water chemistry. I do not think that hydrogen water chemistry stops propagation and, thus, when you increase the inspection resolution, you are going to find cracks that have been there for some time. There are also new cases of stress corrosion cracking or fatigue. I think you have to be careful when you are looking at ageing management programmes : they are plant-specific. You cannot say, “This is a generic type of plant, therefore we will not have problems. Look at Oskarshamm III – no problems therefore there will be no problems in Forsmark III.” – it is not true. You have to do this on a plant-specific basis.

In-service inspection programmes are effective. Many people call these ‘ageing management’ programmes but we think that an ageing management programme is more extensive: it includes maintenance programmes; it includes the ageing of codes and standards; it includes the ageing of personnel, as has been said earlier. However, they are an important basis for ageing management. I think a database can be useful to help analyse both inspection programmes and ageing management programmes. It gives early warning of trends and it can also help assess if the individual programmes are appropriate. I think it is necessary to correlate degradation mechanisms and inspection programmes to include all systems and all components and not limit it to piping. I would recommend, to those that do not already know about it, the international cooperation on the OECD/NEA database, which covers piping. Maybe we should, in the future, extend that to cover more components. Thank you.

Dominique ARNAUD – Monsieur Figueras, spécialiste de la sûreté nucléaire et de la mécanique appliquée au domaine de l’industrie, appartient à l’Autorité de sûreté nucléaire espagnole CSN. Il va présenter la démarche de renouvellement des autorisations d’exploitation des réacteurs en Espagne. Cette démarche sera illustrée par le cas du réacteur Santa Marìa de Garoña, en regard des problèmes de vieillissement.

José Maria FIGUERAS, CSN Spain - Bonjour, Mesdames et Messieurs. Good morning, ladies and gentlemen. I was asked to prepare a presentation in cooperation with some people from one of the Spanish plants: Santa María de Garoña nuclear power plant in northern Spain. The presentation mainly refers to the

specific case of how this plant is conducting their own analysis and studies on long-term operation. First, I will make reference to the Spanish regulatory framework for long-term operation beyond the 40 years' design life. Then I will give a brief description of what an ageing management evaluation is, without describing it because I think all of you know the problems and because it will save some time for the discussion later on. I will go directly to the case of Santa María de Garoña with the analysis specifically of the reactor pressure vessel and some examples of ageing management programmes and time-limit analysis.

To briefly describe the framework of ageing management in Spain, we can say it is divided in four major phases or parts. The first one is the management and evaluation of ageing with the classical phases of scoping, screening, definition of the ageing management review and time-limit ageing analysis. The second part relates to radiological impact. The third one is the analysis of new regulations that could be in place beyond the 40-year period – not only the actual duration but also new regulations in the future, that needs some analysis. Finally, as previous speakers said, we also, in Spain, follow the European scheme of ten-year periodic safety reviews. All this information must be submitted to the CSN under the periodic safety review package.
Santa María de Garoña power plant started in 1971 and is almost 33 years old today. It is a General Electric Boiling Water Reactor, model BWR 1, and containment type mark 3. It has a roughly 500 megawatt electrical output. It is similar to some other plants in Europe and the US, such as Mühleberg, Monticello, Dresden and some others.

At that plant, the owner has prepared a project called 2019 in order to prepare all the tasks needed for a long-term operation and to prepare the documentation in order to submit it to the CSN, to the regulator. From 2002 to 2005, they have prepared all those phases. The actual project status is that they are preparing the other part: the periodical safety review documentation and integrating all the ageing analysis in that periodic safety review application. They intend to submit to CSN this information by next year, mid next year, and we hope that in two years or two and a half years, we will have the review performed in order to grant a renewal of the licence for ten additional years in 2009.

What does the ageing management review look like? The components of the plant are divided into sub-components like, in the reactor vessel, the reactor vessel bottom head. Then, are identified the intended function, the material, the environmental conditions to which it is submitted, the degradation which is expected, the ageing effects which should be hoped for by management and the ageing management programmes which are in place in the plant. Finally, – because we follow almost fully American regulation 10CFR54 for licence renewal rule – we say in which chapter and which table of the GALL Report – the new 1800-1 report – should be found information for analysing this type of evaluation.

Examples of ageing management programmes are typically Section XI of ASME, for: in-service inspection; water chemistry programmes; the reactor head closure stud; for boiling water reactors especially, the feed water nozzle and the vessel internals; thermal ageing embrittlement; and so on. For time-limited ageing assessment analyses, the resolution is the classic one, by extension of the actual analysis to add an additional period of at least ten years and maybe 20 years. This means to reach the 60-year period. In some cases, generic information can be found in standard technical literature but in others, it should be analysed specifically for the plant because it is a specific item.

Concerning the final values that can be obtained for the RTndt, for up to 60 years of effective full power years of operation, the increase in reference temperature is less than the 200-degree limit. For the impulsive energy also, the reduction is well over the limit. That means that embrittlement of the vessel wall by the neutrons will not challenge the vessel in the Santa María de Garoña plant up to 60 years of age.

Let me give some conclusions. The first is that the licensing requirement for long-term operations in Spain has started. Santa María de Garoña is the first plant to apply for that and is now preparing the documentation. We will apply next year. The nuclear regulatory body has prepared a document entitled *Requirements for Long-Term Operation of Nuclear Power Plants in Spain*, that contains those aspects that I have reflected in the first part of the presentation. That means that those requirements put emphasis on ageing issues to ensure that key plant components will perform the intended function during the extended operation period in such a manner that licensing bases are maintained. The third is that, with this first case of the Garoña application, it has demonstrated that there is a robust methodology available to the relevant aging effects of those key plant components and equipment. Finally, the preliminary results for the Santa María de Garoña plant show that, in principle, there are no technical obstacles to the extension to 60 years. Every 10 years, the licence we will grant to Garoña will be to 2019, then they can apply again if they wish for a further 10 years. Thank you very much.

Sophie MOURLON - Je souhaiterais d'abord remercier les trois intervenants pour ces présentations très intéressantes. Ma première question va à Monsieur Figueras.
In relation to Santa María de Garoña. I would like to know if there are maintenance operations or replacements that will have to be made for you to issue the licence renewals.

José Maria FIGUERAS - Yes, I think so. I think there will be changes on maintenance. Personally, they are moving to a more centred maintenance than the classical prescriptive maintenance. If you want to know some more details I prefer that the owner answers the question.

José TORRALBO, NUCLENOR, Santa María de Garoña - Last year we changed our maintenance programme in accordance with ASME, for a more reliability centred maintenance. Our maintenance programme has been changed recently, in the last six to eight years, according to this new approach, LCM and maintenance rule.

We are again discovering new changes for the passive components. We have a list of improvements to incorporate in our programme to adapt our actual programme to these new issues that we are discovering. We have this framework from now to 2009 to incorporate in our programme, and we have decided to incorporate them now and not to wait for a new permit.

Laurent FOUCHER, ASN France - Maybe I could ask a complementary question on this point. Since the replacement is an element in the safety demonstration, sometimes you cannot replace parts and you have to justify by research and development methods. Do you have such programmes to complete the replacement or to complement the safety demonstration?

José Maria FIGUERAS - Yes, there are. Here I will refer only to the Garoña scheme, but this scheme is also relevant to all the plants in Spain. With the exception of the Solita Plant that is going to be closed next year, there is a standard programme for the replacement of components. The most renowned is, of course, the steam generator replacement, but also the vessel head. The big headache that the vessel head has created all over the world! But there are also other systematic replacements, for instance, turbines low pressure and high pressure bodies in the turbine. Also the balance of the plant is more or less systematically changed. And specific or particular problematic parts, for instance, in the Garoña plant they have replaced the clean-up system that is exactly the same system as the pressurised water reactor and the chemical system. All the stainless steel parts have been replaced.

Laurent FOUCHER - My question is: at times you are at the limits of the classical justification methods and you have to improve the justification methods by research and development actions. For instance, you cannot replace the parts or you want to improve your knowledge of the margins which are effectively available. To complete the safety demonstration files, this is a point which I did not find in the presentation. All the programmes are very structured. We might think that the problem is under control but an important part of the demonstration is that sometimes you are at the limit of the classical method, so what do you do?

Karen GOTT - In Sweden we have a requirement that any replacement must be either identical, or a proven technology or tested for that specific application. For example, in 2003, a thermal sleeve was replaced to a T-junction. According to the supplier, it was proven technology, and it had been used in other industries. It very quickly suffered from thermal fatigue and wear problems and caused problems with the flow into the core. They had to shut down. It is very important that you use proven technology for the nuclear industry or that you test the components which you are replacing.

Sophie MOURLON - You said yourself that you think that problems are client specific.

Karen GOTT - Yes.

Sophie MOURLON - So, of course, the problem with qualification of design and manufacturing, having proven technologies is a good thing, but I think that probably it is not enough. So what is good for one plant, may just be very bad in another plant.

Karen GOTT - You can never guarantee, but you can always monitor if there are uncertainties.

Sophie MOURLON - I also have a question about the database. You told us how careful one has to be with such a database because of the data that is in it. The French approach is that the utility should have the database, not the safety authority. So we expect the utility to have this database and to give us the analysis of what is in the database. What do you think of that and what approach is taken in other countries?

Karen GOTT - We certainly would not rely only on a utility database. Over the years, we have had four different utilities. That is one advantage you have, you have one utility, so you have one French database. To get a national database in Sweden we decided that we needed to actually do the work. The utilities have different reasons for having databases. In Sweden they have them in a proactive manner so they know that if they find cracks in one weld, they know all the other welds that have similar material. So they can expand their sample to cover all those welds. They also know whether the supplier has supplied the same material to another plant, so it may be that the sample has to be expanded to other units. I think that you need a national database rather than a utility database.

Sophie MOURLON - That is true. What about Switzerland?

Susanne SCHULZ - In Switzerland we have different companies with nuclear power plants, so they are in competition with each other. They can take advantage of the database of Westinghouse or the GE nuclear power plants feedback. And of course, can get some information through the basis of the Siemens world of pressurised water reactors. The working group of the Swiss Nuclear Power Plant Operators, the GSKL is not an organisation; it is really just a working group where specialists come together from their respective areas and do some work together. There is no institute or anything like that behind it. So sometimes it is not easy to get power plants to collaborate. Each one wants to make its own way in the cheapest manner possible, which can be problematic. We try to encourage them to collaborate because we are sure that all parties will profit. We have no database, the nuclear power plant operators do not have a common database. We have some collections but I would not call it a database.

Katsuji MAEDA, NISA Japan - I think that databases should be shared between licensees and regulators. The regulatory side should confirm the adequacy of the ageing management programme. They should use the same database for the same calibrations. Not only should the database be shared by utilities and licensees of domestic regions, but also I think ageing management databases should be established internationally. Many people are gathered to discuss how to establish or how to make integrity of ageing management programme.

Sophie MOURLON - Maybe for international cooperation databases, we will have some more information at the beginning of the afternoon, with the role of international organisations.

Matthieu SCHULER, ASN France - I am the Deputy Head of École des Mines engineering school in Nantes. My question is again on the database. It is always interesting to look at numbers and figures. I must admit that I was astonished by one number that came up.

When you add the percentage of degradation, discovered by very simple methods, including visual control, penetrate testing and work down, you have nearly 33% of the detection. This means that in the surveillance programme, we have to pay attention to this very simple method. As Sophie Mourlon outlined in her introduction, when we are talking about risk inform programmes, the application of sample checking of very simple methods is, to me, very useful to detect degradations which were not expected before. In this database, I did not see anything that would be safety relevance of the degradation which has been seen. Do you have an analysis of what could have been the safety relevance of the degradation if it had not been detected?

Karen GOTT - Visual inspection also includes the use of TV and video. For example, internals are almost exclusively inspected using visual techniques, so they are not necessarily the simple walk down type of, 'seeing it with your eyes'. Visual techniques used for inspection of internals have to be calibrated, as well as ultrasonic techniques because of the lighting problems, the oxides and the different colorations. So visual techniques can be at least as complex as ultrasonic techniques. I do not think you can just call them 'simple' techniques. The safety relevance of the degradation, yes, we do regular analyses and study trends. I am due to do another complete analysis of the database over the next 18 months or so. To date these have been produced in Swedish, but I feel I am under international pressure to write it in English next time.

Claude FAIDY, EDF France - Concerning databases in our country, we have a first exchange with the safety authority because we have some databases, we probably can not answer all the questions they have, but we are ready to discuss that with them. I have a more general question to the three authors. You mentioned risk-informed use at different levels. This does not apply to France and we would be interested in knowing to what level do you apply it? And what are your requests from a safety aspect for local crack or fracture or low consequences situation. It is the most sensitive aspects which are connected to the unknown aspects.

Karen GOTT - We have applied this qualitative risk-based approach for more than 20 years. You do not know what you do not know and you do not know where it is going to happen. We have a sampling system whereby you have to choose components, materials, combinations, environments, so that you do get a good sample of the plant. And this sample population should be studied in a 10-year cycle. We found PWSCC in safe ends before it was through a wall, using this methodology. It may not be the answer to everything, but it seems to have worked fairly well to date.

Susanne SCHULZ - For Switzerland we also have a simple risk-informed procedure in our ISI regulation for safety Class 2 components. It is only a qualitative method. We must look at the risk relevance of components from PSA studies that cover a whole power plant to see where are the risk-relevant components, independent of the classification system. This way we can get inside the components, which might be important for the safety of the power plant but are not included in the considerations of ageing up until now. It is a means to complete the whole picture of safety.

Laurent FOUCHER - Did you want to comment?

José Maria FIGUERAS - Also in Spain we are performing that kind of risk inspection activity, mainly for Class 1 piping and the primary loops. For instance, you know that on the ASME code XI, you do not need to make an inspection for each piece of piping. When you perform this risk-informed application, you get more risk on the lower than four-inch piping than on the bigger ones. There are some important facts that can be obtained by using this method. On the other side, if you are performing that, you will normally reduce the scope of inspection by a drastic number.
If you take into account that you are going to, in 10 or 20 years, you are reducing the quantity of inspection, you have to balance it. There are benefits and the non-benefits to the application.

Susanne SCHULZ - We also had pilot studies on applying risk-informed procedures, one for the Westinghouse plant and one for GE. The results of these procedures are completely different. At the moment, we are not able to make an interpretation of these findings so we decided to go slowly in that direction.

José Maria FIGUERAS - I agree. It's a case by case application.

Karen GOTT - We have never had the ASME codes as the inspection procedures. If, and when, our utilities go over to a full risk-based inspection procedure they are not going to win a lot of inspection. They are going to direct the inspection to areas where maybe the current system is not capturing the sampling numbers.

Ann MacLACHLAN, NUCLEONICS WEEK, France - You mentioned a requirement for a cost-benefit analysis to be integrated into the long-term operating licence review. You did not detail that point. Could you tell us what is the importance of that or how is it done? The second question is you told us that you are following quite closely the NRC regulations, yet you are preparing to issue a licence for another 10 years. The question is: why not another 20?

José Maria FIGUERAS - The first part on the cost-benefit analysis is something which has been added by the utility. In essence, I guess it will not deal with the safety analysis of the application for a long-term period. There are some aspects which could be studied. The are some possible new regulations to be applied in the next 10 or 12 years. It might be worth having some cost-benefit analysis; it is really important to add a new regulation on how much it implies in the balance of cost and the balance of benefits to the safety.
Related to the second question, we follow American law-making but not fully. One reason we are not fully implementing that is, for instance, we are using the European process of instruction for the safety review so we would like to be more careful granting permits. When you perform TLAA analysis the opportunity normally will perform that for 20, or even more than 20, years. For the regulatory parts, we prefer to grant permits every 10 years and not to extend, as our American colleagues say, to 20.

Dominique ARNAUD, ASN France - Avant d'appartenir à l'Autorité de Sûreté Japonaise, NISA, où il travaille depuis 2003, Monsieur Maeda a dirigé le département de métallurgie chez Toshiba. Auparavant, sa carrière avait été consacrée aux questions relatives à la chimie dans les réacteurs à eau bouillante. Monsieur Maeda vous présentera l'approche de l'Autorité de Sûreté japonaise et la problématique du vieillissement et de la durée d'exploitation des réacteurs.

Katsuji MAEDA - I will show the situation of the ageing management in Japan.
First, *the background of ageing management*. In Japan, the operating period is permitted only about one year. We will also take account of the current legal obligation of implementation of ageing management. Now, we consider effective cooperation of industry and the regulatory side, and the academy. The Examination Committee was implemented last December to make effective ageing management. We prepared an interim report this spring and the final report will be distributed in August.

What is the background of ageing management in Japan? 53 nuclear power plants are operating in Japan, 30 nuclear power plants, NPP, will have been operating over 30 years in 2010. Some BWR plants have been operating for over 40 years. So this kind of situation indicates the importance of creating an adequate ageing management programme. We have nuclear power plants operating in Japan for over 35 to 40 years.

In Japan, the operating period is permitted under this kind of law and regulation. This next piece of background information is very important. Under Section 91 there is limited operation. Beyond 13 months, no nuclear power plant can operate without passing a legal inspection. This is a very different situation compared to international laws. Again, I must say, in Japan, every nuclear power plant can operate only 13 months. This means that if the 13 month inspection can be passed, any nuclear power plant can operate for a very long time period, over 40, 50 or 60 years.

There is a scheme of regulation related to ageing management. Regulatory inspection is required every 13 months to continue operation. PSR is a Periodic Safety Review. PSR is evaluated over the validity of past maintenance activity for plant safety and reliability. One of the parts of PSR – ageing management – will be implemented when the plant is operated just before 30 years. Validation is required every 10 years over 30 years' operation. PSR reviews maintenance management adequacy of the past, ageing management programmes are focused on the future.

Basic policy and concepts of ageing management. The office of natural resources and energy prepared 'The Basic Policy on the Ageing Management of NPPs' in April 1996 but now, in Japan, many BWR plants have long operation of over 30 years. Basic policy, required that these kinds of items, implement ageing management review before 30 years and established that 10 years' long-term operation and maintenance programme based on the above technical evaluations. And this kind of technical evaluation, the long-term maintenance, should be evaluated every 10 years after past ageing management reviews.

What is the concept of ageing degradation and maintenance? The ageing degradation phenomena copes with routine maintenance activities. Because, when ageing management reviews are conducted by utilities, at that time, one of the major purposes is to review the effectiveness of current database maintenance management programme for the ageing degradation. On this evaluation, there is some kind of additional requirement for long-term operation. Key ageing phenomena, for example some kind of degradation, will occur rapidly or will occur maybe in the future in many parts or components. Such kind of degradation should be considered to be very important.

Then we have the concept of ageing management analysis: extraction and extraction systems structure, components and the ageing phenomena. Ageing phenomena is extracted, not only domestic nuclear power plant electric production, but also overseas and other industries and we can compare this kind of phenomena and systems. One of the major viewpoints is the review of current maintenance programme adequacy.

And after the evaluation, PRS ageing management for long-term operation is prepared. There are three items, one is confirmation of current maintenance management programme to be continued adequately. The second is the extraction of additional maintenance programme. The third is extraction of R&D items. Ageing management is covered in three categories: one is predict evaluation of ageing effect and the second is surveillance inspection and monitoring. And the third is repair and replacement.

Utility implemented ageing management reviewed in nine nuclear power plants in Japan. The government has evaluated the adequacy of these licences and reports government review for the nation. As regards the implementation of the ageing management review, nine NPPs have been reviewed for ageing management. This shows the actual names of the plants.

Ageing management has been legally specified as an obligation since October 2003. Before October 2003, ageing management was not conducted on a mandatory basis. But since October 2003, it has become legally specified because the nuclear power plants will operate over 30 years in the future.

Ageing management reviews should be evaluated every 10 years after the first ageing management review. The ageing management review is the one that is based on quality management system. It is very important to conduct it as part of a quality management system.

There has been improvement and consolidation of ageing management. 53 nuclear power plants were operating in June 2005, at that time. And 20 nuclear power plants will have been operating 30 years and some of them will have operated 40 years in 2010. So ageing degradation will be frequently actuated in ageing nuclear power plants, therefore more careful maintenance should be required. Ageing management is a great challenge to ensure safety and integrity. And another viewpoint, as you know, where the Mihama accident, a secondary pipe killed four people. It was because of the flow accelerated corrosion in the pipe seam. There is no good management of ageing. This background has determined that it is necessary to verify if ageing management has an appropriate response to the ageing effect and the re-examination that the government should enforce to the ageing management. We also have actual improvement and consolidation of ageing management.

System strengthen of government. Ageing Management Office was implemented in the government last December. The mission of the Ageing Management Office was the Constitution of Guidance Documents as follows: the constitution and the verification of utilities, ageing management implementation and so on. And another strength is the improvement and conservation of ageing management is system strengths of JNES. JNES means Japan Nuclear Energy Society Organisation. And JNES's mission is […] provides technical support to Ageing Management Office of government. It is very important to evaluate technical views, to evaluate licences, ageing management review. So AEO, Ageing Evaluation Office in JNES has responsibility for reviewing that.

There is a relationship between ageing management and the guidance documents. Publication of the ageing management review report is provided by licensees and the reflection to routine maintenance program. On the other hand, some kind of ageing management document, control document should be prepared. A prescription guide of basic policy considerations for ageing management is prepared by government, NISA and detail relative to ageing management document. One is a standard examination guidelines. It is similar to as a standard review by NRC. And another is the Generic Ageing Technical Database. This kind of document is used and combined with consumer specification. And some kind of consumer specification, codes, guides or standards would be prepared by the requirement of the best policy consideration for ageing management.

This document is applied for the technical review and ageing management programme by licensees. After that, a publication about ageing management review report by licensees, NISA and the government should evaluate the adequacy of the licensees report by using this kind of document.
One of the more important and interesting items is the Examination Committee for Ageing Management. This Committee was implemented last December. The Committee has been reviewed and discussed best policy on important matters such as clarification of ageing management, constitution of guidance documents and technical base for ageing management. The Committee has met four times and submitted a final report in August 2005. These are the activities of the Committee.

Future deliberations in the Committee. This Committee will provide clarification of SSCs in the scope of ageing management. The role of PSR, direction and promotion of safety related R&Ds, active and effective collaborations, among industry and government and NISA. The combination of the three parties on the industry side and the academia and the government. This should make an umbrella network. That network should be coordinated by a responsible coordination function. And this consideration should produce information for the nation and other industries and make information exchange for overseas.

Establishment of a technical information base. The concept of the technical database and ageing management is an issue for the safety and reliability of NPPs. This could be performed by establishment of technical information base. And that will be for research and development. The results or experience of research and development indicates the direction of investigation and R&D result. And after that, synthetic technical information will be implemented.

Development and consolidation of maintenance management and safety ensuring activity for ageing management. So reflecting on actual operating experience is very important. The development and review of maintenance activities should be spiralled, umbrella view, at the same time being considerate of the time axis. Experience and technology will change and be accumulated over time.

We also have to consider emphasis items. One is safety ensuring activity and optimum and rational maintenance. We must consider the maintenance and the improvement of the technical capability by recruiting and developing capable people.

In conclusion, constitution of guidelines documents for ageing management. These three guidelines will be prepared; and now we are discussing what kind of content should be implemented or included in these guidelines. And that committee discussed the adequacy of timing and a period of ageing management. Some kind of ageing management review is required, especially before 30 years operation. But some kind of ageing phenomena will occur before 30 years. So now, we have requested to review the ageing management just before 30 years. The Committee has discussed these kinds of points.

Effective and rational safety regulations. Measures against non-physical ageing such as safety culture, technical transfer, human resources, administration management, corporate culture, and organisational climate. It is one of the most important discussion items in the committees.

Worldwide effective collaboration. What kind of collaboration should be considered? This Committee will prepare some kind of answer this August. The final report will be published in August 2005. And these kinds of above items will make some kind of concrete results. Thank you.

Dominique ARNAUD - Monsieur Michel qui appartient à l'appui technique de l'Autorité de sûreté allemande va maintenant nous présenter la problématique et les aspects techniques du vieillissement des équipements sous pression en Allemagne.

Frank MICHEL, GRS Germany - Ladies and gentlemen, GRS acts as a technical support organisation, in particular on behalf of the German federal ministry for the environment, nature conservation and for nuclear safety, the BMU. I will spend first a few minutes on the service life of German nuclear power plants and the approach to ageing management. Then I will speak about the GRS knowledge base on pressurised nuclear power plant components. I will present the overall results of the evaluation of operating experience. I will inform you about the development of tools for quick access to access to information on ageing degradation mechanisms by GRS. Last, but not least, a few words on recent regulatory activities on ageing management in Germany.

The nuclear power plants, presently being operated in Germany, were mostly constructed at a time when sufficient knowledge had been obtained to avoid the detrimental aspects of ageing from the very beginning. We distinguish between four PWR, design generation and two PWR, construction lines. The operating time for the eleven PWRs ranks from 16 to 30 years, and for the BWR, from 20 to 29 years. Since the year 2000, the lifetime in Germany is restricted by a so-called 'agreement' between the federal government and the utility companies. Accordingly, the maximum electricity volume, which each plant is allowed to generate, is specified in principles of volume, corresponds to a standard operating life of 32 years. Moreover, the utilities can transfer their electricity volumes from one plant to another. However, this restriction led to the shut down of the Obersheim Nuclear Power Plant last month, after 37 years of operation.

The German approach to address ageing issues is, in general, characterised by :

- continuous evaluation of operating experience to identify changes in the reliability of systems, structures and components,
- extended plant monitoring to enhance the understanding of system behaviour of load conditions.
- Evaluation of safety margins for lower bound conditions,
- generic studies to identify areas of limited knowledge and potential future problems.
- Early replacement of components, potentially sensitive to degradation and enforcing technical requirements in codes
- standards to avoid repetition of non-optimised technical solutions.

The GRS knowledge base on pressurised nuclear power plant components consists of several modules containing comprehensive information on codes and standards, design and material, operating experience, analysis and qualification methods. To use this information more effectively, GRS has been developing qualified databases and networks called KomPass with regard to the evaluation of the ageing behaviour of pressurised components.

Databases, KomPass and ALMA MATER play an important role. The database, KomPass, contains detailed information on the operating experience with pressurised components in German light water reactors. It is based on reportable events. And the current database contains about 800 safety related events, occurred in a time span of 30 years. We distinguish between events that occurred at different components, such as pipes, vessels and housings and also between different systems affected, such as the main heat generation system, or the auxiliary systems. On the basis of this database, GRS has performed detailed analysis of the ageing behaviour of pressurised components. In the beginning, this was done on generation specific level, later, more specific evaluations were performed.

What are the end results of the overall operating experience with pressurised components in Germany? We distinguish between different design generations or construction lines and different operating periods. The overall number of safety related events in Germany, at pressurised components, was low. Moreover, no significant increase of events with operating time has been recognised so far. A more detailed evaluation shows the frequency of the events involving piping in German nuclear power plants due to fatigue. The different areas indicate the significance of the respective annual frequency. In addition, it has been investigated whether events due to a specific mechanism are accumulated in any plants and whether there are any indications of safety related shortcomings from the chronology of these events. Corresponding investigations were performed for all types of relevant damage mechanisms, as well as component specific. The overall results can be summarised as follows. In the past, the pressurised components used in German nuclear power plants have yielded experience with different ageing-related degradation mechanisms such as mechanical and thermal fatigue and several types of corrosion such as intergranular and transgranular stress corrosion cracking, strain induced corrosion cracking and flow accelerated corrosion. The overall number of events, due to ageing related degradation, is low. Up to now, no significant increase of ageing-related events with operating time has been recognised.

A few words on the development of the database system, ALMA MATER. Worldwide operating experience and research has yielded a large variety of information on ageing-related degradation mechanisms. However, our practical experience has shown that the quick access to this information often causes difficulties. And for this reason, the database system ALMA MATER is being developed by GRS, starting with a survey of relevant degradation mechanisms, the browser-based navigation give access to relevant information on the individual damage mechanisms. Following a brief initial statement in which the respective mechanism is characterised with regard to its boundary conditions and damage symptoms. The user is guided to more detailed information, these lead to the 4 categories : operating experience, state of knowledge, codes and standards and yellow pages. In the survey results, we differentiated between embrittlement, corrosion, fatigue mechanisms, as well as synergisms such as corrosion fatigue and irradiation assisted stress corrosion cracking. Moreover, materials susceptible and components affected are compiled.

The lead into the category operating experience is via a so-called time bar, where the international and national operating experience with the corresponding mechanism is summarised for a time period of several decades. This was done for flow-accelerated corrosion in PWRs. The information about the international operating experience, which I have outlined, was taken from the OPDE database which is available at GRS. The German experience indicates that local damage in various parts of the secondary systems occurred during the ‘70s in German nuclear power plants. It becomes clear that water chemistry plays the key role for a given design. And to avoid further flow accelerated corrosion, the utilities changed their turbine condenser tubes, made from copper alloys, to stainless steel or titanium, creating suitable conditions for the evaluation and for the application of high or volatile treatment. And in consequence, no safety-related damage occurred anymore in these systems.

A few words on recent regulatory activities in Germany. In July, last year, the German Reactor Safety Commission, issued a recommendation on the management of ageing processes at nuclear power plants. It was prepared on behalf of the federal ministry, BMU. It describes principles on the procedures of managing ageing processes at nuclear power plants. It considers, in detail, all safety relevant, not only physical ageing processes. And it contains requirements of an ageing management system to be applied during the lifetime of German nuclear power plants.

A few concluding remarks. The results of the investigation performed by GRS provide a technical basis for the evaluation of ageing behaviour of pressure-retaining components in German nuclear power plants that can be used in licensing and supervisory procedure. So far, the limited number of ageing-related incidents and the corresponding trends confirm the conservativeness of the safety concept chosen by the design as well as the sufficiency and the remedial actions and the ageing management system applied. However, the current knowledge of damage mechanism and the predictive capabilities are limited. That’s why further plants and component-specific investigations are required, as well as procedures to maintain a sufficient level of awareness.

In future, German licensees need to address ageing management of nuclear power plants on a more comprehensive and detailed level and have to submit periodical plant-specific reports on it, following corresponding recommendations of the German Reactor Safety Commission. Thank you for your attention.

Dominique ARNAUD - Monsieur Edmund Sullivan va faire une présentation sur le processus de renouvellement d'autorisation d'exploiter à la NRC en regard des phénomènes de vieillissement. Monsieur Sullivan travaille à la NRC et sa carrière a été consacrée à l'analyse de la sûreté industrielle et à l'analyse de la sûreté des systèmes industriels, en particulier nucléaires.

Edmund SULLIVAN, NRC USA - Good afternoon. I am going to talk about the nuclear power plant licence renewal process in the United States.
As was mentioned earlier this morning by R William Borchardt, there are 103 licensed plants in the United States. Initially, they were licensed for a 40-year term. And in fact, a couple of those plants, by the year 2009, will have reached the point where the initial licensing term will be expiring. As with many countries, NRC has developed a licence renewal process with requirements for extending the licence. In this case, as I think we discussed earlier this morning, it is for an additional 20 years. My understanding of this process is that it is not the end. A plant can come back for a second, or possibly more, extensions.

Applicants for licence renewal must demonstrate that there are programmes in place to manage ageing effects applicable to passive long-lived structural components have adequate programmes in place. We basically refer to a number of terms that will keep coming up. The AMR, the ageing management review and the other is ageing management programme, another is time-limited ageing analysis.

The principal focus that I want to devote is to the GALL Report. The GALL Report was developed over a number of years but the first version was published in the year 2000. Our headquarters are working on a revision to this GALL, which will be issued in September. This report was issued to assist utilities in developing their licence renewal applications, LRA, and to assist staff in performing reviews. GALL includes a set of ageing management reviews, with typical components, as illustrated on the slide. Ageing management reviews are presented in a tabular format.

We review the applications for consistency with GALL and, insofar as these applications are consistent with GALL, we give them credit. And that basically is the level of review that is done. The GALL also contains a set of programmes. The review consists of looking at the components, the materials, the environments, the ageing effects and the programmes. In addition, there are detailed descriptions of these programmes, where ageing management programmes, AMPs, and what the applicants need to do is identify those exceptions that they are taking to the criteria in this report. Whether it is with respect to the way the ageing management review is done or with respect to a particular programme.

An interesting feature you will see under ageing management programme, 'a plant-specific ageing management programme is to be evaluated'. And what that basically means is that in the GALL there have been certain place-holders put in place where there is no particular ageing management programme which has been described in that report. In these cases, it is up to the licensee to identify what programme they believe is appropriate for their station, so it is not all completely cook-booked into the GALL Report. Then there are other ageing management programmes that you might be familiar with, such as the boric acid control programme, water chemistry programmes, stainless steel and so forth.

As I mentioned earlier, we are in the process of updating this report. I would like to talk briefly about some of the reasons we are pursuing this update. We found it necessary to increase the understanding of the use of this report to avoid inconsistencies and to avoid the number of exceptions that licensees are taking to this report by improving definitions. There is a fairly lengthy section on definitions that describe what we mean by different materials, terms and another section describing the environments. We have incorporated certain lessons into GALL. For example, there have been a number of industry standards and things like chemistry guidelines that have been improved since GALL was first put together. These are folded into the new report. There were some inconsistencies that people were noticing across systems and these have been straightened out. There has been a certain amount of consolidation.

In the current version, which is being updated, there were a number of locations where there was essentially redundancy. A lot of material combinations could be put together or component combinations could be put together to reduce the number of ageing management reviews. I have given a couple of examples where for some components, low alloy steels and carbon steels grouped together. Or for example, for some ageing effects – obviously not all ageing effects – we have been able to combine precipitation-hardened steel and cast austenitic stainless steel (CASS). We have standardised the terminology of environmental effects. We have established some temperature thresholds for certain mechanisms. So for example, there is a temperature threshold for initiation of stress corrosion cracking that we have put into the report. And this has actually enabled some licensees to not take exceptions because for example, if a licensee had a stainless steel in the application below the threshold, they wouldn't really be able or willing to conform to the existing GALL because it would direct them to a programme for management that wouldn't be necessary. So doing things like this has reduced the number of exceptions that licensees have had to take to GALL. Ageing management of nickel alloys and reactor vessel upper-head penetrations. This is a topic that many people are familiar with and was referred to extensively this morning. This update basically folded in the new requirements of the order that NRC issued in 2003.

We consider that the changes in the licence renewal process and the update of the GALL Report will provide for a more efficient and approved basis for reviewing the licence renewal applications.

A few words on logistics. It was suggested by some of the organisers that we talk a little bit about logistics. The NRC devotes approximately 20,000 hours to each review that we do. Who gets involved in doing these reviews? I think first of all we might say that the application comes in to a group of project managers. The project managers basically handle the whole application through its review process. They also do a little bit of technical work in that they identify the exceptions that the licensee takes to the GALL or to the plant-specific line items that require a little bit more detailed review. And they farm those reviews out to the technical folks. There is also a scoping review that is done to make sure that we agree with the way the application is constructed in terms of the components that are covered. We have a group of systems engineers that look at consistency with our regulation in terms of scope. The engineering group, of which I am a part, looks at the exceptions, the plant specific programmes and the time limiting ageing analyses. There is a whole group that does audits. This is one of the efficiencies that we have evolved to in recent years. Instead of the engineering review, doing reviews of these programmes, they are done on an audit basis by staff and contractors who go to the licensee's facilities. This process of doing audits basically cuts down on exchange of questions and answers because these people who do the audits go directly to the facilities and cut down on the paperwork by talking directly with the people who prepared the application. The last group that gets involved are regional inspectors. They have a programme of inspections for looking at the effectiveness of the implementation of the programme. In other words, they take the programmes to the next level and make sure that they are being implemented in an effective way.

In terms of schedule, we set a date of 22 months to complete the review. They are

very well prescribed, in a detailed prescribed fashion. So far, we have been able to adhere to that schedule without any problems. This schedule is the schedule if there is no public hearing. There is an ongoing process in the agency to continuously monitor ways to improve the process; GALL revision 1 is the latest outcome of that. But afterwards, we will continue to look for ways to improve that programme and improve the document.
In terms of programme status we have reviewed 32 applications for licence renewals so far, and granted those applications. We currently have 16 under review and we expect to continue to review about six applications per year until they are all completed, at least all those interested in licence renewal. I think that concludes my talk.

Sophie MOURLON - Maybe we can start talking about the last slides presented by Ted Sullivan. I think it is interesting, as we are here as safety authorities, to talk about regulatory aspects of ageing issues. One of the ageing issues for the safety authorities, I think, is how many people, and how much time, can we, should we, must we, devote to these ageing issues. I am very interested in hearing what Germany and Japan have to say about that.

Katsuji MAEDA - In Japan about two years for the ageing management review. And the meeting, it will be conducted about 200 times. It is very hard work so, in Japan, we are now planning to establish standard procedure and standard operation analysis method. And prepare the same database with the utility and the licences. They use a corrosion date, for example, 15 MDD. But if that number is correct or not, though it is very difficult to judge. So now, we licensee, we needed to decide to recommend to establish the same database and the same analysis method.

Frank MICHEL - GRS has developed comprehensive databases on the operating experience with regard to the ageing behaviour of components, first of all for mechanical components. Of course, we have databases for other types of components too. This was a work which was done over a long period of years – I think we started 20 years ago with the first small database – and this has now been developed. And now I think we are at that point where we are able to get new data very rapidly inside this and we have a structured evaluation of this database so we are able to make a new or updated evaluation without too much effort. Again, this is only operating experience. On this basis we are looking for trends and things like this.

Sophie MOURLON - Are there any other countries in the public which have studied or evaluated or decided on a way to handle this issue?

Alain SCHMITT - I think that in France we are dealing with this subject in a framework of periodic safety reviews. The average time that we devote to the evaluation and the topic is four or five years. After four or five years, we take a position about ageing management.

Sophie MOURLON - And then we start over again for the next periodic safety review.
I have another question for Mr MICHEL. The situation in Germany is very specific. The kind of operation is limited, you are definitely limited in time. You have not talked about either licence renewal or periodic safety review after 30 years because obviously the topic is not… Do you think it is a big difference?

Frank MICHEL - The lifetime is restricted for political reasons to a standard time of about 32 calendar years. As I said, it is a political decision, I am not in a position to predict the political situation next time. And so far, this is our current situation.

Sophie MOURLON - Do you mean that the safety authority and the technical institute would be ready to examine the possible continuation of operation for German plants?

Frank MICHEL - On the technical basis we are very well prepared. We have done a lot of work under the headline of ageing management, not under licence renewal, and so far there is a lot on technical phrases to evaluate ageing behaviour and its influence on the safety of the components.

Ann MacLACHLAN - You spoke of four to five years for a periodic safety review for a specific unit. What do you mean, for each plant?

Alain SCHMITT - With a generic aspect in France because we have standardised reactors.

Ann MacLACHLAN - Because others have spoken of two years or even less. My question is: does standardisation extend the time period needed for the periodic safety review. It should shorten it for each unit logically.

Alain SCHMITT - I do not think you could say that standardisation extends the time for a periodic safety review. The depth of the analysis of the periodic safety review may differ from one country to another. Maybe it is the main explanation for the duration of the process. The idea also is that maybe we could do it faster but we take our time. We like to prepare things far ahead because then we have many reactors undergoing periodic safety review. We have a schedule that starts some years before the actual 10-yearly inspections of the reactors. I would not relate that to the notion of standardisation. And then, of course, as was said by some of the speakers, the ageing issues have a strong plant-specific aspect. We have to look at each plant specifically.

Sophie MOURLON - Another question about the databases. In France we only have one type of reactor but, as we know, there are countries with many types of reactors. Do you cross-reference the information? Do you share it? Are there totally different issues from one type of reactor to another?

Frank MICHEL - I think it is possible to make a distinction between PWR and BWR conditions. If you think about for example, intergranular stress corrosion cracking, it's an issue for BWRs and not for PWRs. It is important to make such distinctions and also to distinguish between different generations. It makes sense always to ask if it is a generic issue or is it a plant-specific or a generation specific issue.

Ray NICHOLSON, HSE United Kingdom, *UK Regulator* - In terms of PSR timescales as applied to UK PSRs. Essentially what happens in the UK that there is a very clearly-defined date when the PSR has to be submitted to us and we have accepted it. If we have not completed our assessment at that date, because either the PSR is unsatisfactory or we have raised additional issues, we will not give the plant permission to continue to operate beyond that date. Going back from that date I think it is about two or three years, we have discussions with the licensees about the scope that is going to go into the PSR, so they produce a fairly detailed summary of what is going to go into the PSR from their perspective. We add what additional items we expect them to address and then they complete the PSR as such and then it comes to us for assessment. And it is over their two to three year period, leading up to the decision date when the detailed assessment takes place.

So I think in the UK, the timescale is perhaps consistent with elsewhere, but we do have this early stage of discussions with licensees to ensure that we know what they are planning on putting in the PSR and we can raise any additional items that we expect to see addressed. So it does perhaps reduce some of the iterations when the timescale is getting rather short.

Dominique ARNAUD - Monsieur Alain Schmitt, directeur général adjoint de l'Autorité de sûreté française, va conclure cette matinée.

CONCLUSION

Alain SCHMITT, ASN France - I will try to conclude these first two sessions briefly with a few ideas that I think came out of the discussions. We had a whole range of presentations by regulators and by technical support organisations about their experience and their practices in the management of ageing.

The first idea that I would like to stress is that, overall, the objective of nuclear safety authorities and their technical support organisations, seem quite similar. And this objective is to ensure the safe operation of nuclear power plants during their total lifetime.

The second idea is that regulatory processes seem quite different. They show quite a variety of tools and procedures. For instance, some countries use licence renewal processes to deal with ageing management. Others deal with it during periodic safety reviews. We also have different uses of PSAs and the risk-informed approach. Also, different approaches to in-service inspection programmes. I think there are common features among all these approaches. The first one is that ageing management is identified as a specific issue by all regulators. The second one is that ageing management programmes are required from the licensee to allow further operation. We have, in all countries, it seems to me, something that looks like ageing management programmes. These ageing management programmes are based on lists of components, lists of ageing mechanisms, and sometimes lists of environmental conditions. We have differences between ourselves but also common features. And I think we have to learn from each other about regulatory practices in ageing management.

The third idea is about generic versus plant-specific aspects of ageing management. One very important theme is that ageing phenomena may very strongly differ between facilities. Of course, between different technologies, for instance, BWRs, PWRs, heavy water reactors, gas cooled reactors, not to speak of other nuclear facilities such as fuel fabrication plants. They also can differ very significantly between reactors of the same type. And this is, I think, one important thing and this leads to the need for a plant-specific approach to ageing management. This is one thing that I think was present in all presentations.

Also, we should recognise that ageing management has a strong generic dimension. As one of the speakers said, nature has imagination. The challenge for the licensee and also for the regulator is to anticipate the outcomes of this imagination. One of the ways to anticipate is to share operating experience on a very extended basis. It is fundamental to keep a questioning attitude and to think of transposing the conclusions of the phenomena, which have been seen on one type of facility to others. For me, one very important and very historically fundamental example is stress corrosion cracking of nickel-based alloys on reactor vessel heads. It also shows the importance of maintaining databases, and not only maintaining databases, but also to use them properly, keeping a qualitative way of assessing things and not only relying on indicators and on databases.

One last aspect relating to this idea is the use of regulatory research. It is a topic that wasn't touched on very often this morning. I think there is a specific workshop this afternoon about this aspect. What should we do in relation to regulated research? What should regulators do, what should regulators have the licence to do?

The last idea is that the recognition of human factor-related issues in ageing management. The loss of skills and know-how in the nuclear industry, and sometimes in the regulator, sometimes supplies may disappear, sometimes components may become obsolete. It is also an important aspect of ageing and certainly, the regulators should be interested in this aspect and extend their supervision to these kinds of problems. This will conclude my summary of this morning's discussions. Thank you for your participation in these discussions.