Restitution des ateliers techniques / Technical summary and conclusions of the workshops

Présidente / President : Sophie MOURLON – ASN France
Interventions des animateurs et rapporteurs des ateliers / presenters of the workshops

Sophie MOURLON - Ladies and gentlemen, we shall now start the last afternoon of our symposium with presentations of the workshops that took place yesterday. Now the different presenters of the workshops of yesterday are going to give short talks on what was said, what are the interesting points and issues that were developed in the workshops. First workshop: Operation and Equipment with Matthieu Schuler.

Matthieu SCHULER - Good afternoon, ladies and gentlemen, and thank you for being on time to start this last and concluding session. It is always difficult, having exchanged a lot of ideas, to be a bit more converging. I know that divergence is better for nuclear plants! I will try to make a synthesis of the very rich discussion we had thanks to our four – indeed five – speakers yesterday afternoon, and to try to answer some of the tight specifications that were set by the organisation concerning the output of our sessions.

In the coming few minutes we will be talking about components in operation. We have focused on reactor pressure vessels and steam generators, let us say the core business of components in the nuclear islands. They are indeed the typical components that have been taken care for a long time, coming from the very big vessels with 4-5 metre diameter, 200 millimetres thick. This is one on one side, RPVs, and, on the other side, you have the steam generator tube bundle, with these thousands of square metres of millimetre-thick alloy 600 or whatever. We had the task, as specified, to identify – concerning ageing for those equipment – practices among our regulatory organisation; if time was available, to identify advantages and drawbacks of those practices; identify also interesting points that could be deepened or discussed further in some kind of complementary session that could be set up later; and, if available, some element of consensus.

Trying to answer the specification, I identified six points that could be divided and grouped in front of the specifications given. I think that all regulatory bodies or technical organisations that took part gave me the clear conviction that there is a great attention to operating events, operating results, concerning those components. For example, given the evolution of RPV embrittlement, how it is compared to what was predicted? We have also a very detailed presentation of US NRC that showed us how they were following early signs of weakness for the alloy 600 steam generator tube bundles for the 600 TT because they were installed in the first replacement steam generators and also in the late reactors installed in the late 80s. It is, of course, of importance because now the fleet of reactors for PWRs are more and more equipped with this type of alloy – a bit less sensitive compared to the 600 MA or the stainless steel from the beginning. This is certainly belonging to the common practices.

Another common practice that I have identified clearly is that there is a constant back-and-forth process between observations made, those without events, and the safety basis for our plants, being for example the safety demonstrations. For example, we have taken time to check whether the different plants that the regulators have under their control still comply with the initial PTS demonstration – Pressurised Thermal Shock, of course – and namely how to deal with the huge scatters of mechanical properties that are to be seen in the RPD. You have scatter at the beginning, when you take a sharp energy transition, you have scatter during embrittlement and you have scatter at the end. How to deal with that uncertainty when you have, at the end, to answer very simple questions, namely in the PSR reviews, like we mentioned yesterday: are we okay for ten more years or not?

Other back-and-forth processes that were identified were concerning the technical specifications, because it is not only the basic demonstration that might be challenged by eventual results, it is also the frame of operation of those components. We have talked about, for example, the way US NRC introduced the feedback of experience regularly to their utilities through information notices or through different types of requirements, to have the technical specifications of steam generator tube bundles evolving. In a less detailed way, we also had a short explanation by NII on potential consequences of RPV embrittlement on the tech specs for RPV operation, especially when you have a very heavily embrittled RPV you might have to operate in harder conditions than could have been foreseen at the beginning of the design.

The first step that also seems to belong to common practices is the common need to touch the implicit margins because at the design basis there were simple but robust demonstrations performed to make people confident that we could run this type of installation for a long time. Nevertheless, when you add the different results and events that are occurring during the operation, sometimes you are touching the limits of your design basis demonstrations and there is a clear need for the regulator – and also, of course, I think, for the utility, that is certain – to have a technical conviction on what is behind those initial demonstrations. For instance, we had a clear and interesting presentation on how, in the case of the Czech Republic, they had to enforce a new surveillance programme to get more precise information about the embrittlement of their reactor pressure vessels. We had the discussion of how to have a clear understanding of the conservatism, if any, between the Charpy transition model and fracture toughness, which is definitely needed in the PTS calculation. After, you have another type of implicit margin, which is between calculation, like the PTS case, and large-scale experiment. In fact, in these installations, we are dealing with calculations and studies that are more and more detailed. It is sometimes very needed to confront them with reality, with experiments. That was the very interesting presentation performed by JRC concerning the different large-scale experiments they had performed.

On this topic of large-scale experiments, we were convinced of the useful and precise link that they provided with the studies. I think, at least for myself, that sharing the results of these large-scale experiments is of acute importance; for example, the results of pressurised thermal shock experiments compared to calculations. You also have experiments for the behaviour of pre-metallic welds, including flows, for instance, and you had also a large-scale experiment on thermal fatigue. Maybe Laurent Foucher will discuss that later. It showed that, for instance, in a world where we are keen to look at every weld in a primary circuit, we might think that a weld is not necessarily the most sensitive place for crack initiation. This is a good question for regulators I think.

Concerning these large-scale experiments – and that is maybe one point that we would have liked to discuss more deeply – for the moment, regulators – which are definitely stakeholders in this type of experiment, or maybe final users, the term used by JRC – could be associated more at the beginning in the decision processes leading to what kind of experiments have to be performed or not.

Fifth point, and we did not have much time to discuss it – it would have certainly belonged to a point where discussions between advantages and drawbacks would have been interesting but we definitely lacked time – is how regulatory bodies take all the event results I mentioned before and what they do with this information. Do they inform the utilities? Do they require something straightaway or a bit later, after having analysed things? How can things be enforced in terms of policy towards utilities? This has only been slightly touched.

Last point which we have already mentioned about yesterday morning: I felt there was a common preoccupation concerning… I think NII used the term 'community ageing'. Regulators, technical support organisations, utilities: we all have in our frame the questions of how to keep competences alive. There are certainly initiatives among us, among regulatory bodies, among TSO and among utilities. The question could be whether, when you have community shrinkage, it would be more efficient to have those questions shared, even if every type of organisation has to keep his own position. I think, for future discussions, it would certainly be interesting to deepen the different kind of experiences that have been set on that topic. Thank you for your attention.

Sophie MOURLON - First, I would like to thank once again the people who made presentations in the workshop. I think it was a very interesting one which had very good quality talks. It was a good workshop. We did not have as much time as we would have liked for discussions but still we had time to debate, so it was interesting. In this workshop, we had four presentations; three of them tackled alloy 600 issues and one of them, embrittlement of RPV steel. The first talk was given by Ted Sullivan and it was on the regulatory perspective and management of alloy 82/182/600 susceptibility and cracking. I will try, for each of the talks, to give the main points. I hope that the people who made the talks will forgive me if I am not as precise as I would like to be.

Ted Sullivan told us about issues related to the heads, with the example of the Davis-Besse vent, and also talked about bi-metallic junctions. He said that the NRC had requested the utilities to define surveillance and service inspection programmes and that they were working on it. The NRC was willing to give a regulatory framework to this process because, so far, what the operators have suggested is not totally satisfactory, as they were considering more one-time actions to check the situation after the Davis-Besse event and the events on the bi-metallic junction. The NRC thinks that a regular basis inspection service is required so there is regulatory work to do here to set regulatory requirements.

My talk was on stress corrosion cracking of nickel-based alloy components. To give the French regulatory experience, I tried to give a bit of the historical background of the Inconel 600 issues in France, starting in the 50s, and to explain the strategy that was adopted for the different issues. First, one issue was the pressuriser, with the steam generators, with the head, and then the adoption of more generic strategy to address the global issue of alloy 600 zones. Also, I tried to talk about the lessons learned for the safety authority with these issues, in particular the fact that relying on models and analysis is not always satisfactory.

Mr Roussel gave a talk on the management of the nickel-base alloy cracking in butt welds at the Belgian nuclear power plants. He told us about the butt welds on reactor pressure vessel end pressuriser and told us about the will to define in-service inspection programmes and justify their frequency on the basis of scientific analysis. This was very difficult as few models are available and little data is available and models, so far, lead to very frequent inspections on pressurisers, at least, which are not compatible with commercial operation. It is very hard to set an in-service inspection on a scientific basis.

Last, Mr Debarberis told us about expertise on reactor pressure vessels and pressure equipment ageing assessment and modelling at the JRC of the European Commission. In particular, he told us about expertise on irradiation embrittlement of the reactor pressure vessel steel. He told us about new models and the most recent results that were obtained on models and how these models would address the contribution in its different phenomena and elements, such as copper, phosphorus, nickel and manganese, give good results and, compared to field results, are quite satisfactory in terms of prediction of embrittlement.

In the discussion, we found out that there were common features in the ideas and approaches of the different countries. First – and it was a surprise – we have had numerous surprises with alloy 600. I am saying it is a surprise because it has been an ongoing issue for decades now and still we are getting surprised, with the Davis-Besse issue, for instance, with VC Summer. We know that there is a problem with alloy 600 and, nevertheless, we still get surprised so often with new degradations or degradations where they are not expected. In the 80s, there were problems with pressurisers and steam generators and then we were surprised with the heads and surprised with the bi-metallic junction. I think this is a common feature for all countries and we have to recognise that we have not probably learned all that we have to learn about this issue.

Another important common feature in the discussions was the importance of manufacturing in addressing material issues. Even though degradations may be identified – the stress corrosion cracking of alloy 600 or irradiation embrittlement – and although we know the degradation, there are models – satisfying or less satisfying, but there are models – for these degradations and we have an idea of what these parameters are. There is a great scatter in the results and in the way that the degradations appear. They often appear where we did not expect them and the sensitivity models are often proven wrong. This is probably linked to the fact that the scatter of properties of the materials themselves, small changes in the properties of the materials, that are induced by manufacturing processes change the appearance and the propagation of the degradations a great deal. This is very important. It should be very important to have precise information and data about manufacturing conditions and processes but that is a problem, because often it was 30 years ago – or even more – and information is not available any more. That is also a problem with models and predictions, because we would need information that we do not have and that we cannot find any more.

There is also the fact that with these materials issues there are more questions than answers.

For instance, the goal is to prevent degradations from appearing or at least to be able to prevent them in time. How can we do that when we do not know the degradation and we cannot really model them? Or, when we can model them, it seems to require inspections which are not compatible with the commercial operation of the plants. How can we do that for present components and for future ones? It seems to be a question. Questions about models, because the appearance of degradations on materials seem very hard to model, rely on a number of parameters that we have not mastered. Also, we do not have enough field data about these degradations. There have been events but, in the end, if we look at the sample – and it is a good thing – there have been few major events. In the end, it means that we have little field data on these degradations to check models. This explains why models are often proved wrong. I will talk about one example that I know. The sensitivity analysis for reactor pressure vessel heads with respect to stress corrosion cracking led to a differentiated hot plenum and cold plenum operating plants and, in France, cracks and very fast-growing cracks were found in cold plenum plants. There are reasons for that and it was understood afterwards why the models were wrong but, every time we try to rely on the model – well, not every time but often – it is proved wrong by field data and field facts.

Questions about how to see these issues from a generic and specific point of view. We can say that if we have had so many surprises with alloy 600 issues, it is because maybe, at the beginning, we did not take a view that was broad enough; a generic view of the problem as an alloy 600 issue instead of being a head issue or a pressuriser issue. At the same time, we said how manufacturing is important and how, in the end, the appearance of degradations and the behaviour of materials is very plant specific and component specific. There were many questions about how to handle these two ways to look at the problem: from a generic point of view and from a very specific point of view. There were also questions about how to categorise and prioritise problems. When there is generic problems, we would like to address the most important ones first. However, to do that, we need models and reliable models and then we are back to the fact that the models are not always satisfactory and very hard to set.
The last point on which I think everyone agrees is that we have to share international experience on these matters. There is little field data because degradations, once again, do not appear so often. We need to broaden the sample to get enough data and to be able to anticipate what is going to happen in plants. To get this larger sample there is not other way than to share international experience and have a broad view of this international experience in order to adapt to national cases what is happening abroad on different types of plants or components.

Differences that we have seen in the way different countries meet those problems. First, there are differences obviously on the use of models and modelling. I will take two examples. In France, basically, for alloy 600 issues we have required the utility to put aside models for designing in-service inspection programmes. Models can be used to define precursors and to try to prioritise the problem, but we cannot rely on them because they have been proved wrong so many times. I said in my talk that we required sample checks on the in-service inspection programmes related to alloy 600 and many of the degradations that were found were found on sample equipment and not on precursor equipment. We consider, in France, that we cannot really rely on models because they are probably not precise enough and because of the scatter of the properties that we do not master and the lack of manufacturing information.

In Belgium, for instance, Mr Roussel from ABN explained how they wanted to use initiation and/or propagation models for designing and defining in-service inspection rate frequency. I see that as a difference in approach. We see this difference because there are different ways to use models: models for understanding the problem and trying to address and prioritise and models for regulatory practices. Obviously, in different countries, there are different ways to look at this. That is one difference. Another one: the use of models is also true for embrittlement. My example was for alloy 600 but, in the same way, we saw that models are not addressed the same way in different countries.

An aspect quite specific to inconel – at least in the scope of the workshop – was the aims which are given to the in-service inspection programmes. Some countries are building in-service inspection programmes in order to detect leaks in time and monitor and handle them in time. Other countries have chosen to require the preclusion of leaks. There are differences there and it is one point that could be interesting to address, to understand why those differences arise and the advantages and drawbacks of each of those approaches.

Thank you very much. During the discussion, if anybody who was in the workshop thinks that there are things that I said are wrong or are not precise enough or if anybody has something to add, please just say. Thank you very much.

Laurent FOUCHER - Bonjour. L'atelier numéro 3 portait sur les dégradations par fatigue thermique et vibratoire. Cet atelier reposait sur la présentation de trois papiers essentiellement basés sur des recherches et développements. Deux papiers ont été présentés par un constructeur qui avance des solutions pour supprimer les sollicitations et donc les chargements de fatigue. Un autre papier, également de recherche et développement, a été présenté par le CEA pour apporter sa contribution à l'explication d'un incident qui a été observé à Civaux il y a sept ans.

Cette question concerne très largement les exploitants, quel que soit leur pays. La spécificité de ce problème est qu'il présente des difficultés d'anticipation particulière. Or l'anticipation est en fait un enjeu majeur pour ce type de question. Cette problématique survient en général en dehors des zones de contrôle habituelles, sinon le phénomène serait détecté – cela pose donc une réflexion sur les programmes de contrôle à développer – ou dans des zones particulièrement difficiles à contrôler – cela pose alors une réflexion sur les développements nécessaires en termes de contrôle – ainsi que dans des zones où le phénomène n'était absolument pas attendu – cela fait donc sans doute référence à la limitation de la connaissance des phénomènes au moment de la conception, par exemple, par le fait de la présence insoupçonnée d'un vortex dans une tuyauterie ou l'existence d'une fuite particulière d'une vanne qui va générer un chargement particulier. Les différentes méthodes pour traiter le problème reposent essentiellement sur la limitation des sollicitations, l'apport d'actions correctives, la conduite d'actions de R&D pour développer la connaissance du phénomène. Je dirai un petit mot en conclusion sur l'enjeu que cela représente pour une autorité de sûreté.

En ce qui concerne la prévention des sollicitations, un des enjeux est l'évolution de la prise en compte de ce phénomène au moment de la conception. C'est un enjeu important dans le sens où les codes de conception qui sont utilisés ne sont peut-être pas très développés spécifiquement sur le domaine de la fatigue. Ce point est sans doute à développer, des phénomènes comportent un niveau d'incertitude dans leur apparition qui n'est pas facile à appréhender au moment de la conception. Nous devons également sans doute développer des bonnes pratiques de conception. J'imagine par exemple que pour les tuyauteurs, il existe des pratiques particulières professionnelles qui capitalisent en fait le retour d'expérience en termes de construction. Ces bonnes pratiques représentent des compléments au code de conception pour la prise en compte de ces phénomènes. Une autre manière de supprimer la sollicitation est que, lorsque le phénomène a été identifié, ce qui n'est pas forcément facile comme nous l'avons vu lors de différents exposés, nous devons mettre en place des solutions technologiques particulières. Les deux présentations de Monsieur Suzuki de Mitsubishi étaient des articles qui proposaient des solutions, notamment pour ce qui relève de la fatigue thermique, rustiques et efficaces, comme nous les aimons dans le nucléaire car plus le niveau de complexité est important, moins les solutions ont de chances de fonctionner.

Le second exposé présenté était la présentation d'un système d'amortissement innovant dans le cadre de la fatigue vibratoire. En ce qui concerne les actions correctives, lorsque nous rencontrons le phénomène, une méthode consiste à supprimer la sollicitation lorsque cela est possible, ce qui n'est pas toujours le cas. Cela nécessite donc par exemple la modification de mode opératoire ou la mise en place de modifications matérielles et opératoires.

Comme je l'ai dit précédemment, il est extrêmement difficile, lorsque nous rencontrons un incident, de tirer un retour d'expérience généralisable pour, par exemple, l'introduire dans des codes de conception ou des codes de bonnes pratiques. Cela est sans doute l'un des enjeux. Le niveau de connaissance pour pouvoir généraliser un certain nombre de conclusions nécessite vraisemblablement le développement d'actions de recherche notamment pour la compréhension des phénomènes, en particulier pour la prise en compte des effets locaux et des effets environnementaux. L'amélioration de la modélisation, présentée par le CEA, est extrêmement intéressante à ce titre puisqu'elle montre que la modélisation thermo hydraulique, en particulier la connaissance du chargement, constituait sans doute un point déterminant dans l'explication d'un phénomène complexe. La référence à cet incident est celui qui est survenu à Civaux en 1998, pour lequel, à l'époque sans bien comprendre le phénomène, nous parlions de chargement chaotique, ce qui est sans doute une manière de dire que nous n'avions pas vraiment compris ce qui s'était passé. La modélisation apportée par le CEA introduit donc une certaine complexité dans la modélisation, ce qui a permis vraisemblablement d'expliquer un certain nombre de comportements. Cette présentation permet de mettre en face des zones de variations de sollicitations et d'observation de la localisation réelle des défauts. Il y a là une vraie valeur ajoutée.

Les autres actions de recherche et développement nécessaires sont donc de disposer notamment de maquettes représentatives, nous restons alors dans le problème de la modélisation telle qu'évoquée précédemment. Sans doute aussi faut-il développer des méthodes d'inspection en service performantes, notamment pour la fatigue thermique, et en particulier dans les zones de mélange ou les piquages, comme cela a été présenté précédemment.

En conclusion, je pense qu'il nous faut rester relativement modestes par rapport à ce type de phénomène. L'objectif pour une autorité de sûreté, pour un constructeur, un opérateur, est d'être en mesure de compléter les méthodes pour anticiper les dégradations mécaniques observées par l'amélioration de la conception, par la définition de critères de tri pertinents, qui permettent en fait de réduire le champ de l'analyse lors de la conception, et le développement pertinent de méthodes d'inspection en service et pour lequel nous pouvons dire également que la définition des critères de classification sont utiles pour tirer bénéfice de la capitalisation des retours d'expérience évoquée avant.

Pascal MUTIN, ASN France - The fourth workshop dealt with the contributions of research and development, especially with anticipating ageing at the design phase and materials. During this workshop, five papers were presented and discussed. The first one was presented by Mr Pineau from Ecole des mines in Paris, and dealt with the development of a local approach to fractures over the past 25 years. It dealt, of course, with theoretical studies.

The second presentation was conducted by Mrs Karlsen, from the OECD Halden reactor project, and dealt with the test facilities and online instrumentation capabilities for core component investigation. The results were related to crack initiation and growth studies, the effect of fluence and water chemistry, irradiation enhanced stress relaxation and so on . It deals with experimental studies.

The third one was conducted by the SMILE PROJECT, which is part of a EURATOM programme, and presented by Mr Kerkhof from the Material Testing Institute of Stuttgart, in Germany, in cooperation with several partners, mainly European ones. This presentation described the warm pre-stress process, which makes it possible to increase the margins for brittle failure compared to virgin-toughness material. The fourth one was concerned with Japan's nuclear energy safety organisation, with Mr Masakuni Koyama. He presented the research activities related to ageing management, dealing with technology and knowledge on material degradation, mainly irradiation embrittlement, production model, fatigue, corrosion, cracking, etc. Finally, the concept of Framatome with Mr Meyzaud, which was talking about preventive measures taken from EPR design and related to neutron irradiation, thermal ageing, fatigue, stress corrosion cracking.

First of all I have to mention that during the workshop we did not have time to have an in-depth debate on the contribution of research and development because many questions were raised. Nevertheless, I will try to sum up the different ideas which came out of this workshop and which were mentioned, partly before doing the session yesterday.

For research and development, it seems that the workshop participants have common themes and common approaches. The first one is to explore both theoretical and experimental fields. For example, as a non-exhaustive list, I can mention these different items: material features, chemical, mechanical, environmental effects, irradiation, corrosion, fracture analysis methods, maintenance, repair, in-service inspection, and so on.

Concerning common fields, they deal also with research project management. We can distinguish national or international projects. These two kinds of projects can be managed, for example for national projects, by the constructor, the facility operator or by organisation operating with public funds, such as Ecole des Mines, the French Institute for Nuclear Safety, the German Testing Institute, GRS, and Japanese institutes and so on. Or, it can be also managed with international organisations or members of these organisations such as OECD, IAEA, EURATOM and so on.

Research project management is also long-term research projects. Each time, when we describe the different tasks concerned with these projects, they last a minimum of three or five years. Human resources involved are also important – it requires a high level of expertise. The objectives of ageing management of existing plants is to improve the existing safety demonstration more than the safety. As you can see, there is a question – this question is open. The main problem is to increase the margins by refining modelling, by the knowledge of mechanical behaviour, for example. It is also to extend the plant lifetime. Another objective is, of course, the design of the next plants. In that case, it is to improve safety by a better design and material procurement specification. We had some questions during the workshop with EPR.

However, we have to keep in mind that research and development is concerned with human resources management. We have to keep a high-level of competence through a worldwide expert network. I would just remind you that three generations of people were successively involved in construction, operation, failure detection and now, new design. That requires us to store and transfer the knowledge through 30 to 40 years of plant operation. Finally, the benefits of this research and development project have to be analysed and discussed by the consortia of facility operators, but also with safety authorities or other organisations that I have mentioned before.

For research and development there are some questions: how to anticipate for unknown degradation mechanisms? As it was mentioned before, multi-parameter studies have to be developed. It is an open question. Another item is the level and type of decision for any research project. That means facility operators, constructors, technical experts, safety authorities, international organisations. It deals also with coordination, funding, and content of projects.

Just to conclude, we think that we have, for the next years, to focus on the three main topics. The first one, for each technical field, is to identify worldwide competence and experts and use them for the research projects. The second topic concerns the introduction of the results of research projects into the codes and standards. And the third one is to share the knowledge through a worldwide database.

Sophie MOURLON - Thank you. Now, we can start the discussion. I would like to make a comment and maybe open a question and debate. For simple models and simple research, when we try to refine models – and refining models often involves research work – are we looking for a better safety demonstration or are we looking for better safety? Probably these issues do not have the same importance for operators and safety authorities. What do you think about that?
Maybe the operators have something to say about it.

Matthieu SCHULER - Maybe we have been too clear in our presentations for questions to be raised! Just one point. I see that in two different sessions – my own and the one that was chaired by Pascal Mutin – we have faced one question which is rather similar concerning the research actions. I presented it in the frame of large-scale experiments and, in fact, as I mentioned there, usually large-scale experiments are very expensive operations.

My conviction is that they are really needed at a certain point of time to establish that we are working on sound conditions and sound hypotheses. The common question that was raised in the frame of Pascal Mutin's session and ours is, who is at the table when the decisions are made to launch such common research experiments? As they need huge funds, there are not a lot that are launched at the same time. My understanding, or my conviction, for the moment – maybe it is logic – for the moment, end users are not financing them, so they are sometimes a bit far from the decision to launch them.

Sophie MOURLON - I have a question related to that. Which countries, which safety authorities, today have required, or strongly asked, operators or operator associations to launch certain research programmes or have decided to push research or require research in one field or another?

Ray NICHOLSON - From the UK point of view, we expect the licensees to carry out a sufficient and adequate nuclear safety research programme which we review and comment on. If we do not regard it as being adequate and sufficient, we will levy the licensees to carry out appropriate research. Also, in terms of large-scale tests, I will go back to a comment that Nigel Taylor made in terms of NESC-1 Spinning Cylinder Test that was carried out. That was funded by the UK Health and Safety Executive. Also, we continue to fund UK involvement, by contractors or research organisations, in some of the European framework programmes. I am singing the praises of the UK regulator here in terms of supporting nuclear safety research, both in terms of large- and small-scale testing.

Claude FAIDY - The end user is implied in research and some organisation of research – we work very hard at EC level for twelve years now to develop some R&D work. Some results, as it has been mentioned previously, are very good results: the spinning cylinder. There are some very good results, but we are defining, for example, the next series of questions for R&D. We have a meeting next week on that subject. The situation is very very difficult because we have difficulties to have discussions between end users to define what we want to do together. I do not know, but my feeling seems to be the same for the nuclear safety side. It is very difficult to have a common view on what we have to do for five years from now or ten years from now. My experience is, in this time, very hard. EDF is ready to discuss and to share needs with any other users but it is very very difficult for the moment. I do not know why, but it is very difficult.

Sophie MOURLON - Now, I will try to summarise what was said and what seems to be important.
In all these presentations and, in fact, throughout these two days, I have the feeling that we are mostly all scientific people here and that we all have the desire to be able to rely on a sound scientific basis to take decisions, to design programmes, and to make regulatory requirements. That is very hard in this field, obviously. For that, we would need to create better models and to confront models with field data more than we can do today. I feel that, in the end, the only solution that we have is to work hard on research and so on, but also we have to stay very humble with these issues. In the end, we are all engineers and science people but somehow we have to work with uncertainty and no scientific certitude and sound basis. We have to keep a questioning attitude on the regulatory side and the operating side, of course. That was my first comment.

Obviously, we all have a good taste for discussing and exchanging views. Time flies and, in the workshops, time flew, and there is much to say. We have identified real ideas for further discussion for future workshops. I hope that we get other opportunities to meet and go on with other talks and thoughts. Also, it appears that obviously we are all looking and searching and trying to find answers. I think that we can gain time by sharing, not only what has been found elsewhere, but also what has been tried elsewhere and which has worked, if so, and what has been tried and not worked, so that we do not address it any more. Of course, this means that we have to share results of research and development and we have to share incidents and data. We also have to share practices and regulatory approaches to try and find ways – maybe not one way, but some ways – to address the different issues and to take advantage of the good ideas that were found elsewhere and that can be adapted locally in our countries.