NUCLEAR ENERGY AGENCY
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

International Operating Experience Workshop Proceedings on
Operating Experience Programme Effectiveness Measures

Garching, Germany
September 8-10, 2014
Workshop hosted by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS)

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NUCLEAR ENERGY AGENCY

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The mission of the NEA is:

– to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes;

– to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information.

The NEA Data Bank provides nuclear data and computer programme services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

The Committee on Nuclear Regulatory Activities (CNRA) shall be responsible for the programme of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. The Committee shall constitute a forum for the effective exchange of safety-relevant information and experience among regulatory organisations. To the extent appropriate, the Committee shall review developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them and assist in the development of a common understanding among member countries. In particular it shall review current management strategies and safety management practices and operating experiences at nuclear facilities with a view to disseminating lessons learnt. In accordance with the NEA Strategic Plan for 2011-2016 and the Joint CSNI/CNRA Strategic Plan and Mandates for 2011-2016, the Committee shall promote co-operation among member countries to use the feedback from experience to develop measures to ensure high standards of safety, to further enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field.

The Committee shall promote transparency of nuclear safety work and open public communication. The Committee shall maintain an oversight of all NEA work that may impinge on the development of effective and efficient regulation.

The Committee shall focus primarily on the regulatory aspects of existing power reactors, other nuclear installations and the construction of new power reactors; it may also consider the regulatory implications of new designs of power reactors and other types of nuclear installations. Furthermore it shall examine any other matters referred to it by the Steering Committee. The Committee shall collaborate with, and assist, as appropriate, other international organisations for co-operation among regulators and consider, upon request, issues raised by these organisations. The Committee shall organise its own activities. It may sponsor specialist meetings and working groups to further its objectives.

In implementing its programme the Committee shall establish co-operative mechanisms with the Committee on the Safety of Nuclear Installations (CSNI) in order to work with that Committee on matters of common interest, avoiding unnecessary duplications. The Committee shall also co-operate with the Committee on Radiation Protection and Public Health (CRPPH) and the Radioactive Waste Management Committee (RWMC) on matters of common interest.
ABSTRACT

The NEA Committee on Nuclear Regulatory Activities (CNRA) believes the national operating experience feedback programmes and the sharing operating experience between countries and organisations are major elements in the regulatory bodies and industry efforts to maintain and improve the safe operation of nuclear facilities. Considering the importance of these issues, the Committee on the Safety of Nuclear Installations (CSNI) established a working group, PWG #1 (Principle Working Group No. 1) to assess operating experience in the late 1970s.

In 1978, the CSNI approved the establishment of a system to collect international operating experience data. The accident at Three Mile Island shortly after added impetus to this and led to the start of the Incident Reporting System (IRS). In 1983, the IRS database became co-sponsored with the International Atomic Energy Agency (IAEA) to be operated as a joint database for the benefit of all of the member countries of both organisations. The IAEA now has the responsibility of database maintenance and quality checks on the input. In 2010, the IRS was re-named the International Reporting System for Operating Experience, while maintaining the same acronym. In 2006, the WGOE was moved to be under the umbrella of the CNRA in NEA.

The purpose of WGOE is to facilitate the exchange of information, experience, and lessons learnt related to operating experience between CNRA Member countries. The WGOE continues its mission to identify issues that should be addressed by other working groups based on their specialty area.

The CNRA, Working Group on Operating Experience (WGOE) organised the International Workshop on Operating Experience (OPEX) Programme Effectiveness Measures. The workshop was hosted by the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and was held in Garching, Germany, from 8-10 September 2014.

Evaluation of safety significant events including the Fukushima Daiichi nuclear power plant (NPP) accident indicated that lessons to be learnt from OPEX could provide an important prevention tool if implemented in a timely manner. The main objectives of the workshop were aimed at providing a forum for the exchange of information on the licensees' and regulators' OPEX programmes and on the approaches to assess or even measure the effectiveness of these programmes.

Participants had the opportunity to meet with their counterparts from other countries and organisations and discussed current and future issues on the selected topic. They developed conclusions and commendable practices and identified methods to improve their own OPEX feedback and assessment methodologies.

Regulatory bodies and potentially commercial organisations could benefit from a generally accepted methodology of assessing the effectiveness of their OPEX programmes. Effective application of OPEX is consistently recognised as a fundamental pillar of nuclear safety. An organization's ability to effectively consider OPEX information and determine the appropriate application of the lessons learnt and best practices identified through consideration of that information should be measurable to foster continuous improvement to OPEX processes and programmes.

A set of effectiveness measures and performance assessment tools – heretofore referred to as measures and tools – applicable to OPEX processes and programmes would provide useful information for the management of these processes and programmes. Ideally, these measures and tools would be structured
such that they would be applicable to all entities responsible for nuclear safety (e.g. reactor, materials, radiation protection) across the international community.

The goal of the workshop was thus to identify effectiveness measures and performance assessment tools applicable to OPEX programmes. These measures and tools would be focused on improving the adoption of OPEX-derived safety improvements and overall OPEX programme effectiveness. Three discussion groups were established to discuss the different aspects of the topic in separate working group sessions. The members of the groups were selected such that a diversity of views for each of the topics was created. Discussions groups met for separate sessions to review their individual topics. The exchange of ideas and opinions between participants was active and the groups formulated conclusions based on the discussions.

The three different topics for the discussion groups were related to measures and tools in the following areas:

- identifying/gathering OPEX;
- processing OPEX information;
- assessing outcomes of OPEX programmes.

Initial results to consider are as follows:

- Potential tools and criteria were identified for effectiveness analysis of the various steps of OPEX programmes.
- Only a few tools or verification instruments were identified as potentially missing.
- Specific criteria have been developed to measure effectiveness of OPEX programmes.

The group concluded that major parts of existing OPEX programs can be assessed with respect to their effectiveness with existing measures and tools.

The group discussions resulted in the following generic recommendations that are applicable to OPEX programmes:

- to develop the missing measures and tools to assess the OPEX effectiveness;
- to address the effectiveness of OPEX in OPEX programme reviews like self-assessments, peer reviews, and international missions;
- to intensify the collaboration with non-nuclear industry.

The evaluation of the workshop results was based on the questionnaire responses received from the participants at the conclusion of the workshop. The results of the evaluation show that the approach used during the workshop was effective in encouraging the active exchange of information between the participants and resulted in meaningful conclusions that could be applied to the participants’ OPEX programmes.
FOREWORD

Evaluation of safety significant events including the Fukushima Daiichi NPP accident indicate that lessons to be learnt from OPEX could provide an important prevention tool if implemented in a timely manner. The main objectives of the workshop were to provide a forum for the exchange of information on the licensees’ and regulators’ OPEX programmes and recommended approaches to assess or even measure the effectiveness of these programmes.

Participants were provided with the opportunity to meet with their counterparts from other countries and organisations to discuss current and future issues on the selected topic. They were tasked with developing conclusions and commendable practices regarding the issues and identify methods to help improve their own OPEX feedback and assessment methodologies.

Regulatory bodies, and potentially commercial organisations, could benefit from a generally accepted assessment methodology to measure the effectiveness of their OPEX programmes. Effective application of OPEX is consistently recognized as a fundamental pillar of nuclear safety.

An organisation’s ability to effectively consider OPEX information and determine the appropriate application of the lessons learned and best practices identified through consideration of that information should be measurable to foster continuous improvement to OPEX processes and programmes.

A set of effectiveness measures and performance assessment tools—heretofore referred to as “measures and tools”—applicable to OPEX processes and programmes would provide useful information for the management of these processes and programmes. Ideally, these measures and tools would be structured such that they would be applicable to all entities responsible for nuclear safety (e.g. reactor, materials, radiation protection, etc.) across the international community.
ACKNOWLEDGEMENTS

The Members of the Organising Committee wish to acknowledge the excellent planning and arrangements made by the staff of the hosting organisation, the GRS, TSO to the German Federal Ministry. Special appreciation is given to Prof. Frank-Peter Weiss and Michael Maqua (Germany) of the host organisation; Benoit Poulet (Canada), Chairman of WGOE and Workshop Chairman; Nancy Salgado, NEA Technical Secretariat for WGOE. Additional thanks to Elisabeth Mauny and Abir Maalouf, NEA assistants, in the preparation of the proceedings.

Special acknowledgement is given to the members of WGOE who worked as facilitators and recorders for each of the topics, including, Harold Chernoff (US), Henk van der Veen (the Netherlands), Laszlo Juhasz (Hungary), David Garmon (US), and Yves Van den Berghe (Belgium), and Peter Corcoran (Canada).
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1. EXECUTIVE SUMMARY

The main objectives of the workshop were aimed at providing a forum for the exchange of information on the licensees' and regulators' operating experience feedback (OPEX) programmes and on the approaches to assess or even measure the effectiveness of these programmes. Participants had the opportunity to meet with their counterparts from other countries and organisations and discuss current and future issues on the selected topic. They developed conclusions and commendable practices and identified methods to improve their own OPEX feedback and assessment methodologies.

Approximately 43 participants from 14 different countries and four international organisations took part in the workshop. Participating countries included: Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Japan, the Netherlands, Russian Federation, Slovenia, Sweden, United Arab Emirates, and the United States. The international organisations included the IAEA, WANO, EU-Joint Research Centre, and the OECD/NEA.

The evaluation of safety significant events including the Fukushima Daiichi NPP accident indicated that lessons to be learnt from OPEX could provide an important prevention tool if implemented in a timely manner.

Regulatory bodies and potentially commercial organisations could benefit from a generally accepted methodology of assessing the effectiveness of their OPEX programmes. Effective application of OPEX is consistently recognised as a fundamental pillar of nuclear safety. An organisation's ability to effectively consider OPEX information and determine the appropriate application of the lessons learnt and best practices identified through consideration of that information should be measurable to foster continuous improvement to OPEX processes and programmes. A set of effectiveness measures and performance assessment tools – heretofore referred to as measures and tools – applicable to OPEX processes and programmes would provide useful information for the management of these processes and programmes. Ideally, these measures and tools would be structured such that they would be applicable to all entities responsible for nuclear safety (e.g. reactor, materials, radiation protection) across the international community.

The goal of the workshop was thus to identify effectiveness measures and performance assessment tools applicable to OPEX programmes. These measures and tools will be focused on improving the adoption of OPEX-derived safety improvements and overall OPEX programme effectiveness. Three discussion groups were established to discuss the different aspects of the topic in separate working group sessions. The members of the groups were selected such that a diversity of views for each of the topics was created. Discussion groups met for separate sessions to review their individual topics. The exchange of ideas and opinions between participants was active and the groups formulated conclusions based on the discussions. The three different topics for the discussions groups were related to measures and tools in the following areas:

- identifying/gathering OPEX;
- processing OPEX information;
- assessing outcomes of OPEX programmes.
Initial results to consider are as follows:

- Potential tools and criteria were identified for effectiveness analysis of the various steps of OPEX programmes.
- Only a few tools or verification instruments were identified as potentially missing.
- Specific criteria have been developed to measure effectiveness of OPEX programmes.

The groups concluded that major parts of existing OPEX programmes can be assessed with respect to their effectiveness with existing tools and criteria.

The group discussions resulted in the following generic recommendations that are applicable to OPEX programmes:

- to develop the missing measures and tools to assess the OPEX effectiveness;
- to conduct OPEX programme reviews like self-assessments, peer reviews and international missions to confirm the effectiveness and allow for benchmarking of OPEX Programmes;
- to develop and/or improve the collaboration and sharing of OPEX information with non-nuclear industry.

The evaluation of the workshop results was based on the questionnaire responses received from the participants at the conclusion of the workshop. The results of the evaluation show that the approach used during the workshop was effective in encouraging the active exchange of information between the participants and resulted in meaningful conclusions that could be applied to the participants’ OPEX programmes.
2. ORGANISATION/OVERVIEW OF WORKSHOP

2.1 Planning

Preliminary planning for this workshop began following the 2012 Meeting of WGOE and was finally approved by the CNRA in December 2013. The topics discussed revealed that the effectiveness of programmes on operating experience feedback could attract the interest of both, regulators and licensees. The WGOE determined that the workshop should have only few lectures in order to maximise time for working sessions on three different aspects of the topic. Germany was selected as the host country for the workshop. The final location was at the offices of GRS Garching (close to Munich). The workshop was organised by GRS staff led by Michael Maqua (Germany), the WGOE Vice-Chair.

2.2 Topic introductions

The evaluation of OPEX and particularly safety significant events including the Fukushima Daiichi NPP accident demonstrate that lessons to be learnt from OPEX provide an important prevention tool. It is important to note that lessons learnt from OPEX can result in nuclear safety-related improvements measures which should be adequately implemented in a timely manner.

The ongoing process of collecting operating experience information, evaluation, definition and dissemination of lessons learned, development and implementation of appropriate improvement measures could be generally described as the OPEX process itself. As all processes it should be assessed with respect to its effectiveness.

It has been shown that several important NPP events could have been prevented had the lessons learned from previous NPP events through OPEX been implemented in an effective and timely manner. The best known example is the 1979 core melt accident at TMI-2 where a precursor event occurred only about one year earlier. Had the lessons learned from this precursor event been implemented at TMI or had the operators been trained on that precursor, the core melt at TMI-2 could have been avoided.

Thus, the main objectives of the workshop were to provide a forum for the exchange of information on both the licensees’ and regulators’ OPEX programmes and on approaches to assess or even measure the effectiveness of these programmes. Workshop participants had the opportunity to meet with their counterparts from other countries and organisations to discuss current and future issues on the selected topic. It was intended that they should develop conclusions and commendable practices regarding the issues and identify methods to help improve their own OPEX feedback and assessment methodologies.

Both, regulatory bodies, and commercial organisations, could benefit from a generally accepted methodology of assessing the effectiveness of their OPEX programmes. Effective application of OPEX is consistently recognised as a fundamental pillar of nuclear safety. An organisation’s ability to effectively consider OPEX information and determine the appropriate application of the lessons learned through consideration of that information should be measurable to foster continuous improvement to OPEX processes and programmes. A set of effectiveness measures and performance assessment tools—here referred to as “measures and tools” —applicable to OPEX processes and programmes provide useful information for the management of these processes and programmes. Ideally, these measures and tools
should be structured such that they are applicable to all entities responsible for nuclear safety (e.g. reactor, materials, radiation protection, etc.) across the international community.

The goal of the workshop was to identify effectiveness measures and performance assessment tools applicable to OPEX programmes. These measures and tools are focused on improving the adoption of OPEX-derived safety improvements and overall OPEX programme effectiveness.

The workshop lasted two and a half days and included panel presentations and breakout sessions. In the breakout sessions diverse groups of nuclear safety experts collaborated on the development of measures and tools applicable to general OPEX programme areas. The presentations were intended to provide specific information on the workshop topic from different points of view used to set the foundation for the breakout session discussions.

The breakout group discussions have been the primary focus of this workshop. Important final workshop deliverables, specifically, measures and tools for assessing the effectiveness of OPEX programmes and commendable practices in this area originated from these groups.

There have been three breakout groups responsible for developing measures and tools in the following areas:

- identifying/gathering OPEX;
- processing OPEX information;
- assessing outcomes of OPEX programmes.

The objectives of each group are described in Table 1 were used as a guide for the development of measures and tools applicable to each area. However, the final product was developed by each breakout group. The breakout groups did not significantly deviate from the original objectives described in Table 1.

<table>
<thead>
<tr>
<th>Group 1 – Identifying/gathering OPEX</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>This group should focus on developing measures and tools that apply to the area of identifying/collection OPEX. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>The following is provided solely to stimulate conversation on what attributes could be measured to ensure:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Timeliness</strong></td>
<td></td>
</tr>
<tr>
<td>- That OPEX is considered within an appropriate amount of time.</td>
<td></td>
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<tr>
<td><strong>Value</strong></td>
<td></td>
</tr>
<tr>
<td>- That the threshold for information that is considered in the OPEX programme is adequate.</td>
<td></td>
</tr>
<tr>
<td>- That the sources being considered within an OPEX programme are adequate.</td>
<td></td>
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<tr>
<td><strong>Quality</strong></td>
<td></td>
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<tr>
<td>- That OPEX is being stored appropriately.</td>
<td></td>
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<tr>
<td>- That the appropriate amount of information is being provided in an OPEX report.</td>
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</tbody>
</table>
### Group 2 – Processing OPEX information

This group should focus on developing measures and tools that apply to the processing of OPEX information once it has been collected. The processing of OPEX information includes the storing and evaluation of OPEX information. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

- **Timeliness**
  - That OPEX is being evaluated in a timely manner.

- **Value**
  - That the criteria for screening an item for further evaluation are appropriate.

- **Quality**
  - That OPEX is stored in a retrievable manner.
  - That effective evaluation of an OPEX issue has taken place.
  - That an effective outcome/application from the evaluation of an OPEX issue has been proposed.

### Group 3 – Assessing outcomes of OPEX programmes

This group should focus on developing measures and tools that assess an organisation's effectiveness in implementing OPEX initiated activities. Within this area, the measures and tools should specifically review the effectiveness of:

1. The communication of OPEX.
2. The effectiveness of OPEX on regulatory oversight and requirements.
3. The effectiveness of OPEX on NPP design. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

- **Timeliness**
  - That the outcomes from OPEX initiatives are assessed in a timely manner.

- **Value**
  - That the value added from OPEX initiatives is worth the cost.

- **Quality**
  - That the OPEX initiatives accomplish their purpose.

### 2.3 Announcement and pre-workshop activities

**Workshop announcement**

The workshop announcement was transmitted to the NEA member and WGOE associated countries to maximise the results of the workshop by engaging world-wide expertise. This approach was meant to ensure that the results of the workshop could improve the efficiency and effectiveness of the regulatory body and industry the OPEX programmes. The announcement was initially sent out in May 2014 to solicit participation of interested organisations and individuals.

**Facilitator training**

Prior to the start of the workshop, facilitators and recorders attended a pre-workshop meeting. Each discussion group was led by at least one experienced member of WGOE. During the facilitator training, the
general objectives of the workshop were discussed in more detail to enable the facilitators to guide the discussions in their breakout groups. For each group a set of expectations were given to ensure the outcomes of the different breakout groups would be compatible and to avoid an overlapping of the discussion topics. In addition a reminder was given on the role of a good facilitator, on the importance of the leader’s role in guiding the group, and on the various methods required to manage an effective group discussion.

2.4 Overview of workshop

The format of the workshop used a modification of the process that was first applied at the 1992 WGIP workshop that was held in Chattanooga, USA. This format, which has evolved over time through the conduct of subsequent NEA workshops, was also used in the joint WGIP/WGOE workshop that was held in Helsinki, Finland in 2011.

The participants in each of the three discussion groups were decided on in advance to provide a diverse group of backgrounds, opinions, and regions. A facilitator and recorder worked with each group to stimulate and encourage discussions. The discussion groups are identified below:

<table>
<thead>
<tr>
<th>Identifying/Gathering OPEX Breakout session - Group 1</th>
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</thead>
<tbody>
<tr>
<td>First Name</td>
</tr>
<tr>
<td>Henk</td>
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<tr>
<td>Harold</td>
</tr>
<tr>
<td>Antonio</td>
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<tr>
<td>Leopold</td>
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<tr>
<td>Mark</td>
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<tr>
<th>Processing OPEX information Breakout session - Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name</td>
</tr>
<tr>
<td>Laszlo</td>
</tr>
<tr>
<td>David</td>
</tr>
<tr>
<td>Fuming</td>
</tr>
<tr>
<td>Yoichi</td>
</tr>
<tr>
<td>Kenneth</td>
</tr>
<tr>
<td>Miguel</td>
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<tr>
<th>Assessing outcomes of OPEX Breakout sessions - Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name</td>
</tr>
<tr>
<td>Peter</td>
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<tr>
<td>Yves</td>
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<tr>
<td>Didier</td>
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<tr>
<td>Benoit</td>
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<tr>
<td>Name</td>
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<td>--------------</td>
</tr>
<tr>
<td>Anita</td>
</tr>
<tr>
<td>Mika</td>
</tr>
<tr>
<td>Angelica</td>
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<tr>
<td>Charles-Henri</td>
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*Bold are the session facilitators/recorders*
3. OPENING SESSION

The workshop was opened by the WGOE Chair, Benoit Poulet (Canada), who welcomed all of the participants and emphasised the important role of each participant to the success of the workshop.

Prof. Frank-Peter Weiss, Director of GRS also provided welcoming remarks on behalf of the host organisation and encouraged the active participation of the members in sharing their knowledge and insights on the workshop topics.

Nancy Salgado, NEA technical secretariat, also welcomed the participants and discussed the importance of workshops like this to provide a forum for sharing experiences, practices, and insights on topics that enhance the safe operation of nuclear power plants, and the importance of taking back the information to each regulatory authority or organisation to apply the knowledge and insights gained during the workshop.

Riccardo Chiarelli, WANO, highlighted the interest to the topic from the operator’s point of view. He discussed shortly the activities of WANO regarding the assessment and sharing of the lessons learned from OPEX. The effectiveness of these activities can be measured by peer reviews of the various NPPs. The results of the peer reviews are fed back to improve the WANO procedures and tools.

In the following days two further presentations were delivered, Ludwig Drees and Lukas Höhndorf presented their work at the Institute of flight system dynamics from the Technical University of Munich titled “Predictive Analysis applied to Flight Operations”. The presentation discussed the approach used by the airline industry to improve safety. The scientific methodology uses similar steps than the analysis of nuclear reactor operational safety. This presentation was an interesting preparation to the visit of the institute on Tuesday afternoon.

On Wednesday Wolfgang Preischl reported on the GRS approach to human factors in operating experience feedback titled "Generic Human and Organisational Performance Feedback from Reportable Events in German Plants”. In a majority of instances a combination of technical, human and organisational factors (HOF) root causes are contributing to significant events. In order to supplement that activity and to obtain a broader view on HOF root causes over a longer period of time GRS developed a specific methodology evaluating all reported events with such contributions. The presentation briefly described the methodology and provided an overview of the first results.

3.1 Results of breakout group discussions

In accordance with the procedures established by the WGOE, three breakout groups were formed to discuss the different aspects of the workshop topic on OPEX programme effectiveness measures in separate working groups. The members of the groups were selected such that a diversity of views for each of the topics was created. Discussions groups met for separate sessions to review their individual topics. The exchange of ideas and opinions between participants was active and the groups formulated conclusions based on the discussions. The three different topics for the discussions groups were related to measures and tools in the following areas:

- identifying/gathering OPEX;
- processing OPEX information;
• assessing outcomes of OPEX programmes.

3.2 TOPIC 1: Identifying/gathering OPEX

The objectives of the Group were to develop measures and tools for identifying and collecting Operating Experience Feedback information. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The group consisted of ten experts from seven countries and a representative of the European Clearinghouse. The background of the participants was diverse and included experts from various Regulatory Bodies, from a Technical Support Organisation and a Research Institute.

The group had four meeting sessions in an informal setting. All participants contributed by providing information about the specific situation in their respective countries and by participation in discussions.

The scope of discussions was mainly focused on OPEX programmes of Regulatory Bodies but there was a strong link with OPEX activities from licensees, TSOs, vendors, owner groups and relevant (mostly international) nuclear organisations like WANO, IAEA and NEA.

The following measures were identified to safeguard the adequate identification and gathering of relevant OPEX info:

• Assure the availability of sufficient resources to perform OPEX activities.

• Assure the smooth transfer of OPEX information within the Regulatory Body and with the identified external stakeholders.

• Assure adequate access to relevant OPEX information
  o Nationally
    ▪ From the NPP’s
    ▪ From TSO’s
    ▪ From others (vendors, owner groups etc.)
  o Internationally
    ▪ From IAEA
    ▪ From WANO
    ▪ From INPO
    ▪ From JRC Clearinghouse
    ▪ From vendors, owner groups etc.
    ▪ Bilateral agreements between countries

• Assure active participation in international OPEX activities (WGOE, IRS, INES, other)

An important issue is the time when reported events are evaluated at the different bodies.

Timeliness

• Timely after reporting of the event;

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1. Timeliness: OPEX is considered within an appropriate amount of time.
2. Value: Threshold for information in OPEX programmes is adequate. Sources of information in OPEX programmes are adequate. OPEX is stored appropriately.
3. Quality: Amount of information in OPEX reports is appropriate.
• Timely processing (screening, distribution and evaluation);
• OPEX will follow near term actions to remediate the event.

Value

Threshold of information in OPEX programmes
• Information in OPEX programmes should be prioritised according to its relevance to nuclear safety. The main focus should be on significant events but in appropriate attention should be paid to the lower level of OPEX (e.g. near misses, events involving non-safety systems etc.).

A set of criteria should be in place to categorise the relative importance of events.
• Analysis and reporting of events should result in high quality reports.
• Special attention has to be paid to recurring events and events of a generic nature.

Sources of information within OPEX-programmes

• From the sites:
  o Incident reports from licensees (O)
  o Regular contacts between RB and licensee (telephone, email etc.) (O)
  o Inspections by RB (R)
  o Other reports from licensee
    ▪ Status reports on plant performance (R)
    ▪ Reports on OPEX activities (low level events, trending) (Y)
    ▪ Periodic Safety Reviews (LF)
    ▪ Conformity Checks (LF)
    ▪ Outage deviation reports (Y or LF)
  o Other sources (inspection bodies) (R)

• From other sources:
  o IAEA
    ▪ IRS (O)
    ▪ INES (R)
  o OECD/NEA
    ▪ Reports (R)
  o WANO
    ▪ Events database (O)
    ▪ Reports (SOER, SER, other) (R)
  o INPO
    ▪ Events database (O)
  o Clearinghouse

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4. Frequency of information: Often (O), Regular (R), Yearly (Y), Less frequent (LF)
3.3 TOPIC 2: Processing OPEX information

The objectives of the Group were to develop measures and tools to assess whether Operating Experience Feedback information is processed effectively after it is received. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The group consisted of 12 experts from eight countries and a representative from each of the IAEA and JRC. The background of the participants was quite diverse and included experts from various Regulatory Bodies, from licensees and from international institutions.

The group had four meeting sessions in an informal setting. All participants contributed by providing information about the specific situation in their respective countries and by participation in discussions.

The initial discussions set a frame to set priorities for the review and analysis of incoming OPEX information which should be screened according to the following attributes:

- Significance
- Applicability
- Difficulty of an Evaluation
- Time for initial screening
- Time for detailed analysis.

The evaluation of the significance of OPEX information should take into account the following:

- Impact on analysed accident sequences
- Real/Potential safety consequences
- Affected Equipment/Procedures
- Affected safety functions/Barriers.

The group highlighted as a good practice the assessment of OPEX regarding its relevance to probabilistic safety analyses and precursor analyses.

Following the screening the next step in the OPEX information process is the determination of the causes (i.e. root causes and contributing causes). These cause analyses should be performed using generally accepted methods. The analysts should have been adequately trained in the applied method(s). The cause
analyses are also relevant for the investigation of pre-event activities (e.g. human factors, operations and maintenance).

One of the most important challenges to the processing is the lack of information on the specific event. The investigators should develop a process to cope with this generic difficulty to get the best benefits from their analyses. It is considered as a good practice, if the evaluation also covers near misses and similar events in other NPPs.

An event analysis should have a high priority when all of the important attributes mentioned above (i.e. significance, applicability, difficulty of evaluation) are present. When some of these attributes seem not to be fully met, the event analysis should have a medium priority. In cases where some of the attributes are missing (or are very weak) the analysis should be attributed a low priority.

Further general attributes of good OPEX processing comprise adequate resources, high qualification of involved OPEX personnel, and the involvement of the NPP management.

The screening process starts with the initial review of the event information. This needs competent (dedicated, diverse backgrounds) reviewers, following established screening criteria for significance [i.e. INES (International Nuclear and radiological Event Scale), PRA (Probabilistic Risk Assessment)/PSA (Probabilistic Safety Assessment) ...]. The screening process finishes with setting the priorities for the further investigations.

The analysis step in OPEX processing is primarily based on the event description that should include the initial condition of the plant, the chronology of the event and a clear description of the related safety concerns.

The following step in the process is the evaluation of the safety significance. This includes the impact on analysed accident sequences, the determination of real/potential safety consequences, investigation on the affected equipment and/or procedures, the evaluation of the affected safety functions or barriers. The group considers it as a good practice when probabilistic assessments are included in the evaluation of safety significance (e.g. PSA and precursor analyses).

The evaluation of the event causes, root causes and contributing factors completes the analysis. It is recommended to use generally accepted analysis methods and to take into account relevant pre-event activities related to e.g. human factors, operations and maintenance.

The major challenge is to complete an adequate analysis despite a potential lack of information. It is usual for the analysis to have to be conducted before all of the event information is available. This often affects the more safety significant cases. A further step in the processing of OPEX information is represented by the response to the results of the analyses (e.g. organisational learning, corrective actions, etc.). The corrective actions should be Specific, Measurable, Achievable, Realistic, and Timely (SMART). Implementation plans should include a prioritisation of recommended actions and these plans should account for risks associated with the implementation of recommended actions. It is necessary to direct the corrective actions toward the appropriate audience.

The generic lessons learned are important for all NPPs and regulators which are not directly affected by the event. These have to be drawn from the analyses and should include the specific messages to be sent to the key stakeholders.

The storage of OPEX information is considered as the final step of the analysis process. Most regulators and licensees prefer a centralized storage for OPEX information. Within the design of such a database the following should be considered:

- Track items as necessary
- Storage and ability to attach and reference related files
- Systematic code word to facilitate information organisation and retrieval
• Capability of trend analysis
• Search functions
• Stakeholders access
• Information directed to appropriate stakeholder
• Storage scheme support timeliness goal
• User-friendly structure
• Training for use
• Clear ownership of the overall process

Some of the items listed will not have the same solutions. As examples, a regulator might allow access to their event database to the public or vendors. In these cases, a filtered version of the database should be established to ensure only information that is intended to be released to a certain population is accessible by that population.

The final results of the working group discussions focus in recommendations developed regarding the timeliness of initial screening and the detailed analysis, the balance between resources and outcomes, and the quality of the analysis.

3.4 TOPIC 3: Assessing outcomes of OPEX programmes

The overarching goal of Group 3 was to verify whether an OPEX programmes is effective in implementing OPEX initiated activities. The group consisted of 16 representatives from national regulators, technical support organisations, licensee operators, and international organisations (IAEA, WANO, and EU JRC). The main objectives should cover the development and proposal, respectively, of measures and tools to assess the outcomes of OPEX programmes.

The Group defined “outcomes” as followed:

*Outcome(s): An effective OPEX Programme in terms of communications, impacts on facility design and NPP operational safety and regulatory oversight effectiveness.*

Major attributes are characteristics and qualities that constitute an effective OPEX programme. These attributes are achieved by “measures” that means actions and/or activities to be taken by organisations (national regulators and licensees). The term tool was defined by group 3 as methods or metrics by which one might measure or assess effectiveness of OPEX programmes.

Having arrived at the definitions above, the group undertook to establish, in logical order, the attributes of an effective OPEX programme, the measures to achieve these attributes, and the tools that could be used to verify these measures are being effective. Due to the mixed composition of the group, the attributes identified relate well to the Regulatory Body, TSO and licensee OPEX programmes.

Having settled upon the approach, the Group considered each of the items above in logical order, beginning with brainstorming to produce attributes, then refining these in small groups and validating them in a plenary session of the Group.

Once the attributes were agreed, the Group worked as a team to propose measures and suggest ways that we might try to demonstrate that these measures were in place and/or gauge their effectiveness.

Some attributes gave rise to several measures and some measures gave rise to more than one metric. Rather than debate the value of any of these, and in consideration of the limited time at the workshop, all were included for consideration by the readers as options for measuring success.

Recognising that all attributes might not have measures and all measures might not have metrics, the facilitators nevertheless felt that these might still be desirable for reasons the group might not have
identified. Therefore the group decided to keep these so others might consider them and might even find measures and metrics for them.

The summary of those discussions on suggested/proposed measures and metrics/tools resulted in the table (see below) as well as the slides for Group 3 as presented at the workshop. The group presented them as a table to the full plenary of the Workshop in hopes that the participants and future readers would have concrete suggestions for consideration in their specific cases.

Some further issues can be found at the end of the table.

OPEX programme managers should look, in a systematic way, at those outcomes that define an effective OPEX programme and seek to develop

i. attributes,

ii. measures and

iii. metrics or tools, which can be used to gauge progress on the attainment of these outcomes.

OPEX programme managers need to seek feed-back from end-users on whether the programme and its lessons learned are helping to improve the NPP operational safety and/or the effectiveness of regulatory oversight.

<table>
<thead>
<tr>
<th>ATTRIBUTES</th>
<th>MEASURES (HOW TO DO THIS)</th>
<th>METRICS (HOW TO MEASURE) AND TOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely communication of OPEX by licensee to regulator [Licensee OPEX programme]</td>
<td>Monitor completion of event notifications (like Licensee Event Reports (LERs))</td>
<td>Ratio of completed LERs within allowed time delay by quarter/year and by licensee/site Average reporting time by the licensee for events</td>
</tr>
<tr>
<td>Timely communication of OPEX by regulator to different stakeholders for information or evaluation [RB/TSO OPEX programme]</td>
<td>Clear timeline and point of contact (PoC) expectations for all forms of communication (Letters, Notices, Info Bulletins from Regulator to licensees; information of other stakeholders, …)</td>
<td>Average time delay to report event(s) to stakeholders (licensees, IRS…)</td>
</tr>
<tr>
<td>Communication should clearly and concisely identify the issue of concern and put it in the proper perspective [RB/TSO OPEX programme]</td>
<td>Clear procedures are communicated through notices and training of staff Use, to the extent possible, clear, consistent terminology and nomenclature</td>
<td>Feedback from trainees that the terminology and nomenclature are understood Feedback loop</td>
</tr>
<tr>
<td>Transparency</td>
<td>Systematic, documented decision-making process for accessing lessons learned and recommendations</td>
<td>Confirmation that process is in place and being used</td>
</tr>
<tr>
<td>Communication should be effectively targeted to the (right) audience (within the regulator and the licensee): • Decision-makers • End users • Technical specialists • Inspectors [Licensee and RB/TSO OPEX programmes]</td>
<td>Communicate with stakeholders directly, in meetings and through safety and technical groups</td>
<td>Feedback loop</td>
</tr>
</tbody>
</table>
## COMMUNICATION OF OPEX (Cont.)

| Effective sharing of OPEX with licensees [RB/TSO OPEX programme] | Share OPEX with stakeholders | No. of OPEX letters, info notices, bulletins issued by quarter/year |
| Effective sharing of OPEX information through international reporting systems [Licensee and RB/TSO OPEX programmes] | Share OPEX with nuclear regulators in other countries | No. of national events reported to international bodies (IRS, FINAS, IRSRR, WANO, etc.) Ratio of events (of total significant national events) reported internationally. |
| Effective sharing of OPEX information through wider collaboration [Licensee and RB/TSO OPEX programmes] | Share OPEX information with non-nuclear regulators, standards associations, vendors and manufacturers | No. of events and OPEX information shared with other organisations. No. of OPEX information items received from other organisations. Leverage opportunities to meet and share OPEX/lessons learned among concerned organisations No. of meetings, conferences, working groups, etc. attended where OPEX is shared. |

## IMPACT ON THE DESIGN AND SAFE OPERATION OF POWER REACTORS (NPPs)

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Measures (How to do this)</th>
<th>Metrics (How to measure) and Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain knowledge of OPEX and lessons learned over the long term [Licensee and regulator/TSO OPEX programmes]</td>
<td>Develop an effective knowledge management database for OPEX with • Ease of access • Flexibility for expansion (new discoveries) • Ability to preserve data over time (keep important lessons current (top of mind))</td>
<td>Feedback loop</td>
</tr>
<tr>
<td>Avoid recurrence of events [Licensee OPEX programme]</td>
<td>Highlight the recurring events</td>
<td>No. and trend of recurring events over an appropriate time interval</td>
</tr>
<tr>
<td>Correctly identifies the safety significance and root cause(s) [Licensee OPEX Programme]</td>
<td>OPEX management committee to review the safety significance and root cause analyses</td>
<td>No. of incorrectly analysed events</td>
</tr>
<tr>
<td>Follow-up of timely completion of Corrective Actions (CAs) [Licensee OPEX programme]</td>
<td>Monitor the completion of CAs Develop a process that confirms that CAs were completed in due time</td>
<td>No. of CAs completed on time No. of CAs opened per quarter No. of CAs closed per quarter No. of CAs remaining open per quarter (carry over)</td>
</tr>
<tr>
<td>Reviews appropriateness of Corrective Actions [Licensee OPEX programme]</td>
<td>Monitor the frequency of CAs management Review Committees (licensees) Monitor the impact of corrective actions on conditional core damage frequency (CCDF) No of CAs deemed by the OPEX review committee to be incorrectly identified/coded for cause(s), root cause and follow-up action</td>
<td></td>
</tr>
<tr>
<td>Evaluates the effectiveness of corrective actions [Licensee OPEX programme]</td>
<td>Develop a process for evaluating the effectiveness of corrective actions in addressing root cause(s) Monitor recurrence of identified root causes of events</td>
<td>No. and trend of recurring root causes</td>
</tr>
<tr>
<td>Implementation by licensees of regulatory requests arising from OPEX [RB OPEX programme]</td>
<td>An effective process to monitor corrective actions in response to regulatory requests Track open regulatory action items arising from OPEX</td>
<td>Peer- reviews (IRRS, WANO) No. of open regulatory requirements No. of national event reports which led to regulatory action on the licensee; No. of international event reports which led to regulatory action on the licensee</td>
</tr>
</tbody>
</table>
### IMPACT ON THE DESIGN AND SAFE OPERATION OF POWER REACTORS (NPPs) (Cont.)

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Measures (How to do this)</th>
<th>Metrics (How to measure) and Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely completion of regulatory action items arising from OPEX (RB OPEX programme)</td>
<td>Track timeliness of completion of regulatory action items arising from OPEX</td>
<td>Average time to completion of action items per quarter or per year</td>
</tr>
<tr>
<td>Identifies the appropriate timeline and level of responsibility</td>
<td>Regulatory body may decrease the time to complete CAs, to avoid recurrence of events</td>
<td>No. of letters from the regulatory body to reduce the timeline for the CA plan</td>
</tr>
<tr>
<td>Shares best practices</td>
<td>Share info among like-minded, interested bodies</td>
<td>(see Communications for metric)</td>
</tr>
<tr>
<td>Implements best practices</td>
<td>Regulator is effectively implementing OPEX lessons learned</td>
<td>No. of enforcement letters sent to licensees resulting from OPEX</td>
</tr>
<tr>
<td>Licensees take appropriate action with respect to documented OPEX</td>
<td>No. of national event reports which led to regulatory action on the licensee</td>
<td>No. of instances (events, inspection findings, etc.) where OPEX guidance was not followed or adhered to</td>
</tr>
<tr>
<td>recommendations</td>
<td>No. of international event reports</td>
<td></td>
</tr>
<tr>
<td>REGULATORY OVERSIGHT EFFECTIVENESS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attributes</td>
<td>Measures (How to do this)</td>
<td>Metrics (How to measure) and Tools</td>
</tr>
<tr>
<td>OPEX forms important input to inspection programmes, technical analysis, regulatory review, and new regulatory requirements</td>
<td>Track open regulatory action items arising from OPEX</td>
<td>Number of open regulatory actions</td>
</tr>
<tr>
<td>OPEX should be part of the core training for staff</td>
<td>To verify that OPEX is included in the training of staff</td>
<td>Verify</td>
</tr>
<tr>
<td>Regulatory OPEX programme should not only be reactive but focus on precursors and low level events</td>
<td>Systematic review / inspection of licensee’s program for inclusions of precursors and low level events</td>
<td>Number of such inspections</td>
</tr>
<tr>
<td>Makes effective use of available resources</td>
<td>Measure of Resources spent on OPEX programme (time/money/effort)</td>
<td>Number / % of person-days (time accounting system…), costs</td>
</tr>
<tr>
<td>OTHER ISSUES (Parking lot) – These were felt to be not in scope or were perhaps part of the scope of Groups 1, 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attributes</td>
<td>Measures (How to do this)</td>
<td>Metrics (How to measure)</td>
</tr>
<tr>
<td>Group 2?</td>
<td>Internal review of appropriateness</td>
<td>No of events that generate tech analysis and/or regulatory recommendations</td>
</tr>
<tr>
<td>Group 2?</td>
<td>Internal review of quality</td>
<td>No. or % of national reports for which in-depth technical analysis is performed</td>
</tr>
<tr>
<td>Group 2?</td>
<td>Clear rationale for corrective actions (CAs)</td>
<td>Rationale for CAs should be clearly documented and understood</td>
</tr>
</tbody>
</table>
4. CLOSING PLENARY SESSION

4.1 Workshop closing remarks

Michael Maqua from the hosting organisation and Vice-Chairman of WGOE led the workshop closing session. In his presentation he provided an overview of the breakout group discussions held during the workshop on the three topics, using operating experience in

- identifying/gathering OPEX;
- processing OPEX information; and
- assessing outcomes of OPEX programmes.

The focus of his presentation was on the conclusions, commendable practices, and challenges identified during the breakout group discussions.

The main findings for the first breakout group related to identifying/gathering OPEX were related to criteria for measurement of distribution of information, required reporting including required reporting quality, and the regulatory follow-up for significant events.

The second working group dealt with the processing of information related OPEX. The main conclusions are related to the timeliness, the value, the quality, the analysis, and further generic aspects in the OPEX process. Such a generic challenge is the lack of information that might stop the cause analysis before all underlying causes are identified.

The third working group developed and proposed measures and tools to assess the outcomes of OPEX programmes related to communications, its impact on NPP design and operational safety, and on the regulatory oversight effectiveness. For all steps attributes, measures, and metrics were identified. For most of the areas, attributes, measures, and metrics were identified, however few gaps were identified in some of the areas where improvements could be made. For example, metrics regarding transparency and OPEX databases could be an area for further improvement.
5. GENERAL WORKSHOP CONCLUSIONS

The following conclusions emerged from the workshop and provide an overview of the effectiveness measures and commendable practices identified by the participants during the workshop. The workshop conclusions and commendable practices are based on workshop discussions which might not reflect a consensus opinion of all NEA member countries. Nevertheless, these can be utilised as a general benchmark for basic comparisons in those areas shared by OPEX experts from NEA member countries.

Tools and criteria were identified for various steps of OPEX programmes. Few missing tools or verification measures were detected. Specific criteria were developed to measure effectiveness. That means that major parts of existing OPEX programmes could be assessed with respect to their process effectiveness. OPEX programme managers should systematically review the outcomes that define an effective OPEX programme and apply the appropriate metrics or tools. OPEX programme managers should develop the programme and assess its impact on NPP operational the effectiveness of regulatory oversight.

Based on the working group discussion following generic recommendations were derived:

- The missing tools and measures identified during the discussion should be developed for further enhancement of the OPEX process.
- These should be considered to address missing verifications in the OPEX programmes review tools like self-assessment, peer reviews, international missions.
- Collaboration with non-nuclear industry and regulators on OPEX should be increased.

Overall the workshop provided an effective means for the participants to share their knowledge and insight on OPEX programme and process effectiveness. A number of commendable practices were identified that the participants were encouraged to take back to their home organisations with the goal of enhancing their own OPEX processes and to improve nuclear safety oversight, to better capture and share OPEX information within their own organisations and the broader international community.

A special thank was expressed to all of the presenters, working group facilitators, and the research institutions in the neighbourhood of GRS Munich that opened their laboratories for the technical visits. The planning and organisation of the workshop by GRS was excellent and it greatly contributed to the success of the workshop.
6. WORKSHOP EVALUATION FORM RESULTS

6.1 Evaluation form

All participants at the workshop were requested to complete an evaluation form. The results of this questionnaire summarised below, are utilised by WGIP in setting up future workshops and to look at key issues for in the programme of work over the next few years. Of the 43 total participants 28 responses were received.

The evaluation form, which was similar to ones issued at previous workshops, asked questions in 4 areas: general - workshop objectives, workshop format, workshop topics and future workshops. Participants were asked to rate the various questions on a scale of 1 to 5 (with 1 being a low (poor) score and 5 being a high (excellent) score. Results are provided in the following charts (which also reflect scores from the previous workshops - for comparison purposes) along with a brief written summary.

6.2 General

The chart below depicts the overall conduct of the workshop and the participants responses on how well the workshop was conducted.

Garching September 2014 workshop: General survey questions: Q1-6

![Chart showing survey results]

These responses to the general survey questions indicate that overall, there was general satisfaction with the conduct of the workshop. Most of the participants valued meeting with other regulators to discuss their operating experience and inspection programmes (average 4.19, with a range of responses from 3 to 5). The quality of the discussions and the exchange of regulatory information were perceived as good by most of the respondents (average 3.50, with a range of responses from 2 to 5, and an average 3.79, with a range of responses from 2 to 5, respectively). Development of conclusions (average 3.79, with a range of responses from 2 to 5) and identifying new methods for using operating experience (average 3.36 with a range of responses from 2 to 5) show a general satisfaction with these areas as well. The majority of the
respondents indicated that they would propose the use of the workshop information in their operating experience and inspection programmes (average 4.00, with a range of responses from 2 to 5).

6.3 Workshop format
This part of the questionnaire looked at the effectiveness each of the sessions. The main objective of these questions focuses on the way sessions are conducted. The responses provide feedback to WGOE and NEA in its preparation and planning for future workshops.

Garching September 2014 WGOE workshop: Format effectiveness: Q7-11

Comparing these WGOE results with the previous the workshop in Helsinki, Finland in 2011 finds very similar result ranges. They confirm that WGOE members continue to be more efficient in preparing and running a workshop. The success of each workshop is dependent on good preparation by the WGOE and co-ordination between the facilitators and recorders for each topic. As discussed in previous proceedings, social interaction outside the workshop sessions clearly enhances the discussions.

6.4 Workshop Topics
In order to assess how well the topics have been addressed, participants were asked to give a rating on whether they perceived the topics were covered adequately.
Workshop participants were generally satisfied with the selection of topics and how they were addressed.

6.5 Future workshops

Workshop participants who responded were unanimous in endorsing future workshops. The results also showed that most participants also agree with the existing format regarding the number of topics and the length of the workshop.

6.6 Suggested future topics

Participants were asked to provide their input on potential future topics. While no specific analysis was applied to the results, WGIP and the CNRA will evaluate these and use them in proposing topics for future workshops. The topics that were ranked as the highest priority (randomly listed) include:

- Safety Culture
- Maintenance related to OPEX
- Measuring Effectiveness
- Information exchange on the setup of countries OPEX-programmes
- Categorisation of events
- Deployment a regular OPEX programme review service (to supplement IRRS OPEX reviews) across all regulators
- What are the criteria to declare an event as significant?
- Continue work on the same topic (OPEX programme effectiveness measures)
- Performance indicators for OPEX programmes in regulatory body
- Connective Actions Evaluation/Effectiveness

6.7 Additional comments received

Additional feedback from participants is provided below:

- I suggest sending a questionnaire prior to the workshop, it helps specify the topics and it forces participants to start reflection.
- Organise training to be more effective in facilitating breakout sessions.
- Provide computers/laptops with English version of Word and PowerPoint and connectable to a beamer.
- Location of workshop was good.
- Size of the groups should be no more than eight or nine persons.
- Format is ok => However, ensure that facilitators are moderators and that they do not dominate group work
- Need more time for discussion of group’s results.
- Participants may be asked to come prepared in advance and/or to give inputs prior to the future workshops.
- Presentations were interesting and gave a “break”.

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7. LIST OF PARTICIPANTS

**BELGIUM**  
PACI Georges  
VAN DEN BERGHE Yves  

**CANADA**  
CORCORAN Peter  
POULET Benoit  

**CZECH REPUBLIC**  
DYMOVSKY Igor  
JAKES Miroslav  

**FINLAND**  
KAIJANEN Mika  
LAAKSONEN Rami  

**FRANCE**  
BILDE Lena  
CRUTEL Vincent  
TAVEL Charles-Henri  
VAUCHER Rachel  
WATTRELOS Didier  

**GERMANY**  
DREES Ludwig  
GOTTSCHALL Manuela  
HÖHNDORF Lukas  
MAQUA Michael  
PREISCHL Wolfgang  
REHR Josephine  
RICKERT Mandy  
WEISS Frank-Peter  

**HUNGARY**  
JUHASZ Laszlo  

**JAPAN**  
ICHIKI Ryuichi  
ISHII Yoichi  

BELGIUM  
TRACTEBEL  
BEL V  

CANADA  
Canadian Nuclear Safety Commission  
Canadian Nuclear Safety Commission  

CZECH REPUBLIC  
State Office for Nuclear Safety  
State Office for Nuclear Safety  

FINLAND  
Radiation and Nuclear Safety Authority (STUK)  
Teollisuuden Voima Oyi  

FRANCE  
Institute for Radiological Protection and Nuclear Safety (IRSN)  
IRSN  
French Nuclear Safety Authority (ASN)  
ASN  
IRSN  

GERMANY  
Institute of Flight System Dynamics  
GRS  
Institute of Flight System Dynamics  
GRS  
Sicherheit und Zertifizierung (ESN)  
ESN  
GRS  

HUNGARY  
Hungarian Atomic Energy Authority  

JAPAN  
Japan Nuclear Safety Institute  
Nuclear Regulation Authority
NETHERLANDS
VAN DER VEEN Henk Ministry of Infrastructure

RUSSIA
KHAZANOV Adolf Scientific and Engineering Centre for Nuclear and Radiation Safety (SECNRS)
ZAKHAROV Oleg SECNRS

SLOVENIA
VRANKAR Leopold Slovenian Nuclear Safety Administration

SWEDEN
SEVERIN Mats Forsmarks Kraftgrupp AB
BROMAN Kenneth Swedish Radiation Safety Authority
GUDMUNDSSON Anita Ringhals AB Vattenfall
ÖHRN Angelica Swedish Radiation Safety Authority
SETTERSTAL Nils Erik Oskarshamm

UNITED ARABS EMIRATES
KEARNEY Mark Federal Authority for Nuclear Regulation (FANR)
MOHAMMED Salem FANR

UNITED STATES OF AMERICA
CHERNOFF Harold Nuclear Reactor Regulation (NRC)
GARMON David NRC

INTERNATIONAL ORGANISATIONS
BALLESTEROS-AVILA Antonio European Commission (EC)
PEINADOR VEIRA Miguel EC
ZERGER Benoit EC
JIANG Fuming International Atomic Energy Agency (IAEA)
PIPLANI Vivek IAEA
CHIARELLI Riccardo World Association of Nuclear Operators (WANO)
SALGADO Nancy Nuclear Energy Agency
8. RECENT WGOE AND RELATED-CNRA REPORTS

NEA/CNRA/R(2015)1 Update of the use of International Operating Experience Feedback for Improving Nuclear Safety

NEA/CNRA/R(2014)1 WGOE Report on Fukushima Daiichi NPP Precursor Events


NEA/CNRA/R(2012)1 WGOE Report: Maintaining and Transferring Knowledge on Operating Experience


NEA/CNRA/R(2011)6 Operating Experience Report: Recent Failures of Large Oil-Filled Transformers


These reports, as well, as all CNRA reports are available online at:

http://www.oecd-nea.org/nsd/docs/indexcnra.html
## APPENDIX A: WORKSHOP PROGRAMME

OECD Nuclear Energy Agency Committee on Nuclear Regulatory Activities (CNRA)
Working Group on Operating Experience (WGOE)
International Workshop on Operating Experience Programme Effectiveness Measures
8-10 September 2014
Garching, Germany
Hosted by the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS)

### Day 1, September 08

<table>
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<tr>
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<th>Location</th>
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<td>1st Session</td>
<td></td>
<td>Main Conference Room</td>
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<tr>
<td>Opening remarks by Prof. Dr. Weiss, GRS, and Mr. Benoit Poulet, WGOE Chair</td>
<td>10:00-10:15</td>
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<tr>
<td>The importance of OPEX programmes</td>
<td>10:15-11:00</td>
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<tr>
<td>Coffee Break</td>
<td>11:00-11:15</td>
<td>Lobby</td>
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<tr>
<td>Developing and managing effective lessons learnt and continuous improvement programmes Riccardo Chiarelli WANO</td>
<td>11:15-12:15</td>
<td>Importance of OPEX programmes</td>
</tr>
<tr>
<td>Lunch Break</td>
<td>12:15-13:45</td>
<td>Restaurant of the Hahn-Meitner-Institute</td>
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<tr>
<td>Introduction to the workshop topic Dr. Michael Maqua, GRS</td>
<td>13:45-14:30</td>
<td>Developing and managing effective lessons learnt and continuous improvement programmes</td>
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<tr>
<td>Breakout session guidance and Coffee Break</td>
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<td>Main Conference room and 2 further meeting rooms</td>
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<tr>
<td>Day one wrap-up</td>
<td>16:45-17:00</td>
<td>Main Conference Room</td>
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<td>Predictive analysis applied to flight operations</td>
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<tr>
<td>Lukas Höhndorf M.Sc., Institute of Flight System Dynamics, Technische Universität München</td>
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<td>Coffee break</td>
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<td>Coffee break</td>
<td>15:30-16:00</td>
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<tr>
<td>Break</td>
<td>16:00-17:30</td>
<td>• Institute of Flight System Dynamics</td>
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<td></td>
<td></td>
<td>• Max Planck Institute for Plasma Physics (fusion reactor research)</td>
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<tr>
<td></td>
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<td>• GRS Analysis Simulator</td>
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<tr>
<td>Evening reception</td>
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<tr>
<td>Welcome remarks</td>
<td>09:00-09:15</td>
<td>Main Conference Room</td>
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<tr>
<td>Breakout session</td>
<td>09:15-10:45</td>
<td>Main Conference room and 2 further meeting rooms</td>
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<tr>
<td>Coffee Break</td>
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<tr>
<td>Groups – preparation of the presentations</td>
<td>11:15-12:30</td>
<td>Main Conference room and 2 further meeting rooms</td>
</tr>
<tr>
<td>Lunch</td>
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<tr>
<td>Human factor research in GRS</td>
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<td>Wolfgang Preischl, GRS</td>
<td>13:30-14:00</td>
<td>Main Conference Room</td>
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<td>Presentation and discussion of working group results</td>
<td>14:00-15:00</td>
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WGOE International Workshop on Operating Experience Program Effectiveness Measures

Highlights From Opening Address

September 8, 2014 - Garching, Germany

The Importance of OPEX Programs

• OPEX Programs are mentioned in 16 CNRA Green Booklets
• OPEX Programs are Cross-cutting:
  • Improvements (backfit) to safety systems
  • Improved operator training
  • Improved procedures
  • Improved inspection and maintenance practices
  • Improved emergency response
  • Improved regulatory framework
  • Improvements in many other areas...
OPEX Program Concerns

- Lessons may be learned but they may also be forgotten or lost over time.
- Response to information learned from the experience of others may be insufficient and/or ineffective.
- There may be tendency to consider foreign operating experience as not being relevant to one’s own program or situation.
- OPEX is not always reported in a timely manner.

OPEX Program Challenges

- OPEX Programs are complex
- OPEX Activities are diverse and may require several types of expertise.
- Implementation of OPEX lessons learned can be very difficult and may take several years.
- There are many Organizations that operate OPEX Programs.
- The effectiveness, benefits, and value of OPEX Programs are not easily demonstrated.
WGOE International Workshop on Operating Experience Program Effectiveness Measures

September 8, 2014 - Garching, Germany
Developing and Managing Effective Lessons Learnt and Continuous Improvement Programmes

Riccardo Chiarelli, WANO OE Team Leader
International Workshop on Operating Experience Programme Effectiveness Measures
08 September 2014
This is WANO

WANO Mission

To maximise the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information, and emulation of best practices.
Membership

WANO membership lets industry professionals focus on one goal: excellence in nuclear safety

Membership is voluntary and every nuclear power plant across the globe is a member:

- Operating companies
- Owners
- Others with significant impact on nuclear safety

More than 130 members work together to achieve the best possible safety standards.

Interactive WANO Member World Map available at www.wano.info

Operating Experience (OE)

The OE programme provides members with the opportunity to learn from events at other plants.
Event reported to WANO

OE in WANO

- SOER – Significant Operating Experience Reports
- SER – Significant Event Reports
- JIT – Just-In Time
- Analysis Reports
- CEO updates
- Hot topics
Precursors

In 2013, around 50% of the significant and noteworthy events* could have been prevented, or their consequences reduced, if the lessons learned provided in WANO SOERs or SERs.

“However, we don’t know what we prevented, we’ll only know when we were unsuccessful.”

J. Hurst, Former WANO OE Team Leader

* reported to WANO

Examples – Severe weather
The Fukushima effect

- Public & political confidence shaken in some regions
  - Japan, Germany
- Momentum returning in others
  - China, India
- WANO looked hard at itself
  - Post Fukushima Commission Report
  - 5 strategic responses
  - 12 projects

What can OE do?

- WANO OE: Effectively helping members to increase their OE effectiveness

- Focus on low level events: There is evidence that low level events are precursors for more significant events. Actions to correct these low level events can help prevent these turning into significant events.
What does WANO do when we find significant events?

**OE Effectiveness**

- SOER recommendations are checked at every PR

- All events received are screened for significance and recurrence

- Significant events are screened periodically for further actions

- Involvement of senior management is reinforced

- Trends are continuously monitored through the database
Thank you for listening

For more information please visit
www.wano.info
Working Group on Operating Experience (WGOE)

WGOE International Workshop on Operating Experience
Programme Effectiveness Measures

Introduction to the Workshop Topic

Dr. Michael Maqua, WGOE
Garching, September 08, 2014

Contents

• Workshop Objectives
• Main Expected Results
• Practical Issues
Objective of the Workshop

The main objectives of the workshop are to provide a forum for the exchange of information on the licensees' and regulators' programmes on OPEX and approaches to assess or even measure the effectiveness of these programmes. Participants will have the opportunity to meet with their counterparts from other countries and organisations to discuss current and future issues on the selected topic. They will develop conclusions and commendable practices regarding the issues and identify methods to help improve their own OPEX feedback and assessment methodologies.

Operating Experience Effectiveness – old version

Figure 1 — Nuclear Power Reactors Operating Experience

Source: PRIS, IAEA
Operating Experience Effectiveness - new version

Introduction to the Topic - WGOE Workshop, Garching 2014

Cumulative Reactor Years of Operation

Source: World Nuclear Association

Topic Idea

On the 5th meeting on the Convention on Nuclear Safety in April 2011 one participant said:

“We should stop with the Convention, because it was proven that we were not successful.”

The basic intention of the Convention is

“Never Again”

And this intention was not met.

Even this statement was just provocative, it leads direct to the question:

“Are we performing our operating experience analysis correctly?”
"Are our OPEX Programmes effective?"

**Issues to Tackle in the Workshop**

Even the question is simple, the answer is difficult:

- How to measure effectiveness of OPEX?
- How to measure effectiveness without being too retrospective? (It does not make much sense to hear in 2020 that I was ineffective in 2014)
- Are there (more or less) obvious and measureable indicators for effective OPEX? (These indicators may differ between operators and regulators!)
- There is for sure an overlap between effective OPEX and efficient OPEX but do we need to look at that issue?
- How effective is effective enough?
**Issues to Tackle in the Workshop**

Even the theory is difficult, we cannot close our eyes …

We have to look for improvement measures:

- Which measures could improve the effectiveness of OPEX programs?
- How can the improvement by these measures be checked?
- Are there predictive tools to assess the influences of new measures?

---

**How to Tackle the Issues in the Workshop**

We have few presentation

but

We have sufficient time for discussion among the participants.

We need you to achieve a result!

Therefore we will break into 3 Breakout Groups to discuss the topic.
Breakout Group (1): Identifying/gathering OPEX

This group should focus on developing measures and tools that apply to the area of identifying/collecting OPEX.

The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

Timeliness:
- That OPEX is considered within an appropriate amount of time.

Value:
- That the threshold for information that is considered in the OPEX programme is adequate.
- That the sources being considered within an OPEX programme are adequate.
- That OPEX is being stored appropriately.

Quality:
- That the appropriate amount of information is being provided in an OPEX report.
Breakout Group (2): Processing OPEX information

This group should focus on developing measures and tools that apply to the processing of OPEX information once it has been collected. The processing of OPEX information includes the storing and evaluation of OPEX information. The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

---

Breakout Group (2): Processing OPEX information

**Timeliness**
- That OPEX is being evaluated in a timely manner.

**Value**
- That the criteria for screening an item for further evaluation are appropriate.

**Quality**
- That OPEX is stored in a retrievable manner.
- That effective evaluation of an OPEX issue has taken place.
- That an effective outcome/application from the evaluation of an OPEX issue has been proposed.
Breakout Group (3):
Assessing outcomes of OPEX programmes

Timeliness
- That the outcomes from OPEX initiatives are assessed in a timely manner.

Value
- That the value added from OPEX initiatives is worth the cost.

Quality
- That the OPEX initiatives accomplish their purpose.

Breakout Group (3):
Assessing outcomes of OPEX programmes

This group should focus on developing measures and tools that assess an organization's effectiveness in implementing OPEX initiated activities.

Within this area, the measures and tools should specifically review the effectiveness of:
Breakout Group (3): Assessing outcomes of OPEX programmes

The communication of OPEX.
The effectiveness of OPEX on regulatory oversight and requirements.
The effectiveness of OPEX on NPP design.
The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

Main expected outcomes

The goal of the workshop is
- to identify effectiveness measures and
- performance assessment tools applicable to OPEX programmes.

These measures and tools will be focused on improving
- the adoption of OPEX-derived safety improvements and
- overall OPEX programme effectiveness.
Expected outcomes from the Breakout Groups

- On Wednesday any Breakout Group should present its findings!
- These findings should be laid down in a presentation (PowerPoint) (ready at lunch time).
- Selected WGOE representatives will formulate the general workshop conclusions on Wednesday noon (during lunch and the GRS presentation).
- These general conclusions will be presented at the end of the meeting.

Expected outcomes from the Breakout Groups

After the meeting, the meeting proceedings have to be developed. This task could be done by GRS, if nobody else volunteers. The proceedings will contain

- A description of the workshop content and outcomes based on the Breakout Group presentations.
- The presentations made.

And, Potentially,
- Some recommendations for further work of WGOE or tasks to be considered by CNRA, CSNI and other Working Groups.
**Practical Issues**

Meeting starts any morning the main meeting room
- Breakout group 1 meets in room
- Breakout group 2 meets in room
- Breakout group 3 meets in room

Lunch will be served in the cantina of MPI (anybody receives a ticket).

Coffee breaks are planned in the Foyer adjacent to the main meeting room.

The participants to the different tours on Tuesday need to decide on Monday to ensure that there is no overload on one tour.

The evening reception on Tuesday will be in the Hofbräuhaus! [Video 1:30](#)

---

**I wish**

you a very successful meeting!
Background

Mission Statement

- Predicting statistically valid accident probabilities for an individual airline based on available evidence from accident-free operation.

- Accounting for airline-specific factors such as operations, training, etc.

Predictive Analysis:
Making quantitative statements about the future state based on previous experience and knowledge.

BUT: How to implement Predictive Analysis for practical application?
Solution?

Classical statistical approach

Runway overrun example

Simple statistical approach is inappropriate and unsuitable for rare events

*Serious incidents as defined in ICAO Annex 13

Flight Data

- Obtained from the “Quick Access Recorder” (QAR)
- Up to 3000 parameters are recorded
- Frequency usually between ¼ Hertz and 8 Hertz
- Number of the recorded parameters increased significantly in the last years.
Basic Hypothesis

Predictive Analysis:
Making quantitative statements about the future state based on:
- previous experience
- knowledge

previous experience
- data/evidence driven
  - recorded data
  - known accident types and their causes

knowledge
  - physical relation between contributing factors and accident
  - known cause-consequence-chains

Basic Hypothesis:
1. Accidents cannot be directly observed in daily operation, however, the contributing factors still occur at high frequency, so they can be measured or observed with statistical significance.
2. The relation between the contributing factors and the accident can be described by the laws of physics and cause-consequence-chains based on operational and procedural knowledge.

Predictive Analysis Concept
Predictive Analysis on Runway Overrun

Contributing Factors (Model Input)
- Weight
- Wind
- Speed
- Flaps
- Start of Braking
- ...

Potential Outcomes
- Outcome 1 (e.g., tail 0515)
- Outcome 2
- Outcome 3
- ...
- Outcome n

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Step 1 Incident metric
- Landing Distance
- Stop margin
- Runway overrun: Stop margin < 0

Step 2 Functional relationships between contributing factors:
- Physical relationships
  - Aerodynamics
  - Propulsion
  - Brakes
  - Gravitation

- Operational relationships
  - Runway Condition
  - Procedures
  - A/BRK Selection

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Incident Model – Causal Chains

- Reverser
- Hydraulics
- A/SKID
- NoGo-around performed
- Over speed
- Check failed

System Failures  Human Factor  Environment
- Runway slope
- Contaminated RWY
- Tailwind

Incident 1  Incident 2  Incident 3 ...

Making Data Talk

- Asking the right question can significantly increase the information we obtain.

Gear Down at 2000 ft AGL? vs. AGL at Gear Down?

- Quality of statistical statements depend on how we look at the data.

Gaussian distribution  Non-Gaussian distribution

Underestimation of high values
- Develop algorithms to extract non-measured contributing factors
- Estimation algorithms are applied to every single flight

Parameter Estimation Implementation during Ground Roll

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Expected Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ω · ω · c</td>
<td>0.1285</td>
<td>0.1517</td>
</tr>
<tr>
<td>ω · ω · c</td>
<td>0.1373</td>
<td>0.0042</td>
</tr>
<tr>
<td>µ · µ · µ</td>
<td>0.0197</td>
<td>0.0043</td>
</tr>
<tr>
<td>µ · µ · µ</td>
<td>0.1123</td>
<td>0.0033</td>
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</table>

Proof of Match
Measured and Predicted Deceleration During Ground Roll

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### Predict

**Method:** Overview of Simulation Methods

<table>
<thead>
<tr>
<th>Analytical solution</th>
<th>Monte-Carlo simulation</th>
<th>Subset simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematically exact solution</td>
<td>Easy to implement</td>
<td>Able to solve for very small probabilities</td>
</tr>
<tr>
<td>Little computing time if solvable</td>
<td>Able to solve for complex geometry and high dimensions</td>
<td>Little number of samples required</td>
</tr>
<tr>
<td>Not applicable for complex geometry</td>
<td>Deteriorating efficiency for small probabilities</td>
<td>Subset algorithm implementation requires some time</td>
</tr>
<tr>
<td>Difficult to solve for high dimensions</td>
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### Quantifying Main Drivers

What are the main drivers behind the incident probabilities?

<table>
<thead>
<tr>
<th>Wind</th>
<th>Flaps</th>
<th>Speed Deviation</th>
</tr>
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<tbody>
<tr>
<td>Postholder</td>
<td>ERV</td>
<td>Influenciable</td>
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</tbody>
</table>

Quantify the sensitivities of the contributing factors.
Change Management

Contributing Factors (Model Input)
- Weight
- Wind
- Speed
- Flaps
- Start of Braking
- Touchdown

Distribution based on actual flight operation (FDM)
Distribution proposed by Flight Safety Manager

Incident Model
Overrun

Model Output
Potential reduction
Incident Probability
Incident Metric

- Predictive analysis allows the assessment of the impact of mitigation actions BEFORE implementing them.
- Impact of mitigation actions to OTHER incidents automatically considered (e.g., runway overrun vs. hard landing vs. tail strike).

Identifying the Unknown

Correlation Coefficient
- Only captures constant dependency between two parameters

Copula
- Capable of capturing variable (nonlinear) dependencies between more than two parameters

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Future Work

1. Comparison between planned and actual performance
   - Takeoff planning
   - Landing distances
   - Fuel consumption
   - ...

Mismatch can be expressed to quantify growth factors

2. Exploitation and correlation of further data sources:
   - ATM data
   - Weather data
   - Training data
   - Maintenance records
   - ...

Summary

Predictive Analysis enables airlines:

To QUANTIFY airline specific incident and accident probabilities BEFORE things go wrong.

To QUANTIFY the effectiveness of potential mitigation actions BEFORE implementing them.
Thank you!

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Technische Universität München
Introduction

- In a majority of cases a combination of technical (T), human and organizational factors (HOF) root causes are contributing to significant events.
- The German event reporting and classification criteria are focusing on technical impacts which might bias the generic learning process from HOF root causes.
- Initiated by a single or a smaller group of events GRS is issuing generic notes including HOF improvement recommendations if necessary.
- In order to supplement that activity and to obtain a broader view on HOF root causes over a longer period of time GRS developed a specific methodology evaluating all reported events with such contributions.
- The presentation briefly describes the methodology and provides first results obtained (application example: events reported in 2011).
Investigation Process, Single Event

- Assessment of potential HOF contribution

- In depth investigation based on an accepted Man/Machine (M/M)-model integrating technical and HOF aspects
  - Technical description of the event
  - Development of an event model (break down into sub-events)
  - Identification of human errors
  - Search for root causes promoting made errors
  - Modeling the impact of administrative and organizational measures (e. g. measures to avoid, detect and correct)

- Provision of a chronological representation of all relevant sub-events

Structure of the Event Model

- Each sub event (SE) describes one human error and is modeled by a M/M- System
- M/M-Systems with successful recovery are added
Human Error Definition, GRS Root Cause Analysis
Methodology HUF

- Each object (part of the plant, e.g. valve or procedure) has a given function/task. That raises requirements on humans interacting with an object.

- Definition:

  Any human behavior not in compliance with the requirements of an object is evaluated as an error

Characteristics of HUF

- About 400 given attributes (including performance shaping factors (PSF), factors promoting errors if unfavorable designed)

- 5 groups of PSFs with about 150 attributes (additional link possibility “biased by organizational impact”)

- Organizational impact defined as "Plant staff within the organization and quality of formal/informal rules impacting front line PSF" (see slide no. 7)

- Additional categories to collect experience about
  - attributes indicating safety culture problems
  - the effectiveness of failure detection and failure compensating measures
Organizational root causes
Plant staff within the organization and rules (formal or professional) impacting front line PSF. Considered impacts:
- Missing or inadequate rules
- Errors of staff working at different organizational levels promoting front line failures

Generic Evaluation, Approach

- Brief description of HOF relevant events selected from all events occurred in a defined period of time (description focus: HOF aspects)
- Broader description of events with safety relevant HOF impact
- Generic evaluation of all revealed HOF attributes contributing to onset and course of the events
Generic HOF Evaluation, Considered Attributes

- Evaluation attributes have been derived from HUF data base codes
- Anomalies in relation to
  - Plant status (e.g. outage)
  - Locations in the plant (e.g. switch gear)
  - Kind of tasks (e.g. maintenance)
  - Group of persons (e.g. external staff)
  - Kind of errors (e.g. commission errors)
  - Error promoting PSFs (e.g. lack of experience)
  - New technologies und procedures (e.g. digital I&C)
- Organizational deficiencies (e.g. work preparation less than adequate)
- Ability to detect made errors degraded (e.g. periodic testing)
- Indication for a decreasing safety culture (e.g. informal non-safe work practice)

Definition „Safety Relevant HOF Impact“

Human and organizational factors are treated like a safety relevant system function. Definition of “safety relevant HOF impact“:

- Significant degradation of a technical safety function and HOF root causes are contributing (e.g. complete loss of residual heat removal during mid-loop operation due to a commission error of reactor operator).

- Minor degradation of a technical safety function and observed HOF root causes impair different measures to prevent, identify and recover errors (e.g. loss of one emergency diesel generator and several measures to detect the problem failed).
Example „Reportable Events, Year 2011“

- 106 new events in 2011
- 104 considered (2 events from research reactors not considered due to very different boundary conditions)
- All events with investigation status “finished”
- All events classified category N (lowest German reporting category) and INES 0
- 53 events impacted by HOF
- All German plants contributed, broad range of plant operational states (including decommissioning)
- 24 Events with safety relevant HOF impact

Safety Relevant HOF Impact, Example

- Event title „Check valve xxx (part of cooling water supply system for safety relevant components) incomplete closed, cooling capacity of one train reduced due to bypass flow"
- Routine walk around reveals a drop leakage at the check valve
- Assembling error causes damage of the valve, screw locking tabs not assembled, comparable omission errors at five additional valves, errors propagate undetected for a long time
- Unacceptable work attitude of assembling personnel
- Measures to assure quality of work failed (e. g. check by second person)
- Available work procedures were inaccurate and in part erroneous, procedure deficiency undetected for a long time
- Repeated deviation from periodic valve inspection regulations (visual inspection requires disassembling of valve)
Results (1)

- Plant status „outage“ dominant
- 28 from 53 events in the context of maintenance and change of construction activities, 10% during test activities
- 10% errors made by constructors (outside the plant, undetectable by the quality assurance measures of the plant)
- Most errors occurred outside central control room (e.g. interaction with components, work preparation, quality assurance of documentation)
- Allocation to specific staff (e.g. contractor, shift or department member) difficult
- Human factors engineering (labels, design of procedures, instruments and indicators) contributes in about 37% of the considered events
- Human centered PSFs (professional knowledge, individual performance capacity) contributes in about 26% of the considered events

Results (2)

- Lack of information about PSFs promoting errors made by task performers within the organization (e.g. work preparation, supervision, quality assurance of work equipment and work results) or by the constructor
- Organizational impact in about 80% of the investigated events (work preparation 28%, operational experience feedback and corrective action 7%, Quality assurance of work results 28%, quality assurance of incoming goods 13%, provision of instructions and regulations 4%)
- Significant impact of organizational factors in the context of design and construction changes
- Degraded measures to detect errors contribute in about 64% of the considered events
- Degraded redundancy and diversity principle 53% (including events where only one train failed but precursors in other trains were identified)
- Concerning safety culture or new technology no relevant observations
Results, Multiple Deficiencies

- Grouping of the contributing attributes in accordance to “human factors engineering- frontline (A)”, “organization (B)” and “ability to detect errors (C)”

- 64% of the reported events with multiple deficiencies within the groups A, B, C (all 24 events classified “safety relevant HOF impact”)

- B and C deficiencies are dominating (all events classified safety relevant)

Conclusion

- The first application (events reported in 2011) demonstrates usefulness of the approach and the obtained insights. The investigations will be continued.

- The time delay between reporting and generic investigation is an inherent disadvantage.

- Quality of organizational factors and measures to detect made errors are relevant parts of the safety conception of the plant but not sufficiently represented in the reporting and classification requirements.

- Generic HOF deficiencies identified in a single event with minor significance might be latently available in more safety relevant areas of the plant (broad impact of such deficiencies).

- Reducing number and significance of reported events requires a reinforced role of HOF during notification and development of corrective measures.
INFORMATION COLLECTION AND GATHERING BREAKOUT

WGOE International Workshop on Operating Experience
Program Effectiveness Measures

OVERVIEW

- Objective
- Setting
- Scope
- Use criteria for effectiveness (timeliness, value and quality)
- Develop measures (main results)
- Develop tools (not relevant)
MOVING INFORMATION

- X% of incoming operating experience documents are distributed to recipients within Y days of receipt
  - Separate measure for each document type
  - Distributed
    - Internal or external
  - Recipients
    - Awareness
    - Actions
  - Encourages timely movement of information and appropriate monitoring of operating experience sources

REQUIRED REPORTING

- X% of required reports are submitted and timely based on a sample of Y events
  - Review a sample of events
  - Determine if required reports were submitted
  - Determine if required reports were timely
  - Encourages the effectiveness of reporting by licensees
REQUIRED REPORT QUALITY

- Review X% of licensee required reports for quality within Y days of receipt
- X% of required reports reviewed do not need clarification
  - While focused on licensee required reports this measure can be applied to other report types (e.g., IRS)
  - Clarification is needed if a report is unclear or difficult to understand
  - Encourage quality and clarity in required reports

REGULATOR FOLLOW-UP FOR SIGNIFICANT EVENTS

- Regulator follow-up on significant events completed within Y days
  - Follow-up per existing programs could involve different types of communications
    - Inspection
    - Meeting
    - Teleconference
  - Encourages high quality information on significant events is available in a timely manner
DIE MAUSEFANGERIN GENEHMIGT
WGOE : Programme Effectiveness Measures

GROUP N° 2 : PROCESSING OPEX INFORMATION

Develop measures and tools to evaluate how OPEX is processed after it’s received

<table>
<thead>
<tr>
<th></th>
<th>First Name</th>
<th>Last Name</th>
<th>Affiliation</th>
<th>Country</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Laszlo</td>
<td>Juhasz</td>
<td>Hungary</td>
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<td>2</td>
<td>David</td>
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<td>Fuming</td>
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<td>Kenneth</td>
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<td>Miguel</td>
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<td>Vincent</td>
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<td>Oleg</td>
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<td>9</td>
<td>Georges</td>
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<td>10</td>
<td>Mats</td>
<td>Severin</td>
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<td>11</td>
<td>Rami</td>
<td>Laaksonen</td>
<td>Finland</td>
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</tr>
<tr>
<td>12</td>
<td>Nils-Erik</td>
<td>Setterstal</td>
<td>Sweden</td>
<td>Sweden</td>
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</tbody>
</table>

TIMELINESS

Generally up to the program to develop a scheme

- Significance
- Applicability
- Difficulty of an Evaluation
- Time for initial screening
- Time for detailed analysis
VALUE

→ **High** *(Safety Significance, Generic applicability)*

Accessible Information
High Quality Evaluation
Relevant Corrective Actions
Relevant Lessons Learned...

Timeliness

→ **Medium** *(Moderate ...)*

→ **Low** *(Some ...)*

**Potential Measures** : Balance between resources and outcomes

---

QUALITY

→ **High**

All the important attributes are present

→ **Medium**

Some of the attributes need improvement

→ **Low**

Some of the important attributes are missing

**Potential measures** : Best practices, Acceptable, Needs improvement
Attributes of Effective Evaluation.

1. GENERAL ATTRIBUTES
   - Adequate Resources
   - Qualification of involved OPEX personnel
   - Management involvement

2. SCREENING PROCESS  *Initial Review*
   - Competent (dedicated, diverse backgrounds) reviewers
   - Established screening criteria for significance (INES, PRA/PSA ...)
   - Prioritizing for timeliness goals
   - Ease of applicability of criteria

3. ANALYSIS (Readable/Understandable by General Engineer Audience)
   *Event Description*
   - Initial condition
   - Chronology of the event
   - Clearly describe safety concerns

Potential measures: Best practices, Acceptable, Needs improvement

Attributes of Effective Evaluation.

*Significance Evaluation*

- Impact on analyzed accident sequences
- Real / Potential safety consequences
- Affected Equipment / Procedures
- Affected safety functions / Barriers
- Good practices: PSA, Precursor ...

*Root Cause / Contributing Cause*

- Completed using generally accepted method (including training)
- Relevant pre-event activities (Human factors, Ops and maintenance)

*Generic Aspect / Missed Opportunity*

- Challenge → Based on potential lack of information
- Good Practice → Evaluation should consider near misses and similar events when possible
Attributes of Effective Evaluation.

3. RESPONSE (LEARNING, CORRECTIVE ACTIONS...)

Corrective Actions

- SMART philosophy (Specific, Measurable, Achievable, Realistic, Timely)
- Prioritized
- Implementation plans with consideration of risks
- Directed toward appropriate audience

Insights (Lessons learned)

- Focus executive summary
- Identification of key stakeholders and specific messages

Attributes of Storage Scheme

Centralized storage for OPE information
Track items as necessary
Storage and ability to attached/ref, files...
Systematic code word used
Capability of trend analysis (challenge)
Search functions
Stakeholders access
Information directed to appropriate audience
Storage Scheme support Timeliness goal
User-friendly Structure
Training for use
Clear ownership of the overall process
RECOMMENDED Measures

- **TIMELINESS**
  
  TIME FOR INITIAL SCREENING AND FOR DETAILED ANALYSIS

- **VALUE**
  
  BALANCE BETWEEN RESOURCES AND OUTCOMES

- **QUALITY**
  
  (Go/No Go) BEST PRACTICES, ACCEPTABLE, NEEDS IMPROVEMENT BASED ON ATTRIBUTES FOR EVALUATION AND STORAGE SCHEME

Thank you for your attention
Effective OPEX Programs

Develop Measures and Tools to Assess Outcomes of Operational Experience (OPEX) Programs

WGOE Workshop – GRS Garching, Germany – Group 3
September 2014

GROUP 3

- Composition
  - Regulators
  - TSOs
  - Industry/Operators
  - European Clearing House

- Approach: Value through Outcomes
  - Attributes
  - Measures (What we can do)
  - Metrics (How we could do this)
Effective OPEX Programs

Overall Objectives – Group 3

- Develop/propose measures and tools/metrics to assess the outcomes of OPEX programs in the areas of:
  - Communication of OPEX
  - Impact on the Design and Safety Performance of NPPs
  - Effective Regulatory Oversight

### Communication of OPEX 1/2

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Measures (How to do this)</th>
<th>Metrics (How to measure) and Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely communication of OPEX by licensee to regulator [Licensee OPEX program]</td>
<td>Monitor completion of Licensee Event Reports (LERs)</td>
<td>Ratio of completed LERs within allowed time delay by quarter/year and by licensee/site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average reporting time by the licensee for events</td>
</tr>
<tr>
<td>Timely communication of OPEX by regulator to different stakeholders for information or evaluation [RB/TSO OPEX program]</td>
<td>Clear timeline and point of contact (PoC) expectations for all forms of communication (Letters, Notices, Info Bulletins from Regulator to licensees; information of other stakeholders, ...)</td>
<td>Average time delay to report event(s) to stakeholders (licensees, IRS, ...)</td>
</tr>
<tr>
<td>Communication should clearly and concisely identify the issue of concern and put it in the proper perspective [RB/TSO OPEX program]</td>
<td>Clear procedures are communicated through notices and training of staff</td>
<td>Number of OPEX letters, info notices, bulletins by quarter/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Due, to the extent possible, clear, consistent terminology and nomenclature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feedback from trainees that the terminology and nomenclature are unambiguous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clearly identify the issue, the safety significance and the response expected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feedback loop</td>
</tr>
<tr>
<td>Transparency</td>
<td>Systematic, documented decision-making process for accessing lessons learned and recommendations</td>
<td>Confirmation that process is in place and being used</td>
</tr>
</tbody>
</table>
## Communication of OPEX 2/2

<table>
<thead>
<tr>
<th>Communication should be effectively targeted to the (right) audience (within the regulator and the licensee):</th>
<th>Communicate with stakeholders directly, in meetings and through safety and technical fora</th>
<th>Feedback loop</th>
</tr>
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<tbody>
<tr>
<td>• Decision-makers</td>
<td>• Technical specialists</td>
<td></td>
</tr>
<tr>
<td>• End users</td>
<td>• Inspectors (Licensee and RB/TSO OPEX programs)</td>
<td></td>
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### Effective sharing of OPEX with licensees [RB/750 OPEX program]
- Share OPEX with stakeholders
- No. of OPEX letters, info notices, bulletins issued by quarter/year

### Effective sharing of OPEX information through international reporting systems [Licensee and RB/750 OPEX programs]
- Share OPEX with nuclear regulators in other countries
- No. of national events reported for OPEX (fiscal year)
- Ratio of events (of total significant national events) reported internationally.

### Effective sharing of OPEX information through wider collaboration [Licensee and RB/750 OPEX programs]
- Share OPEX information with nuclear regulators in other countries
- No. of events and OPEX information shared with other organizations
- No. of OPEX information items received from other organizations

- Leverage opportunities to meet and share OPEX/lessons learned among concerned organizations
- No. of meetings, conferences, working groups, etc. attended where OPEX is shared.

## Safe Power Reactors 1/2

### IMPACT ON THE DESIGN AND SAFE OPERATION OF POWER REACTORS (NPPs)

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<tr>
<td>Minimum knowledge of OPEX and lessons learned over the long term [Licensee and regulator/TSO OPEX programs]</td>
<td>Develop an effective knowledge management database for OPEX with ease of access, flexibility for expansion (new discoveries), ability to preserve data over time (keep important lessons current (top of mind))</td>
<td>Feedback loop</td>
</tr>
</tbody>
</table>

### Avoid recurrence of events [Licensee OPEX program]
- Highlight the recurring events
- No. and trend of recurring events over an appropriate time interval

### Follow-up of timely completion of Corrective Actions (CAs) [Licensee OPEX program]
- Monitor the completion of CAs
- No. of CAs completed on time
- No. of CAs opened per quarter
- No. of CAs closed per quarter
- No. of CAs remaining open per quarter (carry over)

### Reviews appropriateness of Corrective Actions [Licensee OPEX program]
- Monitor the frequency of CAs management Review Committee meetings
- No. and frequency of management review committee meetings

### Evaluates the effectiveness of corrective actions [Licensee OPEX program]
- Develop a process for evaluating the effectiveness of corrective actions in addressing root causes
- Monitor recurrence of identified root causes of events
- No. and trend of recurring root causes

### Communication of OPEX 2/2

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Safe Power Reactors 2/2

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<tbody>
<tr>
<td>OPEX forms important input to inspection programs, technical analysis, regulatory review, and new regulatory requirements</td>
<td>Track open regulatory action items arising from OPEX</td>
<td>Number of open regulatory actions</td>
</tr>
<tr>
<td>OPEX should be part of the core training for staff</td>
<td>Verify that OPEX is included in the training of staff</td>
<td>Verify</td>
</tr>
<tr>
<td>Regulatory OPEX program should not only be reactive but focus on precursors and low level events</td>
<td>Systematic review / inspection of licensee’s program for inclusions of precursors and low level events</td>
<td>Number of such inspections</td>
</tr>
<tr>
<td>Makes effective use of available resources</td>
<td>Measure of Resources spent on OPEX program (time/money/effort)</td>
<td>Number / % of person-days (time accounting system...), costs</td>
</tr>
</tbody>
</table>
Working Group on Operating Experience (WGOE)

Workshop on Operating Experience Programme Effectiveness Measures

Conclusion of the Workshop Results

Benoit Poulet, Canada, WGOE Chair
Michael Maqua, Germany; WGOE Vice-Chair

Workshop Statistics

- No. of Participants: 41
- No. of Organizations: 27
- No. of Countries: 14
- No. of international: 4
Objective of the Workshop

- Discuss approaches to assess or even measure the effectiveness of OPEX programs
- Identify commendable practices and methods to improve OPEX feedback and assessment methodologies

Intention of the Workshop

“However, we don’t know what we prevented, we’ll only know when we were unsuccessful.”

J. Hurst, Former WANO OE Team Leader
Issues to Tackle

Which measures could improve the effectiveness of OPEX programs?

How can the improvement by these measures be checked?

Are there predictive tools to assess the influences of new measures?

Work Organisation (1)

Discussions in 3 Breakout Groups:

- Identifying/gathering OPEX
- Processing OPEX information
- Assessing outcomes of OPEX programs
Common issues to discuss for all Breakout Groups:

- Timeliness
- Value
- Quality

Group 1 proposed criteria for measurement of

- Moving information
- Required reporting
- Required reporting quality
- Regulatory follow-up for significant events
Main Results Group 2(1)

Criteria developed for rating against timeliness, value and quality

- **TIMELINESS**
  - aspects: significance, applicability, difficulty of an evaluation, time for initial screening, time for detailed analysis
  - potential measure: time for initial screening and for detailed analysis

- **VALUE**
  - potential measure: balance between resources and outcomes

- **QUALITY**
  - (go/no go) test regarding: best practices, acceptable, needs improvement based on attributes for evaluation and storage scheme

Main Results Group 2(2)

- **Analysis**
  - potential aspects: best practices, acceptable, needs improvement

- **Generic Aspects / missed opportunities**
  - challenge: based on potential lack of information
  - good practice: evaluation should consider near misses and similar events when possible
Main Results Group 3(1)

Develop/propose measures and tools to assess the outcomes of OPEX programs
- communications
- impact on the design and safe operation of power reactors (NPPs)
- regulatory oversight effectiveness
- Others

For all steps attributes, measures, and metrics were identified

Main Results Group 3(2)

For most of the issues attributes, measures, and metrics were identified, but some gaps show areas for potential development
- No metric regarding transparency and OPEX databases
The goal of the workshop was
- to identify effectiveness measures and
- assessment tools applicable to OPEX programs.

Measures and tools are focused on improving
- adoption of OPEX-derived safety improvements and
- overall OPEX program effectiveness

Results:
1. Tools and criteria were identified for various steps of OPEX programs
2. Few missing tools or verification measures were detected
3. Specific criteria developed to measure effectiveness
4. That means that major parts of existing programs could be assessed with respect to their effectiveness
Summary (3)

Generic Results:

1. Missing tools and measures should be developed

2. It should be considered to address missing verifications in OPEX programs review tools like self-assessment, peer reviews, international missions

3. Collaboration with non-nuclear industry and regulators on OPEX should be increased

Thank you very much for your attendance and your work!

Special thanks to all presenters and facilitators!

Have a safe trip home!
Contents

- Workshop Objectives
- Breakout Groups
- Facilitator’s Role
- Main Expected Results
- Practical Issues
Objective of the Workshop

The main objectives of the workshop are
- to provide a forum for the exchange of information on the licensees' and regulators' programmes on OPEX and approaches to assess or even measure the effectiveness of these programmes.
- Participants will have the opportunity to meet with their counterparts from other countries and organisations to discuss current and future issues on the selected topic.
- They will develop conclusions and commendable practices regarding the issues and identify methods to help improve their own OPEX feedback and assessment methodologies.

Objective of the Workshop (2)

There will be three breakout groups responsible for developing measures and tools in the following areas:

- identifying/gathering OPEX;
- processing OPEX information;
- assessing outcomes of OPEX programmes.
Breakout Group (1): Identifying/gathering OPEX

This group should focus on developing measures and tools that apply to the area of identifying/collecting OPEX.

The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

- **Timeliness:**
  - That OPEX is considered within an appropriate amount of time.

- **Value:**
  - That the threshold for information that is considered in the OPEX programme is adequate.
  - That the sources being considered within an OPEX programme are adequate.
  - That OPEX is being stored appropriately.

- **Quality**
  - That the appropriate amount of information is being provided in an OPEX report.
Breakout Group (2): Processing OPEX information

This group should focus on developing measures and tools that apply to the processing of OPEX information once it has been collected.

- The processing of OPEX information includes the storing and evaluation of OPEX information.
- The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

- Timeliness
  - That OPEX is being evaluated in a timely manner.
- Value
  - That the criteria for screening an item for further evaluation are appropriate.
- Quality
  - That OPEX is stored in a retrievable manner.
  - That effective evaluation of an OPEX issue has taken place.
  - That an effective outcome/application from the evaluation of an OPEX issue has been proposed.
Breakout Group (3):
Assessing outcomes of OPEX programmes

- **Timeliness**
  - That the outcomes from OPEX initiatives are assessed in a timely manner.

- **Value**
  - That the value added from OPEX initiatives is worth the cost.

- **Quality**
  - That the OPEX initiatives accomplish their purpose.

This group should focus on developing measures and tools that assess an organization’s effectiveness in implementing OPEX initiated activities.

Within this area, the measures and tools should specifically review the effectiveness of:
Breakout Group (3): Assessing outcomes of OPEX programmes

- The communication of OPEX.
- The effectiveness of OPEX on regulatory oversight and requirements.
- The effectiveness of OPEX on NPP design.

The proposed measures and tools should be effective in measuring aspects that affect timeliness, value and quality.

The following is provided solely to stimulate conversation on what attributes could be measured to ensure:

Facilitator’s role

“A client asked me the other day what makes a great facilitator. Here’s what we came up with. I thought a list of the top characteristics of an effective facilitator would be of interest for those managers, speakers and trainers.”


1. Stimulates the interaction and the free sharing of thoughts and ideas.
2. Creates the safe environment in order for the group to open up and become actively engaged in the discussion.
3. Are masterful and engaging listeners.
Facilitator’s role (2)

4. Provides the structure for the discussion. Sets the parameters, the intention and guides the conversation.
5. Supports the well-being of each participant as well as the group.
6. Acknowledges the participants and makes them right (and never makes anyone wrong.)
7. Utilizes the art of the question to create and cultivate new possibilities that stimulate new thinking.
8. Taps into the wisdom of each person, as the value derived in each discussion is a result of the co-creation and wisdom of the group (vs. dominates the discussion.)

Facilitator’s role (3)

9. Is charge neutral and responsive rather than reactive.
10. Is fluid and flexible vs. rigid. (Is light and dances gracefully within the conversation.)
11. Connects with the group.
12. Plans effectively yet is fluid based on the atmosphere and needs of the audience.
13. Is authentic and shares themselves with others/is fully self-expressed.
14. Has fun and is passionate about the transformational process that occurs - if done successfully!
Main expected outcomes

- The goal of the workshop is
  - to identify effectiveness measures and
  - performance assessment tools applicable to OPEX programmes.
- These measures and tools will be focused on improving
  - the adoption of OPEX-derived safety improvements and
  - overall OPEX programme effectiveness.

Expected outcomes from the Breakout Groups

- On Wednesday any Breakout Group should present its findings!
- These findings should be laid down in a presentation (PowerPoint) (ready at lunch time).
- Selected WGOE representatives will formulate the general workshop conclusions on Wednesday noon (during lunch and the GRS presentation).
- These general conclusions will be presented at the end of the meeting.
**Expected outcomes from the Breakout Groups**

- After the meeting, the meeting proceedings have to be developed.
- This task could be done by GRS, if nobody else volunteers.
- The proceedings will contain
  - A description of the workshop content and outcomes based on the Breakout Group presentations.
  - The presentations made.
  - And,
  - Potentially,
  - Some recommendations for further work of WGOE or tasks to be considered by CNRA, CSNI and other Working Groups

**Practical Issues**

- Meeting starts any morning the main meeting room
  - Breakout group 1 meets in room
  - Breakout group 2 meets in room
  - Breakout group 3 meets in room
- Lunch will be served in the cantina of MPI (anybody receives a ticket.
- Coffee breaks are planned in the Foyer adjacent to the main meeting room.
- The participants to the different tours on Tuesday need to decide on Monday to ensure that there is no overload on one tour
- The evening reception will be in the Hofbräuhaus!