Risk Management on Strategic and Operational Level during Decommissioning – First Outcomes of the DRiMa Project at IAEA – 14467

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ABSTRACT

In 2007 the International Atomic Energy Agency (IAEA) established the International Decommissioning Network (IDN) to help Member States develop capabilities and plans to undertake decommissioning activities. During its 2011 annual meeting, the IDN discussed and recognized the importance of risk management as an important factor for sound and safe decommissioning of facilities using radioactive material. In order to provide assistance and feedback on the application of risk management during decommissioning, IDN proposed a three years project on aspects on risk management during decommissioning ("International Project on Decommissioning Risk Management – DRiMa"), which was launched in December 2012.

Main aim of the DRiMa project is to provide recommendations and practical illustrations on the application of existing risk management approaches and concepts during planning and conduct of the decommissioning of facilities using radioactive material. After its first year of conduct the DRiMa project elaborated a more detailed understanding on risk management: Risk management on a strategic level is mainly related to strategic decisions setting the outer frame of decommissioning projects and thus is of nature of management of key underlying assumptions; risk management on operational level is related to the details of the decommissioning activities. Although the level of detail when analyzing and treating risks is different risk management at both levels share the same risk families which represent the potential sources of risks. As strategic decisions and the detailed planning depend on each other / influence each other, risks may become escalated from the operational to the strategic level, but can be transferred from the strategic level to the operational level for consideration and management.

INTRODUCTION

In 2007, the IAEA established the International Decommissioning Network (IDN) to help develop Member States' capacities and plans to undertake decommissioning activities [1]. During the IDN's 2011 annual meeting IDN members and participants discussed and recognized the importance of risk management during decommissioning [2]. Despite the availability of a significant amount of recommendations and experience-based feedback on decommissioning, including techniques and safety assessment (refer to e.g. [3], [4], [5], [6], [7], [8]), it was felt that there were not sufficient advice and feedback on the application of risk management specific to decommissioning. In fact, IDN members' and participants' experience showed that safety

assessment is the central concept to ensure safety, but risk management is the system to ensure the overall success of a decommissioning project in terms of e.g. schedule, cost, safety and generated radioactive waste. In order to address this, the participants agreed to establish a three-year project dealing with aspects of risk management during decommissioning.

Based on its Terms of Reference (ToR) [9] of 2012, revised in 2013 [10], the "International Project on Decommissioning Risk Management – DRiMa" (DRiMa project) was launched during its kick-off meeting in December 2012. The DRiMa project focusses on risk management relevant for operating organizations, although the outcomes of the project may be relevant also for decision makers at the national organizational level or for other organizations and institutions involved in decommissioning.

Within the DRiMa project risk is the effect of uncertainties (including events and lack of information) on objectives of a decommissioning project (e.g. [11]). Although in practice risk often is set equal to threats to objectives, risk within the DRiMa project is understood as both, threats to and opportunities for the objectives of a project.

Taking into account existing international standards and experiences on risk management (e.g. [11], [12], [13]), the DRiMa project aims to

- identify good practices based on Member States' experiences;
- provide recommendations on the application of general risk management methodology and maintenance of a risk management system for decommissioning at a strategic level, typically related to the planning phase of decommissioning, and at operational level, typically related to the conduct of decommissioning;
- illustrate the role of risk management at strategic level and at operational level;
- illustrate the optimization of risk treatment strategies and how these can minimize threats and maximize opportunities during decommissioning. (These strategies include the development of fallback or contingency plans); and
- improve the capabilities of Member States in this field and enhance the exchange of information between Member States on lessons learned.

According to its work plan a first interim meeting was conducted in May 2013 at which the working groups of the DRiMa project met to further develop recommendations on risk management related to decommissioning. First preliminary outcomes of the kick-off meeting and of the interim meeting 2013 were discussed during the second annual meeting of the DRiMa project in October 2013. During the first year of the DRiMa project significant decommissioning specific insights in the alignment of risk management at strategic level and risk management at operational level and in the nature of risk, covering threats and opportunities, were gain; this led to a revision of the ToR [10] which has been approved by the members of the DRiMa project during the annual meeting of the DRiMa project in October 2013 and by the IDN members and participants during the annual meeting of IDN in November 2013.

The DRiMa project will become completed by end of 2015, the publication of a DRiMa project report is foreseen for 2016 [10].

Following is an overview on the DRiMa project itself and a presentation of first preliminary outcomes related to decommissioning related risk management, resulting from the first 12 months of the projects work.

OVERVIEW ON THE DRIMA PROJECT

Objectives and Scope

The overall objective of the DRiMa project is to provide recommendations on, and practical illustration of, the application of risk management during the planning and execution of decommissioning of facilities using radioactive material to manage the associated project risks. As such, the DRiMa project does not limit its focus on risks as defined in the nuclear field (e.g. [4], [5]) as the combination of the likelihood of a scenario based on existing hazards and the related radiological consequences, but to any project risk in terms of threats to and opportunities for the objectives of the decommissioning project.

The more specific objectives of the DRiMa project are

- to collect and analyze participants' experiences related to risk management;
- to explain and specify the application of generally accepted risk management methods in planning and executing the decommissioning of facilities using radioactive material;
- to illustrate the application of risk management in specific decommissioning tasks and actions; and
- to support continuous sharing of risk management experience among participants.

The DRiMa project intends to provide recommendations to operating organization, contractors and other specialists involved in the planning and execution of decommissioning, as well as to acquaint project participants on the implementation of risk management, i.e.

- on supporting the application of risk management and decision making during planning and execution of decommissioning;
- on optimizing the success of decommissioning projects by minimizing threats and maximizing opportunities; and
- on assisting in the development of fallback/contingency plans in order to minimize disruption to decommissioning activities and actions.

The outcomes of the DRiMa project will also provide useful background information to key external stakeholders, such as regulatory bodies and the general public.

The recommendations to be developed will support the use of generally accepted risk management methodologies (e.g. [11]) and of the results obtained from it during planning and execution of decommissioning. Hereby, the dynamic nature of decommissioning risks will be addressed; as part the need for these to be periodically reviewed and reassessed (as appropriate) will be addressed as to reflect any relevant changes in the configuration of the facility, the maturity of the decommissioning project, safety hazards and the potential complexity of decommissioning tasks.

Within the DRiMa project emphasis will be laid on risk management at strategic level, typically related to the planning phase of decommissioning, and at operational level, typically related to the execution of decommissioning (refer also to Fig. 1). The DRiMa project will explore the interfaces between the risk management system, the evolution of the safety assessment, associated project studies for decommissioning and other managerial systems in place.

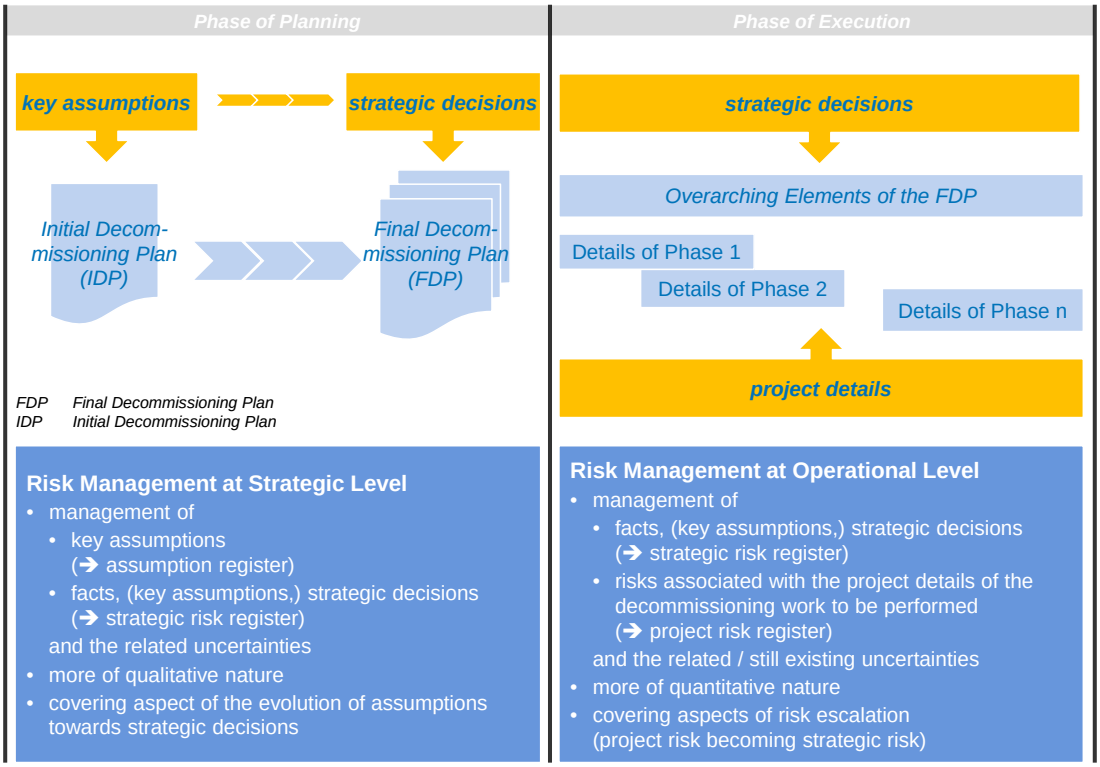

Fig. 1. Risk Management at Strategic and Operational Level within the DRiMa Project.

The DRiMa project will consider all types of risk that can negatively and positively affect the progress of a decommissioning project by considering risk as a multi-dimensional entity which includes safety, technology, security, legal and commercial aspects and stakeholder management. Inter alia, it will review and define the groups of factors that influence risks, so called risk families, and will address the fundamental types of risk such as assumptions, constraints, interdependencies and uncertainties. The DRiMa project will also illustrate how a graded approach can be incorporated and used within risk management, and how this results in the effective use of the available resources within a decommissioning project and in the reduction of the overall project risk.

According to its approach of relying on generally accepted risk management methodologies, the DRiMa projects intends to incorporate experiences on risk management from other highly hazardous industries, such as the petrochemical industry. Already during the kick-off meeting of the DRiMa project first contributions from outside the nuclear sector were collected and the DRiMa project will strive to further continue this collection of experiences.

Concept And Structure Of The DRiMa Project

Based on good experiences from the past projects at IAEA, especially from the DeSa project and the FaSa project (e.g. [7], [8], [14], [15]), the 3 year DRiMa project is structure in several working groups (refer to Fig. 2) in which the outcomes of the DRiMa project are elaborated. Hereby, the conduct of the DRiMa project follows a format comprising annual meetings (with plenary sessions

and sessions of several working groups) and additional working group interim meetings and working group activities between the annual meetings as deemed appropriate to achieve the project's objectives.

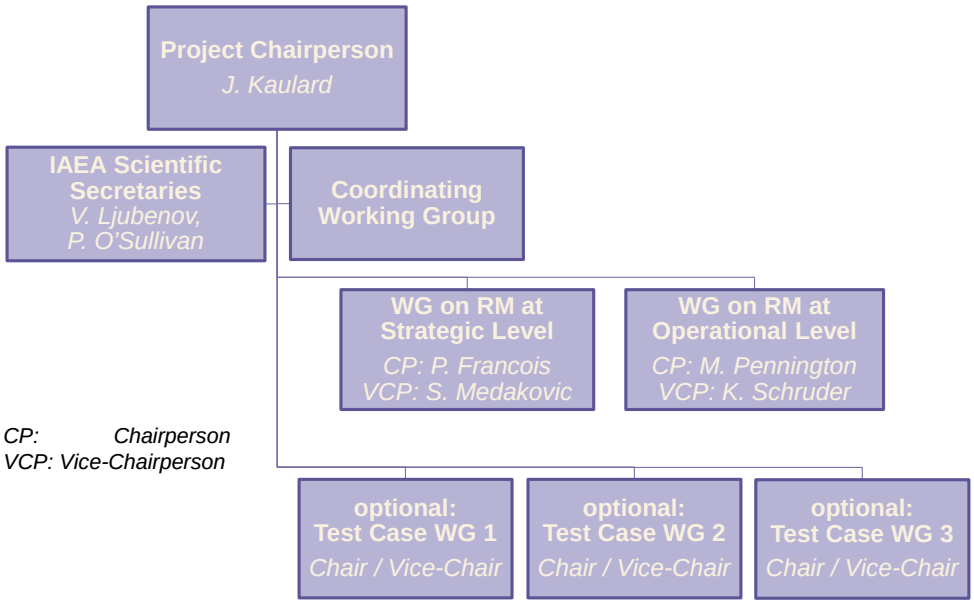

Fig. 2. Structure of the DRiMa Project.

The annual meetings serve to establish a regular exchange of experience and information among the participants, as well as to contribute to the working group activities. At the annual meetings the progress of the project during the preceding period is reviewed, working plans for the next period will be revised (if necessary) and target achievements are agreed upon.

The project's work is performed mainly within the framework of working group activities. Each working group is headed by a chair and a vice-chair. During the kick-off meeting of two working groups have been established dealing with aspects of risk management methodology and its application during decommissioning — a working group on risk management at strategic level (WG RMSL) and a working group on risk management at operational level (WG RMOL). The WG RMSL will develop recommendations on the application of risk management during strategic decision making for decommissioning – due to the nature of strategic decisions and the associated timeline risk management at strategic level it will focus on the management of assumptions and their evolution towards facts. The WG RMOL will develop recommendations on the application of risk management that are relevant to decommissioning at the operational level. The WG RMOL will hereby provide recommendations on how to reduce threats and realize opportunities; it will provide recommendations on the different risk treatment strategies and how to control the remaining risks associated, inter alia, with the development of detailed work plans.

In addition, depending on the experience feedback on risk management issues by the members of the DRiMa project during the first phase of the DRiMa project (optional) test case working groups might be established to test and illustrate the developed recommendations on the application of risk management during decommissioning. During the 2nd annual meeting of the

DRiMa project in October 2013 it has been preliminarily decided to perform a dedicated risk management workshop early 2015 instead of executing different test cases; elements of such a risk management workshop were applied by the WG RMOL during its 2013 meetings with good results concerning feedback on the methodology, transfer of knowledge to and engagement of the members of the DRiMa project. A final decision on the risk management workshop, which will be based on input from a real decommissioning project will be made during 2014.

Finally, in addition to these working groups, a coordinating working group (CWG) has been established to coordinate and manage the project.

The conduct of the DRiMa project is closely linked to the IDN. This is because of the high interest in risk management shown by the IDN members and participants. As part of this linkage, the project Chairperson will report during the annual IDN meetings on the progress and results gained so far in order to receive feedback from the IDN and advice regarding its subsequent activities. In addition, this allows to collect and to integrate further experiences from IDN members and participants. In total, the IDN act as an advisory group to the project.

Expected outcomes

The DRiMa project is expected to result in recommendations on the application of risk management for the decommissioning of facilities using radioactive material. These recommendations will provide the IAEA Member States with practical examples of the practices and procedures used for risk management in the planning and execution of decommissioning.

In particular, the project is expected to result in

- an identification of good practices based on Member States' experiences collected through the project, including examples from the application of risk management methodologies in conventional industries;
- providing advice on the application of general risk management methodology and maintenance of a risk management system for decommissioning;
- an illustration of the role of risk management in key decision making during the lifecycle of nuclear facilities (i.e. decisions relating to the planning and execution of decommissioning);
- an illustration on the optimization of risk treatment strategies and how these can minimize threats (including fallback or contingency plans) and maximize opportunities during decommissioning; and
- a contribution to improving the capabilities of Member States' in this field and enhancing the exchange of information between Member States on lessons learned related to decommissioning related risk management during all periods of the lifecycle of nuclear facilities that are relevant to the development and implementation of decommissioning plans.

The project output and its recommendations will be summarized in a DRiMa project report. Supporting information and practical examples drawn from Member States' national experience will be made available via electronic media.
Information on the progress of the DRiMa project will be shared during conduct of the DRiMa project through regular newsletters, as well as via the CONNECT system [16] and the IDN web

page [17].

FIRST SPOTLIGHT ON RISK MANAGEMENT DURING DECOMMISSIONING

Note: the following subsections provide some spotlights on first preliminary results on particularities related to risk management during decommissioning gained within the first year of conduct of the DRiMa project. A full picture will become available at completion of the DRiMa project.

Overall Aspects Of Risk Management During Decommissioning

Risk management related to decommissioning follows the same general concepts on risk management as in any other industrial field. Accordingly, risk management requires a clear understanding on the principles related, establishing a framework and executing a risk management process itself, which forms the central part of risk management. Fig. 3, based on the international standard ISO 31000:2009 [12], shows these three elements.

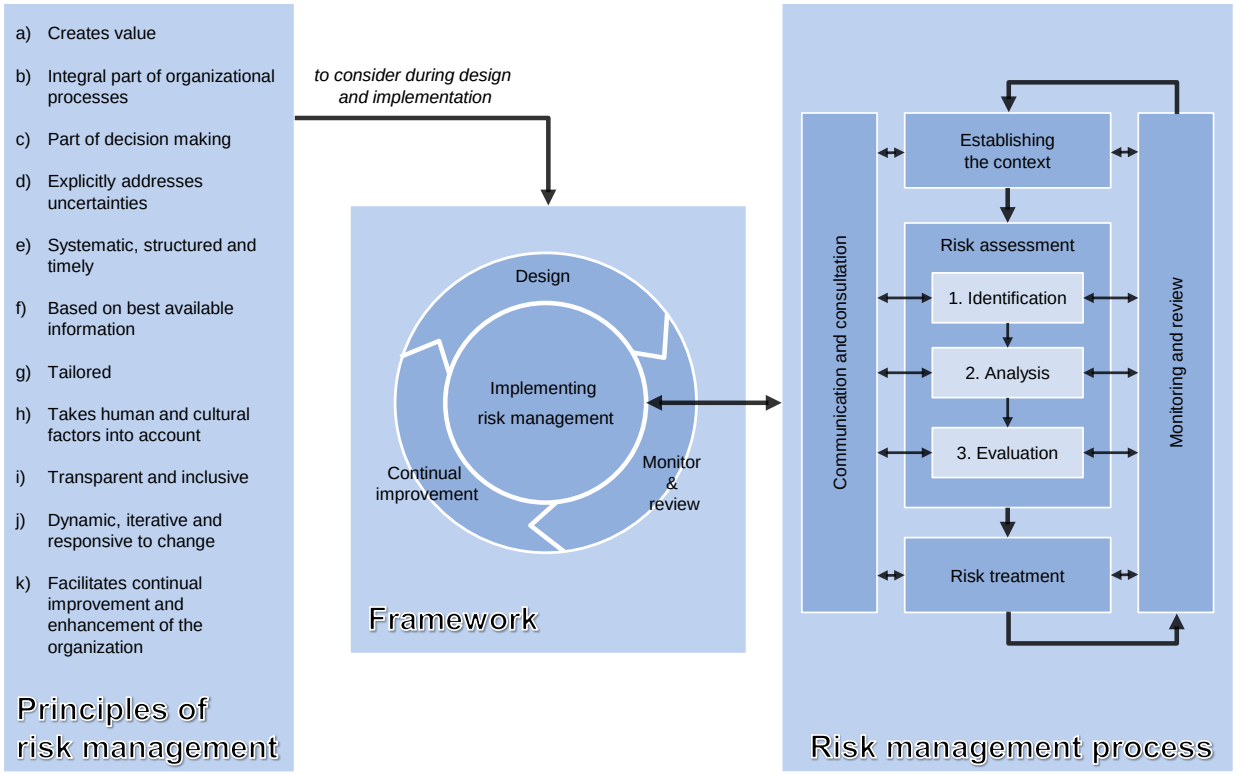

Fig. 3. Elements of Risk Management (based on [12]).

First discussions within the DRiMa project showed, that with respect to the principles and their consideration in the design of the risk management it is crucial to clearly define the value which ought to be created. With respect to decommissioning the risk management ought to help identify threats which might negatively influence the success of the decommissioning project, but ought to

help also identify opportunities, which improve the likelihood of success of the decommissioning project. There is a tendency to ignore the benefit from addressing opportunities as part of the risk management and to ignore the chance to improve a project by a systematic opportunity management.

Closely linked to the aspect of creation of value, it is important during design of a risk management to clarify how to determine threats and opportunities in terms of success of a decommissioning project. Typical aspects of success are related e.g. to safety, costs, schedule (including reliability of project plans), volume or mass of radioactive waste and material to be cleared, exposure of personnel and the environment. It is a matter of fact, that not all aspects can be maintained on the same level as they might e.g. contradict each other – accordingly, all relevant aspects of success ought to be identified and ought to become prioritized. It is important to recognize, that the priorities will change when moving from risk management at strategic level associated with the initial decommissioning plan to risk management on operational level associated with the final decommissioning plan and related detailed planning of work packages.

As in any industrial process, resources are limited. With respect to risk management not any risk (threat or opportunity) ought to be processed but focusing on the most relevant is necessary. Accordingly, during design of the risk management clear criteria and approaches need to be set to ensure that with respect to the objectives of the project only “relevant”, i.e. important threats and opportunities are treated. Fig. 4 shows an example according to [17] in which the probability of occurrence of a threat or opportunity and the associated consequences on a more quantitative scale will be used to determine which threat / opportunity to process further on – threats / opportunities in the read area will be addressed further on.

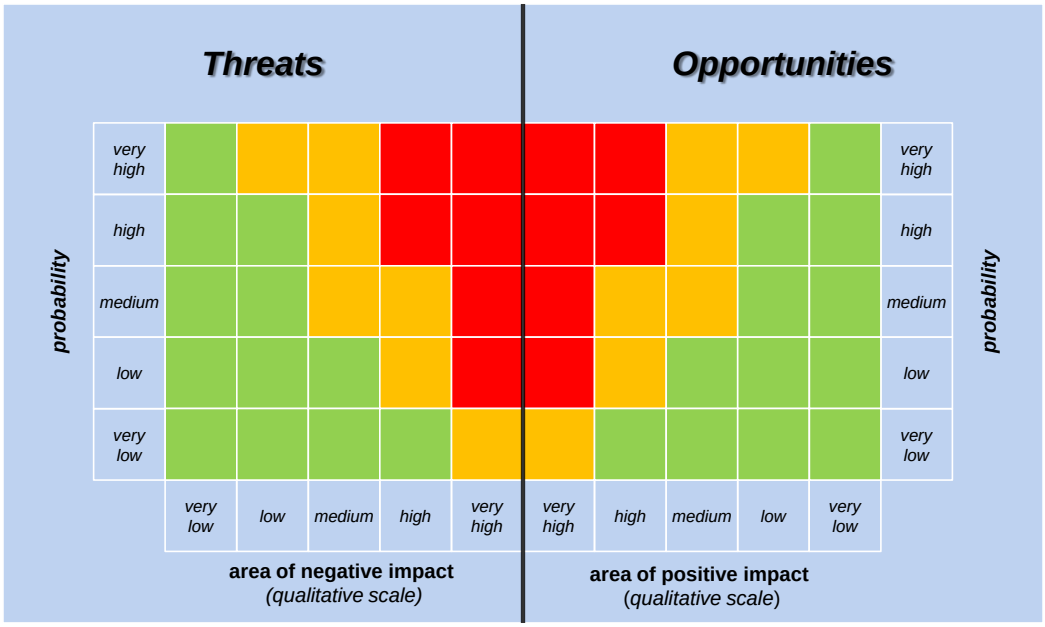

Fig. 4. Example on a Double Probability Impact Matrix for Opportunities and Threats (based on [18]).

The core of the risk management is the risk management process implemented according to the design developed. As outlined in Fig. 3 it typically comprises

- establishing the context
- risk assessment, covering identification, analysis and evaluation
- risk treatment
- communication and consultation, and
- monitoring and review.

In short, these five elements form an iterative and systematic process to ensure, that all risks are known and monitored, treatment strategies stay effective and risk are communicated. Depending on the risk treatment strategies decisions and plans for decommissioning might become changed.

To support the identification of risks a systematic and specific approach is advisable. Within the DRiMa project a set of risk families is under development which serves to identify sources for risks specific to decommissioning. Risk families represent a kind of grid to look at the decommissioning related decision and activities to understand where risk might originate from.

As part of the analysis the probabilities of occurrence and the degree of impact on the objectives will be determined. This requires a set of criteria to determine the impact on the objectives; this set is developed during the process step of “setting the context” and is based on the more general definition of the aspects of success of the project which are developed as part of the design of the risk management.

Probability and impact are used to decide on whether to further treat an identified risk. This decision is the objective of the process step of evaluation within the risk assessment; it takes into account those pre-defined decision criteria which have been set during design of the risk management and which have been concretized during setting the context of the risk management process itself (for an example refer to Fig. 4).

Discussion shows that the risk treatment strategies are those applied in any industrial project. Following the concept of [18] these are

- *exploit*, which in case of threats reads as *avoid*;
- *share*, which in case of threats reads as *transfer;*
- *enhance*, which in case of threats reads as *mitigate*; and
- *ignore*, which in case of threats reads as *accept* (including the preparation of contingency plans).

As an outcome of the risk assessment an assumption register or risk register will be developed in which threats and opportunities are listed; other risk related information covered are associated treatment strategies, which become implemented step by step. An example from a decommissioning project is given in Fig. 5. Depending on the implementation a re-assessment of risk will become necessary, as e.g. existing risks might change or new risk might become introduce.

Identification	Assessment Prior to Mitigation			Response	Assessment After Mitigation					Monitoring & Control
	Calculate Risk Score (P x I)				Calculate Risk Score (P x I)					
Risk Description	Probability Scale (1 to 5)	Impact Scale (1 to 5)	Risk Score (P x I)	Response Action(s) with Timeline	Probability Scale (1 to 5)	Impact Scale (1 to 5)	Risk Score (P x I)	Probability (%)	Probability Rating	Actual Outcome / Progress
Interface problems between packages of work may be encountered during the installation of the Packaging Station and Vacuum Vessel, causing delays and increased costs to the Project.	4	3	12	Ben - Complete a walkdown of remaining activities with key staff (RR to confirm and provide a list and dates to AECL)	2	3	6			

Fig. 5. Example on a Risk Register for a Decommissioning Project.

Monitoring and review of all identified, not only treated risks is of high importance to early recognize changes of risks, to measure the effectiveness of the treatment strategies and in general to keep them under control. Accordingly, it is important to ensure, that this review and monitoring is working properly and related oversight-monitoring is in place as part of the risk management framework.

Risk Management At Strategic Level and At Operational Level

Fig. 1 provides a first definition on risk management at strategic level and risk management at operational level. Risk management at strategic level is related to the initial decommissioning plan and the strategic decisions associated with the final decommissioning plan; by nature is more a type of assumption management and of qualitative character and needs to deal a significant set of uncertainties. Risk management at operational level is associated with the final decommissioning plan and the details as in work plans etc.; it is more of quantitative nature and dealing with less uncertainties and more facts.

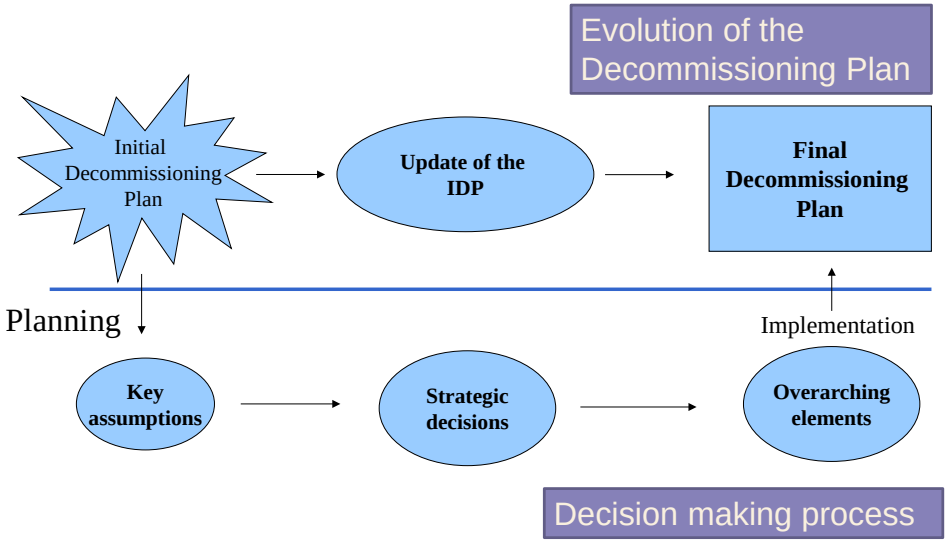

Fig. 6. Evolution of the Decommissioning Plan.

As mentioned risk management at strategic level is clearly linked with the initial decommissioning plan, which with time will be transformed into the final decommissioning plan (for further details refer to [19], [20]). Accordingly, the risk management at strategic level will follow this transformation process. Fig. 6 gives an example on the transformation process and aspects relevant to risk management.

Latest during construction of a facility using radioactive material an initial decommissioning plan has to be developed which inter alia serves to demonstrate that the facility can be decommissioned safely at the end of its life cycle and that radioactive waste can be managed; according to IAEA the initial decommissioning shall form the base for any cost estimates for the later decommissioning. As the life cycle of a facility can be of several decades the initial decommissioning plan often will be based on a set of assumptions e.g. on available disposal routes. The assumptions often are uncertain and by nature bear a non-zero probability of not becoming true at the end of the lifecycle of the facility. As a consequence, any assumption must be identified, assessed with respect to their uncertainties and the related consequences and monitored. It is the risk management methodology which helps to keep the assumptions under control and to react on changes. Similar to a risk register the assumption management results in the build-up of an assumption register but different to a risk register the treatment strategies incorporated mostly are limited to just monitor the assumptions and to react in case of changes e.g. by re-assessment of the consequences or adjustment of the assumptions.

The closer the final shut down comes the more the initial decommissioning plan will be transformed towards the final decommissioning plan. More and more the assumptions will be replaced by more certain strategic decisions which further evolve towards a set of boundary conditions in which the final decommissioning plan will be developed and which are reflected in the overarching elements associated with the final decommissioning plan. At the same time the assumption register evolves towards a register of risks associated with the strategic decision e.g. on general technology to be used or on waste management concepts. This register remains relevant during all decommissioning activities as the decisions and the resulting overarching elements may be associated with risks by themselves, e.g. via regulatory requirements.

During preparation of the final decommissioning plan the strategic conditions and overarching elements may define conditions which impose risks on the operational level. Accordingly a top down analysis is needed as part of the risk management to identify such consequences and to treat the related risk on the operational level appropriately; often, such analysis results in changes of plans or decisions and hereby threats are eliminated or opportunities are identified.

On the level of the final decommissioning plan and the detailed work plans developed during conduct of the decommissioning project a full risk management needs to be applied to handle the risks on the operational level. Compared to the risk management at strategic level the risk assessment within the risk management process becomes more detailed and by that more complex. In case of risks which cannot be appropriately treated on the operational level, e.g. because boundary conditions need to be changed, their treatment and monitoring will become subject of the risk management at strategic level. This means, that a risk becomes escalated from the operational to the strategic level. In general, it does not matter whether a risk has been identified on the operational or strategic level – in both cases effective treatment strategies need to be in place and the risk needs to be subject to an effective monitoring and review. Accordingly, a joint risk register and a single risk management (and risk management process) addressing

both level might be advisable.

Risk Families

As mentioned earlier risk families support a systematic identification of risks associated with decommissioning. Within the DRiMa project a first set of risk families have been determined. Each risk family comprises a top-level specification and two sub-level specifications to allow a more detailed identification process. Both working groups, WG RMSL and WG RMOL, elaborated independently from each other proposals on risk families, specific to their aspect of risk management. Within a first consolidation step both sets of risk families have been already harmonized on the top-level. TABLE I shows a first draft of current risk families and related first sublevel.

TABLE I. First draft of risk families identified within the DRiMa project.

Top-level Specification	First Sub-level Specification
1. Initial conditions of facility	1.1 Physical status 1.2 Radiological status and characterization 1.3 Waste and materials status 1.4 Site characteristics
2. Final end state of decommissioning	2.1 Clear definition of the end-state of the project 2.2 Difficulty to achieve the end state
3. Waste and materials management	3.1 Legal and regulatory framework 3.2 Waste estimation and characterization 3.3 Waste management infrastructure (on-site / off-site)
4. Program / Project	4.1 Program / project context 4.2 Program / project planning
5. Organization and human resources	5.1 Organizational structure 5.2 Human resources 5.3 Organizational processes
6. Finance	6.1 Cost 6.2 Funding 6.3 Financial governance
7. Technological scenarios and technology	7.1 Decommissioning scenarios 7.2 Technology
8. Legal and regulatory framework	8.1 Laws and regulations 8.2 Licensing and authorization
9. Safety, security	9.1 On-site 9.2 Off-site
10. Public acceptance	10.1 Public information 10.2 Stakeholders involvement 10.3 Public opinion

Current understanding within the DRiMa project is that the top-level specification will be appropriate within the risk management process at the strategic level; the two sub-levels might be necessary to more easily identify risks at the operational level.

CONCLUSIONS

In December 2012 the three year "International Project On Decommissioning Risk Management – DRiMa" (DRiMa project) of the IAEA was launched to develop recommendations and illustrations on the application of generally accepted risk management methodologies in decommissioning projects. The project was initiated by the members and participants of IAEAs International Decommissioning Network.

Within the first year of conduct the DRiMa project elaborated first details on risk management associated with strategic decisions, i.e. at the strategic level, and risk management related to the details of any decommissioning activities, i.e. at the operational level. With respect to a systematic identification a first draft set of risk families was elaborated which is applicable at both levels of risk management.

After the first year, further details need to be elaborated. While the work within the project was up to now mainly focusing on the risk families, further project work needs to address inter alia further explanations on the generally accepted risk management strategies, on details of risk registers and of risk management plans, details of designing and establishing a risk management and on the integration of risk management into existing management systems at decommissioning projects and on the relationship between risk management and safety assessment.

Already during the first year of the DRiMa project risk management workshops with limited scope and audience were used to verify the risk families developed. An important step within the DRiMa project will be a risk management workshop addressing all recommendations on risk management during decommissioning on base of information of a real decommissioning project. This workshop is preliminarily foreseen in early 2015.

Finally, it is important to note that the progress made and the engaged and enthusiastic participation of more than 50 experts from about 30 IAEA Member States clearly indicate the high interest in the objectives and outcomes of the project and ensures that recommendations will be developed with high value to the decommissioning practice.

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