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TECHNOLOGY ROADMAPPING FOR IAEA SEALS*

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ABSTRACT

In the fall of 2002, the U.S. Support Program (USSP) initiated an effort to define a strategy or "roadmap" for future seals technologies and to develop a generalized process for planning safeguards equipment development, which includes seals and other safeguards equipment. The underlying objectives of the USSP include becoming more proactive than reactive in addressing safeguards equipment needs, helping the IAEA to maintain an inventory of cost-effective, reliable, and effective safeguards equipment, establishing a long-term planning horizon, and securing IAEA ownership in the process of effective requirements definition and timely transitioning of new or improved systems for IAEA use.

At an initial workshop, seals, their functions, performance issues, and future embodiments were discussed in the following order: adhesive seals, metal seals, passive and active loop seals, ultrasonic seals, tamper indicating enclosures (including sample containers, equipment enclosures, and conduits). Suggested improvements to these technologies focused largely on a few themes: (1) The seals must be applied quickly, easily, and correctly; (2) Seals and their associated equipment should not unduly add bulk or weight to the inspectors' load; (3) Rapid, in-situ verifiability of seals is desirable; and (4) Seal systems for high risk or high value applications should have two-way, remote communications.

Based upon these observations and other insights, the participants constructed a skeletal approach for seals technology planning. The process begins with a top-level review of the fundamental safeguards requirements and extraction of required system features, which is followed by analysis of suitable technologies and identification of technology gaps, and finally by development of a planning schedule for system improvements and new technology integration. Development of a comprehensive procedure will require the partnership and participation of the IAEA.

The presentation will include a description of the roadmapping approach developed for safeguards technologies and an overview of the initial seals workshop results.

BACKGROUND

The USSP initiated a roadmapping exercise to see whether experience in DOE R&D programs could help improve management of IAEA safeguards technology. Technology

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roadmapping is a structured process that brings technology holders in direct contact with end users in order to identify near- and long-term technical opportunities and develop plans to make use of those opportunities. The goal is to improve the quality of equipment specifications, design, performance and reliability, thereby reducing the number of short-term solution and emergency requests. The objectives of this effort are to help the IAEA:

a. Maintain an inventory of reliable and effective safeguards equipment at a reasonable cost
b. Become proactive rather than reactive in addressing safeguards equipment needs/requirements
c. Develop a lifecycle approach to safeguards equipment development that addresses technology development and implementation from cradle to grave
d. Establish the foundation for a 15-year planning horizon
e. Take ownership of the process as reflected in the R&D Programme

The USSP and the IAEA have taken other actions that are generally consistent with this approach.

First, the IAEA reorganized the Division of Technical Support by equipment categories and gave each section both the development and maintenance responsibilities for its equipment. With developers and maintenance staff in the same organization the integration of new technologies becomes better aligned with goals for field performance and reliability. The IAEA has encapsulated the reorganization and revised plans in the latest R&D Programme.

Second, after several costly experiences with parts obsolescence, the Agency, equipment suppliers, and the USSP realized that in many cases, critical components must be pre-purchased to avoid having to redesign equipment or purchase entirely new systems because replacement parts were no longer available. The benefits of this strategy have already been observed.

The IAEA hosted a workshop (not called technology roadmapping but similar in spirit) on techniques for partial defect measurement of spent fuel, began discussing a roadmapping workshop for surveillance technologies, and submitted a request for an evaluation of the SAL lab equipment needs.

USSP PRELIMINARY ROADMAP EFFORTS

In late August 2002, the USSP held a kick-off meeting to develop the goals of technology planning and outlined an initial approach. Equipment planning is to be based on IAEA functional needs and is to consider the technologies that are currently used or could be used to meet each functional need. Examples of these needs are measurement and accountancy, containment, and surveillance. Associated technologies are non-destructive and destructive assay, seals, and surveillance systems. Other areas, such as environmental sampling, would be viable topic areas. Each area would be planned as a separate effort.

The first technology roadmapping workshop was planned as a trial with the expectation that the IAEA and other member state support programs would participate in future meetings.

Seals were chosen as the focus because it was initially thought to be a reasonably manageable task. Included among the participants were seals manufacturers, seals developers, a former IAEA inspector, a vulnerability expert, a requirements specialist, and USSP program managers.

Since the workshop, members of the USSP have met briefly with IAEA staff about USSP roadmapping activities and have discussed the IAEA's desire to proceed with technology planning in the areas of seals and surveillance. Independently, the IAEA hosted a workshop on partial defect measurement of spent fuel, which embodied the roadmapping ideals and process that the USSP hopes will be used in other areas.

In summary, the USSP goals of roadmapping are to develop with the IAEA an equipment planning and development to phase in new equipment when it is needed; develop an equipment development and use process that spans the lifecycle of the equipment; and ensure that reliable and effective safeguards equipment can be produced and maintained at reasonable costs. The product of these meetings, a roadmap, is envisioned to be a guide for planning that identifies challenges, charts the feasible development paths, and identifies and prioritizes separate development efforts. The roadmap is not meant to be an inflexible, prescriptive text, but a planning tool.

ROADMAPPING WORKSHOP PROCESS

The agenda for the initial roadmapping workshop was organized around two goals. The first was to understand the current and future status of seals and containment technologies so that the USSP improves its process of planning for future technology investments. The second purpose was to prototype a process to develop roadmaps for other technology areas.

Background information was provided by former IAEA inspectors. Descriptions of typical IAEA seals and their applications were followed by an assessment of seals' effectiveness and limitations. Many application and performance factors are not necessarily taken into account during the design phases or foreseen until the seal is put to use. The use of seals is sometimes determined independently by the inspectors, rather than called out by a specific IAEA agreement or procedure. For these reasons and others, the discussion highlighted the importance of gathering frequent feedback from the inspectorate for use in the technology planning process.

The participants were then led through a step-by-step examination of specific seal technologies. Seals functions and their shortcomings were discussed, followed by listing needed enhancements and improvements categorized by immediate needs, next generation, and "Star Trek Fantasy" (longer term) time frames. The lists that were generated by these discussions have not yet been validated by the IAEA. By answering these questions, the major development challenges can be mapped for each seal technology. While each discussion is centered on particular technology areas, the focus was on meeting the functional needs of containment, not to improve technology for its own sake. Although these discussions were generally felt to be useful, the participants also noted that the absence of IAEA representatives prevented understanding of important information, such as current

containment functional requirements, failure rates and modes, and where and how the IAEA could benefit most by new or improved seals technologies.

SKELETAL TECHNOLOGY PLANNING APPROACH

On the second day of the meeting, the participants began to see a pattern in the discussions that led to the development of a rudimentary, generalized approach for seals planning. They constructed a skeletal technology planning approach for safeguards equipment, Fig. 1. Out of this process, they defined general guidelines for safeguards technologies and for completing the seals roadmap.

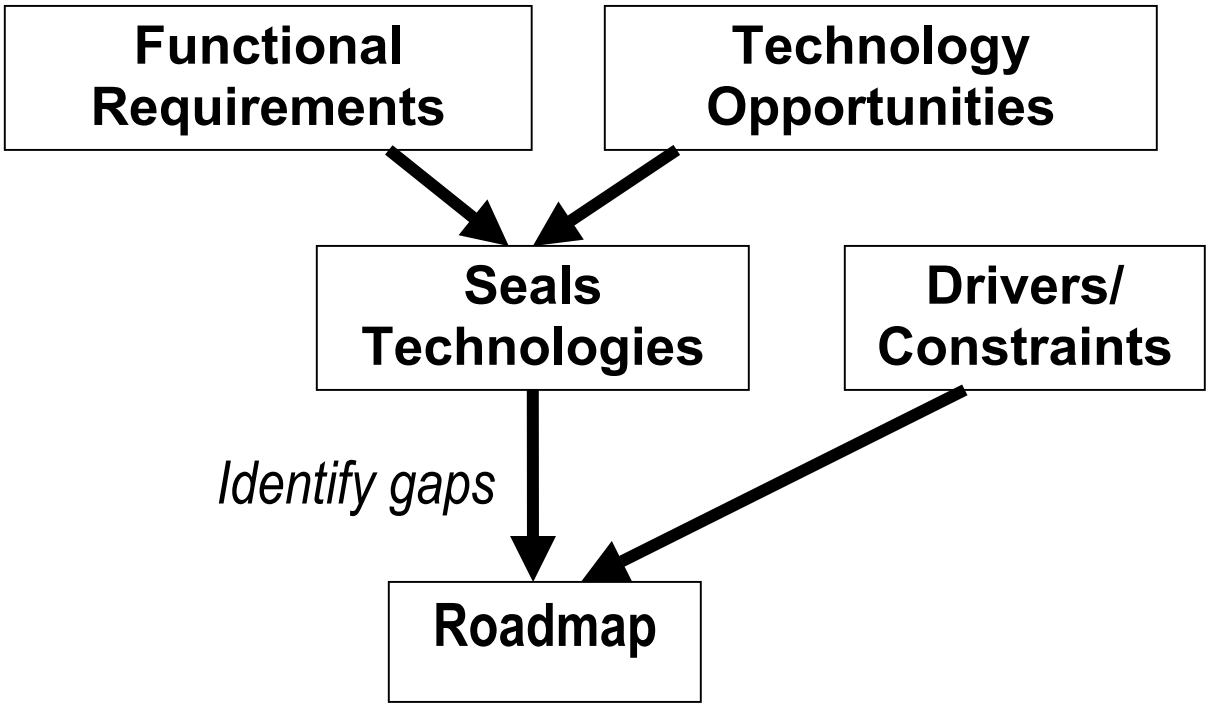

Figure 1. The IAEA containment functional requirements and technology opportunities are used to select sealing options. Other drivers and constraints, such as lifecycle costs, development schedules, and vulnerability assessments, regulate the seals and containment system selections.

The participants recognized that top-level, functional requirements should be integrated with bottoms-up technology capabilities. A thorough review of current and anticipated safeguards policies is deemed necessary for constructing an accurate list of requirements. Laying this foundation should ultimately help to increase equipment standardization, potentially expanding the use of a seal technology across multiple applications; ensure all containment scenarios are addressed; and encourage the consideration of new approaches for existing or planned containment applications.

At the same time, a broad examination of technologies and other containment approaches should be reviewed for applicability. The participants realized the trap of focusing too soon on upgrading existing technologies thereby limiting the solution set, but also understood that resource constraints would limit the ability to take advantage of technical opportunities.

For containment, the top-level requirements are derived from two containment scenarios:

(1) Material moving toward long-term inaccessible storage, and
(2) Material visited by multiple entities.

Information about what materials, facilities, and information should be kept under containment, for how long, and under what conditions come directly from IAEA Subsidiary Arrangements with member states regarding the application of safeguards in their facilities. Another consideration should be the evolving safeguards policies. Key features of a containment system can be extracted from this information. Constructing a matrix of applications or containment scenarios versus technology features can be used to group features common to multiple applications. Feature groups would then be evaluated against existing and prospective sealing systems. A seal or other containment approach must meet all of the required features to be considered for use. Other drivers, affecting seal technology choices such as ease of use, vulnerability, cost, and relative value of the containment, can either be built into the features matrix or can be evaluated in a separate matrix. Where the technology does not fit, there is a "gap" which must be addressed. Analysis of these gaps becomes the basis for the technology roadmap. The gaps point to the needs and requirements not met by current or proposed technologies. The roadmap becomes the plan for closing those gaps by identifying the required developments, the priorities, and the schedules.

CONCLUSIONS

The workshop began the roadmapping process by addressing one type of seal technology at a time. While this effort was useful, the participants realized that it would have been better to start the process with IAEA containment requirements. Experienced IAEA policy staff, inspectors, and technical support staff should be part of the roadmapping effort in order to capture the IAEA containment philosophy and requirements, realities of the inspection process, and constraints of the technical support section. The roadmapping effort must also include enough of a science component among the participants to imagine the possibilities for future sealing systems, which are not necessarily just improvements of existing technologies.

A matrix approach to analyzing safeguards containment needs, specifying appropriate technologies, and identifying the gaps in capabilities is a more systematic analysis of the requirements gaps and can be used to structure a technology roadmap to guide development prioritization and scheduling.

The USSP looks forward to working with the IAEA to develop a technology planning process that builds on our respective efforts.

NEXT STEPS

- The USSP plans to participate in a more complete treatment of the seals roadmap with the IAEA and other member states.
- The USSP and the IAEA are planning a surveillance technology roadmapping workshop with IAEA in the fall, at Brookhaven. As part of that effort, the USSP is supporting an initial surveillance technologies study.
- The USSP plans to continue to support roadmapping efforts across other safeguards areas. Potential topics include:
    - Nondestructive Analysis
    - Destructive Analysis
    - Remote and Unattended Monitoring
    - Information Collection/Analysis
    - Environmental Sampling & Analysis
    - Satellite Imagery
    - Communication, Data Handing, Software