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United States Support Program (USSP) Lessons Learned from the Management of Complex, Multi-Stakeholder Projects for International Safeguards

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DISCLAIMER

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Abstract: This paper will summarize USSP experiences and lessons learned in the management of complex equipment development projects for the IAEA. The focus will be on identifying lessons learned to formulate strategies to minimize risk and maximize the potential of providing IAEA high priority equipment to address field deployment needs. Topics addressed are: 1) initial agreement between all stakeholders on the need for the development based on market studies of existing/near term future COTS technology capabilities; 2) initial agreement on a project schedule from request acceptance to commercial unit production including per unit cost and quantities; 3) periodic IAEA reaffirmation during product development of the need, quantity, and unit price for the product.

Introduction

Since 1977, the United States Support Program to IAEA Safeguards (USSP) has funded complex, high cost equipment development projects at the request of the IAEA. The projects addressed the IAEA's high priority equipment needs. Most of these projects involved initial development followed by equipment commercialization and procurement. Recent projects include the Next Generation Surveillance System (NGSS)[1], Remote Monitoring Sealing Array (RMSA) system[2], and the Universal Non Destructive Assay Data Acquisition Platform (UNAP)[3]. The International Safeguards Project Office (ISPO) at Brookhaven National Laboratory, which is responsible for the day-to-day technical and administrative management of the USSP, has reviewed the equipment development lifecycle experiences of ISPO, the U.S. labs and companies that built this equipment for many of these important projects. This review included identifying opportunities for improvement in our project management approach that can be addressed in future equipment development or equipment upgrade projects. This paper discusses the results of ISPO's review and issues that should be considered during the lifecycle of a complex equipment development project. This paper describes a project management process for such projects which includes the initial consideration of the request, acceptance of the request by the USSP, initiation of the project, monitoring progress during development including reaffirming the need for the equipment, commercialization, and procurement. The predominant criteria for the success of a USSP funded equipment development project is IAEA use of the equipment.

[1] The Next Generation Surveillance System: The German Support Program and the United States Support Program funded this joint member state development project
[2] The Remote Monitoring Sealing Array (System): The USSP funded Sandia National Laboratory and Canberra Industries Inc. to develop RMSA
[3] Universal Non Destructive Assay Data Acquisition Platform (UNAP): The USSP funded Canberra Industries, Pelowitz LLC, Foiani LLC, and Los Alamos National Laboratory to develop UNAP.

Project Management

Complex, multi-stakeholder development tasks require strong, dedicated, and sustained project management. Based on its recent experiences, ISPO has listed below project management best practices that should be followed during the entire equipment development process:

1) Build and maintain multi-level support for development project including the end user. To the extent practicable, the same ISPO Task Monitor and IAEA Task Officer should lead and coordinate the project from beginning to end. This will avoid loss of institutional knowledge and gaps in project leadership and accountability. Each project should have an IAEA management project champion who understands the need for the project, is committed to the project, and will provide leadership and sustained support during development. The IAEA should ensure the end user of the equipment is involved from the start and throughout the development process ensuring their needs are adequately addressed. Ideally, the project champion will be supported by the relevant IAEA Safeguards Division Director. Changes in project champion, IAEA Task Officer, or Division Director should trigger a strategic review by ISPO.
2) Equipment development requests should include a User Requirements document prepared by the IAEA. This important document is driven by IAEA institutional needs indicating design parameters and required performance of the equipment. The IAEA and ISPO should agree on the equipment testing requirements.
3) It is possible to minimize risk in equipment projects through the use of parallel and serial equipment component development. Serial development of components can be disadvantageous because it can extend the schedule if one component's development holds up all other work, but it does enable succeeding elements of the project to build on the concrete accomplishments of previous stages and results in decreased risk. Parallel development of equipment components can shorten the schedule, but it requires the developer to make assumptions that can add risk. Whichever approach is adopted, the developer must understand the risks, communicate these to ISPO and take steps to minimize adverse impacts.
4) Our experience shows that it is preferable not to have equipment development projects involving multiple developers. The project management effort is significantly more complex and can be less effective as well as less efficient. Whenever possible, one developer should be selected to produce the equipment. This developer can include subcontracts and cooperative research and development agreements (CRADAs) in their bid. Thus, a single developer will be responsible for internally addressing all issues and delivering the product at the agreed contract cost and schedule. This should also facilitate production and control costs by ensuring that one entity has overall control of the technical elements of the project.
5) At the outset of a project, a detailed project schedule should be prepared and agreed upon by ISPO, the IAEA, and the developer. This should include agreement on the IAEA prototype testing schedule to ensure timely finalized commercial unit design, procurement and IAEA equipment deployment.
6) The schedule, the development budget, and the projected unit cost should be reviewed periodically to determine that project cost criteria are being met. The schedule should include distinct project milestones that are measureable and can be accomplished within a specified timeframe. The schedule should be updated by the contractor in real-time to reflect progress and any changes as they occur.

7) During the development process, when a modification is proposed to the equipment specification and/or user requirements by IAEA or developer, the impact of this modification on the schedule, budget, unit cost, and production must be fully understood and approved (or rejected) by the IAEA, ISPO and the contractor.
8) The contractor's scope of work should include a preferably independent, equipment vulnerability review to identify issues and allow for design modification during the development process. This will minimize the possibility of issues being identified by the IAEA during its independent Vulnerability Assessment after the development phase is complete. Issues identified after the completion of the development phase can result in the need for retrofits that will increase the cost and extend the schedule. Very significant vulnerabilities which can't be effectively addressed may result in the product being abandoned.

IAEA Equipment Development Requests to the USSP

ISPO periodically receives requests from the IAEA for equipment development based on documented needs in the Development and Implementation Support Programme for Nuclear Verification[4]. These requests should contain justification of the need for the product, the identification of equipment that is slated for replacement, and the estimated date of equipment procurement along with the number of units and the per unit target price. Requests include a detailed User Requirements document that is driven by institutional need and indicates design parameters and required performance of the product. A specification detailing the equipment design requirements may also be included, but the specification does not preclude the need for a User Requirements document.

An IAEA management commitment prior to and during the lifecycle of equipment projects is essential for these development projects. One example of institutional commitment is an IAEA request containing the above elements. If the IAEA's request does not contain these elements, ISPO may offer IAEA assistance in preparing them. For example, if user requirements have not been developed, and the USSP is supportive of the project, ISPO will identify a technical consultant who can assist the IAEA in the preparation of the equipment user requirements as the first phase of the project. During the evaluation of the request, ISPO and IAEA should determine if adequate project management support can be provided with existing staff in both organizations. The ISPO and IAEA staff assigned to the project should have previous equipment development project management experience and also the time to adequately support the project during the lifecycle. If not, a dedicated project management consultant, or possibly a cost free expert (CFE) sponsored by the USSP, may be needed to help IAEA support the project.

If the equipment technology being requested is not fully understood by ISPO, ISPO and the IAEA may agree to have a U.S. laboratory or contractor perform a feasibility study to reduce the project risk prior to commencing with the development. If this study verifies that the technology is viable for the IAEA, the USSP and IAEA can decide to move forward with the project.

If the IAEA's request does not provide adequate justification for the need for the project, the USSP may want to review the intended use, the technology, and the market, and contact other

[4] The biennial Development and Implementation Support Programme for Nuclear Verification is prepared by the IAEA Department of Safeguards. The current edition covers 2014 and 2015 and is dated December 2013.

stakeholders to verify the need, the practicality, and the viability of the suggested project. The USSP review may also include an assessment to estimate the expected cost of the project, consider the risk associated with the project and identify whether similar equipment is already on the market.

ISPO always considers the risk associated with projects. ISPO asks contractors to explain the level of risk associated with a project in their proposals. This helps the USSP to understand how likely it is that our developers will encounter obstacles during development and what level of oversight will be required to ensure that the project stays on schedule and within budget. Risk is an element of all projects and if it is managed carefully, significant adverse impacts can be avoided. Instrument developments sponsored by the USSP can became obsolete before deployment due to new COTS equipment being released during the equipment development lifecycle. In a practical sense, this means the technology is no longer cutting edge or that the parts are no longer readily available. A lengthy development schedule can exacerbate the risk of this happening. If it is possible to shorten the development schedule, this can increase the probability that an instrument can be deployed while the technology is still novel.

The USSP would like to maximize the potential that equipment development will result in field deployment. Changes in the development environment can reduce or end the IAEA's interest in or need for an instrument. For example, the delays in the Japan Mixed Oxide Facility reduced the need for replacements for the miniGRAND and JSR-12. Such changes can result in the IAEA deciding a project is no longer necessary and withdrawing from it. ISPO attempts to reduce the likelihood of equipment under development not being deployed in the field by periodically ensuring IAEA end user needs are still valid and reviewing similar equipment advances in the market.

When developing a new instrument, the USSP and the IAEA need to be mindful of the entire lifecycle of the equipment from development to retirement. In addition to development costs, there are costs associated with deployment and maintenance. The lifecycle costs to sustain the new equipment following approval for use should be estimated and agreed to prior to the start of development. The stakeholders should agree in advance as to responsibilities for the lifecycle stages.

New and upgraded Commercial-off-the-Shelf (COTS) equipment is continually entering the market and ISPO needs to remain cognizant of these developments when considering pending IAEA equipment development requests. Through market surveys, ISPO can become aware of competing products that are under development or already being sold. The market survey includes a thorough review of commercially available (or soon to be available) equipment that may satisfy the request. Available COTS, Modifiable-off-the-Shelf (MOTS - commercially available equipment that can be modified to meet the IAEA's needs[5]), and Government-off-the-Shelf (GOTS - products typically developed by the technical staff of a U.S. government agency for which it was created) will be reviewed. The equipment will be evaluated against the IAEA User Requirements. Use of COTS, MOTS, or GOTS equipment will minimize/eliminate

[5] " NGSI's UF6 Cylinder Monitoring Project Update", Karyn Durbin, National Nuclear Security Administration, Michael Whitaker, Oak Ridge National Laboratory, 2014 Institute of Nuclear Materials Management Annual meeting

development time and cost and allow for leveraging the demonstrated performance of existing equipment. Equipment identified in this market survey, will be discussed with the IAEA to determine the feasibility of using or modifying these existing designs.

Roles and responsibilities for intellectual property, commercialization, and procurement should be considered and agreed to by ISPO and the IAEA at the outset of a project. The IAEA Procurement Section should be consulted to ensure that the requirements for procurement are understood prior to the start of the project and that the procurement can be conducted in accordance with IAEA rules. ISPO and the IAEA should set expectations at the outset as to who will be responsible for financing and procuring commercial units and who will hold the intellectual property associated with the product. There should be an agreed plan from the outset for licensing so that technology transfer activities can be performed in parallel with equipment development.

Funding Approval and Start of Project

Once ISPO completes its reviews and consideration of the request, the appropriate project management oversight is put in place, and the IAEA is in agreement with the equipment development approach, the USSP's Subgroup on Safeguards Technical Support (SSTS) makes a decision regarding funding the request. Most work with the private sector is performed through a contract between the Brookhaven National Laboratory (BNL) and the vendor(s). If this is the case, BNL's Procurement and Property Management (PPM) Division will tender bids from developers and make a selection. The bid package will include the IAEA user requirements, a statement of work, an IAEA equipment specification (if it is available), prototype testing requirements, and an equipment delivery schedule including quantities. Each vendor's bid is required to include a detailed project schedule including milestones and deliverables. Prototype test requirements are specified in the bid package and equipment is tested to ensure it successfully operates after being exposed to possible field deployment conditions. This testing may consist of operational, environmental (e.g., temperature, humidity), mechanical (e.g., vibration) and electrical (e.g., radio frequency) tests. The bids include a proposed equipment specification detailing the equipment design requirements (in response to the user requirements) if this document has not been provided by the IAEA. If multiple bids are received, a panel of technical and program experts reviews the bids, evaluates them against a set of criteria, and selects the winning vendor. After selection, the vendor will complete the detailed equipment design including drawings. The IAEA, ISPO and the developer will carefully review and agree on this design prior to commencement of prototype production. Based on this design, prototypes will be manufactured and tested. Ideally, the equipment prototype design will be virtually the same as the final commercial design with minimal modifications.

ISPO-IAEA Strategic Project Reviews

Equipment development projects should have periodic strategic project reviews where ISPO and the IAEA discuss the technical progress and challenges of the project. During these strategic reviews ISPO and the IAEA can decide to continue, modify, or terminate the project. The reviews will consider changes to elements external to the project, including delays in facility construction or commissioning that affect product usage, competing products that enter the market, change in IAEA commitment, and IAEA procurement policy changes which adversely impact the agreed procurement plan. This review will provide all stakeholders the opportunity to

determine if the project is still aligned with their objectives. The strategic reviews will be designed to help the stakeholders evaluate the costs, benefits, and risks associated with the project. During the strategic reviews, ISPO will ask the IAEA to indicate that it is still in agreement with the product design (form, fit, and function) and delivery schedule including estimated equipment quantities and unit cost. At any point where the IAEA states that the design no longer meets its needs, the IAEA and ISPO should either agree on modifications to the project, addressing the cost and schedule implications, or agree to terminate the project.

IAEA Testing

Once equipment prototypes are provided, the IAEA typically tests the hardware and software against operational, environmental, and safety requirements and conducts an independent Vulnerability Assessment (VA). The IAEA uses the results of the VA to identify any items that must be modified to ensure the security of the equipment and its data. If the items identified during the VA are significant, the project could be terminated. Modifications to prototype design may be necessary to correct the vulnerabilities. Upon successful completion of the VA, the IAEA performs in house testing followed by extensive testing in the field. Once all testing is satisfactorily completed, commercial procurement can commence, followed by equipment deployment. The period of IAEA testing varies. If this period can be reduced, equipment procurement and field deployment could occur sooner.

Summary/Conclusion

There are many important factors to consider prior to and after funding complex, high cost IAEA equipment development requests. As indicated in this paper, effective and responsible project management requires significant effort before a task is approved by the USSP. A sound, technical and operational justification for each project is vital. It is important for ISPO and the IAEA to be in full agreement with the planned path forward from acceptance of the request to procurement of commercial units and field deployment. Equipment development projects will have periodic strategic project reviews, where ISPO and the IAEA discuss the technical progress, status of pertinent milestones, and proposed changes along with impacts. The IAEA and the USSP will decide to continue, modify, or terminate the project. During the lifecycle of each project, it is important to identify and document lessons learned. These lessons will be used to improve the management of future equipment development requests. By integrating lessons learned from past projects into future development projects, we will improve the chances of realizing the agreed goals of the project. The USSP looks forward to working with the IAEA to improve our management of complex projects so we can effectively respond to future IAEA equipment needs and support the deployment of safeguards equipment to increase the effectiveness and improve the efficiency of IAEA safeguards.

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Organization: International Safeguards Project Office, Brookhaven National Laboratory

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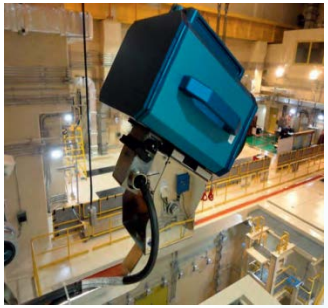
Outline

1. Presentation Objectives
2. Equipment Development Life Cycle Overview
3. IAEA Equipment Development Request Components
4. USSP Considerations When Reviewing Request
5. Improved Project Management Plan
6. Summary

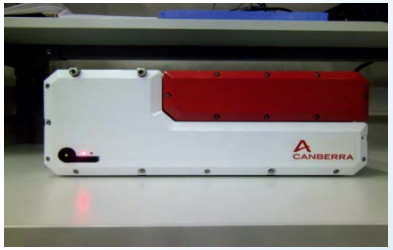
Presentation Objectives

“Tools” (Equipment Development) is one of the seven USSP Strategic Objectives



NGSS

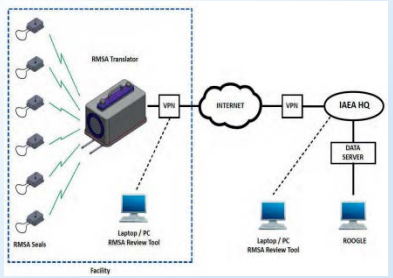
- Focus on how to minimize risk and maximize the potential of providing IAEA high priority equipment to address field deployment needs



UNAP

- Review USSP considerations when evaluating IAEA equipment development requests

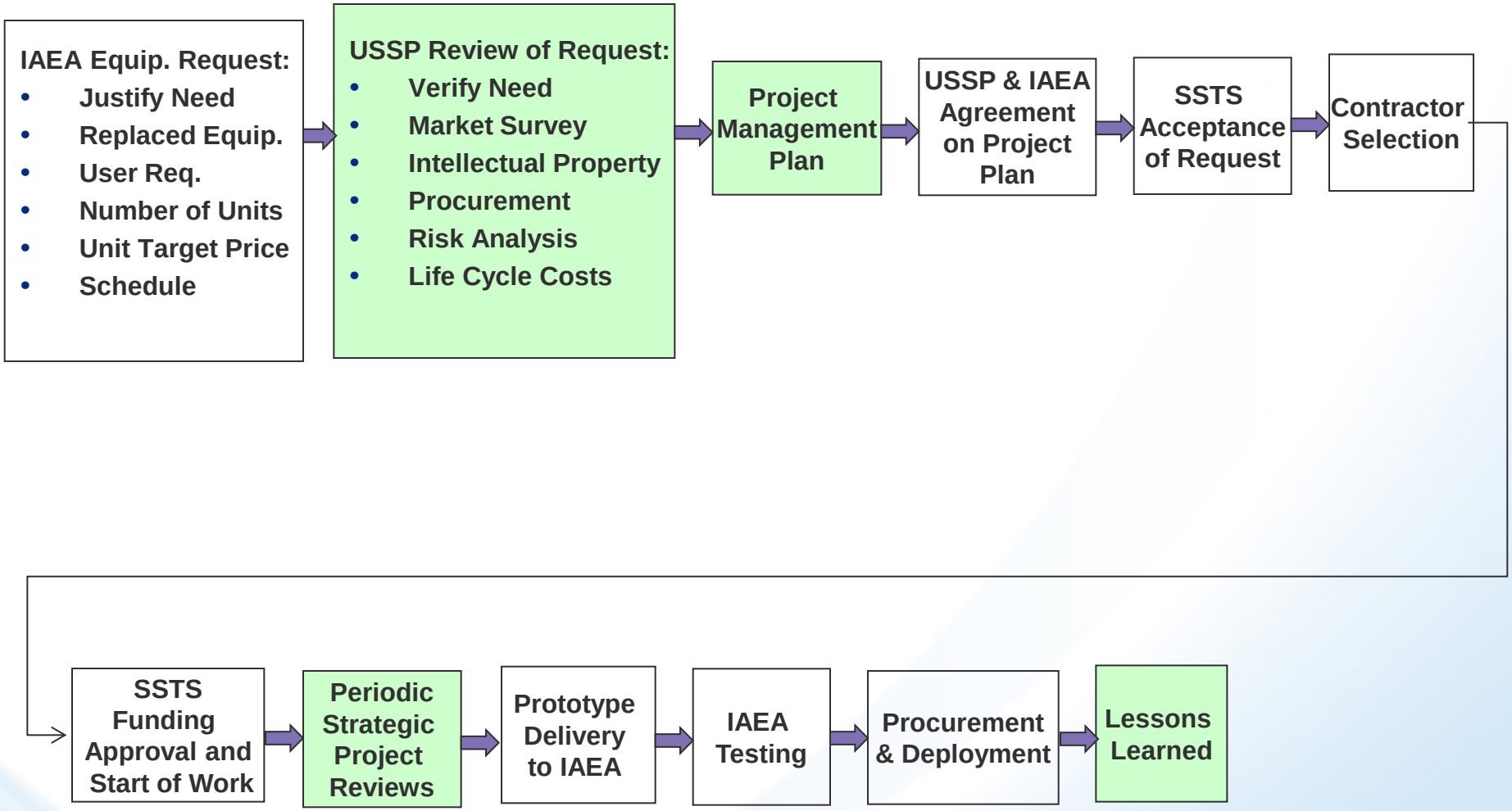
- Share equip. development project management improvements based on lesson learned



RMSA

USSP Equip. Development Life Cycle

(Presentation to focus on highlighted in green boxes)



IAEA Equipment Development Request to Include:

- Justification of need
- Equipment to be replaced including quantities
- Number of units and per unit target price
- *Estimated Schedule including milestones for:*
  - Prototype production
  - IAEA testing, including independent VA
  - Procurement/field deployment
- User Requirements
- COTS Market Survey (if available)
- Equipment Specification (if available)
- IAEA can request USSP assistance in preparing the above items


IAEA

Ms. H. Hoffheins

ISPO Liaison Officer
U.S. Mission to the International Organizations
in Vienna (USNVIE)
Wagramer Strasse 17-19
A-1220 Vienna

RECEIVED USNVIE-ISPO
DATE: DEC 12 2007

2007-12-07

Subject: Task Proposal 07/TSR-03

Dear Ms. Hoffheins,

With reference to the U.S. Support Programme, I am pleased to provide the following new Task Proposal:

07/TSR-03 *Development of a Reusable Identified Sealing Array*

This task is part of the Improved Techniques and Instruments for Sealing and Containment Verification Project. The project manager is Mr G. Wenks

Please inform me at your earliest convenience whether the content of the proposal is acceptable to the U.S. Support Programme or if you would like to introduce any amendments. In your reply, please also provide the name(s) of the U.S. contact person(s) responsible for the task.

Upon acceptance of the proposal, the IAEA will transmit the Task Outline to you indicating the name of the IAEA task officer. Our understanding is that the U.S. Support Programme and the IAEA task officer will then establish a detailed task workplan.

I would also like to express the appreciation of the IAEA for the valuable contribution provided by the U.S. Support Programme to the IAEA's safeguards efforts.

Yours sincerely,

M. Abdelrahman
Director
Division of Technical Support

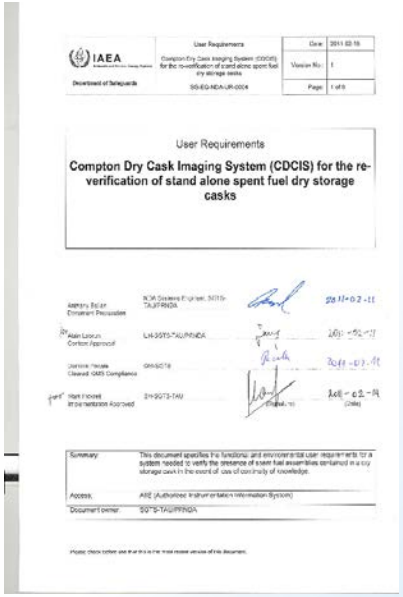
Enclosure

IAEA SP-1 Request

USSP Review of IAEA Equip. Develop. Request - 1

How to maximize the potential that the equipment will be used by the IAEA

- *Verify IAEA high priority equipment need:*
  - Review SP-1, User Requirements, specification
  - Justification for equipment and concept of operations
  - Evaluate proposed deployment environment/s needs
  - Ensure End User needs are satisfied
  - IAEA Management Project Champion commitment through equipment lifecycle


User Requirements

Compton Dry Cask Imaging System (CDCIS) for the re-verification of stand alone spent fuel dry storage casks

IAEA Equip. User Requirements

USSP Review of IAEA Equip. Develop. Request - 2

Equipment Market Survey:

•Investigate the feasibility of using or modifying existing equipment

•*Evaluate existing equipment form/fit/function vs User Requirements/Specification*

- Commercial-off-the-Shelf (COTS)
- Modifiable-off-the-Shelf (MOTS)
- Government-off-the-Shelf (GOTS)
- Existing/under development MSSP equipment

Canberra JSR-14

• *Benefits of using/modifying existing equipment:*

- Leverage off demonstrated performance
- Minimize/eliminate development time and cost
- Greatly reduce/eliminate equipment development risk
- Established equipment supply chains

Ortec Micro-trans-SPEC

USSP Review of IAEA Equip. Develop. Request - 3

•Agree to project roles and responsibilities including ownership of Intellectual Property and Technology Transfer (Licensing)

•*Verify adequate IAEA/USSP project management support*
- ➢ USSP Consultant and/or IAEA CFE may be needed

•Possible need for Feasibility Study if application of technology being requested is not fully understood

•Estimated schedule, including milestones, from SP-1 acceptance to field deployment

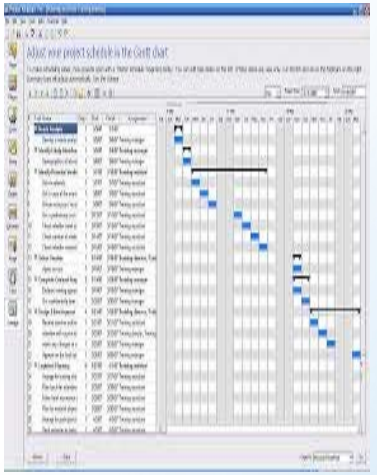
•Costs to deploy and maintain equipment during lifetime

•USSP can provide IAEA assistance in obtaining the information needed to allow us to make an informed decision on the IAEA equip. request

Project Management Plan - 1

•Focused and sustained Project Mgmt. (PM) through equip. lifecycle

•IAEA and USSP agreement on Project Management Plan prior to request acceptance by USSP



•*Implement PM Best Practices including lessons learned:*

- Detailed project schedule including milestones
- <u>End user involvement from request evaluation through equipment development</u>
- One developer in charge of all project aspects including prototype delivery schedule and per unit cost:
  - U.S. National Lab expertise via a CRADA
  - Subcontracts with other vendors (ex: software, testing)
- Same ISPO Task Monitor and IAEA Task Officer through life of development, if possible

Project Management Plan - 2

- *Proposed Equipment Modifications During Development:*

  - Evaluate impacts including schedule, unit cost, anticipated quantities
  - Ensure end user is in agreement with proposed change/impacts
  - Accept or Reject proposed modification and impacts

- Periodic Strategic Reviews

  - Discuss and document project technical progress and challenges
  - Does equipment still meet IAEA needs
  - Is schedule, per unit cost, and quantities still in line with IAEA needs

Project Management Plan - 3

Periodic Strategic Reviews (continued)

•Review impacts of external project elements:

- Competing products that entered/will enter the market
- Change in end user need for the equipment
- Changes in IAEA Procurement policy that adversely impacts agreed to procurement plan

•Decide to continue, modify, or end the project

Summary

•Many important factors to consider prior to and after funding IAEA equip. requests

•The USSP will perform a thorough review to verify equipment need

•Equipment Market Survey to identify and possibly leverage off COTS, MOTS, GOTS, or other MSSP equipment

• IAEA and USSP agreement on project management plan from request acceptance to equipment field deployment prior to request acceptance

•End user involvement from request evaluation through equipment development to ensure their needs are satisfied

•One developer in charge of all project aspects is the preferred approach. Developer to maintain detailed project schedule with milestones.

•Periodic Strategic Project Review meetings to determine if equipment is still inline with current IAEA needs

•The USSP looks forward to working with the IAEA in improving our management of complex equipment development projects so we can maximize the potential of IAEA deployment of high priority equipment

END OF PRESENTATION

THANK YOU FOR YOUR ATTENDANCE

QUESTIONS?