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AN APPROACH TO NUCLEAR PLANT DESIGN AND MODIFICATION SUPPORT FOR RUSSIAN-DESIGNED PLANTS IN EASTERN EUROPE

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ABSTRACT

The Western nuclear countries have embarked on numerous programs to improve the safety of the Russian-designed nuclear power plants. In Russian-designed plants in Eastern Europe, plant management is being asked for the first time to decide which safety projects to implement and is finding itself lacking in nuclear safety analytical tools and practices, funds, and experience with project management and project engineering skills and tools. Some of the major areas where assistance is needed are:

1) Defining plant weaknesses toward nuclear safety
2) Evaluating and grading the importance to safety of proposed modification.
3) Project Planning and Scheduling using computer based scheduling software
4) Project Finance Development and Management using well defined cash flow management techniques
5) Contract Management and Change Control
6) Interface Management

Each of these areas requires a significant amount of discussion to understand the issues and problems associated with them. However, this paper is limited to the Project Management areas.

This paper encourages the use of a design engineering firm experienced in safety practices and associated management and technical skills to serve as the Owner's Engineer/Project Management Consultant for the program period for a Russian-designed plants located outside Russia. This approach would allow for the availability and transfer of knowledge of safety practices to plant personnel and owners engineers at nuclear plants outside Russia, improving their nuclear safety culture. The plant personnel would control plant modernizations and upgrades based upon a proven and well-defined process for detailed project definition, configuration change control, and project management. This offers the opportunity to enhance the long-term safety culture by developing plant personnel knowledgeable of the safety practices, plant design basis, developing a modification control process enabling them to control the design basis through future projects and providing plant personnel the continuity of assistance necessary to gain sufficient

experience in these areas. It further helps assure that the plant's expectations for modifications are met.

The Project Management Consultant would establish a modification planning and scheduling protocol for use by plant management on all tasks. The Consultant would focus on development of the modification package process from the problem definition phase through detailed design to the new as-built documentation phase. Additionally, the Consultant would work with the plant staff to develop those managerial programs required to support the modification package process. At project completion, plant management would have these new processes in place and the experience of working with these processes on all plant equipment changes performed during the period, enabling them to work effectively within traditional Western-style contracting schemes.

1 BACKGROUND

1.1 Project Definition

Development and Implementation of a successful project definition process by plant management allows for meaningful decisions on project priorities. Whether the work is funded internally or externally, early development of accurate task expectations supports efficient use of resources by all participating organizations.

1.2 Plant Design Modification And Control Process

The goals of a design modification and control program include:

- Identifying the plant design and operations basis, applicable industry standards, and licensing commitments.
- Complying with the design basis and licensing commitments.
- Maintaining plant configuration control.

Implementing plant modifications without a good understanding of the plant design basis and licensing commitments is not an acceptable situation, and could lead to plant nuclear safety and operational problems. The first critical step in developing a design modification and control program involves the identification and acquisition of plant design base documents and information, and as-built drawings. When this information is unavailable, design base reconstitution and verification is required to establish original system and equipment design and performance requirements. It must be noted that this phase may be included as part of a modification effort and can be based on using existing design documents and drawings, and actual system/equipment operating performance data, along with appropriate design margins. Inclusion of "Russian experts" and personnel from local engineering firms with plant knowledge as part of the team can assist in the identification of the design bases and intent. Implementation of an effective design modification and control program requires access to the current as licensed design base. It must be noted that the licensing authority may not have accurately captured at times the licensed basis and that they are relying on the owner to provide this information to the Authority.

An essential element of a design modification control program is configuration control. This ensures the plant as-built condition is reflected in the plant design drawings and documents. Configuration control also means that changes made during a design modification are approved by the responsible design group and reflected on as-built drawings. Configuration control is critical for the plant modification process, and for the safe and reliable operation and maintenance of the plant. Since operators rely on procedures and drawings to operate the plant, these documents must reflect actual plant conditions. Wrong or outdated information on a drawing/document can have

significant operational consequences in an abnormal or emergency situation. Configuration control can be divided into three areas:

- Design configuration - design requirements placed on the system by the designer to meet all operational modes.
- Licensed configuration - plant required performance to meet all of the accident based requirements from the regulator.
- Operations configuration - where the plant is configured to provide maximum power and operational flexibility to meet customer demands.

In addition to the benefits outlined above, implementation of a design modification and control program integrates the safety culture between plant operations and engineering organizations. It also expedites cross-organizational communication, a necessary ingredient for long-term safe and reliable plant operation.

1.3 Project Management

Modifications to nuclear generating facilities require a significant amount of planning, management and coordination to be successful. Plant owners typically coordinate the activities of these functions through a dedicated project manager. The process involves the utility organizations, regulators, financing organizations, suppliers, vendors, contractors and sometimes representatives from the government. If a separate plant group is not developed for project management, the responsibility typically falls to the Consultant or plant engineering organization based on their specific experience with developing conceptual solutions and evaluating the feasibility of changes or modifications to meet licensing and design basis commitments.

The Project Management team's responsibilities include moving the modifications from the concept stage to successful implementation. The project management role combines the abilities and experience of planning, scheduling, estimating, contract management, procurement, expediting, quality assurance, administration and finance. The Project Management team brings together the skills and knowledge of the operators, engineers, constructors and vendors to successfully complete the assigned task.

2 REALITIES IN EASTERN EUROPE

The Soviet nuclear program in Eastern Europe relied heavily upon the centralization of nuclear expertise in design, manufacturing and construction. Following plant construction, in many instances, this expertise moved on to other countries for the next projects, but continued to provide the technical support, work control processes and project management to the host country via Russian staff loaned to the Ministry or the local Power Engineering organization. Typically during this period, the Electric Company relied exclusively on the Russians to do much of the engineering, procurement and installation associated with modifications or changes, from the design through the implementation and return of plant to the operators. Under this structure, this was expected to be a long-term relationship. However, the breakup of the Soviet Union removed from many of these host countries the project management and technical skills necessary to replace the departing Russian expertise.

The G-7 countries have recognized the negative impact on nuclear safety that has resulted from these changes and responded with programs to assist them and the responsible plant owners. This support has centered on improving operations and maintenance, improving the safety culture and providing needed hardware.

In the first area, initiatives were developed to provide plant management with the opportunity to work with Western firms and learn how to improve their existing training and procedure programs; to provide advanced training facilities including simulators; and to provide

programs to train plant instructors. Through this combined approach, improving the long-term safety culture of the people responsible for the day-to-day plant operations and enhancing plant performance and reliability.

In the second area, the support has provided new equipment, components and systems- Mostly in the areas of plant operation and control of both the reactor system and the turbines. While this needed hardware and better plant control technology are beneficial, this work has identified deficiencies in not only understanding the plant design bases and the processes necessary to maintain design control during plant life, but also the definition of the design basis. Unlike plant operators who understand the mechanics and the theory of plant operations, the plant personnel are generally inexperienced in the design processes of the nuclear systems and do not understand specific design details of why the plant systems were designed as they are. Just as the approach for operations and maintenance support builds the self-sufficiency of plant management for future improvements, the process to provide hardware must address the ability of the plant staff to maintain nuclear safety through design bases control.

The current assistance process could be altered to provide the plant with replacement equipment and make a positive impact on the ability of the plant staff to improve nuclear safety through control of the plant design base.

The following areas illustrate the typical weaknesses of the host country or specific plant to adequately respond to offers of international assistance:

2.1 Project Definition

The ability to adequately define and prioritize the needs of a particular plant depends on the specific capability and technical requirements at the plant. Plant management is usually too involved in the day-to-day plant operation to perform this role and historically has not had this responsibility. Preparing a Request for Proposal (or Tender) supported by a bankable project document and an acceptable evaluation process that will allow for a meaningful response by suppliers to meet the requirements of the funding agency has proven to be difficult. The development of tenders is not something that is easily assimilated or for that matter copied from other documents. It is necessary to have a clear understanding of what is being purchased and enough specificity developed to ensure that the submittals could be evaluated on an equivalent basis. The removal of ambiguity and generalities will help to obtain the product desired without the additional cost associated with the vagaries that exist in so many of the tenders currently being developed. It is worth the extra cost to have this tender prepared by an experienced organization that has an understanding of the need and the market place into which the tender will be offered.

2.2 Modification Processes

Following the breakdown of the soviet system, many plants lacked an established design change process for modifications and the design basis for the plant. Without a standard process, individual changes to the plant depend on the technical and managerial expertise of individuals -- a situation that can compromise nuclear safety. With the loss of the specific knowledgeable individuals, the basis is lost. Without the design basis to reference, each modification task must reconfirm the design requirements. This can be time consuming and requires design experience, traditionally lacking outside the Russian design organizations. In addition, the recreation of the design bases after a period of time can lead to errors to be introduced each time it is recreated, and the original bases could easily be diluted or lost.

2.3 Hardware Supply

The traditional Western contracting approach assumes the plant owner has an in-depth understanding and documentation of plant design and operations criteria to specify the contractor's work. In Eastern Europe, this assumption often does not apply and has frequently resulted in the following:

- The equipment arrives and is never installed because it is incorrect for the application.
- Equipment does not meet the expectations of the client
- The equipment arrives and the vendor "field engineers" the system around the component to make the system functional. Although this result appears successful, it is technically and financially challenging for vendors with limited nuclear system design capabilities, and does not increase the plant owner's knowledge of the overall plant design.

2.4 Project Management

Project management expertise gained when building a plant is often lost after construction and must be replaced. In Eastern Europe, finding project management expertise may be difficult because during plant construction the Russian design and construction organizations work with the host country in a turnkey arrangement through the EnergoProject section of the Ministry of Energy. When the Russian organizations withdrew, the EnergoProject was left very limited or no understanding of the plant or the project management experience to undertake major plant changes. Development of project management skills is necessary to expedite the near-term safety system equipment installation and to support the long-term viability of efficient safety plant upgrades. With the large amount of funding necessary to achieve a successful program of modernization or major component changes it is very easy to lose track of commitments and the control of changes that will continue to increase the cost of the project ("scope creep"). The implementation of an Integrated Project Schedule becomes paramount to being able to control the project and it s costs.

3 RECOMMENDATIONS

Experience in Eastern Europe indicates the Owner's Engineer/Project Management Consultant approach provides technology transfer opportunities necessary to improve the nuclear safety culture related to plant modifications. Assigning an experienced nuclear plant design engineer to support the plant for three to five years would provide plant personnel adequate time to learn how to perform the responsibilities previously done by the Russian engineers and Project Managers. Acting as the Owner's Engineer, the Consultant working with the plant engineers on an initial plant modification task would oversee development of a plant modification process. The scope of this process would include the following:

1. Definition of candidate safety enhancement design modifications and other tasks.
2. Task prioritization.
3. Development and evaluation of conceptual solutions, including cost estimates.
4. Conceptual solution selection and preparation of a conceptual design.
5. Design and installation modification package.
6. Development of an Integrated Project Schedule

7. Design change evaluation and review, including supporting safety analysis.
8. Specification, placement and evaluation of competitive tenders for equipment supply.
9. Preparation of the detailed design including
   - Supporting calculations and drawings
   - Bills of materials.
10. Development of procedure changes and training requirements.
11. Documentation of new as-built configuration.

During these activities, the team would identify existing or required procedures or programs that would become part of the plant modification and control process as well as the project management process. At the non-Russian plants, it is expected that design basis documentation would be complete. While it may be difficult to obtain the original plant design basis, establishing the design base without this information can be accomplished. Using existing design documents and drawings, and actual system/equipment operating performance data, along with appropriate design margins, the Consultant can work with the plant staff to establish a design base document that specifies system/equipment required function, and design and operational parameters on each specific task. This information can then be applied to the plant design modification package and procurement specification for equipment.

In parallel with the Owner's Engineer activities, the Consultant would assist plant staff in developing a modification planning and scheduling protocol for use on all tasks. Through this protocol, plant management will gain the skills necessary to establish viable and achievable task plans for future tasks as well as integration of scheduling for all ongoing tasks.

The initial modification task would result in physically modifying the plant to enhance safety and operational performance and identifying those supporting processes that must be established to plan, develop and safely install future design modifications. As each subsequent task is performed, the Consultant and the plant staff can refine the original modification process and fill in the appropriate design databases verified during the performance of each specific task.