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A REGULATORY PERSPECTIVE OF THE ROLE OF CONSTRUCTION  
IN REVITALIZING THE UNITED STATES NUCLEAR INDUSTRY

Victor Stello, Jr.

Deputy Executive Director For  
Regional Operations and Generic Requirements

U.S. Nuclear Regulatory Commission  
Washington, DC

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ABSTRACT

Technical and managerial experience in nuclear power plant construction is presented from the perspective of the United States Nuclear Regulatory Commission (NRC). In the context of actions that would contribute to revitalizing the nuclear industry in the United States of America, greater effectiveness of utility management during construction is proposed. The reasons why management effectiveness is so important are developed, beginning with summaries of defects that were built into several United States plants under construction. The root causes of these significant defects were management failures. In terms of benefits, effective management is important because of its effects on nuclear safety, project construction costs, and future reliability of the plant after commissioning. Actions that would enhance good management include emphasizing the inseparable nature of production and quality, that quality cannot be inspected into a plant, and that a strong construction management staff and exchanges of experience and information are essential. Techniques that have been used successfully in construction management are discussed. NRC and industry initiatives are in progress to improve management responsibility and learning from experience. Projects include Owner's Certification, assessments of licensee performance, fostering good practices across the industry, and improving the NRC inspection programme. Revitalization will not be easy, but it is achievable.

## 1. INTRODUCTION

This is a most welcome opportunity to participate in this conference and to share with you my thoughts on the complex issues before us. The conference is a positive step towards improved communications and mutual safety goals as well as better understanding and exchanges of technical and managerial experience. Since I am not here to promote the nuclear industry, I will not discuss the promotional aspects of revitalization.

I have limited my remarks primarily to nuclear power construction because effective management of construction is critically important to project success and, in general, to revitalization. From my perspective, I see plant construction as the life stage during which we can make significant improvements that will be of mutual benefit to all of us. I am convinced that the industry can build plants properly the first time. I am excited about the prospects of quality construction, because I know it is achievable, not only in future plants not yet ordered, but also in those now under construction.

I want to emphasize the impacts, in terms of costs and delays, that have been caused by problems in construction. The causes of these problems are identifiable. We can all achieve real benefits in terms of safety, costs and future reliability if we can prevent these problems. I will present United States nuclear industry and NRC initiatives that I believe are necessary for revitalization. Many of these initiatives are under way, others are planned, and the remainder are concepts that both industry and NRC should both consider. The initiatives are based not only on my own perceptions, but also on observations made by hundreds of NRC employees and members of industry. We recognize the for a climate of confidence in the ability of the industry to construct plants properly and on schedule and the ability of NRC to inspect and license them.

## 2. CONSTRUCTION PROBLEMS

The problems in construction are real. Let me enlarge on this subject with examples from experience within the United States of America.

At one site, an NRC investigation revealed inadequate pipe whip restraints and structural defects in a reactor sacrificial shield wall. Because of improper welding, the wall would probably not withstand accident-generated shear forces. The investigation also substantiated doubt whether quality assurance procedures and specifications were used, workers and inspectors were qualified, receipt inspections were adequate, and management controls were effective in resolving identified problems.

Significant, costly delays have occurred at this site. Comprehensive evaluations and an effective corrective action programme are prerequisites for resuming safety-related construction work.

At another site, safety-significant concrete voids, surface defects and honeycombs occurred in concrete. First attempts to patch them were unacceptable. Then, the State Boiler Code Inspector discovered that compliance with codes was questionable. All safety-related work was suspended while programmatic problems were corrected. Safety-related work resumed gradually after a delay of more than one and a half years while the utility verified construction quality and corrected construction programme defects. Delays in construction and efforts to correct these and other problems are estimated to have cost the utility hundreds of millions of dollars.

At still another site, safety-related structures have settled excessively because of inadequate specifications and poor compaction of foundation backfill. Several years before this condition was discovered, significant quality problems arose in cadwelding of steel rebar in safety structures.

In a final example, another utility has experienced costly delays due to defects in the quality of cadwelds, concrete, cable separation, and piping welds in safety systems.

The point of these examples is that real defects were built into the plants. I am not talking about unsatisfactory paper trails but rather real construction defects. I am gravely concerned about shoddy construction because of its potential impact on public health and safety. I expect that you are concerned not only about the safety impact, but also, about additional costs of delays and repairs during construction and reduced reliability and availability during the plant's operating lifetime.

### 3. CAUSES OF THE PROBLEMS

I have thought at length about the root causes of defects at construction sites. All too often the symptoms are remedied while the root cause continues to fester and produce new defects sometimes similar to prior defects and seemingly unrelated at other times. The question is this: Have we not collectively poured enough concrete to know how to do it right the first time? Have we not compacted enough backfill, made enough cadwelds, installed enough pipe hangers, anchors and restraints, run enough cable, or welded enough pipe to do it right? Few major problems are first of a kind. Most are generic and have occurred before. Each problem that you or I identify has a slightly different

twist; but why did it develop? Why was it allowed to exist? In situations where defects recur, why was the root cause not corrected the first time it was found?

In the case of each defect, the details may include a collection of immediate causes such as unqualified workers or quality control (QC) inspectors, falsified records, intimidation of quality control inspectors, lack of authority, lack of communication, inadequate staffing levels, inadequate corrective action systems, lack of supervision, poor or nonexistent procedures, poor design and change control, design errors, inadequate analysis, poor quality components, and so on. We can boil down all of these causes to one cause: quality assurance failed. But if we back off one more step, we see ineffective management. I believe this is the real root cause. There are myriad excuses and reasons why management fails. Some are explicit. Others, such as attitudes and perceptions are difficult to define. Management ineffectiveness leads to physical defects that are built into a plant. NRC cannot accept these defects because of their enormous impact in terms of public risk. The impacts on industry also involve cost, public attitudes towards nuclear power in general, and perceptions of competence.

#### 4. THE NEED FOR REVITALIZATION

What does the United States nuclear industry need if it is truly committed to revitalization? Most important is management effectiveness. This quality must pervade the entire nuclear power plant life cycle. In design and construction, management effectiveness means many things, and these things are not cheap. It means planning, staffing, controlling, and all of the other management functions, and doing each one well. These are fine words, but how should industry and NRC practice effective management? I do not profess to have all the answers, but here are samples of what I am talking about.

Production and quality are inseparable concepts. Quality must be built in. NRC, utilities or their contractors cannot inspect quality or safety into a plant. Quality rests with the worker, who does it right the first time or must correct defects that directly affect you when the high costs of rework and delays occur. The universal worker category encompasses designers, construction craftsmen and all other personnel in engineering and the trades regardless of whether they work on the site or in a vendor shop and whether they are utility or contractor employees. Industry needs to integrate production and quality instead of perpetuating attitudes of "us versus them" between worker and inspector, between utility and contractor.

Expertise is essential in planning, coordinating, exchanging information, identifying design issues, eliminating construction interference, and developing effective management controls and quality assurance programmes. Professional disciplines must be represented in utility staffing. The up-front costs of developing and managing an effective staff during construction are high, but how much more would a one and one-half year construction delay cost you? How about a one-month delay?

#### 5. INDUSTRY INITIATIVES

I have cited some examples of serious construction defects and have related them to management failures. I have also touched on broad concepts that should be considered. Let us move to more specific industry initiatives within the United States that would contribute to revitalization. From my perspective, they should focus on management responsibility and learning from experience.

The Atomic Industrial Form, Inc., report of June 1982, entitled "Improving the Efficiency of Nuclear Power Plant Design and Construction", discusses techniques for reducing uncertainties. Many of these techniques relate directly to basic, sound, good management. Examples include starting construction at a time when engineering is 40 to 60% complete, utilizing standardized designs with minimal customization, maintaining staff continuity during design and engineering, managing construction interfaces, reducing construction interference, and using scale models or an existing duplicate plant as a model.

In the area of management responsibility, planning and scheduling should be more realistic with better definition of necessary controls on all activities that affect construction.

Staffing policy and practices not only must provide high-calibre people with relevant experience, but also must result in locating onsite those senior managers with authority over construction in progress.

The performance of vendors and contractors is vital to the overall success of the project and is a direct responsibility of utility management.

The Quality Assurance Programme must be comprehensive. It must apply to vendors and contractors located on or offsite. QA must identify and aggressively correct the root causes of problems.

Learning from experiences is a key element in management effectiveness. Industry initiatives that could greatly improve this element deal with information exchange. I often wonder why we seem to reinvent the wheel at each new construction site. Where are the pitfalls in licensee QA and construction contracts? How have other licensees solved these recurring problems? Are those of you who have constructed plants willing to share that experience? Are you who are constructing plants too proud to seek forerunners' advice and experience? Could you benefit from others who have done it right? My point is that good advice and information on construction experience has not been transferred effectively.

In terms of a simple cost-benefit analysis, is the incremental cost of a staff of one to five professionals dedicated solely to exchanging information, experience, and technology too high for you to finance even if it could save only one week of construction delay? Will you acknowledge that the cost to you of effective information exchange, which could prevent repeating the mistakes of others, is probably orders of magnitude lower than the cost in debt service alone of a protracted construction delay? The requisite quality should start with the worker who knows how and does it right the first time and is assisted by good construction management and good information. I see information exchange as an industry aid to reducing poor quality in the first place.

Owners' Certification is a concept that may improve the exchange of information. NRC and other United States organizations within the industry have formed a committee to analyze this concept. I would hope that such a programme would provide benefits to the industry in terms of opening new channels of information exchange among utilities, regulators, insurers, and organizations such as the Institute of Nuclear Power Operations (INPO). Through this certification process within the industry, a utility could benefit from the industry-wide body of knowledge and, in the best judgement of a board, be certified as being capable of effectively managing quality construction and safe operation of a nuclear power plant.

I would also hope that regulations, code requirements, insurance requirements, and industry's good practices could be consolidated with mutual recognition and information exchange among organizations such as the Nuclear Regulatory Commission, Institute for Nuclear Power Operation (INPO), American Society for Mechanical Engineers, and insurers. The benefits of consolidation would, it is hoped, reduce demands on utilities to support duplicate inspections, audits, visits, certifications, etc., that are spread among several organizations and jurisdictions.

INPO in itself is a recent initiative. I heartily endorse its goals and I think INPO is heading in the right direction. The opportunities for improvements in construction have been recognized and included in INPO programmes. INPO has expanded its involvement to design and construction activities to assist in fostering good practice learned from experience across the industry.

## 6. NRC INITIATIVES

The NRC role in revitalization is not promotional, and it will not compromise safety. Our initiatives involve both effectiveness and efficiency in accomplishing our regulatory mission while, at the same time, facilitating cost-effective, timely nuclear power plant construction. In this post-Three Mile Island era, regulatory requirements have had an enormous impact. Senior NRC managers confirmed our perceptions of the impact in a 1981 survey of nuclear utility organizations within the United States.

In its Policy and Planning Guidance for fiscal years 1982-1987 the Commission re-emphasized its commitment to achieve and maintain adequate protection of the public health and safety. NRC requirements, both individually and collectively, that are imposed on the industry, will have a positive contribution to safety. The licensing review process and public hearings will be structured so that operation of adequate facilities will not be delayed. We continue to seek wide public participation in rule-making proceedings. New and revised rules will be explicit, unambiguous and enforceable with the minimum reporting and record-keeping burdens necessary for compliance. We want to determine where less regulation is possible without degrading safety. As Deputy Executive Director for Operations for Regional Operations and Generic Requirements, I am directly involved in limiting the proliferation of regulatory requirements that are imposed on licensees. Each new requirement is carefully considered by an NRC Committee to Review Generic Requirements (CRGR). Safety benefit costs, estimated impacts and realistic schedules for each new requirement, are major aspects of CRGR reviews. The committee is working and showing positive effects in improving regulation.

Within the licensing and hearing processes, we are considering deletion of antitrust requirements, deletion of financial qualifications determination; one-step licensing, standardization of designs, and deletion of alternate site requirements.

Several initiatives within the NRC Regional Offices will contribute to revitalization.



NRC resident inspectors have been stationed at all construction sites where active construction is at present under way and the project is at least 15% complete. The resident inspector enhances NRC's ability to monitor quality and identify the symptoms of breakdown in management control. Although utilities and vendors may contend that the latter advantage to NRC is of no benefit to them, I argue that early detection of a loss of management control and aggressive corrective action at that time are in their best interest because of the potential to reduce costs overruns and future construction delays.

Licensees are responsible for management effectiveness, but NRC's role of ensuring that they are doing their job becomes operative when public health and safety may be affected.

The NRC Construction Inspection Programme is under revision to accomplish several objectives. We are recasting inspection procedures to delete inspection activities of lesser importance and to reduce duplication of effort by resident and regional-based specialist inspectors. In situations where inspector resource limitations preclude completing the entire inspection programme, we have given priority to the programme elements so that the most important inspections will be completed by priority to the extent that resources permit. Key inspection procedures have been added to emphasize the management aspects of quality assurance programmes.

We have completed a trial programme of team inspections at several construction sites. This approach enables NRC to gain a total project perspective to a greater extent than past practice. The advantage of this detailed "snapshot" is enhanced ability to evaluate management effectiveness; getting to root causes. Our task is now to determine the proper mix between teams, resident and regional inspectors, balancing inspection effectiveness, and human resource limitations.

The NRC Systematic Assessment of Licensee Performance (or SALP) has been used at construction sites. The overriding goal of SALP is improved performance of the industry as a whole. The SALP is a licensee management assessment process in which NRC Regional managers, inspectors, the licensing project manager, and senior NRC managers review the collective NRC experience with each licensee. NRC discusses the results with corporate management, focusing on broad issues of management effectiveness and specific areas of good performance and needed improvements.

We are now using our own mobile laboratory for nondestructive examination (NDE) at construction sites. This NDE van has multiple capabilities that include radiograph development, metallurgical analysis and hardness, ultrasonic, dye penetrant and magnetic particle testing. The examinations that

we perform are intended to confirm quality based on a selective sampling approach. Our NDE does not substitute for licensee's NDE and in no way does it relieve licensees of their responsibilities for quality. Our independent verification is an end-product check of the programme, systems and controls used to get quality into a plant. It is a check of management effectiveness.

The NRC Office of Inspection and Enforcement is improving its enforcement programme to give more credit to licensee-identified violations and prompt corrective actions, to recognize good compliance histories, and to reflect industry comments that we have received concerning the current enforcement criteria. The enforcement programme is not "soft". I would, however, prefer to find effective management, quality construction and safe operation rather than compliance that requires enforcement action.

In addition to our inspection and enforcement functions, the Regions are conducting portions of the licensing safety evaluations at plants undergoing operating license (OL) review. Our assistance in these reviews contributes to earlier completion of NRC final safety evaluation reports and reduces potential delays in operating license issuance.

We are also transferring some of the licensing functions to Regional Offices so that NRC can be more responsive to utility needs.

## 7. SUMMARY

I have discussed problems in construction to illustrate the need for improved management. I have suggested industry initiatives that I think will contribute to revitalization efforts. I have mentioned NRC initiatives intended to improve effectiveness of regulation. Although the purposes of industry and NRC may differ, mutual goals exist in terms of construction quality, operational safety and management effectiveness. These goals are achievable with mutual benefits, but getting there will be neither easy nor cheap.

The ideas, concepts, and opinions that we have brought to this conference must be forged not only into words, but also into actions. The United States nuclear industry needs to make some difficult decisions and firm commitments to itself if revitalization is to succeed.



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555

Deputy Executive Director For  
Regional Operations & Generic Requirements

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Victor Stello, Jr.