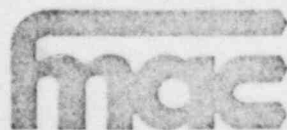


PUBLIC SERVICE COMPANY OF INDIANA, INC.
MARBLE HILL PROJECT DIAGNOSTIC

POOR ORIGINAL

October 2, 1979



MANAGEMENT ANALYSIS COMPANY

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I. INTRODUCTION

Public Service Company of Indiana, Inc. (PSI) has suspended construction of its Marble Hill Nuclear Generating Station. An order from the United States Nuclear Regulatory Commission confirming that suspension has been issued. In order to assist PSI in restarting construction under proper conditions and controls, Management Analysis Company (MAC) performed a diagnostic evaluation of the Marble Hill Project. The diagnostic focused primarily on the areas of Quality Assurance, Construction Management and Project Management. The purpose of the diagnostic was to provide the management of PSI with a measure of the overall Quality Assurance and management effectiveness of the participating organizations in the Marble Hill project. Additionally, it was to provide a framework for any necessary corrective actions. This report summarizes the MAC evaluations and recommendations for appropriate action to restart construction at the Marble Hill Nuclear Generating Station. It provides recommended organizational realignments to effectively manage the scope, schedule and cost of the project at the necessary level of quality.

By nature, a report such as this focuses on problem areas with appropriate solutions in order to be of maximum value to executive management. MAC, as a policy, prepares management diagnostic reports in this manner to make the executive aware of problem areas only. Throughout the project there are fine management systems and suborganizations in place which were functioning well with excellent staffs. This report is not intended to highlight those areas.

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During the evaluation, a team of experienced personnel from MAC interviewed involved personnel from PSI, Sargent & Lundy Engineers, Newberg Construction Company, Cherne Construction Company, Commonwealth-Lord Joint Venture and the Commonwealth Edison Company. The interviewees represented the functional portion of the project - Engineering, Quality Assurance, Construction Management, Licensing, Startup and Test, Purchasing Contracts, Personnel and Finance - and personnel in the plants being replicated. These people were stationed at the Marble Hill site, the corporate headquarters at Plainfield, Sargent & Lundy Engineers offices in Chicago, and the Byron station in Illinois which is the

replication model for the Marble Hill station. A team of ten experienced people from MAC reviewed and evaluated the results of these interviews to produce this report. The team represents over one hundred thirty years of commercial nuclear experience associated with more than one hundred nuclear power generation projects.

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II. SUMMARY

MAC believes that PSI's approach to the management of this project parallels their excellent fossil power plant experience. However, the magnitude, complexity, and demands of a nuclear project exceed those of a fossil unit. There are greater material quantities and components of every type. The systems are more complex. The demands for quality assurance are more rigorous and the safety and licensing requirements are more stringent. A higher level of experience with commercial nuclear power plants is required to efficiently deal with these problems than is presently available on the Marble Hill Project. The deficiencies in the Category I concrete which led to the PSI order and the NRC order confirming suspending construction are a symptom of this lack of experience.

The replication concept adopted by PSI after selection of the basic component suppliers is excellent. Almost certainly it reduced the engineering costs, licensing problems, and overall schedules when related to a custom plant. The combination of the replication concept and fixed price contracts has solid merit for further minimizing the cost of the project. However, the number of detailed changes occurring at the base plant, combined with the lack of commercial nuclear experienced personnel at the site, diminished the full potential of this combination to the extent that the currently anticipated cost and schedule may be impacted significantly. It is MAC's opinion, however, that the original cost and schedule anticipations, even with the benefits of replication and fixed price contracts, were too optimistic.

There has been insufficient overall scheduling and integration of major contractor efforts at the site. As the project proceeds into the more complex combined mechanical, piping, and electrical phases, the need for integration will grow. Without a strong and aggressive program of integrating contractor efforts, PSI can expect additional change orders and delays that will add to the cost of the project.

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PSI's contractors at the site require more experienced commercial nuclear personnel. PSI's insufficient attention to Newberg's QA/QC, combined with the lack of experienced personnel in both organizations, has been a contributing factor to the Category I concrete problems. Additionally, Newberg planning efforts are too short range and do not provide a sufficient basis for planning by the electrical, piping and mechanical contractors. The piping/mechanical contractor, Cherne, appears to be developing a detailed network planning approach. It has not however, been properly integrated with the master schedule. Commonwealth-Lord's planning efforts and QA/QC program seem to be starting out well, however it is too early to get a clear indication of their capabilities. It should be noted that it is difficult to objectively measure the performance of any of the contractors without an integrated schedule network aggressively managed by PSI as the construction manager.

The Vice President, Electrical System, became the de facto Project Manager in the latest reorganization. The combination of his vice presidential duties and the project management duties may exceed the capabilities of a single manager. There is a need for a project manager with strong nuclear experience to manage the project and report directly to the Vice President, Electrical System. This person must have the full authority to act and resolve problems expeditiously. The chart set forth in Figure 1 is a suggested approach to organizing the project effort.

Of major importance to the project is the management direction of an equally experienced Project Quality Assurance Manager, to be located at the site. The Quality Assurance staff must have the capacity and experience to recognize developing problems early and must also have the ability to work with the Project Manager in a team effort to institute solutions before problems become major.

In order to be completely effective, the Project Manager and the Project Quality Assurance Manager must have proper tools to be able to work with

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SUGGESTED MARBLE HILL PROJECT ORGANIZATION

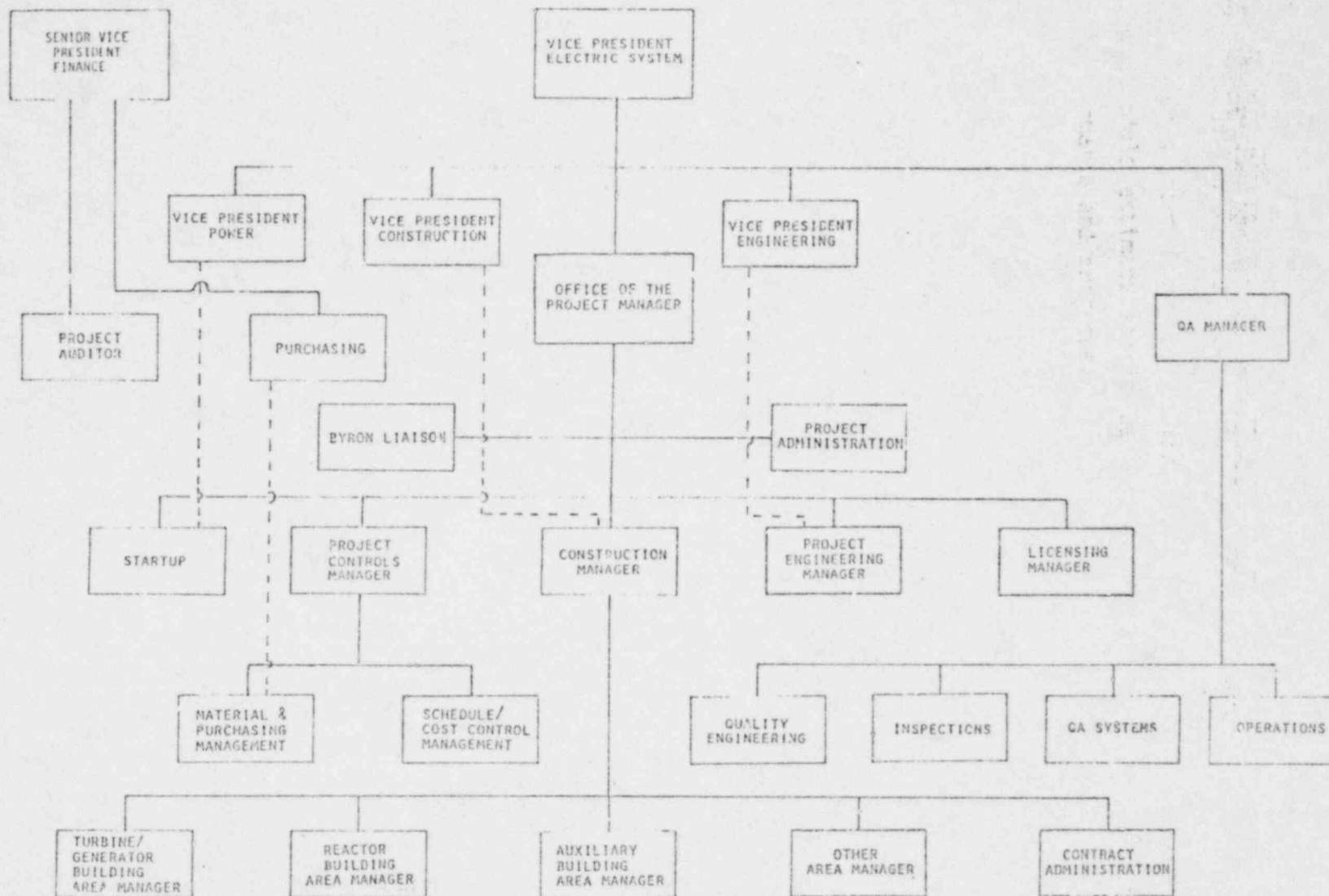


FIGURE 1

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all the parties in the project. Thus, an integrated total project plan must be developed and the proper project control tools and measurement devices which are already available must be more effectively used. The existing material controls system should be improved and integrated to provide better support for construction activities. A revised baseline cost and schedule estimate should be established in order to properly measure performance and progress.

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III. GENERAL CONCLUSIONS

The Category I concrete problems that led to the suspension of construction were primarily a result of insufficient commercial nuclear experience within PSI and its contractors. The concrete problems primarily involved workmanship. It was brought to our attention that the inspection and technical analysis of existing concrete is underway to demonstrate that there are no significant safety problems. After necessary repair work has been defined and carried out under the guidance of experienced and qualified construction and quality assurance personnel, the plant should meet nuclear standards. The existing personnel, when supplemented with sufficient experienced personnel and more effective management tools, can in the future manage and complete the Marble Hill station within a reasonable time and at a reasonable cost.

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IV. GENERAL RECOMMENDATIONS

These general recommendations are positive steps that PSI can take which will assist in improving the timely and cost-effective construction of the Marble Hill Generating Station with the requisite quality. These are based on MAC's assessment of Marble Hill and are as follows:

A. Changes in Project Management

A Project Manager should be established for Marble Hill reporting directly to the Vice President, Electric System. He should have all activities reporting him with the exception of Quality Assurance. It is also recommended that a seasoned Quality Assurance Manager be hired for the Marble Hill Project.

B. Quality Assurance

It is recommended that the Quality Assurance organization and program be restructured and staffed with experienced personnel. The objective is to provide a "hands on" QA management team that is structured to emphasize the importance of preplanning of activities to maximize problem prevention. Present staffing numbers at the requisite experience levels are more than adequate to operate the QA function effectively.

C. Experience and Staffing Levels

Specific areas in the project organization have been identified as needing increased staff. Experienced personnel must be brought into key positions to strengthen the project team. This can be accomplished by hiring key personnel in certain areas and by supplementing existing PSI personnel with experienced consulting support personnel on an as needed basis.

D. Management Focus

Due to the significance of the Marble Hill project to the overall financial picture of PSI, it is recommended that the President and Vice President, Electric System attend a monthly site meeting that

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focuses on overall project status, definition of problems and establishment of a key action list.

E. Centralization of Activities at the Site

There is a need to relocate some forces and functions from the headquarters offices in Plainfield to the construction site. This need is primarily in the areas of cost and schedule, material control, document control, contract administration, and Quality Assurance/Quality Control.

F. Byron Liaison

It is recommended that the benefits of the replication approach be emphasized through the assignment of key personnel at the Byron site to provide early information on any problems and the as-built configuration.

G. Activity Integration

A project of this magnitude and complexity requires closest coordination and integration to minimize cost and schedule. It is recommended that the use of a scheduling resource tool such as the PREMIS program (presently in existence at PSI) be expanded to utilize its full capability in integrating the activities of PSI, S&L and major contractors. Additionally, it is recommended that the material management program as presently structured around the existing PIE system be further expanded and developed into a more effective management tool.

H. Financial Controls and Management Reports

Financial controls associated with contractor change orders and contract administration should be improved. It is recommended that a full time financial auditor be assigned to the site. An evaluation should be made for potential improvements in management reports, document control and design change control.

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I. Effective Use of Fixed Price Contracts

The fixed price approach utilized by PSI has solid merit for controlling costs. Fixed price contractors tend to place their best personnel on the job and labor tends to be more supportive.

To derive the maximum benefits of the fixed price construction contracts in the environment of constant change, PSI should investigate breaking down the scope of existing contracts into smaller elements and aggressively monitoring them at the site by more experienced personnel augmented by contracts administration people. Significant nuclear experience in contract monitoring and administration is a necessary ingredient to handling changes and minimizing cost and schedule impacts. A larger staffing level is required to effectively accomplish this.

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V. SPECIFIC IMPLEMENTING RECOMMENDATIONS

In order to derive maximum benefit from the general recommendations, the following specific implementing recommendations are suggested:

- A. The Project Manager's effectiveness can best be maintained with an organization such as shown in Figure 1, Project Management Organization.
- B. The functions of contractor administration and project auditor should be created and staffed with suitable personnel on site. PSI project financial reporting practices should be reviewed and appraised with respect to adequacy to meet management's need for appropriate information for decisions.
- C. Activity integration can be best achieved with the following steps:
 - 1. Revise Master Schedule, validate and integrate Engineering, Materials, Construction and Startup.
 - 2. Put CRTs and printer in field.
 - 3. Establish area system of controls.
 - 4. Combine the cost system with PREMIS.
 - 5. Outline specific management reports.
 - 6. Develop a six-month action plan. (See Section E.10)
 - 7. Redefine the weekly coordination meeting.
 - 8. Transfer the Procurement-Inventory-Expediting (PIE) system to the field and integrate with PREMIS. Revise PIE procedures to make it more useful.

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- D. Because of the importance of the Marble Hill project to the overall financial picture of PSI, risk analysis appraisals should be initiated by PSI management. These appraisals would be initiated by a re-validation of cost and schedule activities using probabilistic techniques. Based on those results, a series of contingency plans should be prepared for a series of possible total costs. The impact of the proposed Capital Cost Recovery Act should be included in the analysis. Likewise, a series of contingency plans should be prepared for delayed startup dates as indicated by the risk analysis.
- E. In staffing and developing the project organization, the following issues should be considered:
1. PSI should continue its re-evaluation of salaries for project personnel. PSI should consider revising its overtime policy and special site pay (relocation and/or per diem) for exempt personnel who are required to work extended overtime because of conditions beyond their control.
 2. MAC believes that the major effort of the Construction Engineer should be in the preplanning of the work with the contractors. The purpose of this plan is to identify potential problems, interpretation of requirements, control points, etc. This permits a unified approach which is beneficial to all concerned. The area team must be intimately involved with the contractors and should look ahead to minimize problems.
 3. Hard copy drawings, specifications and reference books (codes and standards) should be made more readily available to the PSI construction staff.
 4. Improved formal and informal routine communications must be established between the PSI site and home office. Reports should include a "look ahead" aspect in addition to "where we

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are" and "this is what we have done" approaches. The reports should include overall project status, quality trends, significant events, potential and actual problem areas and their recommended or completed resolutions, along with responsible personnel and timetable for resolution.

5. There is a need to train everyone on the job in his area of performance and on the necessity of a commitment to quality. This includes personnel such as clerks, pipefitters, junior engineers, and managers and should be done in a manner which will improve their effectiveness. It is suggested that a formal training and indoctrination program be given to each employee before the site is started up and then on a continuing basis.
6. A Material Controls organization should be established on the site under the PSI Construction Management organization. This organization will handle all procurement, expediting, and materials problems associated with Marble Hill. After the purchase order is issued, the responsibility of the control of the material should rest with this organization. It should provide total control of the material including documentation, equipment quality verification, storage, preventive maintenance and vendor payment releases. All construction contractors should identify specific PSI supplied material requirements for work packages well in advance of the construction activity. Material schedules should be updated and maintained current. The present system should be expanded to incorporate all material and equipment brought on the site. The program should be expanded to include construction and startup spares and have provisions to add operational spares. Institute use of PIE in the field with the use of CRTs.

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7. Due to the volume of changes it appears contract administrators should be assigned to each contract to administer changes in the field. Arrangements should be made which improves PSI control over changes.
8. PSI should initiate a study of the design change system with particular emphasis on the following:
 - a. Use of a single design change form for field generated changes regardless of whether they originate with PSI or contractors.
 - b. Utilization, if possible, of the existing form employed by Byron such that approved Byron changes can be utilized directly on Marble Hill.
9. Establish a project planning and scheduling control organization in the field which includes the functional elements of Planning, Scheduling, Cost Engineering, Estimating, Data Management and Material Control
10. Develop an immediate interim plan which will carry the project for the next six months while the detail staffing, planning, schedule and controls are established. The interim plan should deal with such issues as; organizational structure, personnel assignments, site facilities, construction restart (including analysis of existing concrete and any necessary repair work), re-inspection of safety related work as necessary, project procedures and controls, cost and schedule estimates and risk analysis, material control systems, Byron liaison, NRC reviews, a total long range project plan, and executive reviews.
11. The restructuring of the site organization with appropriate definition of job authority will establish clearer lines of responsibility and authority, and eliminate the present duplication of QA/QC functions and construction engineering

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function. PSI should rewrite their Construction Management Manual and clearly define the goals and objectives such that they are structured and provided with the necessary procedures to control the project without duplication with QA/QC. Responsibilities should be clearly established for processing of changes, planning/scheduling, contract administration, material management and engineering.

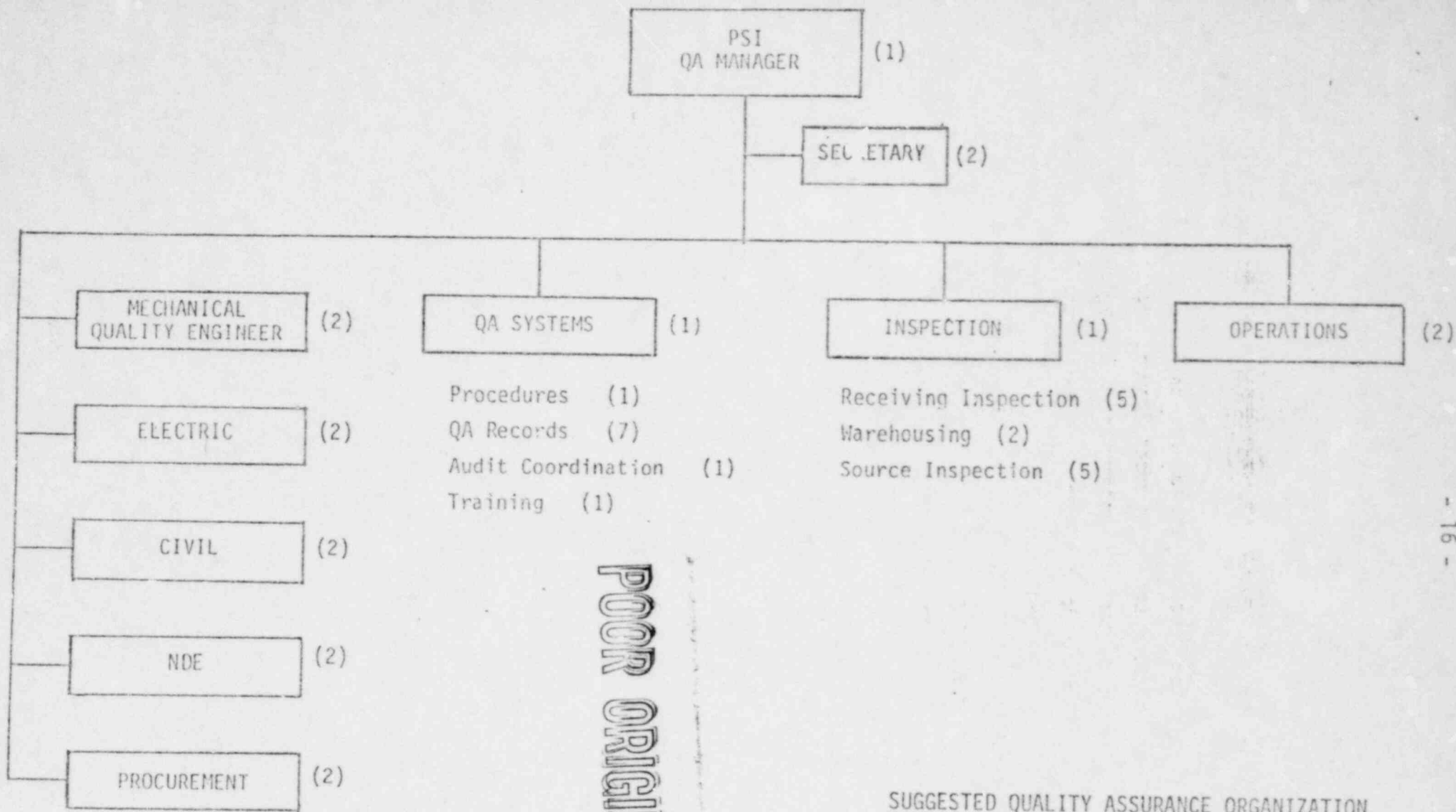
F. The required improvement in the Quality Assurance organization and programs would be enhanced with the following specific recommendations:

1. Reunite the Quality Assurance and Quality Control functions under one qualified manager located at the site. A suggested organization is shown in Figure 2, Quality Assurance Organization.
2. Review and assure understanding of the PSI Quality Assurance charter and its role of conceptually managing the quality assurance efforts of the A/E, NSSS suppliers and on site contractors.
3. Establish a program for formal QA on-site review of contractor quality programs.
4. Provide guidance to contractor organizations in quality achievement, but neither preempt nor relieve contractor responsibility for achieving and verifying the quality required under the contract.
5. Clearly define the uninhibited authority of PSI Quality Assurance to stop the performance of unsatisfactory work.
6. All NRC exit interviews should include key contractor personnel involved in the audit.

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SUGGESTED QUALITY ASSURANCE ORGANIZATION

Figure 2

- Review and approve contractor and supplier QA programs
- Audit site contractors
- Approve inspection planning of contractors
- Obtain corrective action of deficiencies

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7. QA/QC manpower ceilings should be maintained at their current level except for a planned program of upgrading personnel to achieve a greater experience level.
8. As QA manual sections and procedures are revised to reflect changes brought about by reorganization and by reactivation of Category I construction, include as a goal the simplification of procedures and provision of clear definitive instructions on how PSI Quality Assurance performs its work.
9. There is a need to have piping isometrics reviewed by the A/E to reduce the possibility of errors in A/E drawing interpretation, errors in installation, interference, snubbing and support. Consider requiring the piping fabrication and installation drawings be reviewed and signed by the A/E for conformance to design. Determine by surveillance and audit that such reviews and approvals have been made.
10. PSI Quality Assurance should review with contractors their procedures for preparing inspection planning and checklists to assure that adequate definition of accept/reject criteria is provided and to assure that the completed document will be satisfactory for a quality assurance record, including identification of the inspector and verification that required quality was attained.
11. Establish a centralized document control at the site with the responsibility of receiving, distributing and dispensing all technical project documents, and for assuring that proper reviews and approvals have been accomplished prior to release, for identifying proper drawing and specification status for assuring, through a receipt mechanism or similar process, that the correct revision has been distributed to and received by the using organization.

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12. Establish a manual filing capability for QA records at the site. Identify required quality records and established suitable controls to assure their adequacy upon receipt or completion and their integrity, safety and security. Postpone the microfilming of QA records until after plant acceptance.
13. Utilize the current lull in construction to evaluate all record packages where the hard copies have been destroyed to determine if there are any documents that are not clearly readable when reproduced from microfilm/mic fiche. Initiate a program for the replacement of any such legible records while supplier/contractor originals are still available.
14. Discontinue the practice of enhancing contractor documents for reproduction purposes. Require prompt replacement with acceptable and reproducible documents.
15. Initiate a program of interfacing with other utilities or with records management experts, to determine staffing facility and equipment requirements for document control and records storage.
16. Reassess the storage program with assigned responsibility for a storage maintenance program. Expedite receipt of component manufacturers' instructions for storage maintenance. Institute a QA surveillance program to assure requirements are met.
17. Establish an on-going program of reducing all significant problems to a QA action list. The review of the action list should be an important adjunct to weekly QA meetings, with schedules updated and referrals made to appropriate levels of management to accomplish the action. The key objective is to retain cognizance of a problem until it is finally resolved.

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18. Establish the quality trend analysis program as an integral part of the management information system.

G. Contractors

1. General

Prior to a restart of safety related work on Marble Hill, two actions should be taken with respect to the contractors. A general review of contractual commitments should be made to define in detail the commitments of the contractors to implementation of the QA program. This should specifically address staffing levels, qualifications and number and level of work instructions required to support the crafts. An in-depth quality assurance audit should be conducted on each major contractor to evaluate their overall QA programs.

2. Newberg

As a result of the contractual review and audit noted above, a determination of action items required prior to restartup should be made and documented. This action list should include all QA requirements as well as any additional project management requirements and should be pursued in weekly meetings which include the Project Managers and QA Managers of both PSI, Newberg and MAC recommends that Newberg continue to acquire supervision with nuclear experience and provide additional training in placement of Category I concrete. This program must be expanded to develop detailed training for crafts personnel in areas for which they are going to participate in the placement activities.

3. Cherne and Commonwealth-Lord

Cherne and Commonwealth-Lord QA programs were looked at in detail. With the exception of the review and approval problem associated with Cherne isometric drawings, there is not a notable QA problem. These contractors should be monitored closely however, as they are in the early stage of program implementation.