Quality Assurance as a Management Tool for Large Projects

Assurance de la qualité comme moyen de gestion d'un grand projet

Qualitätssicherung als Führungsinstrument für grosse Projekte

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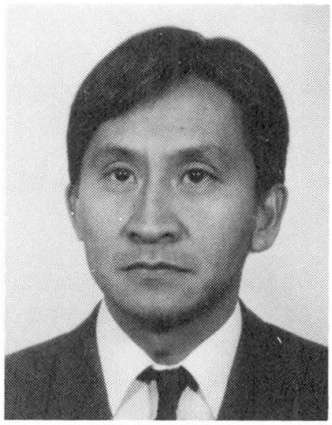

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SUMMARY

The setting up of a Quality Assurance programme should not generate unnecessary formal procedures and excessive paperwork which may discourage the personnel whose efforts are wasted on the «trivial many» and not concentrated in the «vital few». The key solution is to adjust the QA requirements according to the importance and complexity of the activity. Moreover, QA principles should be extended to the management of all aspects of a project: quality, programme and cost. With theses principles, management by objective technique (MBO) can be used as appropriate means to motivate the personnel to peak performance.

RÉSUMÉ

La mise en place d'un programme d'assurance de la qualité ne devrait pas entraîner un excès de documentation et de formalisme qui peut démotiver les intervenants dont l'effort est gaspillé par «le grand nombre d'événements sans importance» et non concentré sur «les quelques uns qui comptent». La solution clé est de moduler les exigences AQ en fonction de l'importance et de la complexité de l'activité. D'autre part, les principes AQ devraient être étendus au management de tous les aspects d'un projet: qualité, délais et coûts. En combinaison avec ces principes, on peut aussi utiliser la technique de Direction par objectif (DPO) comme moyen de motivation du personnel afin d'obtenir une performance maximale.

ZUSAMMENFASSUNG

Bei der Einführung eines Qualitätssicherungs-Programms sollten eine allzugrosse Dokumentation und übertriebener Formalismus vermieden werden. Sie entmutigen das Personal durch grossen Zeitaufwand für Unnötiges, anstatt auf das Wichtigste aufmerksam zu machen. Das Programm sollte dem Ausmass und der Vielfalt des Unternehmens angepasst werden: Ausserdem sollten die Prinzipien des Programms alle Gebiete des Managements umfassen, das sind Qualität, Termine und Kosten. In Verbindung mit diesen Prinzipien kann auch «Management durch Ziele» als Mittel zur Motivation der Mitarbeiter zu Spitzenleistungen angesehen werden.

1. SAFETY AND QUALITY ASSURANCE OF CIVIL ENGINEERING STRUCTURES

Safety and quality assurance requirements are not normally applied to civil engineering work in the same way that they are to other parts of a nuclear power station.

In a nuclear power station the safety-related components and systems are classified according to the contributions they make to the overall safety of the plant. The classification determines the design and construction rules that need to be applied to individual components and systems to ensure that they meet the appropriate requirements for structural integrity and quality.

But while the various ASME codes and the American National Nuclear Standards provide safety classifications for pressure boundary components and electrical, instrumentation and control equipement components and systems, and sometimes for their supports, they rarely cover the embedded items (which serve as the link between these supports and the concrete structure), the concrete structure itself, and the foundations of the building inside which the equipement will be installed.

Because it is not practicable to "nuclear classify" a civil engineering structure in the way that electrical and mechanical components and systems are classified, the current practice is for the structural requirements of a nuclear power station to be developped and specified by qualified and experienced structural engineers according to the best engineering practice. However, civil structures are, like electro-mechanical systems, classified according to their ability to meet the effects of seismic disturbances, and in particular to remain functional if a safe shutdown earthquake (SSE) occurs. Thus according to the US NRC Regulatory Guide 1.29 "Seismic design Classification", the main portion of the nuclear island (nuclear buildings, electrical building, diesel generator buildings, essential water pumping station and tunnels) is classified Seismic category 1, and therefore these structures have to be designed to withstand the effects of the SSE and the associated load combinations.

In contrast, quality assurance (QA) requirements are not subject to classification according to the safety importance of the item covered, but are applied universally. In addition, the majority of QA standards are still directed towards the manufacture of electro-mechanical components because this is where the safety stress lies. For example, the concrete containment is included in the ASME code (which concentrates on the QA systems for pressure boundary components) not as a building structure but as pressure retaining barrier that retains or controls the release of radioactive or hazardous effluents.

In practice, QA programmes in compliance with ANSI N. 45.2. or its equivalent must be applied to the design and construction of the reactor containment. For other parts of the nuclear power plant, the degree to wich QA programmes are implemented depends on agreement between the owner and the contractor. Generally the situation is one of all or nothing : either the QA programme required for the containment is applied to the whole plant, or no QA programme is required except for the containment.

The first approach may generate unnecessary formal procedures and excessive paperwork that damages the motivation of those involved because their efforts are wasted on the "trivial many" and not concentrated on the "vital few".

In the second approach, the absence of a formal QA programme means that the minimal documentation to demonstrate quality is incomplete or non-existent, and the management of quality is subjected to numerous organizational conflicts and conflicting requirements between the design and construction phases.

2. A RATIONAL APPROACH TO CIVIL QA

In 1976, SPIE BATIGNOLLES set up quality assurance programmes for the civil works of several nuclear power plants in compliance with ANSI N.45.2.

Then in 1979, the Company took advantage of what had been learned and started to elaborate its own quality assurance standard in collaboration with MOTOR COLUMBUS and SOCOTEC. The standard has since been developed and improved based on the experience gained on large construction projects by the three parties.

The published standard (1) outlines the basic concept of the system. The quality management requirements are presented in separate chapters of the standard, covering design, manufacturing and construction for each of three quality assurance levels. Each chapter repeats the same pattern of basic and specific QA requirements adapted to the activity and graded to suit each level of quality assurance. This is done to establish the optimum way of performing an activity, in the environment where it has to be done, and to achieve the required results at a given price.

The standard aims to structure the QA requirements in such a way that they remain compatible with existing QA standards and codes (ANSI.N. 45.2, IAEA Code of practice 50 CQA, BS 5750, CSA Z 299, AFNOR NFX 50.110.) and at the same time allow them to be implemented realistically.

The special features of the quality management standard are thus that :

1. It is specific to civil works.
2. Its requirements are adapted specifically to each of the project activities : design, manufacturing and construction.
3. These requirements are adjusted or "modulated" into different levels of QA or quality management according to their importance and complexity.

It is important to note that the technical requirements for quality may be the same for each level and only the methodology for the management of this quality is graded from level 1 to 3. Therefore, quality assurance level 1 provides the most systematic, formalized, time consuming and costly methodology. Level 2 combines the reasonably desirable with the practically feasible. Level 3 constitutes what is considered as good normal practice.

In principle, each QA level contains fewer or less stringent requirements than the one immediately above. This does not mean that the good practices resulting from meeting the requirements of the higher level should be abandoned when producing an item to the lower level. It means that at the lower level, lesser assurance is required in the form of documentary evidence of the implementation and effectiveness of theses practices.

For example in the area of quality records (construction activity), QA level 1 (C1) requires the maintenance of records to demonstrate that each portion of the QA programme has been established and effectively implemented. These records include as appropriate :

1. QA manual, QA procedures and quality plan.

(1) "Quality Management for Civil Works", Macmillan Press, London, 1984

2. Technical records such as specifications, drawings, calculation notes and inspection and test procedures.
3. Records of qualification of special processes (procedures and personnel).
4. Records of calibration of measuring and test equipement.
5. Procurement records
6. Corrective action records
7. Audit records
8. Final performance records such as : as built records, materials test reports or certificates, NDE reports, inspection and test reports, non conformance reports, concrete batch plant print out etc...

QA level 2 (C2) requires only maintenace of those records relating to items 1,2,3 and 8. At QA level 3 (C3) only specifications, drawings, calculation notes and inspection and test reports are required to be maintained.

In establishing a methodology for adjusting or modulating the QA requirements to these different levels it was recognized that a complete and complex civil engineering structure is composed of simple parts and that theses simple parts can be verified to be acceptable by utilizing simple quality assurance programme.

The setting up of a quality management system for civil works starts with a detailed classification in which each structure or part of the building is considered in order to obtain a consistent system. For such classification, the following factors must be taken into account :

- the complexity of design, manufacturing and construction activities involved in the building, structure and its parts ;
- the maturity of the technology, and
- the importance of malfunction (this factor includes the safety aspect and safe operation during seismic disturbances).

In this manner, according to the following structure of the standard :

		Design (D)	Manufacturing (M)	Construction (C)
Quality Assurance Levels	1	D1	M1	C1
	2	D2	M2A / M2B	C2
	3	D3	M3	C3

D1 to D3, M1 to M3 and C1 to C3 designate the different sections of the standard at the different levels of quality assurance.

The classification for the reactor building of a 900 MW PWR plant shall be as follows :

	Design	Manufacturing	Construction
Raft	D 1		C 1
Containment :			
- structure	D 1		C 1
- liner	D 1		C 1
Internal structure	D 1		C 1
Handling gantries	D 2		C 2
Aggregates		M 2 B	
Cement		M 2 A	
Concrete		M 2 A	
Rebars		M 2 A	
Prestressing materials :			
- ducts		M 2 B	
- strands and anchorage		M 1	
Liners steel :			
- liner base		M 3	
- liner, liner anchors, penetration, sleeves, equipement hatch, personnel air locks		M 1	
- polar crane corbels		M 2 A	
Primary steel work (handling gantries)		M 2 B	
Decontaminable paint		M 2 A	

The quality management standard provides then the different organizations participating in the design, manufacturing and construction of these items and structures with a readily available set of QA requirements that enable them to set up their corresponding QA programmes.

The same procedure shall be done for the rest of the plant including the conventional parts (turbine building and others).

It is important to note that the quality management standard could be applied to non nuclear projects.

Thus, for a building with a relatively simple design but a complex construction method, the quality management system could be set up according to the following classification :

DESIGN	MANUFACTURING	CONSTRUCTION
		C1 Structural works
D2	M 2 B Reinforcing Structural steel cement Aggregates	C3 Painting Drainage Waterproofing

The quality management standard allows the implementation of clean and efficient QA requirements that provide assurance of quality commensurate with the relative importance and complexity assigned to each structure or item. It provides a rational and realistic solution for quality management of civil works.

However the success of such a system depends on the strict enforcement of the standard at all levels within the participating organizations. Modulation must not be interpreted as laxity : it must be a consistent decision supported by detailed analysis and extensive experience in order to determine the most legitimate QA requirements taking into account the particularities of a given activity or item, the most appropriate level consistent with the obligation to observe all specified requirements that have been judged indispensible.

In other words, the following well-known quality management principle is applied to increase the probability of better quality and therefore better safety, cost and schedule : requirements must be realistically set and rigidly enforced.

3. QA AS MANAGEMENT TOOL

A QA programme requires always the use of formal procedures which may deteriorate human relationship. The creation of an independent QA department responsible for the establishment of manual and procedures, their implementation and verification thereof may lead to the dilution of responsibility of personnel performing project activities. These latters may consider that from now on, quality is under the sole responsibility of the QA department.

On the other hand, the absence of a formal QA programme leads to the situation that we have already mentionned at the end of the first paragraph of this paper.

Based on these reflections, SPIE BATIGNOLLES has developed a management system which covers all aspects of a project : quality, cost and programme.
This management system combines QA principles with personnel motivation factors.

Thus, the following QA principles are retained :

- The clear definition of organisation and responsibility of each participant to the project.
- The planning and preparation of project activities (by means of project plans and procedures).
- The use of independent review performed by experts inside or outside the project team.
- The documentation of activities and results.
- The verification of the implementation of the management system by audits.

On the other hand, it must be noted that :

- There is no independent QA department.
- Management of quality is the responsibility of personnel who performs the project activities.
- The responsibility for the implementation of the management system is assumed by the Project Manager who establishes himself (with his team) the project procedures.
- Only the audit function is independent from the project management team.

Moreover, the organization of the project is based on two key principles which affect the efficiency and reaction capacity of the system :

- A temporary and autonomous project team structure.
- The decentralization of responsibilities and management of objectives (MBO) through :
  - . the appointment of a Project Manager who receives a large and clear delegation of responsibilities and authorities.
  - . the division of the project into sub-project each of which the management of technique, programme, quality, costs and contracts is placed under the responsibility of one person.
    The Sub-Project Managers receive delegation of authorities from the Project Manager.
  - . project objectives and sub-project objectives are clearly defined by consensus and followed up.

All these principles are recorded in a DIRECTIVE FOR MANAGEMENT OF MAJOR PROJECTS approved by General Management and issued to all persons involved for implementation.

At the start up of a project, the Project Manager establishes and submits to General Management for approval :

- a project manual defining organizational rules, responsibilities and tasks of each participant. These rules comply with the principle of project division mentionned above.
- a project plan proposing the objectives (quality, costs, programme) for the project and for each sub-project.

During the execution of the project, the project activities are subject to project procedures established by the Project Manager and his team.

In the area of quality (of design, manufacturing and construction) the project procedures are established in accordance with the requirements of the quality management standard.

The implementation of the project management system, from the start-up, through the execution and upto the completion of the project, is subject to periodical audits to assure its compliance with the rules of the DIRECTIVE.

The audit department reports directly to General Management but performs as expert adviser and the audit reports are issued directly to the Project Manager for action. The General Management is called in as ultimate recourse only when important disagreement appears between the Project Manager and the audit team.