Practical aspects of planning for quality

Practical Aspects of Planning for Quality

Aspects pratiques de la planification de la qualité

Praktische Aspekte der Qualitätsplanung

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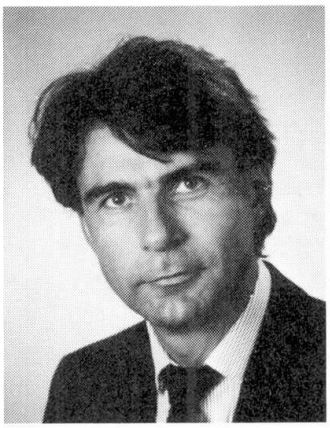

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SUMMARY

What are the main topics of quality planning, the complete and exact determination of the quality objectives or should it be the optimum project organization including the planning of effective controls? Ensuring the quality in civil engineering first requires an identification of critical areas in planning and execution, followed by the specification of priorities for their treatment. Exact observation, documentation and analysis of experience are essential activities. The crucial problem finally is the transfer of the results into practice. All departments in a company have to acknowledge these duties and cooperate with respect to this objective. It is of utmost importance that the board declares quality as an objective of the company.

RESUME

Sur quoi la planification de qualité doit-elle se concentrer en premier lieu? Sur une détermination complète et exacte des buts de qualité ou sur une organisation optimale du projet comprenant la planification de contrôles efficaces? Pour garantir ou améliorer la qualité des travaux de génie civil, les domaines critiques de la planification et de la méthode de construction doivent d'abord être identifiés, et des priorités fixées pour leur traitement. L'observation exacte, la documentation et l'analyse des expériences sont des activités essentielles. La difficulté consiste à mettre en pratique les résultats et les recommandations. Tous les départements d'une entreprise doivent accepter ces objectifs prioritaires. La condition essentielle pour la réussite est que le conseil d'administration déclare la qualité comme un but de l'entreprise.

ZUSAMMENFASSUNG

Worauf soll sich die Qualitätsplanung vorrangig konzentrieren, auf die vollständige und genaue Ermittlung der Qualitätsziele im Rahmen der technischen Anforderungen oder auf den richtigen Ablauf zur Leistungserbringung einschliesslich der Planung wirksamer Kontrollen? Um die Qualität bauingenieurgemässen Handelns zu gewährleisten oder zu verbessern, müssen zunächst kritische Bereiche in Planung und Ausführung erkannt und für ihre Bearbeitung Prioritäten gesetzt werden. Notwendig sind weiter genaue Beobachtung, Dokumentation und Datenaufbereitung. Entscheidend ist schliesslich die Umsetzung der Empfehlungen und Ergebnisse in die tägliche Praxis. An diesen grundsätzlichen Aufgabenzielen haben sich alle die Qualität der Bauausführung beeinflussenden Stellen zu orientieren. Voraussetzung für den Erfolg ist, dass die Geschäftsleitung Qualität zu einem erklärten Unternehmensziel macht.

1. The building process

The building process corresponds to the development of a prototype. Even only another location of the construction site involves a lot of new conditions which have to be considered: Other ratios of the foundation soil, building materials of another provenance, a new working team, other atmospheric conditions and modified quality requirements of the user.

The construction of a building is a complex process. The first steps involve the specification of the requirements by the user in terms of quality objectives. To fulfill the objectives the process of construction has to be kept under control during the following main phases

- planning
- structural analysis and design
- construction.

Demands to quality are always related to the requirements and cannot be requested absolutely. In the first place economic aspects ask for an individual differentiation of measures for the envisaged building project. Therefore the significance of the building determins the extent of the planning effort. Conventional building projects differ from those with special requirements.

Conventional (every day) projects refer to "standard" planning processes without special requirements for the contractor. Less sophisticated technologies (housing) and normal technologies (bridges) may be considered as conventional projects. Respective guidelines for the various project phases are generally codes, standards and particular prescriptions ergo in Germany the "German contract procedure in the building industry" (VOB).

For building projects with special demands (offshore-platform, nuclear power plant) the "standard" planning procedures are not sufficient because of the high technical risks. For instance specialised departments may be entrusted with specific planning for projects with a special safety demand.

In this contribution reference is only made to building projects with special safety demands.

Execution of projects with special demand, normally large scale projects, require interdepartemental activities, and usually even cooperation of different companies is necessary. Planning thus calls for a time - and placebound coordination.

In the following emphasis is placed on the coordination of quality planning of the building process with special reference to the handling of weak points.

2. The planning procedure

What are the main topics of quality planning?

- the complete and exact determination of the quality objectives, or should it be
- the optimum project organization including the planning of effective controls?

In order to determine quality objectives the expected influences on the structure are selected by utilisation scenarios and hazard scenarios. Utilisation scenarios are descriptions of operational, environmental and boundary conditions associated with the normal use of structures.

Hazard scenarios are similar descriptions of conditions dominated by a hazardous occurence during construction or the service phase, which alone or in combination with other normal conditions could cause the vital functions of a structure to be lost. Application of corresponding scenarios to the construction phase renders decision criteria for optimizing the project organization.

In common opinion quality planning refers to the process of determination of quality objectives. Quality governing and quality control are then employed to meet these objectives and to prove the efficiency of the measures.

However, the success of the realization of major projects depends more on the application of management rules than on exactly elaborated technical details. The following basic principles in this sense, have been recognized by Jolivet [1].

- suitable organisational set up of the construction firm
- formalisation of the procedures
- sufficient clarification of the responsibility of the single stages of execution
- permanent effort to improve efficiency and
- involving the contractor to planning at a very early stage

Experience shows, that the main causes for errors, defects and damages can be reduced to human insufficiency as

- ignorance
- carelessness
- negligence
- covetousness.

Concerning the complex projects in construction engineering performing new technical tasks is a minor problem. The larger problem is to solve simultaneously a lot of interdependent detailed tasks.

Weak points in the complicated organisational set up and operating sequence are not necessarily impediments on quality. But they definitely will influence costs in an extremely negative way, if only by causing delays in the project schedule.

3. Feed-back

3.1 Damage analyses

Analyses of building damages suggest that inadequate quality depends more on unsufficient planning and organisational errors than on poor detailing and erroneous construction. More errors are produced in offices than on site. Hence, table 1 comprises three analyses of building defects.

	PLANNING	CONSTRUCTION	Building materials environmental infl. service conditions
Germany (F.R.G.)	40,1 %	29,3 %	30,6 %
Belgium	49,0 %	22,0 %	29,0 %
Switzerland	>50,0 %	< 50,0 %	10,0 %

Table 1 Individual sources of building defects [2], [3], [4].

3.2 Companies' experience and communication

To improve the quality of engineering conduct it is an upmost importance to identify critical phases in the course of planning and execution and to associate priorities.

Information on damage statistics may promote a better understanding of problems among the personnel involved. Basicly, transformation of this information is as difficult as the transfer of research results to practice. Exchange of informations, e.g. within training courses, of weak points and their causes may be considered as the most effective way to positively control the frequency of damages. Focusing on the major aspects is the prerequisite for the successful training towards an increased attention.

It should be noted that changing of recommendations and regulations influence quality. Too complicated and detailed prescriptions run the risk of not beeing considered, additional errors may occur dueto lack of clearness. Therefore the scope of decision should be enlarged for quality conscious engineers by appropriate code drafting.

Additional sources of information:

- Laboratory experiments to determine the behaviour of structural elements
- Observation, documentation and statistical treatment of data using stochastic models for assessing actions and hazards
- Practical experiences attained in similar projects
- Data from building insurance agencies for the frequency of damages

A well known complicating factor are the differing interests of the various parties involved. As an example take a building contractor and cement and conrete supplier, thus, a workshop of the German Concrete Association (DBV) for future problems in concrete technology suspects, that there is an increasing tendency for the liability of building contractors with respect to building defects, for which they are actually not responsible. This tendency arises because approved concrete mixing materials are substituted by other products. Basicly the contractor depends on the deliverer to provide him with material which must comply with his own expectations and those of the user. Moreover, his own requirements concerning quality objectives are based on the information offered by the supplying industry without, however, a clear acknowledgement of responsibilities.

4. Measures for quality planning

Ensuring an appropriate operating sequence for attaining operational efficiency is regarded as one of the most important interdepartmental quality assurance tasks. Up to now they are described only in very general terms in codes relating to quality assurance. A major issue for discussion is whether more details should be incorporated in codes or should this field remain competence of the company?

4.1 The interdepartemental organization

In the Federal Republic of Germany prescriptions with legal character require a framework description of the quality assurance activities for the construction of nuclear power plants. The aim of the framework is to improve the assessment of quality assurance measures including the organisational premises. A joint venture formed by a power supplying company, a plant supplier and two contractors drafted an outline for such a quality assurance frame, the requirements of which with respect to the internal organization of the contractor are as follows [5].

4.2 The masterplanning

The three parties with prime responsibility for the construction and safety in use of a nuclear power plant are

the power supplying company
the plant supplier
the contractor.

With the increasing number of groups concerned the necessary connections increase compared with conventional building projects. Thus explicit specifications of coordination rules are a useful instrument in the project organization and may be adopted according to the enclosed outline for nuclear power plants.

4.3 Quality assurance within the Technical Department

The activities and the quality assurance measures in the Technical Department are divided into internal and external activities. A detailed description would surmount the frame which is set here so that only the most important quality steps with external organizations are represented in the appendix.

5. Identification of weak points

Weak points may be identified within the phases of construction, design and organization.

Referring to weak points of the design, Design-Review-Checklists are a successful supplement in examining the design. They may assist in detecting weak points e.g. crucial quality characteristics which require increased data and information and a sophisticated analysis.

For very critical quality characteristics reliability assessments are necessary. Weak point analyses are therefore applied. A standardized method is the fault-tree-analyses (DIN 25424) which focuses at a unique adverse result and persecutes the causes back to the origin. The report of Dr. Rüdiger Rackwitz deals with that method which is mainly applied to detect causes with considerable risks for human safety and financial investment.

One of the main aspects associated with large scale projects is the fact that long lead times are involved.

To attain the quality objectives fixed by utilization and hazard scenarios the activities first focus on a schedule relevant for the following phases:

- planning
- structural analysis and design
- construction

It defines the operations which have to be required by whom and at what time respectively. Checking and approval of the shuttering drawings, interior work plans and reinforcement drawings are important activities.

A typical schedule for a nuclear power project is shown in the appendix as an example. However, the periods shown for different activities as well as the starting points are approximate and should be considered only indicative.

The main project-related and time-bound activities relating to the time schedule are (see appendix page A):

D - shipment of layout plans for the entire building and loading plans for regular and extraordinary loads.

W - detailed load data for main supporting systems and a schematic description of supports of components

- basic plans for structural work (partial systems)

E - shipment of the basic plans, scale 1:50 (partial systems become obligatory)

F1 - approval of the shuttering drawings for design and reinforcement and of steel construction arrangement plans

F2 - approval of the shuttering drawings for the start of placement of formwork and reinforcement

A - start of the work at the construction site

As long as skilled personnel executes the work, as are engineers, chief operators, foremen and technical workers not all details must be extensively planned. We know, however, that certain unplanned works influence quality and economy in a most negative way. The following examples will focus the attention to some of those critical details.

5.1 Structural weak points

Basic decision of the type of structural systems are made at the stage of preliminary design. Hence, structural engineers should be involved in planning as early as possible. Experience shows that errors established at the initial phase hardly are corrected later. As an example take the preliminary design of a nuclear power plant which is planned on the basis of an existing but maybe out of date plant.

Groundwater sealings with expected dynamic loading should be considered at the earliest stage because they influence the design concept especially the details of joints separating the buildings. Usually the design of groundwater sealings is for a limited foundation depth. The suitability for deeper foundations may require experimental testing. Actions which are not standardized must be prescribed by the user. The selection of an Architect Engineer for a large scale project must mainly be taken on the basis of his competence in the field and on the key personnel that be can make available for the project.

5.2 Organizational weak points

Activities affecting quality shall be performed in an organizational structure with clearly defined responsibilities and authorities. Information obstacles have to be minimized. Engineers must have knowledge of the boundary conditions, missing it they cannot perform changes in a workmanlike and appropriate manner.

The planning of the work at the construction site must consider distinct market conditions, e.g. the building materials abroad very often do not satisfy domestic requirements.

Special attention has to be paid to the ventilating system of industrial structures, causing additional roof loads and wall penetrations, since it is often enlarged or not planned in advance because the construction period of the plant often lasts for several years.

Cracks are undesirable at housing construction. At industrial construction, apart from structures for which impermeability of water is required, cracks are of less significance. Exaggerated crack reducing requirements may thus be superfluous.

The adequate choice of the structural system and of the corresponding details should be based on decision criteria related to material, type of construction and manufacturing.

Aspects to consider include: [6]

- knowledge on the structural behaviour of different systems
- careful consideration of the advantages of hyperstatic systems with regard to redistribution capacities versus the disadvantages in the case of constraints caused by temperature, drying shrinkage, settlement and the like
- detectability of poor workmanship in manufacturing
- possibility of local failure due to accidental actions, improper execution, insufficient durability, etc.

6. Summary and conclusions

Ensuring the quality in civil engineering first requires an identification of critical areas in planning and execution, followed by the specification of priorities for their treatment. Exact observation, documentation and analysis of experience are essential activities. The crucial problem finally is the transfer of the results into practice. All departments in a company have to acknowledge these duties and cooperate with respect to this objective. It is of utmost importance that the board declares quality as an objective of the company.

Engineers, foremen and workers must be motivated to produce quality. They must be assisted because they suffer under narrow deadlines and often do not know whom to cantact in the company for support in case of urgent problems. Generally there is not enough time available to study technical literature. Check lists are missing for many important operations. With respect to information for special tasks planning data are often unsufficient.

There is an optimistic expectation that quality can be improved by motivation provided that the individual personality in the process of civil works is sufficiently regarded. This presumes well experienced engineers, foremen and skilled workers who fortunately are still available at the time beeing. But a tendency for a diminishing qualification is apparent. Hence, we must pursue possibilities in order to maintain the high quality standard of today with less experienced personnel in the future. Our activities will be successful if we make use of the principles of modern quality assurance systems as an essential part of industrial management by transferring them to civil works.

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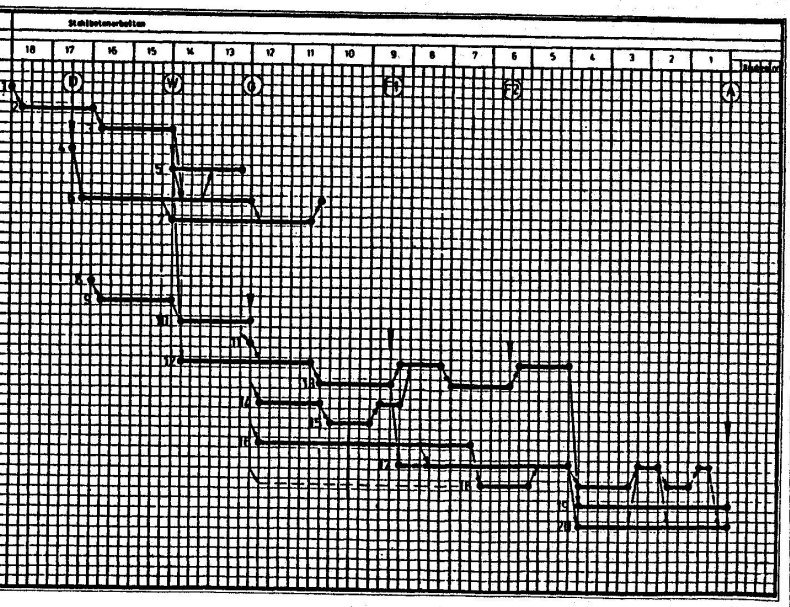
Abbreviations for the time-bound activities see chapter 5.

	Planungs-ablauf	PROJECT	
1	Einmaliger Planungsablauf für das Gesamtbauwerk		
1	Berichte der Belastungsspezifikation, welche übergeordnet oder zur Berechnung der Haupttragsysteme erforderlich sind		IA
2	Durchsicht der Sonderlastberichte (inhaltlich Aufbereitung der Lasten, Verständlichkeit usw.)		B Z
3	Ggf. Überarbeitung der Sonderlastberichte		IA
4	Dispositionspläne, Regelbelastungspläne		IA
5	Vorläufige Werkpläne: Lastangaben, welche zur Berechnung der Haupttragsysteme erforderlich sind; Erahnung und evt. Überarbeitung der Werkpläne		IA
6	Vorbemessung, Lastabtrag, Standsicherheitsnachweise für die Sonderlastfälle		B Z
7	Baustatische Prüfung des Lastabtrags und der Standsicherheitsnachweise für die Sonderlastfälle		IA
11	Planungsablauf für die einzelnen Bauabschnitte eines Bauwerks		
8	Belastungsspezifikation: Sondereinbauteile der IA mit vorläufigen Lasten		IA
9	Durchsicht der Sonderlastberichte und Beurteilung der Sondereinbauteile der IA; ggf. Ausarbeitung von Änderungsvorschlägen		B Z
10	Ggf. Überarbeitung der Belastungsspezifikation und der Sondereinbauteile der IA		IA
11	Sämtliche Detaillastangaben; endgültige Werkpläne		IA
12	Schalplanbearbeitung		B Z
13	Schalplanprüfung		IA
14	Stahlbauübersichtspläne mit Ankerplatten		B Z
15	Prüfung der Stahlbauübersichtspläne		IA
16	Statik der einzelnen Bauabschnitte		B Z
17	Bewehrungspläne		B Z
18	Baustatische Prüfung		IA
19	Arbeitsvorbereitung (Schalung)		Baustelle
20	Arbeitsvorbereitung (Bewehrung)		Baustelle



SCHEDULE FOR A NUCLEAR POWER PLANT
DURING THE PHASE OF PROJECT PLANNING

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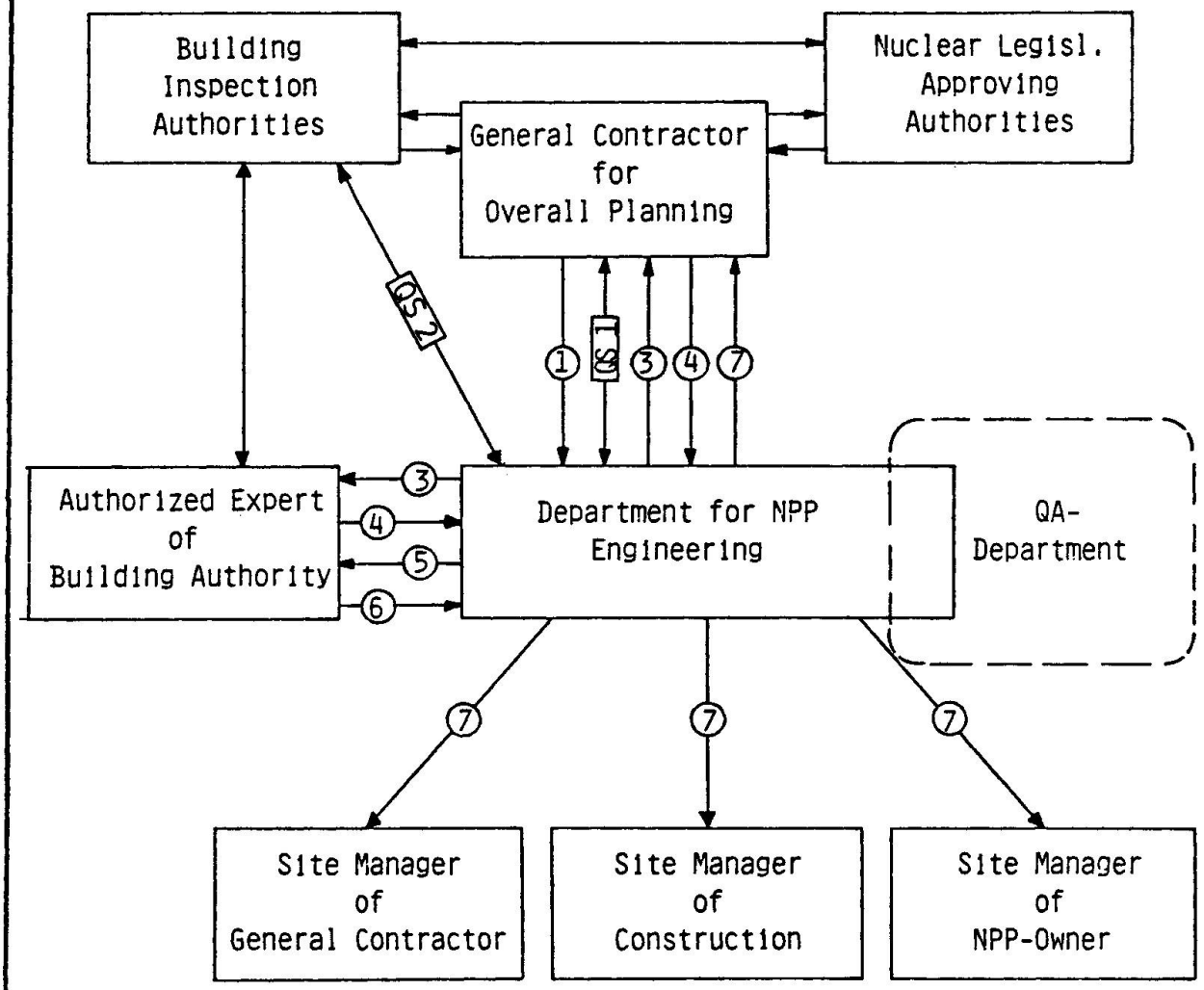

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(Sign) Arranging office	Activity
(1) General	Planning and computation data for the civil part of NPP (Nuclear Power Plant) Technical description Overall-Plans scale 1:100 Detailed plans scale 1:50 Load plans continuous and discontinuous general loads additional loads resulting from special load reports
(QS 1) Department for NPP-Engineering	Examination of design data concerning correctness, completeness, in case correction
(2) Building Authorities	Requirements for approval documents unusual external loads (earthquakes, external explosions, aeroplane crash) supplementary safety requirements for interior unexpected loads
(QS 2) QS Department for NPP-Engineering	Examination of approval documents concerning completeness, clearness, in case completeness Application of licences for new building materials, structures or construction methods
(3) Department for NPP-Engineering	Shipment of shuttering and subcontractor drawings for the approval
(4) General Manager of Authorized Expert	Shipment of the plans approved for construction
(5) Department of NPP-Engineering	Shipment of the construction documents, required by the approval documents, for examination and approval
(6) Authorities Authorities Expert	Approval for construction of the construction documents (drawings and specifications) Agreement for the application of licences for new building material, structures or construction method
(7) Department of NPP-Engineering	Shipment of approved documents for construction

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