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QUALITY CONTROL AND SAFETY DURING CONSTRUCTION

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ABSTRACT

The concept of Quality control has arisen to ensure that customer demands, and a level of quality and conformance are achieved. Quality Assurance is provided through the implementation of systemic management techniques ensuring control of the activities carried out by each party. This research provides a review of the topic of Quality control. In particular it looks at the meaning of quality control and the needs for its introduction into the construction industry.

Current quality standards in the construction industry and the alternative quality systems, including the British Property Federation system, the Construction Industry Development Association's Code of Practice, and the Building and Construction Council's Quality Assessment Scheme are discussed. The quality control and safety during construction are highlighted.

Key words: Quality Assurance, Quality control, safety construction, Quality Assessment.

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1. INTRODUCTION

Quality control and safety represent increasingly important concerns for project managers. Defects or failures in constructed facilities can result in very large costs. Even with minor defects, re-construction may be required and facility operations impaired. Increased costs and delays are the result. In the worst case, failures may cause personal injuries or fatalities. Accidents during the construction process can similarly result in personal injuries and large costs. Indirect costs of insurance, inspection and regulation are increasing rapidly due to these increased direct costs. Good project managers try to ensure that the job is done right the first time and that no major accidents occur on the project.

As with cost control, the most important decisions regarding the quality of a completed facility are made during the design and planning stages rather than during construction. It is during these preliminary stages that component configurations, material specifications and functional performance are decided. Quality control during construction consists largely of insuring *conformance* to this original design and planning decisions.

While conformance to existing design decisions is the primary focus of quality control, there are exceptions to this rule. First, unforeseen circumstances, incorrect design decisions or changes desired by an owner in the facility function may require re-evaluation of design decisions during the course of construction. While these changes may be motivated by the concern for quality, they represent occasions for re-design with all the attendant objectives and constraints. As a second case, some designs rely upon informed and appropriate decision making during the construction process itself. For example, some tunneling methods make decisions about the amount of shoring required at different locations based upon observation of soil conditions during the tunneling process. Since such decisions are based on better information concerning actual site conditions, the facility design may be more cost effective as a result.

With the attention to conformance as the measure of quality during the construction process, the specification of quality requirements in the design and contract documentation becomes extremely important. Quality requirements should be clear and verifiable, so that all parties in the project can understand the requirements for conformance. Much of the discussion in this chapter relates to the development and the implications of different quality requirements for construction as well as the issues associated with insuring conformance.

Quality Assurance

"Quality Assurance" is a term that often is not fully understood. Indeed the concept of quality assurance often gets confused with quality control and quality inspection.

The American Society for Quality™ (ASQ) is regarded as one of the world's leading authorities on quality the ASQ defines assurance and quality as follows:

Assurance: The act of giving confidence, the state of being certain or the act of making certain.

Quality Assurance: The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.

Control: An evaluation to indicate needed corrective responses; the act of guiding a process in which variability is attributable to a constant system of chance causes.

Quality Control: The observation techniques and activities used to fulfill requirements for quality.

2. SAFETY DURING THE CONSTRUCTION

Safety during the construction project is also influenced in large part by decisions made during the planning and design process. Some designs or construction plans are inherently difficult and dangerous to implement, whereas other, comparable plans may considerably reduce the possibility of accidents. For example, clear separation of traffic from construction zones during roadway rehabilitation can greatly reduce the possibility of accidental collisions. Beyond these design decisions, safety largely depends upon education, vigilance and cooperation during the construction process. Workers should be constantly alert to the possibilities of accidents and avoid taken unnecessary risks.

3. ORGANIZING FOR QUALITY AND SAFETY

A variety of different organizations are possible for quality and safety control during construction. One common model is to have a group responsible for quality assurance and another group primarily responsible for safety within an organization. In large organizations, departments dedicated to quality assurance and to safety might assign specific individuals to assume responsibility for these functions on particular projects. For smaller projects, the project manager or an assistant might assume these and other responsibilities. In either case,

insuring safe and quality construction is a concern of the project manager in overall charge of the project in addition to the concerns of personnel, cost, time and other management issues.

Inspectors and quality assurance personnel will be involved in a project to represent a variety of different organizations. Each of the parties directly concerned with the project may have their own quality and safety inspectors, including the owner, the engineer/architect, and the various constructor firms. These inspectors may be contractors from specialized quality assurance organizations. In addition to on-site inspections, samples of materials will commonly be tested by specialized laboratories to insure compliance. Inspectors to insure compliance with regulatory requirements will also be involved. Common examples are inspectors for the local government's building department, for environmental agencies, and for occupational health and safety agencies.

4. QUALITY STANDARDS IN THE CONSTRUCTION INDUSTRY

The international standard series IS0 9OOO covers quality assurance and has been adopted by many countries, including Australia, and published as national standards. In Australia they are theAS3900series, Quality Systems. Because they are of general application, an attempt to provide specific guidance for building and construction **was** made in Australia by creating AS 2990 -1987 Quality Systems for Construction and Engineering Projects. This standard **has** been applied by larger companies in mainly government contracts, but is to be phased out in 1995. A new standard AS3905.2-1993 is to provide guidelines toAS3901, AS 3902 and AS 3903 for construction *AS2990 - 1987.* This particular quality system has been adopted from a Canadian series of standards (CSA 2299) primarily dealing with manufacturing and the electricity generating industries. The standard's theme is to encourage contractors to produce quality manuals that clearly define their philosophies and policies towards quality, and how they intend to implement such a policy. One advantageous feature of this system is that it enabled those concerned with the project to choose hom three categories of quality systems thereby giving more flexibility in the use of the standard. Each category identifies the risks involved in the project, the accessibility to Quality Assurance resources and the contractors' capacity to deliver Quality Assurance. The categories in order of complexity are as follows:

Category A

High commercial hazard risks good access to Quality Assurance resources high capacity of Contractors to deliver Quality Assurance

Category B

Good access to Quality Assurance resources high capacity of contractors to deliver Quality Assurance

Category C

Low commercial hazard risks reasonable access to Quality Assurance resources reasonable capacity of contractors to deliver Quality Assurance As no two commerce projects are the same, this system helps the project team by enabling them to choose the category best suited to their projects' aims and objectives. Once the appropriate category has been chosen for the project, then the exact Quality System to be incorporated will be known. It is here that the "adopted standard presents its first problem. As the system has been from Canada, there is no grounding for its development in Australia and consequently no input into its requirements. The danger of adopting other people's quality documents is obvious [191. Added to this, the standard is predominantly one for the manufacturing and electricity generating industries which creates the following problems for AS 2990 - 1987: it requires much technical input which therefore makes the system an expensive one to implement and run. due to its origins in Canada and the fact that it was developed for a manufacturing type industry, the

terminology used does not always suit that required in the building industry, nor in the Australian context. There is no allowance in the system for varying levels of quality of the project; this is often the case in the construction industry, unlike the manufacturing industry on which this standard is based. The system includes an assumption that the manufacturer of the product is also the designer. This is very rare in the construction industry

5. WORK AND MATERIAL SPECIFICATIONS

Specifications of work quality are an important feature of facility designs. Specifications of required quality and components represent part of the necessary documentation to describe a facility. Typically, this documentation includes any special provisions of the facility design as well as references to generally accepted specifications to be used during construction.

General specifications of work quality are available in numerous fields and are issued in publications of organizations such as the American Society for Testing and Materials (ASTM), the American National Standards Institute (ANSI), or the Construction Specifications Institute (CSI). Distinct specifications are formalized for particular types of construction activities, such as welding standards issued by the American Welding Society, or for particular facility types, such as the *Standard Specifications for Highway Bridges* issued by the American Association of State Highway and Transportation Officials. These general specifications must be modified to reflect local conditions, policies, available materials, local regulations and other special circumstances

6. TOTAL QUALITY CONTROL

Quality control in construction typically involves insuring compliance with minimum standards of material and workmanship in order to insure the performance of the facility according to the design. These minimum standards are contained in the specifications described in the previous section. For the purpose of insuring compliance, random samples and statistical methods are commonly used as the basis for accepting or rejecting work completed and batches of materials. Rejection of a batch is based on non-conformance or violation of the relevant design specifications. Procedures for this quality control practice are described in the following sections.

An implicit assumption in these traditional quality control practices is the notion of an *acceptable quality level* which is a allowable fraction of defective items. Materials obtained from suppliers or work performed by an organization is inspected and passed as acceptable if the estimated defective percentage is within the acceptable quality level. Problems with materials or goods are corrected after delivery of the product.

In contrast to this traditional approach of quality control is the goal of *total quality control*. In this system, no defective items are allowed anywhere in the construction process. While the zero defects goal can never be permanently obtained, it provides a goal so that an organization is never satisfied with its quality control program even if defects are reduced by substantial amounts year after year. This concept and approach to quality control was first developed in manufacturing firms in Japan and Europe, but has since spread to many construction companies. The best known formal certification for quality improvement is the International Organization for Standardization's ISO 9000 standard. ISO 9000 emphasizes good documentation, quality goals and a series of cycles of planning, implementation and review.

7. CONCLUSION

The process of construction is becoming more quality orientated. There is a greater interest in obtaining better value for money. In order to successfully implement a quality management

program there must be a total commitment by top management to improve company performance. This includes both establishing a company structure and operating procedures which fit the company objectives. A QA system does not promise to solve all problems on a construction site. It does, however, ensure that, if conducted properly, the chances of committing mistakes are greatly reduced. Similarly as a consequence of the additional documentation and planning, potential problems have a better chance of being recognized prior to their occurrence. Quality Assurance systems should commence at the brief and design stages of a project, and continue throughout the construction until completion. Quality Assurance will only work effectively if all parties involved, client, designer, contract administrator, contractor and subcontractors, are convinced that Quality Assurance is good for their own business.

Safety during the construction project is also influenced in large part by decisions made during the planning and design process, safety largely depends upon education, vigilance and cooperation during the construction process. Workers should be constantly alert to the possibilities of accidents and avoid taken unnecessary risks.

REFERENCES

[1] Quality Control and Safety During construction. http://pmbook.ce.cmu.edu/13_Quality_Control_and_Safety_During_Construction.html

[2] Ang, A.H.S. and W.H. Tang, Probability Concepts in Engineering Planning and Design: Volume I - Basic Principles, John Wiley and Sons, Inc., New York, 1975.

[3] Au, T., R.M. Shane, and L.A. Hoel, Fundamentals of Systems Engineering: Probabilistic Models, Addison-Wesley Publishing Co., Reading MA, 1972

[4] Bowker, A.H. and Liebermann, G. J., Engineering Statistics, Prentice-Hall, 1972.

[5] Fox, A.J. and Cornell, H.A., (eds), Quality in the Constructed Project, American Society of Civil Engineers, New York, 1984.

[6] International Organization for Standardization, "Sampling Procedures and Charts for Inspection by Variables for Percent Defective, ISO 3951-1981 (E)", Statistical Methods, ISO Standard Handbook 3, International Organization for Standardization, Paris, France, 1981.

[7] Skibniewski, M. and Hendrickson, C., Methods to Improve the Safety Performance of the U.S. Construction Industry, Technical Report, Department of Civil Engineering, Carnegie Mellon University, 1983.

[8] United States Department of Defense, Sampling Procedures and Tables for Inspection by Variables, (Military Standard 414), Washington D.C.: U.S. Government Printing Office, 1957.

[9] United States Department of Defense, Sampling Procedures and Tables for Inspection by Attributes, (Military Standard 105D), Washington D.C.: U.S. Government Printing Office, 1963.

[10] what is quality assurance http://www.buildingprofessionals.com/quality-assurance/what-is-quality-assurance-2

[11] Quality Assurance in the Construction Industry Albert P.C. Chan a School of Building and Planning, University of South Australia , North Terrace, Adelaide, SA, 5000, Australia

[12] Wocdhead, W.D. & Syafraniec, A. (1993) Quality assurance – beyond theory into practice, Australian Institute of Building Bulletin No. 1,Canberra

[13] StandardsAustraliaAS3900,3901,3902,3903,390(41 987),Standards

[14] Standards Australia AS 2990 (1987), Standards Australia, Sydney

[15] Bant Singh and Dr. Srijit Biswas, Effect of E-Quality Control on Tolerance Limits in WMM & DBM in Highway Construction - A Case Study. *International Journal of Advanced Research in Engineering and Technology (IJARET).* 4(2), 2013, pp. 33–45

[16] Amani, M Al Hadidi. Assessment and Quality Assurance. *International Journal of Civil Engineering and Technology,* 8(1), 2017, pp. 199–202.