8. Management of Fabrication Quality

8.1. Aims of Quality Management

This chapter describes the elements of a quality management system used in a fabrication facility or site, although the same principles are used to describe quality management in all manufacturing and service industries. Note that the term 'Quality Management' is introduced, which is intended to include all aspects that affect the quality of the product. The adoption of a Quality Assurance system as outlined in AS/NZS/ISO 9000 is only one aspect of quality management. Other systems are in use, such as AS/NZS/ISO 3834. Principles such as Total Quality Management are also used to manage quality.

The aims of quality management are to:

- Provide a product or service that meets the customer's expectations
- Limit risk to the public and the environment
- Demonstrate through a systematic approach that the product or service is fit for purpose

These days the principles of quality management are being used as a basis for an integrated system of management. All aspects of the business are managed by the same system, including:

- Product quality
- Environmental control
- Employee and public safety
- Business ethics
- Cost control
- Financial control
- Et cetera

Of these, the first four are subject to customer and public scrutiny.

Many organisations are finding that having a quality management system is not just about ensuring the customer receives good product. It is also about providing the product on time, with correct invoices, ensuring any queries are courteously dealt with and after sales service is available. It is also about minimising cost of scrap and rework by having a system to limit recurring problems. It is about avoiding warranty claims, product liability costs, loss of market share, and loss of opportunity because of low quality and efficiency.

8.2. Appropriate Level of Quality Management

Management of quality is also management of risk. Quality management requires effort and expenditure. The principles of risk management are used to determine the appropriate level of effort.

8.2.1. Consequence of Failure of the Product

Engineers constantly have to assess the consequences of failure, which may have significant safety, environmental and cost penalty. The risk may affect the manufacturer's personnel, his customers, the public or the environment. The failure of a building, bridge, pressure vessel or similar large structure is a major event causing a significant risk to life and the environment. The huge impact of disasters like Flixborough, Alexander Keilland, Piper Alpha and Chernobyl are obvious, but failure of even light structures such as furniture, play-equipment or handrails may risk injury or death. In many industries, such as Oil and Gas, failure of equipment can have huge cost impact because of unplanned outages. Such risks can only be minimised by an appropriate level of quality management.

Some failures may only have minor impact, for example detract from cosmetic appearance. They do not warrant high management effort. A faulty compact disk will not play, which is only a minor annoyance. Fortunately, these discs can be made to high quality with little impact on the price.

In the heavy engineering industry, the fabricator often has little knowledge of the operation of their product. Only the owner and designer can foresee the risk of operational problems, and therefore cannot pass on all liability to the fabricator. The owner and designer must therefore take responsibility to ensure that an appropriate level of quality management is applied.

8.2.2. Chance of Failure

a) Complexity of Design

The chance of failure depends on the complexity of the design, and the interaction between different aspects of the design. A complex item may fail catastrophically in a large number of ways. For example, a carbon steel air receiver is relatively easy to manufacture as it has a simple shape, is not dimensionally critical and is made of few materials. A submarine is a complex structure, whose safety depends on many factors (hull structure, power system, breathing air, water purification system). If any of the critical systems failed, the integrity of life could be affected directly or indirectly by failure of other critical systems. A submarine contains a large number of items, many of which are critical to operational safety.

b) Maturity of Design

As you design or fabricate anything ask, "Have we or the fabricator done this before?" If not, "Has anyone else done this before?" The big question is, "Can all the manufacturing and operating problems be anticipated?" In most cases safe practices have evolved and been written in national and international codes and standards. These standards are adequate for fabrications subject to normal service conditions. If the structure is subject to extreme or unusual service, it is difficult to predict failure. Particular care is necessary if such failure could be catastrophic.

c) Complexity of the Manufacturing Process

The risk of a fabricator failing is dependent on the complexity of operations at the workshop or site, particularly the number of different materials and processes he needs to control. This is not necessarily related just to one project, but to all jobs at their site or workshop. A stainless fabricator must have a system of control to assure that the structure

is made of the right grade of material for it, and that it is not confused with material for someone else's job.

Complexity of manufacture is dependant on the size of the organisation, the range of materials and processes involved in manufacture, and the extent to which quality is dependent on the manufacturing process. For example welding a super duplex stainless steel for extreme corrosion resistant service (seawater piping) requires that welds have arc energy in the range 0.5 to 1.5 kJ/mm. This is difficult to assure without considerable training, supervision and inspection.

8.3. Quality Assurance to ISO 9000

The use of QA has become an essential requirement over recent years, as it is a requirement of major customers, both government and industry. More designers and fabricators are required to introduce AS / NZS / ISO 9000 generic quality systems.

ISO 9000 covers all manufacturing and service industries from Abattoirs through Metal stamping to Zipper fasteners. It does not attempt to define individual elements of control, because it is very broadly based. It relies on there being adequate knowledge of the essential factors in both the accrediting and manufacturing organisations.

The ISO 9000 family of standards has three levels of accreditation:

- ISO 9001 for organisations with design and fabrication responsibility
- ISO 9002 for organisations with fabrication responsibility only
- ISO 9003 for inspection organisations

8.3.1. Requirements for a Quality System to ISO 9000

In order to establish and implement a quality System to ISO 9000, an organisation must:

- Develop a quality manual and written procedures that cover the complete manufacturing process
- Implement the manual and procedures by involvement and training of relevant personnel
- Through internal audit, demonstrate the system's implementation
- Have the system assessed by an independent QA accreditation body, who will audit the system and issue a certificate of compliance to ISO 9000.

In Australia, the major accreditors are QAS, a Standards Australia subsidiary; the shipping classification authorities, Bureau Veritas, Lloyds Register, and Det Norske Veritas (DnV) of Norway; and some commercial inspection organisations such as ETRS and SGS.

8.3.2. Elements of a Quality System

A quality system to ISO 9000 will address all of the relevant elements listed in Table 7.

Table 7 Elements of an ISO 9000 Quality System

1	Management Responsibility	11	Calibration
2	Documented Quality System	12	Inspection and Test Status
3	Contract Review	13	Non-conforming Product
4	Design control	14	Corrective action
5	Document control	15	Storage, Packing and Delivery
6	Subcontracting and Purchasing	16	Quality Records
7	Purchaser Supplied Product	17	Internal Audits
8	Identification and Traceability	18	Training
9	Process Control	19	Servicing
10	Inspection and Testing	20	Statistical Techniques

8.3.3. Problems with ISO 9000 Quality Systems

Quality management systems have been subjected to some criticism over the years. They are perceived as expensive in view of the heavy reliance on documented systems and records. There is a major difficulty in deciding which processes should be controlled. There are only vague descriptions in ISO 9000 of how processes should be controlled and the appropriate level of control. This is because ISO 9000 has such a wide application. It relies on the knowledge, skills and judgement of the accreditor and manufacturer to ensure the system is sufficiently comprehensive.

Unfortunately, the accreditors are all commercial organisations who are acting for the company being assessed. There is therefore commercial pressure to act for the manufacturer's benefit rather than the customer or public benefit. Often the assessor does not have the relevant technical knowledge of the organisation being assessed.

Another drawback is that ISO 9000 standards do not cover competence, only requiring that suitable training be given. These standards therefore offer no help in deciding who should have competence in controlling technical operations. They therefore rely on other standards to do this.

This situation has led to a number of inappropriate systems being approved, with the result that ISO 9000 quality systems have failed to avoid major disasters. There is reluctance in countries such as Germany which have entrenched standards based on regulation and proof of competence, to accept ISO 9000 quality systems as equivalent to their own.

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Contents