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REPORT**

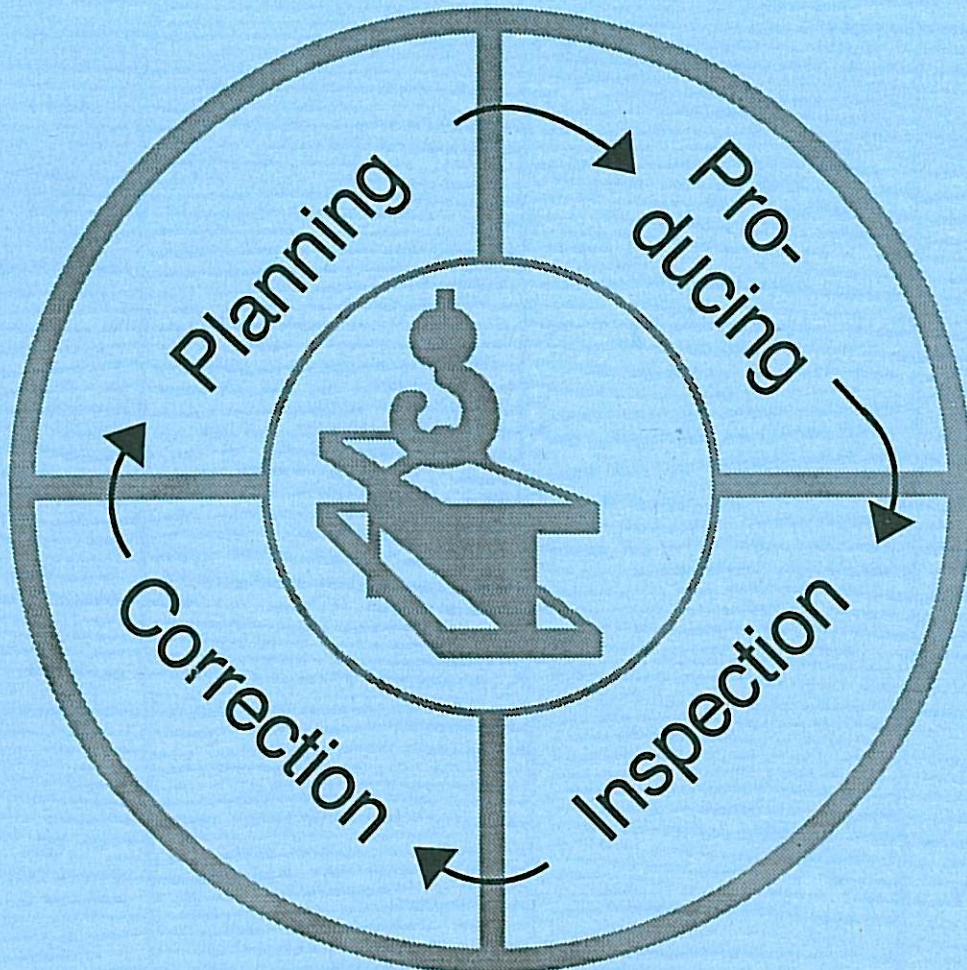


**BYGGFORSK**  
Norges byggforskningsinstitutt

Norwegian Building Research Institute

# Quality Management

A Challenge for the Building Industry



Ralph Hansen and Odd Sjøholt

# Quality Management

## A Challenge for the Building Industry

Norwegian Building Research Institute 1989

**Quality Management. A Challenge for the Building Industry**  
**UDK 568.562**  
**ISBN 82-536-0319-3**  
**Composed by Torunn Benestad, NBI**  
**500 copies**  
**Printed by NOR-TRYKK A/S**

**©Norwegian Building Research Institute 1989**  
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## Preface to the Norwegian edition

The priority given to quality control by the 3B Program in the period 1985-89 has led directly to a collective effort, valued at nearly 20 million Norwegian crowns, within the active section of the building industry. Both companies and trade organisations have participated in the development work, with both financial and active support. On behalf of all parties, there is good reason to thank the 3B Program's management and administration for showing such trust and confidence in the granting of project funds, and for following up, and carrying through the project in such a positive way.

The company groups were created partly as a result of an initiative from the trade organisations. Here we should give a special mention to the Norwegian Union of Plumber's Companies. They have set an excellent example, by encouraging their membership companies to go in for their own individual development. Motivation is an important part of the Union's objective to contribute to the increase of the trade's competence, and improvement of its reputation.

The Norwegian Building Research Institute has led most of the 3B supported projects, and the following efforts at promotion. Nearly twenty companies joined the program from the start. All the companies have been very open and obliging, and that has contributed much to the fact that experience gained from the project was continuously and immediately put out into practice.

The results of the project seem, up to now, to be very promising. The companies claim that they have gained much from their participation, and the number of participants is continually increasing, through courses and new company groups. In addition to this, compared with other lands, we have a good starting point. Requests for translations for systems and methods have already been received. International experience of this nature will stimulate our national work, and lead to increasing efforts in the field.

This report is based primarily on the results and practical experience gained from projects that the Norwegian Building Research Institute (NBI, Byggforsk) has been involved in. The other developments in the field are also described, but in less detail. The report evaluates where Norway stands in relation to other countries in this field, and gives a rough picture of the areas we ought to concentrate on in the future.

The project team at the building institute has consisted of Birger H. Skaar and the editors. We have found the project both inspiring and educational, and are grateful to the nearly 200 people who have more or less actively participated in the work.

We would also like to thank the following editing team for valuable advice during the writing of the report:

- Managing director Åge Hallquist,  
Norwegian Building Research Institute.
- Chartered Architect MNAL Inger Stray Lien,  
Norwegian Technical Science Research Council.
- Cand. Scient. Trine Tveter,  
Norwegian Ready Mixed Concrete Association

We have also received excellent, and necessary support from Maria Tveito, with linguistic guidance, and Torunn Benestad, who has drawn the figures by means of a computer.

We hope this report furnishes more companies with ideas, and the motivation to make use of our Norwegian experience in their own internal development and improvement program.

Oslo, June 1989

Ralph Hansen

Odd Sjøholt

# Preface to the English edition

Quality Control and Quality Management are now very topical themes in the building industry in most European countries. In some lands the development and practical trials of quality systems are carried out in connection with national programs and with government funding. At the same time there is a continuous international exchange of guidance lines and practical experience through various organisations.

The Norwegian Building Research Institute has carried out a number of measures to aid development in Norway, and is actively promoting and helping to establish quality management in individual companies. The Institute's methods and results have been presented to several international forums through the medium of the international organisation for building research, CIB's Working Commission, W88 Quality Assurance. In addition, our methods have been presented at seminars arranged in 1987 and 1989 by Construction Section of the European Organisation for Quality (EOQC).

Several lands have shown great interest in the Norwegian methods, and we have received requests for both material and consultancy services. These include the process of both building up a quality system, and establishing it step-by-step in the company. The Norwegian model, of a 30 month long co-operative team project between a group of smaller companies for the development and establishment of quality management, has also drawn great interest.

In order to give better information to interested parties, NBI has decided to translate the material on quality management from Norwegian to English. This report is a direct translation of a corresponding Norwegian report, with a few minor adjustments. This has been translated by Babs Sivertsen. In addition an English edition of the Quality Management System for Building Contractors will be published in the summer of 1990.

We hope that this report will contribute to an increasing international contact, with the exchange of both theoretical views and practical experience - and that it can give inspiration to those companies that are themselves working with the development of quality management.

Oslo, October 1989

Ralph Hansen

Odd Sjøholt

# Contents

	Page
Preface to the Norwegian Edition	3
Preface to the English Edition	4
Contents	5
Summary	6
Development of quality control on company and project level during the years 1985-89	7
Co-operative groups for the development and establishment of Quality	10
Why establish Quality Management? - the potential for savings	13
The five step model for the establishment of a Quality Management System in a company	16
The structure and content of a quality system	22
Work model for company groups in co-operation	29
Explanation of Quality concepts in practice - ISO 8402	31
The scope of the standards ISO 9001-03, and how they should be interpreted and used in the building industry	33
The contractual demands for quality assurance - and how these are met in practice by the contracting parties	36
Internal Quality Management - ISO 9004	38
International development of Quality Management in the building industry	39
Recommendations for further measures	42

## Summary

In 1985 the 3B Program (for the development of housing construction in Norway) published a report on the quality control situation in the building industry. After a large building trade conference the conclusion was drawn that practical measures within the individual companies, and through projects would be preferable to direct research.

During the first few years some clients demanded the fulfillment of "off-shore-like" requirements such as handbooks and check lists. Many companies were thereby induced to carry out a good deal of paper work that had little practical use. The result was the development of a rather negative attitude towards quality assurance, which was regarded as expensive and ineffectual. Even so many companies regarded quality assurance as necessary in order to satisfy the requirements of future customers. Little by little these pioneering companies began to concentrate their efforts on internal organisation and control. The concept of quality control as a series of documents for the customer was gradually replaced by quality control as a means of achieving the company's quality aims. Therefore improvement and profitability became directly linked to quality and quality control.

Because of this situation in 1985 there was great interest among the companies to co-operate with the aim of finding more efficient solutions that could at the same time satisfy the clients' demands for quality assurance from their suppliers. With support from the 3B program, company groups from three different building trades started developing a common quality management system, and began to integrate the system in their companies. A great deal of material was collected, through the parallel development of the Contractors', Plumbers' and Precast Concrete Factories' groups. As project supervisor, NBI was in a position to work out a common model for the main characteristics of a quality system, and then supplement with a more detailed account for certain aspects for each of the trades.

The result of this process was published in 1988 as the **MODEL FOR QUALITY MANAGEMENT SYSTEMS**, a reference work for each of the three participating building trades. The contents give advice on the development of a company system, and on the drawing up of quality plans for a building project. A large number of procedures, and other written aids such as forms, check lists, and memo lists comprise the greater part of the

contents. The intention is not that the model should be copied directly, but that it should furnish ideas for the company's own development. The most important single factor experienced by the company teams was that developing a "quality attitude" in an organisation is a process that takes time, and must be carefully supervised by the management. Therefore a suggestion is worked out for a five step development program, lasting two years or so, which can be used by any company.

The form in which the co-operation developed, with 6-8 companies comprising a project team, has shown itself to be both inspiring and mutually educational. Both the contractors, and the plumbing companies from the first project teams decided to extend their co-operation a further two years. And in the autumn of 1988 a new team of plumbing companies started up. The companies, during the course of 30 months, will be following a five step integration model, under the continuous guidance of NBI. Experience gathered in the first year was very positive, and should be transferable to other trades within the building industry. There are plans to start yet another team of plumbing companies, and a team of contractors in 1989. At the same time introductory courses are being arranged for companies that wish to start their own internal development process.

Parallel with the building industry's practical development of quality systems, the new international standards for the suppliers' quality assurance have been adopted in Norway. Some of these (ISO 9001-3) are intended for use in contracts, and have already been referred to in several building contracts. Unfortunately these have often been used rather uncritically, and with little modification to suit the nature of the project. A new standard (ISO 9004), is intended to give the basis for the individual company to establish its own internal quality system.

In other countries too the development of quality assurance and quality management is under way. The direction of this development has, to a great degree, been determined by the national conditions of the country. In England certifying authorities are working eagerly to incorporate the whole of the building industry into a system where approval of the company's quality system functions as documentation for the client. In Denmark the development has been influenced by the ordinance of a

building damage trust for government financed housing, and by demands for quality assurance for both design and production. The level of development in Norway, compared to that in other lands, is judged at the moment as being advantageous for those companies that have already decided to adopt quality management.

Of all the knowledge gained from five years of efforts at improving quality management perhaps the most important lesson is that all development work has to be carefully planned and continuously supervised if one is to

achieve permanent change and improvement. At the same time efforts to increase the efficiency of the entire industry must be stimulated. Therefore a 3-4 year development plan should be drawn up, with delegation of tasks and responsibility, and financial support should be obtained for several special tasks that the building trades have in common. Several lands are now using government funds to make national industries more efficient by concentrating on quality management.

## Development of quality control on company and project level during the years 1985-89

### Introduction

In the beginning of 1985 the Building Council, with support from the 3B Program, arranged a trade conference on quality assurance. At the same time a report was published, that analysed the topical development tasks. The 3B Program concluded with the wish that:

- \* concrete projects should be established, aimed at gathering experience on how quality assurance should be set up in building companies.
- \* these projects should be organised such that most of the building industry could draw benefit from them.

In 1989 the Building Council arranged a new conference, with building damage as the main theme. One could register that, after a difficult start for many, the development of quality control now seemed to be on the right track.

During the period 1985-89 quality management has become more concrete in its content for many companies. Originally one had seen it as an extra demand from the client, as an extra guarantee for his orders. This was often regarded as an extra expense, and a burden.

But later developments contributed to a change in attitude. Quality management is now generally accepted as the company's own internal measures to control the quality of its own products from start to finish. The objective is to carry out the task as efficiently as possible, thereby contributing to increased profitability. Therefore the search for improvement has become a permanent process, both on company and project level.

### What has happened?

In Norway the building industry came into contact with more bureaucratic systems for quality assurance relatively early, through deliveries to the oil industry in the North Sea. Many companies had to work out their own handbooks and systems without any direct contact with practical reality. Many used the standard NS 5801 for supplier's quality assurance as a basis. To a large degree, texts from the standard were simply copied into the handbook. Handbooks from one company were often copied by another. Other companies employed consultants who made "off-shore like" systems. Check lists on the build-



ding site were introduced, without their users feeling that they gained any advantage from them. Altogether this created a lot of unnecessary paper work.

Gradually the pilot companies' experiences led to a broad effort to develop and establish quality control on both company and project management level. During the period 1985-89 a good deal of money, both from public and private funds, have been invested in the development and establishment of quality systems. In fact, the sum invested amounts to tens of millions of norwegian crowns.

The market situation in this period has affected the development. In the beginning the market was strongly inflated, whereas towards the end it became rather still. At its busiest there was little time to concentrate on individual development work, while when the market slackened companies tended to concentrate on marketing themselves, and drastically reduced all development costs that didn't give immediate returns. But a few companies realised that it was exactly in this situation one had to improve to survive. At the same time employees were motivated to personal engagement and effort in order to secure their own jobs.

The following pages will give a short account of what has been happening within the different branches of the construction industry.

## The client

A few professional clients, who build more than once, have already started on the development of their own internal quality system. At the same time they make demands on the quality system of their suppliers. Companies such as Aker, Statoil, and recently, Aker Eiendom, have had a good deal of influence on the development through the demands they make of their suppliers. Through the various projects the parties have become more and more pre-occupied by written aids for effective quality control, and want to avoid inflated handbooks and unnecessary documentation.

Within the public sector a good many practical measures have been gradually started up, eg. at the P.S.A (Property Service Agency) - both within the civil and military sectors, and by the Department of Transport. The Department of Transport, and its equivalent county offices are co-operating on producing a quality system, and running local courses for its practical integration.

Clients that only build once seldom express special desires for quality assurance from the supplier, but a few consultants have begun to introduce quality requirements in the invitation for tender to the supplying company. Up to now such requirements have been on paper only, and haven't been followed up under execution.

In 1985 the project Control and Co-ordination in the Building Process (CCB) was started up in co-operation between clients and the construction industry. Trial projects and reports will mostly be concluded in 1989. Quality Assurance has been one of the themes. But the most

important contribution from CCB to the trade's further development is the creation of a systematic base on which to determine the clients objectives.

## Architects and consultants

Some architect firms have been drawn into quality assurance through their work with various projects, while, at the same time several have decided to improve their own office procedures. The Architect's Office, Einar Vaardal Lunde has developed extensive internal company and project routines, and incorporated them into a handbook. This book is mentioned in several of the building industry's courses, and is published under the name "Quality Assurance Manual 88".

In 1986 the Association of Consulting Engineers, Norway (ACE) published a general model book for members, see fig.1, accompanied by a nation wide information course. From 1987-89 ACE has been working with the design of model forms for procedures and other written aids. In 1989 ACE are planning to publish a hand book on the quality assurance of all the information that flows between individual firms and specialists in the course of a project.

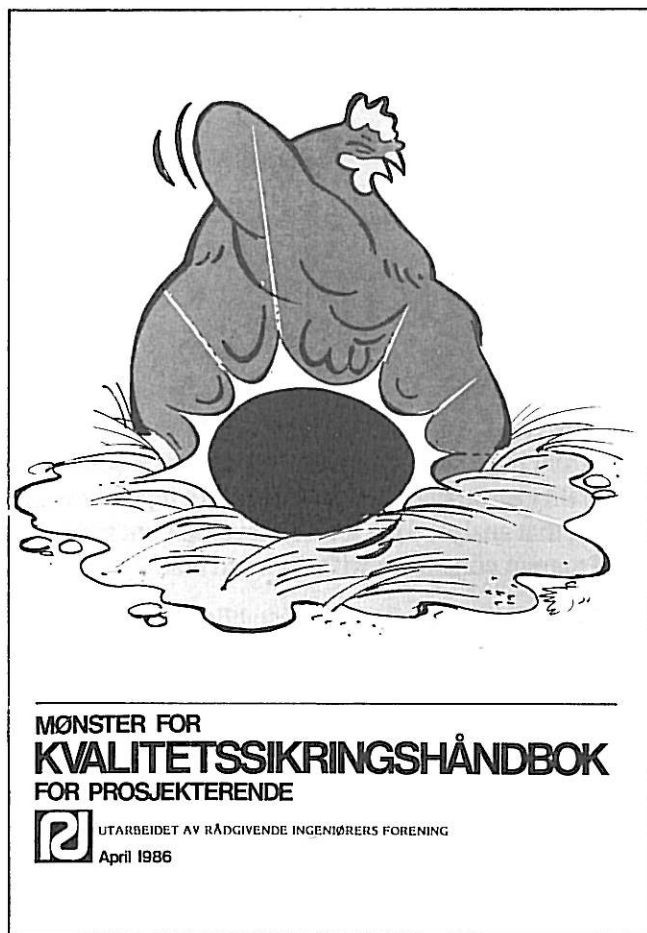


Fig. 1. The Quality Assurance Manual from the Association of Consulting Engineers provides the user with a frame designed for filling out in the individual companies.

In certain contracts consultancy practices have been obliged to display their system for quality assurance. But clients have, so far, only to a minor degree demanded continuous documentation.

### Construction companies

The large contractors, with contracts for tasks connected with the oil industry, decided in the middle of the 80s to make their own special quality manuals and quality assurance procedures. Following the model from another industry the managements employed people specially to develop and integrate quality systems both in the central administration of the company and on site for larger projects. This gave the impression that quality assurance was something that could be carried out independent of project foremen, reporting directly to the top management.

At the same time many of these pilot companies already had many internal procedures for quality assurance on company and project level that was more or less in daily use. Partly because of this it took time before companies began to aim at integrating systems for quality control into the daily life of the firm, and began to regard it as the responsibility of the crew foremen to integrate and use the systems.

After a while there came a break through for the concept of quality control as a part of the entire company's steering. At this point **TOTAL QUALITY MANAGEMENT** became the catch word for several of the companies. Through campaigns and training they built up study

groups for improvement work, partly in the form of so-called quality circles.

An especially extensive co-operation on the development of quality systems was carried out during the years 1985-88. Three project groups, consisting of contractors, plumbers and prefabricated-concrete factories, worked together with the Norwegian Building Research Institute to develop a **MODEL FOR QUALITY MANAGEMENT SYSTEMS**. An account of the effort itself, the results, and the spreading of ideas to new groups follows in the next chapters.

The spreading of ideas from the active companies to others within the building industry has happened partly through direct information by lectures, courses etc., and partly through the performance of building tasks. During the building process external demands for quality assurance have often been transferred from the contractor to the sub-supplier. Small sub-supplying companies have therefore had to undergo the same educational process as the larger companies, in order to understand that the introduction of internal improvements are a better basis from which to work than the fulfillment of external demands.

Altogether the industry has, in recent years, shown a positive development towards the acceptance of quality assurance as an aid to increasing efficiency and quality awareness. The spreading of both demands and knowledge has occurred through practical project work, an important factor in ensuring that the solutions integrated are really useful. But this is a very slow process, if one relies upon this for the promotion of a development throughout the entire industry.

# Co-operative groups for the development and establishment of Quality

## Co-operation on the development of the model for Quality Management

By 1985 several companies within the contractor's trade had already started up the development of their own quality management systems. In the 1970's several of these companies had co-operated in groups in the development of production management systems under the leadership of NBI. Based on the experience gained from this project NBI drew up a program for a new co-operative project on quality assurance in April 1985. This program was supported by the 3B Program. By August '85 the following companies had agreed to participate in the three year long project:

- \* Aker Entreprenør A/S, Oslo
- \* Byggholt A/S, Bærum
- \* A/S Anlegg, Trondheim
- \* Lau Eide A/S, Bergen
- \* Berntsen & Boe A/S, Oslo
- \* Ragnar Evensen A/S, Oslo
- \* A/S Betong, Sandnes
- \* Petter Kristiansen A/S, Kongsberg.

Norsk Hydro A/S joined the group as the client's representative.

In the Spring of 1985 a few plumbing companies in the West of Norway received demands for quality assurance from their clients. The Norwegian Union of Plumbers decided that the time was ripe to start up a co-operative project between a group of companies. With NBI's participation a program was drawn up. Again, the 3B Program gave the necessary financial support, and by the end of 1985 the following companies had agreed to join the project:

- \* Andersen and Forsman A/S, Asker
- \* Anders O. Grevstad A/S, Bergen
- \* VVS K. Lund A/S, Trondheim
- \* ORAS A/S, Oslo
- \* Teknisk Bureau A/S, Stavanger
- \* Chr. M. Vesterheim A/S, Bergen

The program "Concrete '84", set up by the Norwegian Concrete Industry's Union, had already started on several projects for stimulating the development of the concrete industry. Quality assurance was proving to be a more and more prominent theme, and, as before, a co-operative program was drawn up with the help of NBI, and the financial support this time of both the 3B Program and

the Industrial Trust. Within the first three months of 1986 the following companies had agreed to participate:

- \* A/S Betong, Sandnes
- \* A/S Block Berge Bygg, Klepp
- \* B. Brynildsen & Sønner A/S, Moss
- \* Norcem Betong A/S, Fredrikstad

Spenncon A/S joined the group in the Spring of 1987.

The project supervision and the responsibility for drawing conclusions was all the time collected in one place. The three projects were set up with similar programs, and with great emphasis on making reciprocal use of any experience gained, successful methods discovered etc.

## The development, trials and recording of the model for Quality Management Systems

The aim of the project groups was to develop a model for quality assurance that could be used by the whole industry, but at the same time was flexible enough for the individual companies to be able to integrate it into a system that was effective for their special needs. One also had the aim of spreading the results to other companies in the industry. The project was aimed at the collective administration both of the company itself and of its production projects. The main idea was to integrate special quality assurance elements into the management of the company and its production management.

The strategy was to build further on all the good procedures and practices that already existed in the participating companies. Together one was to develop a more complete and coherent MODEL FOR QUALITY MANAGEMENT with examples of solutions. The ideas were tried out, and experiences compared, recorded, and finally worked into a written record: the model itself.

The project administration was supported by a project council for each of the three groups. Personnel from the Institute for Building Organisation at the Norwegian Technical University were engaged in the development work of the contractor's group. In addition, several students carried out projects and theses in co-operation with various of the companies.

The development work started by collecting in all the company's procedures and forms. Through meetings further information on existing good practices, and areas where reform or development was needed most was re-

corded. The material was continually systematised, and revised at the secretariat, and presented and commented in revised form to group meetings and to the individual companies.

Trials were carried out little by little, sometimes on special trial building sites. Various different problems arose in the process. Most of the companies found "holes" in their own systems, and got new ideas from the project group meetings. In this way the project was continually receiving new information.

It had already been decided that the records of conclusions and results were to be compiled into some form of handbook. Along the way it was decided to include both the material giving guidance, and models and examples in one single publication, **THE MODEL FOR QUALITY MANAGEMENT SYSTEMS**, see fig.2.

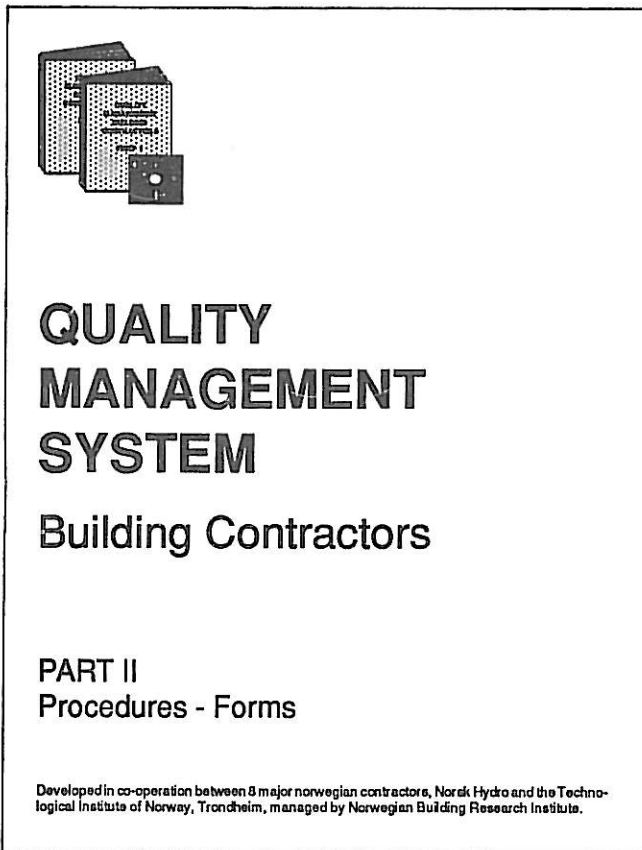


Fig.2  
**THE MODEL FOR QUALITY MANAGEMENT** exists in editions designed for contractors, plumbing companies, and prefabricated concrete factories. The three editions are similar in design, and much of the material can be used by many other types of companies.

### Why use co-operative groups?

Crucial to the success of the project was its co-operative form. Working in groups gave both width and depth to the material collected, and entailed a critical examination of all recorded material, thereby ensuring that the material would also be useful for other users.

This form for project work also resulted in the compa-

nies' learning a good deal from each other. At the same time the companies have had to engage themselves thoroughly in the project, partly because of pressure from each other to report on their internal progress at each meeting.

One considerable weakness in this form for project work was the lack of specially designed common measures, or programs for further motivation and spreading of ideas within the individual participating companies. This has, however, given some important lessons on the basic requirements necessary for internal development work to survive at all. These lessons have been included in the **MODEL FOR QUALITY MANAGEMENT** in the form of a suggested program for the introduction and establishment of quality management in a company, see fig. 3. The five step program is described in another chapter.

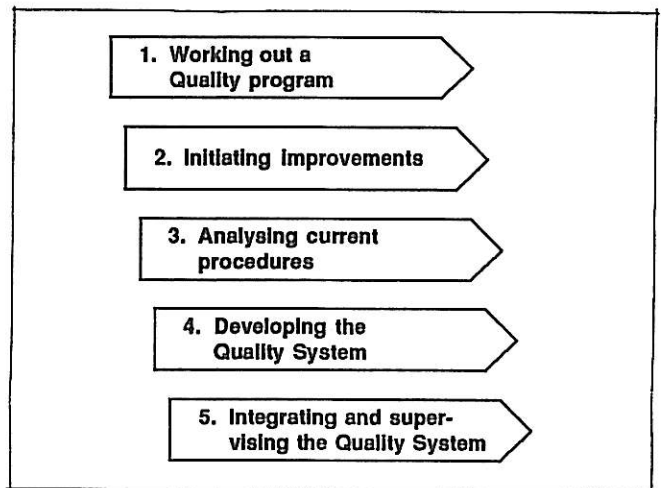


Fig. 3.  
 The introduction and establishment of quality management is carried out through a five step program, which suits all types of companies.

The co-operative projects were completed as planned in 1988. But the companies that had participated decided to continue with their own internal development of quality management. The contractor's and plumbing companies chose to continue with their co-operative groups for a further two years. The company managers felt that their experience with that form for project work, and the contact that it brought them was so positive that it would also be of good support in the work with further motivation and integration.

Company managers have high expectations of quality management and its ability to increase their competitive edge. As general manager Øystein Berntsen in Aker Entreprenør A/S stated at a project group meeting: "Our managers are no longer judged by the profitability of their projects alone. We also expect them to ensure that our quality system and procedures are followed within their area of responsibility, and that they generate enthusiasm and engagement from those working with them, and goodwill from our customers. All managers are followed up through "co-worker conversations" twice a year".

## New measures and new project groups for the establishment of Quality Systems

The way in which the project results were spread from the project groups to the rest of the industry was specially designed to stimulate a process of change in other companies.

A special introductory course has been set up, where both managers and people in key positions in the company are invited to participate. The course trains participants to start working out their own five step quality program for their own company. The intention is that the course gives the participants sufficient basic material for them to be able to start up their own development. After the course one can buy the MODEL FOR QUALITY MANAGEMENT as a support for further work. If desired, NBI also offers individual help with the establishment of a quality management system within the company.

During 1988-89 approximately 50 contractor's and plumbing companies have participated in the introductory course for quality management. The participants approved of the five step program as a simple and logical method for establishing quality management. Several companies are working further on this basis. Everything points to the conclusion that this form, where courses aim at the whole company, is more effective in achieving changes than the more traditional form where courses aim at individuals.

A more permanent effect can be achieved, of course, if one draws up a long term program. The experience gained from several years of group work has been so positive that a special group project program for the establishment of quality systems has been drawn up in detail. This system combines many advantages. The principle behind such a group project is that each company works purposefully on its own improvement, and is committed to sharing the experience gained in the process with the other companies in the group. In this way, everyone learns more than they would by working alone. The program is based on the five step program, supported by the MODEL FOR QUALITY MANAGEMENT. It includes various processes, common to all participants, that aid each company's own execution of the program, and include a step by step training and educational development of the company's employees.

Fig. 4 shows the program for a 30 month group project. The program is explained in more detail later.

As a step in the process of spreading information to the rest of the industry, more project groups are to be started up, that are to follow the new program. The prefabricated concrete piping industry have been invited to form a group, and contractor's companies are also working to establish a group for middle sized companies. A new

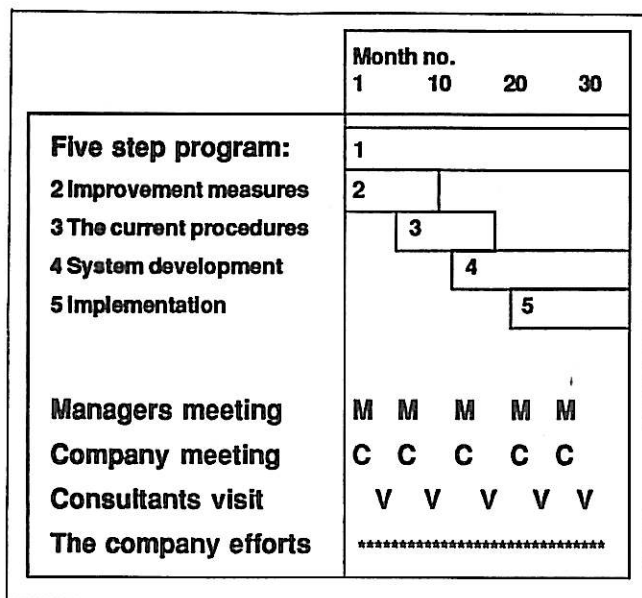


Fig 4.

Program for a five step establishment of quality management in a group of companies.

group of plumbing companies started up already in 1988, and another is planned to start up in the autumn of 1989. The newly started plumbing company group is following the five step program for establishing quality management. This functions as an extra control that the system works as intended. The following companies have joined the group:

- \* A/S Helge Lid VVS, Ålesund
- \* Finn Midbøe A/S, Stavanger
- \* J.C. Haugs Sønner A/S, Lillehammer
- \* Olav Grevstad A/S, Bergen
- \* Rørleggeriet A/S, Bergen
- \* Sig. Halvorsen A/S, Sandnes
- \* Vann og Varme A/S, Harstad
- \* Werner-Winther A/S, Oslo

The starting phase during the first year has been very promising. The company managers, and people in key positions have developed good insight into the process of leading work to establish a quality system, and share useful ideas and working solutions with each other.

We quote from a lecture by general manager Dag Halvorsen from Sig. Halvorsen A/S: "By the end of the first meeting each company had already worked out its program to be carried out before the next meeting. The idea was to build further on the system already in use in the company - to develop further that which was positive, and to improve that which was negative. The eight companies had therefore drawn up eight different programs. But we had each promised both ourselves and the others that our own program would be carried out, and that we would personally answer to each other for what we had achieved by the next meeting."

# Why establish Quality Management? - the potential for savings

## The concept of quality

The word "quality" means nature or character.

In daily usage we talk of "good quality" as a valuable property.

The word "quality" is neutral: we have to have something to measure quality against. In industry this results in our referring to things as having the "right" or the "wrong" quality according to how well they fulfill the requirements demanded of them.

The definition of quality given by the standards ISO 8402 is:

"The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs".

This means that quality, seen from outside the company, means fulfilling our customer's requirements, within the given framework.

Internally, in the context of production, it means fulfilling those requirements that are demanded of the product or task.

## The first meeting with quality assurance

The contracts demanded that:

"The supplier shall present the customer with written proof of a quality system that fulfills the standard ISO 9001"

This is often a company's first meeting with quality assurance: that the terms of a contract, or the customer company demands that the quality system is displayed as part of the pre-qualification.

The simplest solution is to get some consultant to write a handbook. This is an emergency solution, and easy to resort to. The book could save the contract!

But little by little the awareness has grown that the company in fact gains from quality work. It pays: Quality work aids rationalisation, which in turn represents a saving. One book alone is not going to give the "right" quality. Quality is generated by the knowledge and attitudes of every single employee. The changing of attitudes is, of course a process that takes time, but results already begin to appear early in the process.

## The basis for rationalisation

Quality management is defined as the techniques and

processes used to fulfill the quality requirements.

What does this mean in practice? Fig. 5 shows the so-called "Deming's circle". This circle of management represents the essence of quality management.

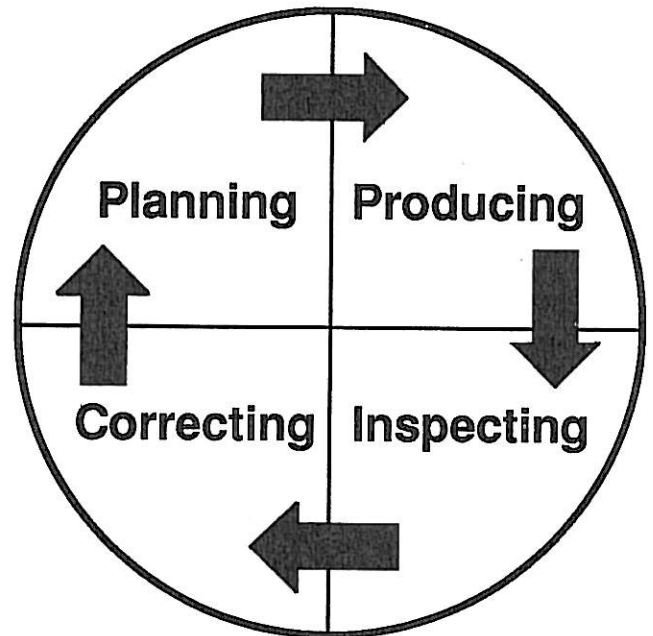


Fig. 5.

The Deming's circle shows a "management route" that summarises the process behind quality management.

Every task has to be planned, and is then carried out according to the plan. Then one has to check that the task has been carried out correctly. If necessary the result must be corrected. What is learnt from this process is utilised the next time one has to plan the task, etc...

The most usual problems:

- \* It is easy to underestimate the need for planning of a task. There is a marked tendency to start straight away on the task itself.
- \* It is also easy to neglect the inspection and testing of the work. In order to check one has to have something to measure against. Do we know what the criteria for approval are?
- \* Perhaps the most important part of the circle is the feeding of any experience gained back to the planning stage. This is often very difficult, especially when one

takes the entire company into consideration. One has to have a system for learning not only from our own, but from others' experience.

Quality management will ensure that the Deming's circle is closed. Therefore quality management will contribute to a continuous rationalisation of the company.

### The potential for saving

**What does it cost us when we don't do things right first time?**

Everyone can see that it costs us both time and money if we don't do the job right first time. We have the cost of repairs, of rejection, of complaints etc. And this is only the top of the iceberg! See fig. 6.

must be regarded as an investment in the same way as any other investment. One has to expect at least the same profit on one's invested capital as one would for any other investment.

This can be achieved by lowering the entire company's quality costs. The concept quality costs is often called "non-quality costs" because they are costs resulting from non-conformity, not from the right quality.

An oft quoted definition of quality costs is: "The difference between the actual cost of developing, producing and marketing a product, and the reduced cost that would be possible if there were no chance of making mistakes in development, production, marketing or use of the product."

This is a very comprehensive definition, but it emphasises the fact that quality costs is a wide concept. It can be useful to group the different elements covered by the concept of quality costs as shown in fig. 7.

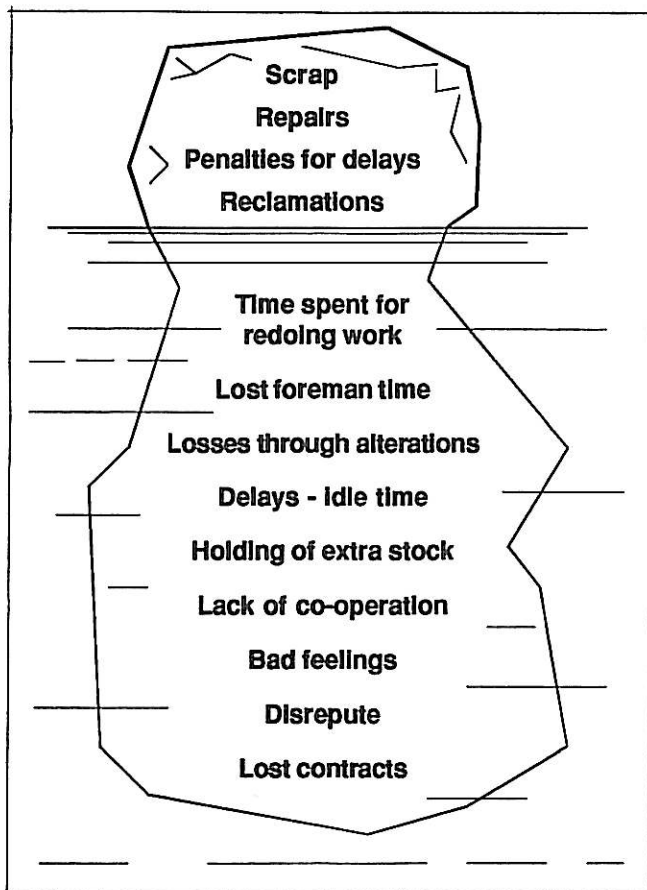


Fig. 6  
The costs caused by quality problems are like an iceberg, with only the top 10% visible.

The greatest potential for savings lie with managerial problems such as waiting time, problems with purchasing, problems with co-operation, lost confidence, etc.

### The concept of quality costs

Establishing a quality system in a company is the task of the management. The costs of establishing such a system

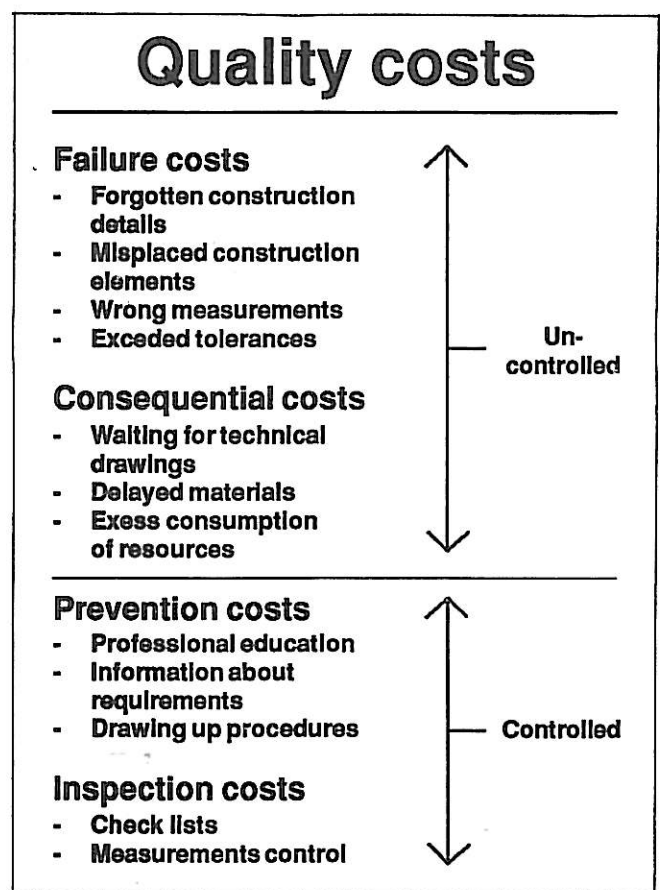


Fig.7  
An illustrative quality costs model

Here follows an explanation of the words in the model:

- \* preventive costs: costs that arise from the planning and execution of measures that prevent mistakes from happening, or in some other way contribute to decreasing the total quality costs.
- \* testing and inspecting costs: costs that arise from planned inspection or testing, or are directly connected to these.

- \* failure costs: costs that arise from unplanned rejections, corrections, replacements etc. of non-conforming products.
- \* consequential costs: costs that arise as a result of mistakes made in other areas than those in which the cost actually arise.

Preventive costs, and testing and inspection costs are possible to control and make decisions about. They are the controlled costs.

Naturally, one attempts to minimalise failure and consequential costs, but they arise usually through a defect in the organisation. They are the uncontrolled costs.

One of the main principles of quality management is that one decreases the uncontrolled costs more than one increases the controlled costs.

### Potential for saving

Several surveys exist that claim that 15-20% of the turnover in the Norwegian building industry comprises quality costs! The surveys also show that it is possible to reduce these costs substantially. Swedish surveys have resulted in similar figures, and they appear to agree with surveys from other industries. These figures are, however, only estimations, and must not be regarded too literally.

One of the world's leading authorities in quality management, Philip B. Crosby, divides companies into five categories, or "stages" according to their state of quality awareness, from ignorance to knowledgeable, see fig. 8. He also states what quality cost levels can be expected of each of these categories, and suggests a potential saving of more than 10%!

Quality Management - Diagnosis of state					
Area \ State	Uncertainty	Wakening	Under-standing	Insight	Certainty
Quality cost in per cent of sales	Unknown Probably 15-20%	Assuming 3% Actually 14-16%	Assuming 6-8% Actually 10-12%	Assuming ca. 5% Actually 7-8%	Assuming ca. 3% Actually ca. 3%
Summing up: Company attitude to quality	We don't know why we have a quality problem	We try motivation efforts, often short sighted	Problems revealed and solved by an improvement program	Preventive efforts are a natural part of the operations	We know why we don't have a quality problem

Source: Philip B. Crosby

Fig. 8

A company can be in several stages when it comes to quality assurance- from ignorant to knowledgeable.

In order to achieve gains of such a size it is necessary for the firm to undergo a systematic long term quality improvement process. But even with less potential profit, it will still pay well to invest in quality management. Note that any profit coming from quality improvements is net profit!

### Is quality management profitable?

We quote from the board of the contractor company Petter Kristiansen A/S' annual report for 1988:

"Quality assurance work continues to be given priority, and is plainly bearing fruit when we see that the amount of work going into correction of complaints is decreasing. At the same time P.K. is confirming its reputation in the market as a company one can trust to produce solid quality."

In January 1988, the prefabricated concrete company Spenncon A/S started up a systematic registering of all nonconformities arising in the factory. The nonconformities were classified into 56 possible causes altogether. The register showed that:

Corrections: 4 causes were responsible for altogether 82% of the time spent on correction of executed work.

Rejection: 6 causes were responsible for altogether 79% of work rejected.

Lost production: 6 causes were responsible for altogether 63% of lost production.

This analysis was used to aid the company's search for methods to lower costs. One could now concentrate on the few but expensive nonconformity problems. This together with other methods of rationalisations led to Spenncon's reducing its staff by 50%, while maintaining its level of production. The remaining jobs were secured.

The plumbing company VVS K.Lund A/S refers to pronounced gains in rationalisation, and fewer complaints since they had established a quality system for plumbing in detached housing.

### Japan's quality revolution

Recently we have heard much talk of Japan's quality revolution. Quality management expert J.M.Juran explains this revolution as having three main elements:

\* *Massive quality focused training programs*

Quality training is aimed at everyone in the company. One starts with the company management, and works one's way down through the chain of command step by step. Every job in the company is affected.

\* *Annual programs for quality improvements*

Because the occupiers of all jobs at all levels in the company are trained in quality work, it is possible to carry out annual programs for quality improvements. Improving the quality of a product or process becomes a habit.

\* *High level managers take personal responsibility for directing the process of change.*

The company management contributes actively to the quality management. A high level of knowledge and good written aids are found throughout the whole company, and the staff take advantage of them.

These points demonstrate clearly that quality work is a process of gradual improvement that has to be managed and controlled.



# The five step model for the establishment of a Quality Management System in a company

## Experience already gained from establishing Quality Management Systems

As already described in detail, the MODEL FOR QUALITY MANAGEMENT SYSTEM was developed by three separate groups from three different trades, in parallel.

The aim of each of these groups was to work out a model quality management system for their own respective trades.

Although group work concentrated on creating a model system, each company was working with the development of quality thinking, and the establishment of a quality system in practice in its own company.

This made it possible to observe the results in each individual case, and systemise the criteria for the successful establishment of a quality system in a company.

The most important criteria are:

- \* The establishment of a quality management system starts at the top and spreads downwards through an organisation. The top management must be actively engaged in the process.
- \* The process has to be organised and supervised. Realistic plans for objectives must be drawn up, and sufficient resources set aside for the purpose of achieving these objectives. One person should be responsible for running the process.
- \* Concrete objectives, with methods of measuring the degree of success, should clearly state which improvements should be aimed at first.
- \* The establishment of a quality management system takes time. One has to choose which areas to give priority to, and where to concentrate one's efforts. It is just as wrong to go forward too fast as it is to go too slowly.
- \* A quality management system must build on a company's existing procedures. In all companies there are good procedures and systems which are wholly or partly followed. These should be collected and used as a base for further developments.
- \* It is the users of the quality management system that must develop the system. Each company must take responsibility for its own development. It isn't possible to buy a ready-to-use quality management system.
- \* A quality management system is promoted by its own reputation. When each individual discovers that his

work is easier with a quality management system than without, then he will follow the system. This will contribute to continuous renewal, updating and improvement.

These criteria are built into the five step model, presented by the MODEL FOR QUALITY MANAGEMENT SYSTEM, for the establishment of a quality management system in a company.

Establishment of Quality Management in a company. The process must be organised and supervised. (Step 1)

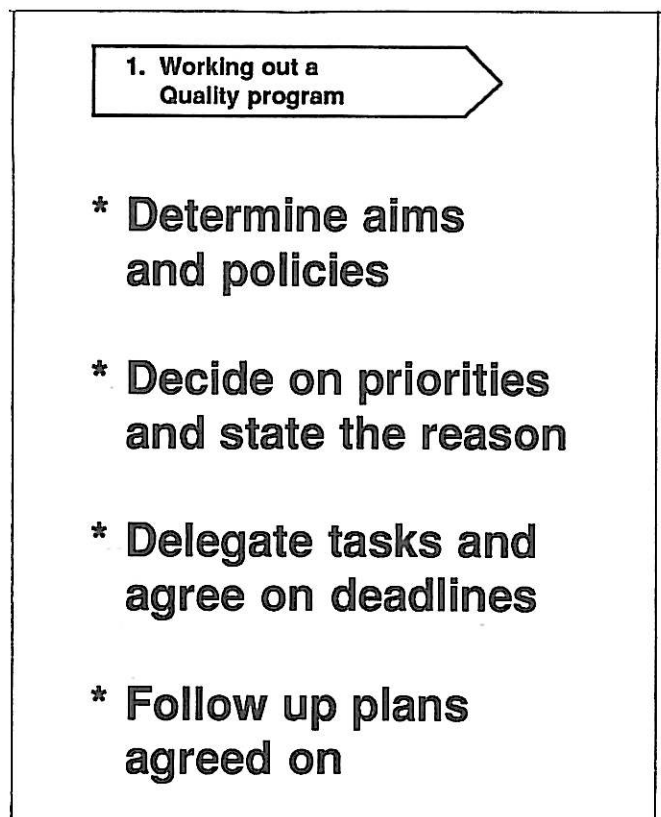


Fig. 9. Drawing up a Quality Program. The main points of Step 1.

Step 1, Drawing up a Quality Program, is a continuous task that will be in progress throughout the process. It is here that the aims for quality improvement work are decided, and the planning, organising and supervising of development work is scheduled.

A quality program means a program for the actual execution of quality improvement work in the company.

The quality program must contain a survey of concrete objectives. It must state which tasks are included, who is responsible and who is involved in each task, time limits, and if applicable, budget.

Usually one starts with a rough draft, which is then filled in with the necessary degree of detail for each task or part of the total project.

### The tasks of Step 1

Organise the drawing up of the program:

- Key words: why, what, how, who and when.

Appoint a managing group with a project manager for the development work.

Train key personnel:

- Whoever is manager for the program is to be thoroughly familiar with the criteria and the methods for such a development process.

Study the company's present situation and improvement potentials.

Set aims for the improvement of quality, punctuality and economy.

Evaluate measures, and decide on priority.

- Describe the means by which the aims are to be reached, eg. quality system, training etc.

Draw up a program for a limited period, eg. 1/2-1 year at a time.

- Plan all tasks with a time limit, assignment of responsibility, and, if applicable, budget.

Ensure execution and supervision of the chosen tasks.

- Ensure that information on the measures, and their results are given internally.

Evaluate results, deviations and alterations of tasks continuously.

- Keep searching for possible improvements. Update and revise the quality program continuously.

In addition a few introductory measures may be necessary, such as:

- \* investigating the possibilities of obtaining professional help from outside the company.
- \* participation in external courses to learn more about quality management
- \* internal seminars etc.

QUALITY PROGRAM		ASSIGNMENT SCHEDULE								
		DATE 10.03.89								
OCCUPATIONNAME 1. HELGE 5. MAGNE 2. ARNE 6. RANDI 3. KALLE 7. TOVE 4. ARVE 8. GANG FOREMAN		WORK ASSIGNMENT R = RESPONSIBLE C = CO-OPERATING COMMENTS = WEEK NO.								
NO.	TASK/PROCESS	1	2	3	4	5	6	7	8	COM.
1	Preparation of a meeting for all plumbers together to work out priorities for improvement measures.	R	C							15/16
2	Adjustment and completion of already made draft procedures	R								
3	Distribution of a schedule for employee's registering of effective and weak areas of the company	R								13/14
4	Meeting in the quality group on further work	R								15/16
5	Collecting and filing all types of existing forms	R								23
6	Procedures for administering stock and stores	R				C				
7	Procedure for the plumbers loan of tools in common	C	C		R					10
8	Change of the purchasing procedures	C	R							
9	New design of procedures and forms		R							10
10	Quality program for the autumn 1989	R	C			C				22
11	Follow up the plumbers meeting on Quality	R	C							23
12	Follow up the staff meeting on Quality	R	C							23

A/S HELGE LID VVS  
MYRABAKKEN, 6010 ÅLESUND

QUALITY MANAGEMENT SYSTEM  
PLUMBING COMPANY

Motivation - improvement of Quality is simple. (Step 2)

## 2. Initiating Improvements

\* List possible improvements

\* Give priority to certain tasks and carry them out quickly

\* Inform everybody on results "It's worth it"

Fig. 10.

Example of a quality program in an early phase of the establishment of quality management, from the company A/S Helge Lid VVS.

Fig. 11.

Starting up improvement measures. Main points of step 2.

Step 2, the "improvement step", is the phase where the organisation is trained to search for possibilities for improvement, and carry out concrete measures to realise them. There are no formal requirements as to how these improvements are to be recorded.

### **Why have an improvement step?**

Here it is useful to repeat that it takes time - often several years - to establish an operative quality system. (One is never finished with the process - it's always possible to get even better!) Motivation for the necessary quality work is therefore highly necessary, and the whole organisation must participate in the process.

Some of the reasons for having an "improvement step":

- \* It entails a rough analysis of the improvement potential in the company.
- \* Employees become more enthusiastic.
- \* It gives employees training in improvement work.
- \* It produces concrete results which show that work for the improvement of quality pays.

### **The work cycle in step 2.**

The "improvement step" consists of the following cycle:

- \* Roughly analysing the possibilities for improvement.
- \* Working out priorities among the possible improvement measures.
- \* Selecting a few improvement measures which are then carried out swiftly.
- \* Informing the rest of the company on achieved improvements.
- \* Select new measures to be carried out....etc.

### **The tasks of step 2.**

Plenary meeting for key people from the project groups.

- Collect together the key people who are to carry out the improvements in the various departments and disciplines. The intention of this meeting is to give information about quality management, explain words and concepts, and motivate to making an effort. How to organise the execution of the programs for the various departments and disciplines should also be discussed. Training in techniques for solving problems arising can also be given.

Surveying possibilities for improvement within departments and disciplines.

- Collect together the personnel in groups according to their departments or disciplines. Inform them on the plans for quality management, explain words and concepts, and motivate to making an effort. Stimulate a discussion about where the company is effective,

where it could be better, and what values to build on. Take up the work situation for the individuals involved, daily problems, and where there is potential for improvement. Work out priorities, and choose which improvement measures to concentrate on first.

Development and execution of improvement measures within departments and disciplines.

- Assign responsibility for the execution of the selected measures. Key words: who, what and when. Agreements arising from these surveys must be binding for all parties!

If necessary one big problem should be divided into several smaller problems in order to find an area where improvements can be executed swiftly. The emphasis is on speed. One is attempting to demonstrate that it pays - that concrete measures can improve the work situation. Already the quality work is bearing fruit.

Plenary meeting with a summary of needs and possibilities.

- Collect together the groups again. This meeting is for information and discussion about the practical means of improving the selected areas. One can also discuss further work with other possible areas of improvement.

### **Which measures should be carried out?**

Any area of the company where one feels that improvements are possible could be chosen for improvement measures without such measures necessarily being related to quality management in the narrowest interpretation of the concept. The most important thing is that the aims are clearly defined, and the results can be measured.

Questions of administration and economy are often given high priority, as are factors that influence the work environment.

Several of the companies in NBI's project groups chose the reduction of invoicing time as a concrete aim. Although this is a purely administrative problem, it bears upon other, more production orientated problems. The advantage of this particular aim is that it is easy to measure.

One of the companies managed to reduce invoicing time by eight days. Up to now it has given a yearly saving of three times the elaboration costs of the new procedure.

At this phase it is important that the discussions are constructive. Experience shows that employees start out with the attitude that one's own problems are everyone else's fault. First when the idea matures does the employee begin to think about what he or his department can do to ease co-operation, and contribute to improvements.

## Collecting and evaluating the company's procedures and forms. (Step 3)

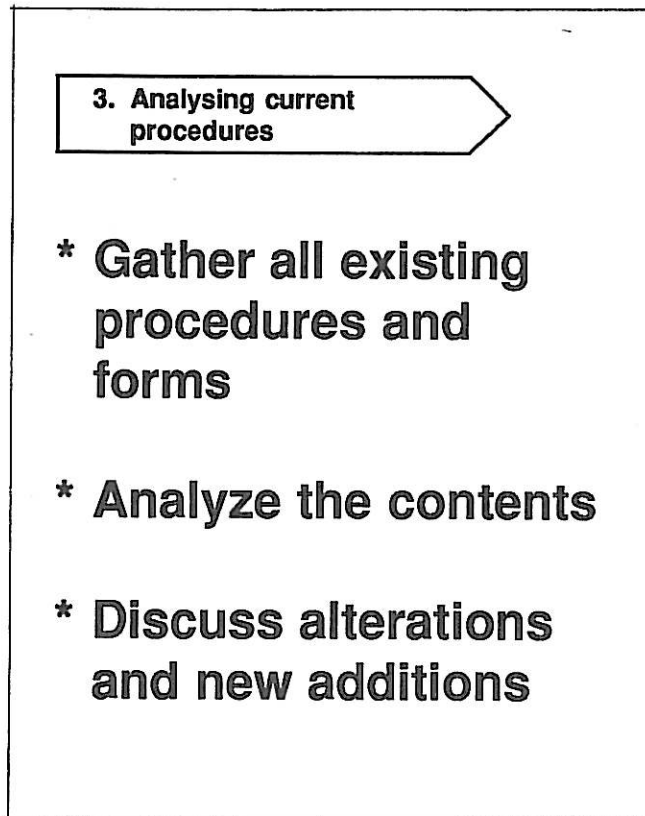


Fig. 12.  
Collecting and evaluating the company's procedures and forms. The main points of step 3.

Step 3, the collection and evaluation of the company's current procedures and forms is the phase where the company systematically analyses its own organisation and management.

Here one investigates what is recorded in the form of procedures, check lists, schedules etc., and how well they reflect reality.

One should also draw up a plan showing what should be changed, added or worked out in order to satisfy internal needs and external demands.

### Why collect and record the company's procedures?

All companies have several good, established procedures that are followed. But these are not always recorded, and it isn't always clear who is responsible for what.

If one is to improve one has to know what is being done, who is doing it, and why it is to be done. This is achieved

by recording those procedures that are actually carried out.

Some of the advantages of recording one's procedures:

- \* It leads to discussion and analysis of one's own work situation. This has often proved to be the basis for concrete improvements.
- \* It clarifies the delegation of responsibility. When recording procedures one is forced to decide who is responsible for what. The expression: "Relax, I've done it already" has never caused a problem. It's much worse to hear: "I thought YOU'd done that!"
- \* It makes it possible for other to take over in cases of illness etc.
- \* It makes the training and introduction of new employees to their work much easier when the company's procedures are written down.
- \* Written procedures can be used as a basis for discussion. One cannot plan improvements without being familiar with current methods!
- \* Written procedures can be presented to the customer who requires documentation of one's quality system.

In step 3 one collects in the existing written material in the company. First in step 4 does one begin to record unwritten procedures, and develop these further.

### The tasks of step 3.

Plenary meeting, where the topic under discussion is the registration and recording of routines according to departments or disciplines.

- The employees of one department, or, if more suitable, a discipline or work area, come together and discuss and record which tasks are carried out by them.

Collecting in written material.

- Each department collects in all its existing written material: procedures, instructions, forms, check lists, circulars etc. The material from all the departments is then sorted into a collective file for the whole company.

Evaluation of the material within departments and disciplines.

- The collected material is evaluated. What is good? What can be improved? Is some of the material out of date? Is anything missing? Is anything overlapping?

Plenary meeting with a review of connections between departments or disciplines.

- The various departments and/or disciplines must also be co-ordinated. This can be done either by overlapping of personnel in the project groups or by plenary meetings. Here one can also discuss one's list of priorities over new or improved solutions.

## Developing the Quality System further, on both company and project levels. (Step 4)

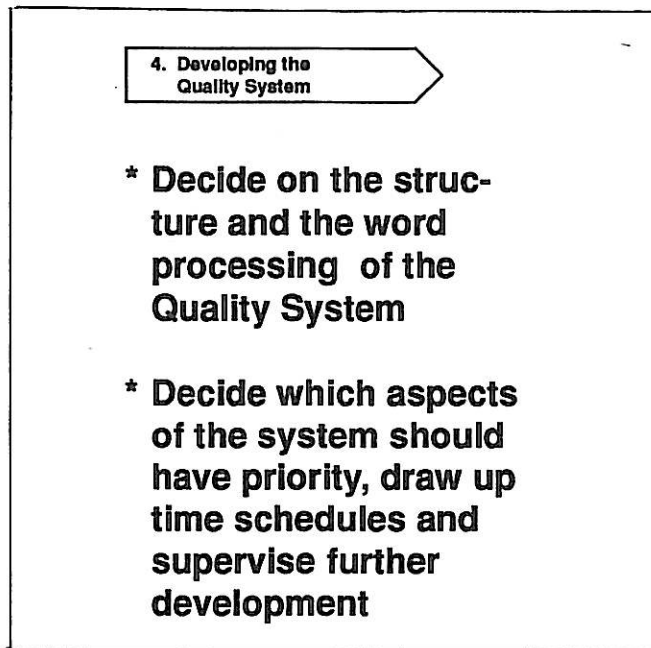


Fig. 13. Developing the quality system further on both company and project levels. The main points of step 4.

The objective of step 4, developing the quality system further, is to record, co-ordinate, systematise, and supplement the company's procedures and forms etc., in order to create a collective system for the company's quality management.

The object of a quality system is that internal aims are achieved and external demands satisfied.

### Which procedures should be written down?

It is not necessary to record all of the procedures in use in a company. This would merely cause a pile of unnecessary paper work. One should only write down procedures where it is deemed necessary. This is decided by evaluating the danger of nonconformities occurring, and the consequences of these nonconformities.

The following principles can be used to decide the scope of the procedures to be recorded:

A procedure should be written down:

- \* when earlier experience has shown that the absence of a written procedure has led to mistakes or misunderstandings in the execution of the task.
- \* when common sense says that the possibility for defects would be considerably reduced by the existence of a written procedure.
- \* when the company wants a standard execution or product from a procedure.

By following these principles the company will achieve a tailor-made quality system that satisfies the company's own special needs. One must distinguish between the

recording, or "documentation" of routines, and the "documentation" of the product, ie. the signed papers that accompany the product and verify its standard and authenticity. A product is "documented" to the degree considered necessary, and this is previously decided and built into the procedure itself.

### Who should write down the procedures?

The person/people who are to carry out the procedure should be delegated the task of writing it down, if necessary with help from a central quality assurance manager. In this way several positive results are achieved, among them:

- \* the individual is forced to think through his work situation.
- \* one has a chance to air thoughts and ideas he has been chewing over.
- \* one is forced to assign responsibility.
- \* the best of all the possible practices is the one which becomes established.
- \* the individual receives training in "thinking rationalisation and improvement".

We refer to the next chapter for the actual design of the written system.

The procedures and written aids that are to be developed form the basis for the various projects quality plans.

### The tasks of step 4

Decide on the scope and the principles for the design of the quality system.

- This point includes deciding how to edit the quality system, and what areas are to be included. It also includes evaluation of the design of procedures and other written aids, and the setting up of a coding/filing system.

Agree on a common program for the recording and writing down process, compare with step 1.

Process the material from rough draft to finished document. This process includes:

- \* elucidating the need for written procedures, and other aids.
- \* making a survey of current practices and improvement potential (see step 3)
- \* drawing up a rough draft/suggestion for the procedure.
- \* inviting comments from those affected.
- \* comparing the resultant edition with needs and demands.
- \* obtaining the approval of those who are to use the final edition.

Co-ordinate departments and disciplines with each other, and decide which areas are to be given attention next.

Work out a system description for the company's quality management system.

## Establishing and supervising the use of the Quality System. (Step 5)

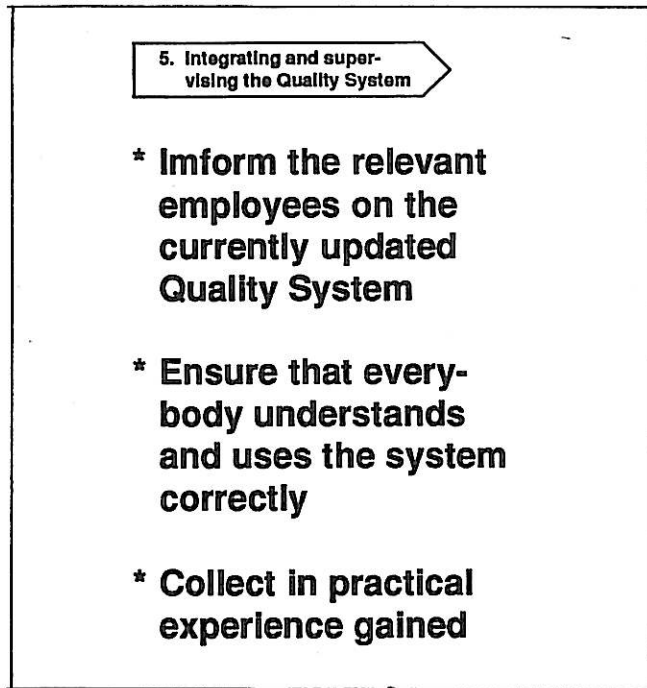


Fig. 14. Establishing and supervising the use of the quality system. The main points of step 5.

The objective of step 5, the maintenance and further development of the quality system, is to ensure that as the system develops it is distributed to the right people, used correctly, and to the correct degree. Step 5 should also ensure that the users of the system understand how to make use of the system, and that any practical experience gained from the use of the system is fed back into the system again.

### Quality plans on the project level

A quality plan is a description of how the quality management system for a project is designed and works. It should record for all contract parties how the company will ensure that the terms of the contract will be fulfilled.

The quality plan should explain how the company will design and plan, produce, check, document and administer the project.

The client may demand the drawing up of a quality plan specific for his project.

Experience shows that it actually pays for the supplier to work out a quality plan.

By working out a quality plan one elucidates factors that bear on the progress and execution of the project at an early stage. This aids the supplier in his effort to manage the project correctly.

Certain conditions should be fulfilled by the quality plan:

- \* It should focus on the most important points - those where the danger of nonconformity or its consequences are great. The important points should not drown in the rest of the plan.

- \* It should be short.
- \* It should be lucid and easy to follow.
- \* It should be quick and simple to draw up.

### Feedback of experience gained

Feeding back experience gained from the use of the system is a very important point in any quality system. The use of computer aided word processing is a deciding factor in the successful and continuous updating of the system.

The quality system should consist of set procedures that everyone in the company should follow. In addition one must have a set of procedures specific to a project/projects, which describe how certain tasks relevant to the project are to be carried out.

If one builds up a filing system, a "library" of project specific procedures using computers, a project manager for any project can select those that are relevant to his project, and easily make any necessary alterations.

If new material is worked out for an individual project, then it should be the duty of those responsible for the project to ensure that this material is entered into the "library".

This will give the next project manager completely updated material to work with when drawing up a quality plan for his project.

### The tasks of step 5.

Draw up the distribution routes for the quality system.

Distribute the material.

- Remember to ensure that out of date versions are collected in and destroyed.

Help new users to become familiar with the use of a quality system, by, eg. letting them help the project manager with working out and following up the quality plan for the individual project.

Systematise the feedback from any experience gained from the use of the procedures.

Analyse reports of nonconformity and complaints to find out which problems consistently appear.

Take the initiative in making changes and improvements based on the feedback.

### The quality manager's job

In practice one person should be given the responsibility for all the tasks in step 5. In earlier steps, too, it can be a great advantage to have someone to act as a catalyst in the development process - a "quality manager".

The quality manager's job can be shared with other tasks, depending on the size and organisation of the company. But experience shows that if the job of quality manager is combined with tasks of an operational nature the latter will be perceived as more important, to the detriment of the work as quality manager.

The quality manager should not be responsible for the quality of the product. This responsibility should lie with the site and crew foremen etc.

# The structure and content of a Quality Management System

The three editions of the model for the Quality Management System are based on the experiences of the three groups of companies, representing three different building trades

## The intention of the MODEL FOR QUALITY MANAGEMENT

THE MODEL FOR QUALITY MANAGEMENT is a collection of written aids for the development and establishment of quality systems both on company and on project level.

The intention is to stimulate a general effort within the building profession to improve quality management, and to discourage the limitation of this effort to the formal, client-orientated quality assurance, with its emphasis on documentation.

The model is made by and for production companies, but most of the contents are also directly relevant to other parties involved in the building process. In particular, the principles for the development, structure and design of the system are universal. They should therefore be applicable or adaptable to the needs of most potential users.

THE MODEL FOR QUALITY MANAGEMENT is not designed for any one company. It covers both the administration of the entire company, and the execution of individual tasks. In this way the frame work covers all departments and all employees of a company. Therefore it is not limited to those who have a direct influence on quality. At the same time the contents cover all the usual and important tasks and processes that contribute to a "right first time" execution.

The practical contents of the model are far from complete. The main tasks of the company are given the best coverage, while questions of economy - budgeting, accounting and invoicing are omitted.

The main idea behind the model is that companies should use it as a basis and inspiration for the development of their own individual quality system, and improvement work. The model is intended to be a reference work where a company can look for special material, or study a whole area in order to find ideas for their own efforts.

The model presents no final solutions, just examples of how a problem can be solved. Direct copying of procedures and model forms is very inappropriate. Success is

conditional on each company's developing its own quality program, according to the situation in that company (see the previous chapter). Generally speaking, all companies, both large and small, can make use of the examples, but one must select the relevant material from the model book as one goes, and adapt it to one's own requirements, see fig. 15.

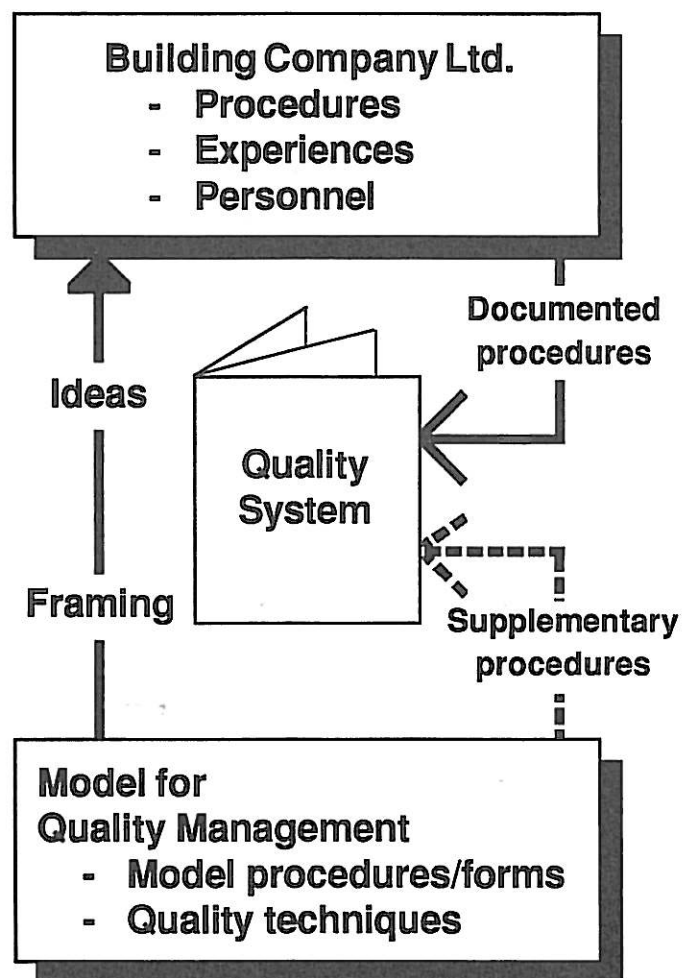


Fig 15.

A company must develop its quality system according to its own situation. The model can give a framework for the design and structure, and ideas for the contents.

## Contents

The model for Quality Management System consists of two volumes. Part 1 (about 150 pages) contains a user guide and a system description. Part 2 contains detailed procedures, and the forms, check lists etc. that belong to these, in all about 250 pages. See fig. 16.

## Part I

User guide (yellow)  
System description (blue)

## Part II

Procedures and forms (white)

Fig. 16. THE MODEL FOR QUALITY MANAGEMENT consists of part 1, with a universal model for the design and structure of the system, and part 2, with procedures and model forms of a more specific nature, for contractors, plumbers or prefabricated concrete factories.

The User Guide explains the design and structure of the system. Behind it lies a far-reaching effort to develop solutions that are both practical and flexible enough to be able to be adapted to a greater area within the building profession. The book also contains material on the use of norwegian standards for quality systems, and an account of how the control and supervision of quality costs forms the basis for any improvement measures. It also includes a register of key words, a table of references to ISO 9001, and an extensive list of references to relevant literature.

**The practical experience from the use of the system, and future updating.**

Byggforsk owns the copyright for the system and the responsibility for its further administration. Those who buy the MODEL FOR QUALITY MANAGEMENT are licensed to use the system in one company. After participating in an introductory course, the company is free to change and adapt the model procedures for internal use only. One can also buy the system in a diskette edition, see Fig. 17.

The intention is to continue the development of the MODEL FOR QUALITY MANAGEMENT, so that the building industry has a continually improving tool at its

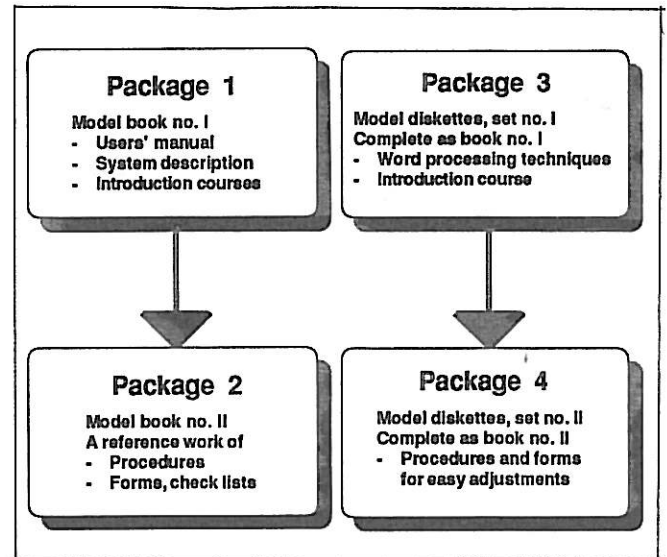


Fig. 17

THE MODEL FOR QUALITY MANAGEMENT can be obtained step by step in four packages.

disposition. Therefore, all users of the system are invited to report on their opinions of and experience with the system. The extent of updating and further development is, however, dependent on the distribution and the income from the sale of the Model System.

The principles for the design and structure of a quality system, based on experience gained while developing the model books, are given a closer look on the following pages.

## The structure and design of a Quality Management System

**Three system levels for a company and its projects**

The quality system is divided up into levels according to the degree of detail required for different areas of use, see Fig. 18.

Level 1 is the general level - the system description - which gives a summary of the model. Level 2 is the intermediate level- the procedures. Level 3 is the detailed level - the model forms - with written aids connected to the procedures, for practical daily use in the individual's working situation.



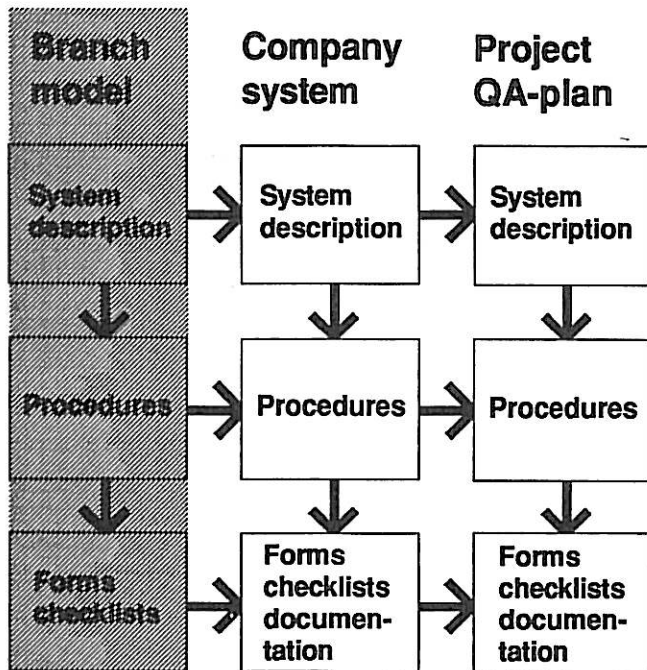


Fig. 18  
The sub-division of the quality system into three levels suits both the administration of the company as a whole, and the planning of individual tasks.

Many use the word manual for the system description, but this requires a closer definition of the scope and content.

#### The division into chapters, according to the company's main work areas

A quality system must cover all the phases of a building process that the company normally works with. Each phase consists of a chain of activities from the moment the task is received to the moment the product is handed over to the next phase. Each phase includes planning, execution, handing over, and a survey of practical experience gained in the process.

When planning the division into chapters the most important things to consider are:

- \* the reduction of the quantity of paper - how easy it is for the user to extract just the material that meets his needs and no more.
- \* the ease of retrieval - how easy it is to find one's way in the system.
- \* updating and development - how easy it is to make additions/changes in, eg. procedures and model forms.
- \* the suitability for word processing.
- \* the utilisation of earlier systems of division.

The division of a quality system into chapters ought to follow the phases/main tasks a company usually covers. Chapters set up along these lines will usually correspond to the organisational division of the company into departments, sections etc. It therefore becomes easier for the individual to place and retrieve material, see fig. 19. We

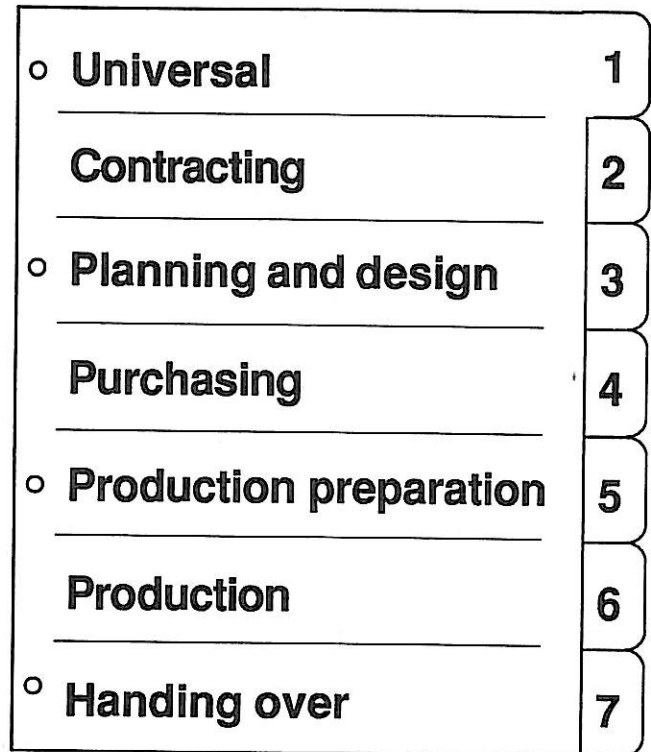


Fig 19.  
The division of the quality system into chapters should reflect the work areas covered by the company.

do not recommend a system of division that follows the headings of the quality standards, eg. 9001.

For all types of companies, material which is universal, or common to all departments can be collected into Chapter 1 Universal. This includes the company's central administration and management, as well as clerical tasks.

Other chapters cover the individual areas covered by the company. Marketing, estimation of costs, tender and contract writing can, for example, be placed in Chapter 2 Contracting/Sales. The next area could be Chapter 3 Design/ Construction. For production companies this would cover the working out of the technical production details, and the hiring or administration of design services outside of the company. For design companies, the material on design is the main content and is therefore divided into several chapters, eg. clients brief/program planning, tender material/detailed design, execution/handling over and administration/running/maintenance.

For production companies material on purchasing and storage can be collected into Chapter 4 Purchasing. This post is organised very differently from company to company. This chapter could, for example, cover central and universal tasks in the purchasing process, including those involving a central storage facility, while requirements for goods or services would then come respectively under other chapter headings.

The area under "production" can contain sections such as production preparation, rigging, prefabrication, production etc. The company is recommended to divide the material between Chapters 5 and 6 as it suits the company.

Material on handing over/delivery/guarantee, and service/running/maintenance can be collected in Chapter 7 Handing Over, or divided into two chapters.

Every chapter is sub-divided according to the same system.

By using the same system for the sub-division of chapters one can find the same material at the same place in the chapter. Fig. 20 shows an example of a set system for dividing chapters into sections sub-chapters 0-9.

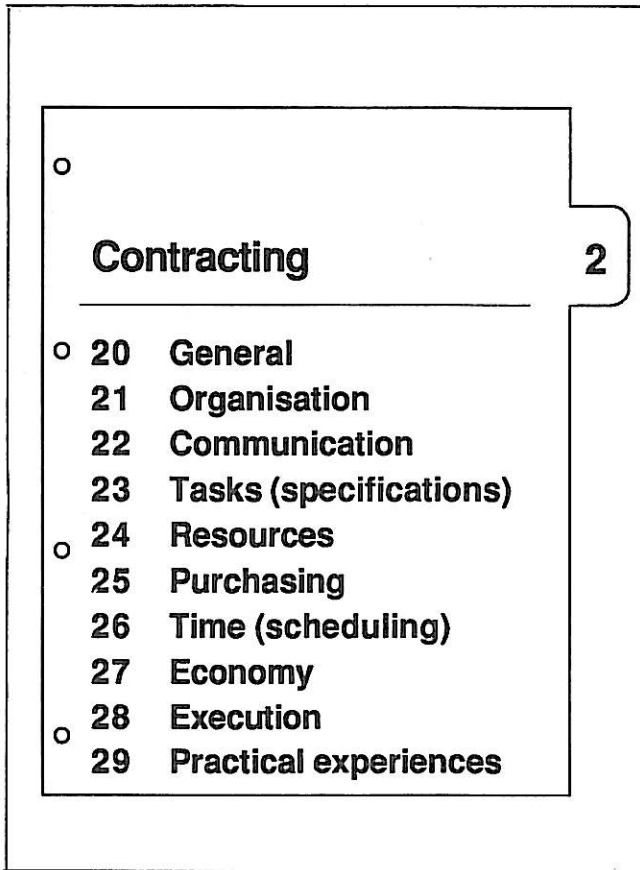


Fig. 20 Suggestion for a set system for the sub-division of chapters in a quality system. This subdivision covers most of the types of material that are involved, to a greater or lesser degree, in each of the work areas (departments).

The first sub-chapter, 0 General includes tasks and work areas that are common to a whole department (chapter), such as organisation, setting objectives, routines, group meetings, assignment of personnel etc. The following sub-chapters 1-9 cover all those points that are involved in a particular task (building project):

- 1 *Organisation* covers those aspects of organisation that must be agreed upon for each fresh project: assignment schedule, adaption of assignment descriptions etc.

- 2 *Communication* covers special project meetings, clerical services, post and filing systems and other written information.
- 3 *Tasks* covers project material together with specific requirements, review of project material and evaluation of solutions.
- 4 *Resources* compares the projects resource requirements with the availability.
- 5 *Purchasing* covers the process of obtaining and evaluating goods and services.
- 6 *Time* covers delivery time, co-ordination of own work and deliveries, on several levels of detail, and with the possibility of running adjustments.
- 7 *Economy* covers budgeting, accounts, analysis, agreements and alterations, invoicing, insurance, guarantees and quality costs.
- 8 *Execution* covers preparation and execution, control, registering, recording and documentation, treatment of nonconformity and corrective action.
- 9 *Practical Experience* covers the compiling, evaluation and circulation of useful material, together with the examination or audit of procedures.

**System Description**

A system description is a summary of the quality management system, see fig.21

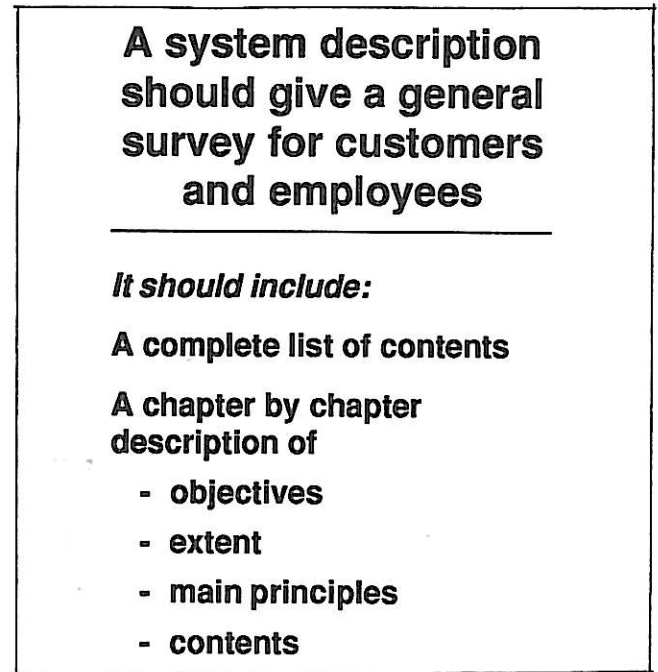


Fig 21 A system description is a summary of a quality system, giving a list of contents, and an explanation of the system of subdivision and the connections between the various sections.

A *list of contents* must show both what the system contains and where the material is placed. Two characteristics are essential: the contents must be uniquely defined, and the information must make it easy for the user to be able to find the correct document.

The list of contents must contain:

- \* *the document number* for ease of placing and retrieval.
- \* an unambiguous and unique *document name*.
- \* *an edition number* showing which edition is included in the system.

A written description gives a summary of the principles and main contents of a quality system. The intention is that the user can rapidly ascertain what the system covers, and how he can find the material he requires. In addition he is supplied with an explanation of the structure and design and the principles on which the system is built, and is given guidance in the use of the system. From the description he should also be able to judge for himself the scope of the system.

Each chapter should have its own system description with references to the updated list of contents for that chapter.

The material in a system description should be sorted, as far as possible into sections, in order to ease both the writing and the reading of the description. The following sections could be used:

- \* the objectives for that particular chapter of the system.
- \* the scope: what is covered, special exceptions or omissions, and important connections with other chapters in the system.
- \* the main principles together with any special conditions that have affected the design of the system.
- \* a brief description of the actual contents of the system, divided up so as to be easily comprehended.

### Procedures and task descriptions

Procedures are systematic descriptions of the method, and assignment of work for clearly defined and limited tasks, either within company administration, or on a project level. The word procedures also covers set processes, work instructions etc. The work with the continuous development, improvement and establishment of good procedures is the main task in the process of establishing better quality management.

The aim of a system with procedures is that:

- \* while working out/adapting procedures one utilises experience and ideas to create progressively more rational solutions, and a better work environment.
- \* guide lines for the execution of a task are recorded so that the product is always "right first time" in conformity with work standards and quality requirements.
- \* one stimulates co-operation and co-ordination, with an effective system of recording and spreading information both internally and externally.
- \* material for an effective training of new personnel is always available and updated.

A procedure must be carefully limited, so that:

- \* the task covered by the procedure has well-defined, natural limits, or is a sequence that repeat itself.

- \* the requirements of both starting point and result can be described and/or measured.
- \* the task can be performed by one person, or a few people working together.
- \* The routine can be described on one A4 page - cases of exception should not exceed a very few pages.

The contents of a procedure should include the following:

- \* the conditions for starting and the state of the material one starts with.
- \* the requirements for the end result, and how these can be measured.
- \* responsibility and practical work assignment (see task assignment schedule)
- \* references to written aids that should be used during the procedure.
- \* reporting, recording and, if necessary, documentation.
- \* the timing, and the connection with other tasks, before, during and after.
- \* what should be done, how it should be done, and in what order.

A company should write all its procedures according to a set model. This simplifies both the drawing up and the use. An example for the key words, or headings for a procedure is shown in fig. 22.

## Model for procedures

---

Unique name/no.

Objectives

Executed by

When

Previous procedure

Basis

Forms, check lists

Reporting

Following procedure

---

Execution

Fig. 22

A set model for procedures is a useful tool in a quality management system.

The model for administrative procedures can also be adapted easily to task descriptions. It is recommended that task descriptions should be collected in files according to the discipline/work area they cover, eg. divided up according to the letter codes for NS 3420 and NS 3421.

### Forms and other written aids

Most procedures involve the use of written aids such as forms etc. These could be forms for filling in information, orders, etc, check lists for crossing off, or comments, and many other formulas for processes that repeat themselves, both at company and project level. The purpose is to make certain that the tasks that are frequently repeated, or sufficiently important are ensured a correct and effective execution.

Forms and other such written aids act as the blood circulation of a quality system. It is essential that such aids are continuously adapted to new situations, so that they fulfill the practical requirements, and are therefore constantly in use.

A form must be carefully limited, so that:

- \* the task/part of a task covered by the form has well-defined, natural limits, and is frequently repeated.
- \* it covers an obvious need.
- \* the responsibility for filling in and approving the form is associated with defined jobs or people.
- \* there is space for the information on a page of A4 size or smaller. If necessary the material can be divided onto several pages placed beside each other.

A well designed form should be such that:

- \* the filling in requires little written work, and follows a natural order.
- \* it is easy to understand what should be filled in and how.
- \* there is sufficient space to write the necessary information.
- \* the information is arranged so that it is easy for others to understand, check and use.
- \* limitations, connections, and transfer of data from one form to another are given proper consideration.
- \* the forms are sufficiently general to be able to fulfill several functions (e.g. time schedules).
- \* a unique and explanatory name, and the correct code-number is written on all forms.
- \* all forms belonging to one company have the same general presentation - the same type of printing, framework and logo etc.

### The numbering (coding) system for documents in the quality system.

The coding system should exclusively identify each document in the system. The system for placing and retrieval of documents in the system should be adaptable enough to suit different users. It is not therefore possible to arrange all forms in the chronological order in which they are used in one process.

In a word processing system the use of the code numbers instead of the name to identify a document is effective. It allows a practical and swift handling of documents, and makes the possibilities for sorting and further development more flexible. The number codes within the

Word Perfect program can, for example consist of eight digits/characters before a point, and three after it.

It is recommended that the coding system is built up in such a way that the code number tells which chapter and sub-chapter the document belongs to, whether it is a procedure or a form to be filled in etc, and (in the case of a form) which procedure it belongs to. See fig. 23.

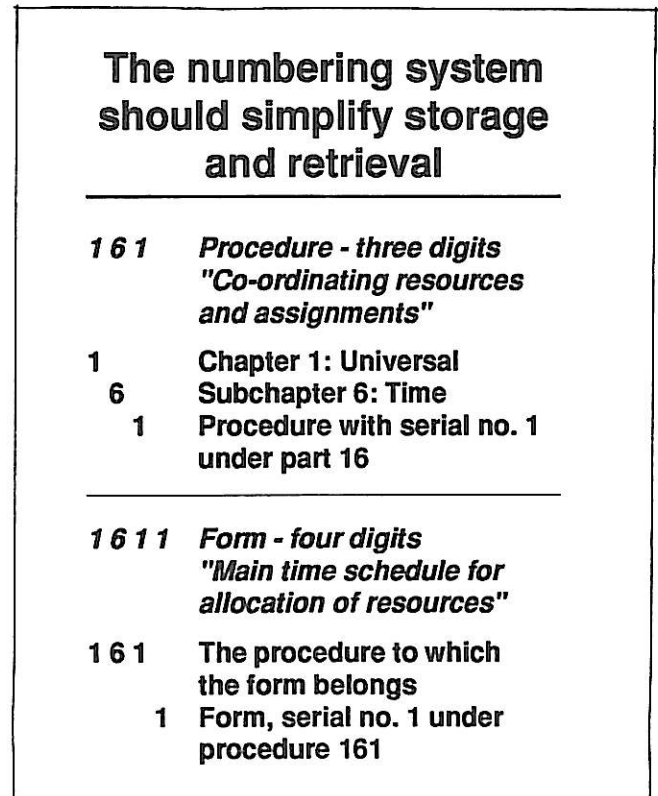


Fig. 23

A well designed coding system for all documents simplifies the process of building up the quality system.

The coding system is also used to show where in the system one has covered the demands of a quality standard. One can choose the degree of detail for a chapter or sub-chapter, and compare the contents with the demands of a standard in table form. See fig. 24.

### Using word processing as a tool

Word processing is a necessary tool for all companies building up a quality system. All model forms for procedures and forms etc. can be stored on file, ready for use, with built in tabulators, margins, headings, key words etc. Earlier procedures and forms can be retrieved and revised as required.

It is also very useful to be able to store and retrieve documents on PCs.

For print outs one can have a set document framework with the firm's logo.

A tidy appearance, with simple, well designed details in the model forms is of importance to both user and customer. It pays, therefore, to give a good deal of thought to the presentation, and to exploit the possibilities afforded by word processing.

<b>A companies Quality System</b>						
<b>1 Universal</b>	<b>1</b>					
<b>2 Contracting</b>		<b>2</b>				
<b>3 Planning and design</b>			<b>3</b>			
<b>4 Purchasing</b>				<b>4</b>		
<b>5 Production preparations</b>					<b>5</b>	
<b>6 Production</b>						<b>6</b>
<b>7 Handling over</b>						<b>7</b>
<b>ISO-9001 Requirements</b>						
<b>1 Mgmt. responsibility</b>	*		*	*	*	
<b>2 The Quality System</b>	*		*	*		*
<b>3 Contract review</b>			*		*	
<b>4 Design control</b>			*			
<b>5 Document control</b>	*		*	*	*	*
<b>6 Purchasing</b>				*	*	*
<b>7 Cust. suppl. product</b>						
<b>8 Prod. traceability</b>						
<b>9 Process mgmt.</b>	*		*		*	*
<b>10 Inspection and testing</b>			*	*	*	*
<b>11 Insp. and testing equip.</b>						*
<b>12 Insp. and test status</b>						*
<b>13 Nonconformity</b>	*				*	*
<b>14 Corrective action</b>	*					
<b>15 Handling, storage, deliv.</b>						
<b>16 Quality records</b>	*		*	*	*	*
<b>17 Internal quality audits</b>	*					
<b>18 Training</b>	*					
<b>19 Servicing</b>						*
<b>20 Statistical techn.</b>						

Fig. 24

Particularly for the client it is important to be able to show where in the system one has covered the demands of, eg. ISO 9001. This can be shown simply and effectively in table form.

# Work model for company groups in co-operation

## General experience with quality development in companies through co-operating groups

### Why work in groups?

Competing companies working together to develop a quality system is a special norwegian approach which has drawn attention far beyond the norwegian borders.

Here are some of the advantages of working in groups like these:

- \* Each company must work out its own improvement measures. The plans are reported to the other companies. This means that the development work is rooted in reality. The system also works as a corrective for each firm's course.
- \* Each company must report to the others what they have done and achieved since the last meeting. In addition Byggforsk travel round and visit the companies. Many company managers have claimed that this has worked as a strong incentive to keep the process in the company going.
- \* The different companies give priority to different areas for their initial efforts in development, according to their own situation and needs. Since they all have to present their results to each other, all learn from each other.
- \* The meetings give the participators inspiration to continue the effort when they come back to their respective firms.
- \* The companies get to know each other better, a factor that can also be useful in other contexts.

### The necessary ingredients for successful quality development through co-operating groups.

Although none of the groups led by Byggforsk were organised or run in quite the same way, one could pick out the ingredients that were necessary for a successful result.

- \* the companies must commit themselves to co-operation. Each company has to declare their willingness to share their results and any useful material developed.
- \* The development process must be accepted by and led from the top. Every single top manager must support the project and participate in meetings.
- \* Each company must work independently within a controlled process. Each company must find out where it

has potential to improve, how to develop, which areas are to be given priority, and how to get other key people in the company to join in the effort.

- \* The process must be supervised by external people who have no direct interest in any of the companies. This is essential if there is any real competition between the co-operating companies.
- \* The guidance that is given must consist of help towards helping oneself. The company itself must take responsibility for its own development. Help and support are of a theoretical nature, only in exceptional cases can there be a question of increasing the capacity of a company.
- \* The company representatives must meet regularly and report what they have been doing since the last meeting. Questions of a professional nature should be highlighted and discussed. No meeting should close without all companies having presented their plans and aims for the period before the next meeting.
- \* There must be sufficient time between meetings for the companies to work independently in the mean time. The development of a company takes time.
- \* There must be a gradual transfer of responsibility for the contributions to the meetings from the project supervisors to the participators from the individual companies. By the end of the project period the supervisors should not be doing more than co-ordinating the meetings.
- \* The project supervisors must visit the participating companies regularly. On these visits one reviews what has been done. In addition to supervision, a project leader can give guidance and advice about concrete problems.

## A 30 months program of group work to develop Quality Management

Based on the experience gained from the projects mentioned above, Byggforsk has developed a 30 month group co-operation program for companies wishing to develop their own quality management systems.

The model is now being tested in a group consisting of 8 plumbing companies (as mentioned earlier).

- \* The form of participation varies between managers' meetings

\* plenary meetings where more employees from each company participate

\* visits to the company from Byggeforsk.

In the periods between such meetings/visits the companies must work independently on their own improvement measures.

### Managers' meetings

The managers meet twice a year.

The object of these meetings is to aid and motivate managers and key people from the companies to design and carry out their own quality program.

The agenda of these meetings includes reporting on, and discussion of the organisation and supervision of each company's internal work.

It is important that quality management is put into a perspective which includes the whole company, see fig. 25. There is little point in working with quality assurance on the construction site when not all sections of the company are delivering the "right" quality.

### Plenary meetings

Plenary meetings are organised twice a year. Each meeting lasts 24 hours - from evening to evening.

Here one presents professional themes. The object is a step by step training of key people in internal improvement work.

To begin with these "meetings" are really seminars, where the project supervisors give lectures and lead course activities. As the participants progress they will themselves contribute more and more to the meetings.

### Visits to the company

The main object of the project supervisors' visits to the company is to ensure that the schedule, development work, training, information and following up are progressing according to the company's wishes.

Company visits are planned by the company itself, and are tailored to meet the company's needs.

But such visits have certain set items on the agenda:

status report, supervision of concrete measures that have been carried out, and discussion with the company's managers and those responsible for the development.

### Progress

Progress in the development work will follow the five step model described already in this report (see fig.4)

The system and material in the MODEL FOR QUALITY MANAGEMENT should be exploited to the full so that the company can concentrate on its own internal quality development, and does not need to use its resources to develop a new system.

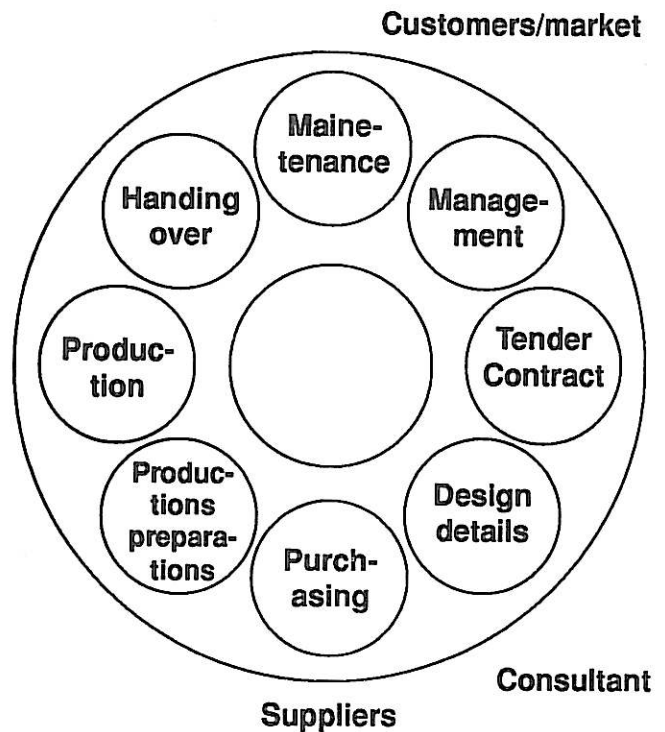


Fig 25.

The quality wheel illustrates the fact that all the sections of a company are dependent on all the other sections. If the "bearings" are to work, all the balls must glide easily. Everyone has to deliver the "right" quality.

# Explanation of Quality concepts in practice - ISO 8402

A special quality terminology has been established, which has now been standardised in the standard "ISO 8402 Quality. Vocabulary".

## The client's wish is the suppliers' guide

In order to deliver quality, we must first define the requirements. Quality is defined in ISO 8402 as "The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs". If the needs are not fulfilled we get non-conformity, defined as "The non-fulfilment of specified requirements". And if these are not corrected we get defects, defined as "The non-fulfilment of intended usage requirements".

Nonconformity in quality in one phase of the building process is carried over to the next phase, and the consequences increase progressively.

The definition of quality makes it possible to divide quality concepts in the following way:

- \* *the programmed quality* is the degree of agreement between the program specifications (clients brief) and the demands the product/construction is actually to fulfill. This is often the weakest point in the building process. A defect or omission here can be painful to discover when the building is finished.
- \* *the designed quality* is "right" when drawings and descriptions correspond to program specifications, when they do not contain elements of confusion, mistakes or omissions, and when they are ready at the appointed time.
- \* *produced quality* means that the final product corresponds to drawings and descriptions.
- \* *the product quality* achieved is measured against the original requirements.

## How can the client be confident that we will deliver the right quality?

Clients that wish for assurance that an ordered product will fulfill requirements can demand documented quality assurance, defined as "all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality".

Before an order is confirmed, the client could receive a general description of the suppliers' quality assurance system, while the contract can ensure that a quality plan is made. This is defined as "A document setting out the

specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project".

The "right quality" never appears of its own accord. It has to be built in and supervised. When we wish to achieve a set objective, we have to control the process, first by planning and organising, and then by executing as planned and following up the results. When non-conformity occurs we must correct the process so that it doesn't occur again. This applies to the control of both time and economy, of both company and individual projects. This is quality control, defined as "the operational techniques and activities that are used to fulfill requirements for quality".

Control of quality is an integral part of company and project management. It would be irrational to employ several overlapping systems. The objective is co-ordination. Since the word quality can apply to both time and economy we can choose to let quality control apply to all forms of control within the company.

## The company's aims and policies steer quality control

Techniques and processes for designing a company's aims and policies are well known. Construction companies have been slow to formalise this work. But the development and establishment of a detailed management of both company and individual projects depends on the managers' drawing up a framework first. This framework should include a quality policy, defined as "The overall quality intentions and direction of an organisation as regards quality, as formally expressed by the top management".

The quality program is "A plan for how the company will organise, manage and execute a process for improving and controlling quality".

## The management carries out its intentions with the help of a quality system

In order to carry out the company's business in the spirit of the company's aims and policies, all parts of the company must co-operate, a fact that necessitates a total company system. Correspondingly, a quality system is defined as "The organisational structure, responsibilities, procedures, processes and resources for implementing quality management"



Procedures comprise the main content of the system. This word is defined such that it covers all types of routines and instructions.

The basis for determining the quality is the specification, defined as "The document that prescribes the requirements with which the product or service has to conform".

Project review is an integral part of a project. This can start with a design review, defined as "A formal, documented, comprehensive and systematic examination of a design to evaluate the design requirements and the capability of the design to meet these requirements and to identify problems and propose solutions". In the same way both construction and the methods of production are examined before commencing production.

In the course of the process, as laid down in the quality plan or elsewhere, an inspection is carried out. This is defined as "Activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity". The result is recorded, and either non-conformity must be corrected or a concession (waiver), defined as "Written authorisation to use or release a quantity of material, components, or stores already produced but which do not conform to the specified requirements", must be obtained. But usually it is even more important to correct the defect in the system or execution, so that the non-conformity cannot occur again.

To protect both the client and oneself against failures in the quality system or quality assurance, a quality audit, defined as "A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives" should be carried out.

Such continuous preventive measures are a part of quality surveillance, which is defined as "The continuing monitoring and verification of the status of procedures, methods, conditions, processes, products and services, and analysis of records in relation to stated references to ensure that specified requirements for quality are being met".

The management will, at regular intervals, require a quality system review, defined as "A formal evaluation by top management of the status and adequacy of the quality

system in relation to quality policy and new objectives resulting from changing circumstances".

All definitions referred to here are, with the exception of the concepts programmed quality, projected quality, produced quality, product quality and quality program, quoted from ISO 8402.

### Other quality standards

ISO 8402 is part of a series of quality standards, see fig. 26.

The other standards are presented in the following section.

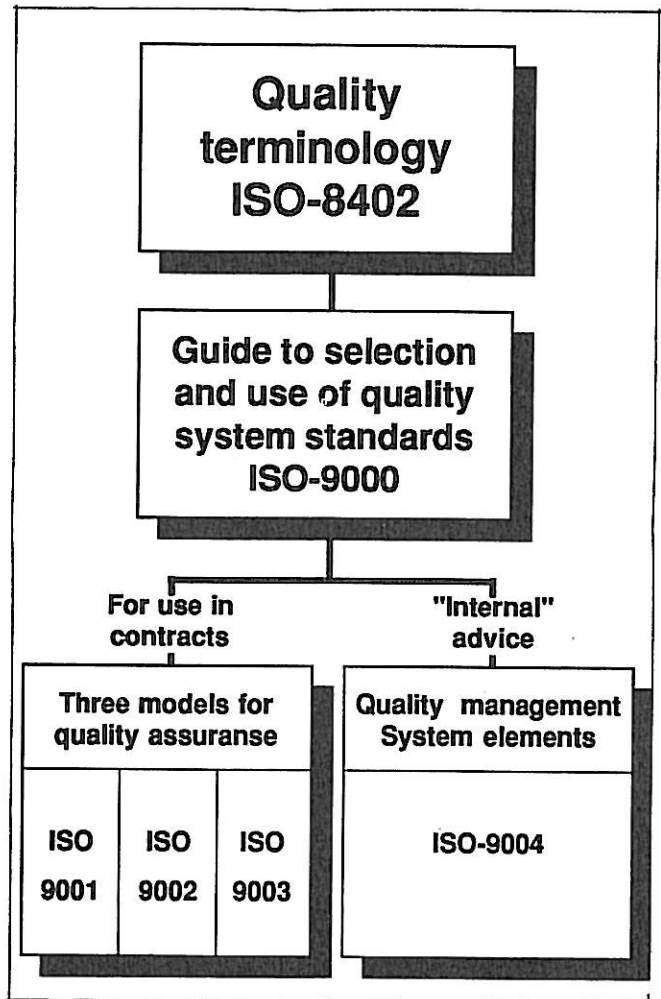


Fig. 26  
Quality standards, ISO series.

# The scope of the standards ISO 9001-03, and how they should be interpreted and used in the building industry

## ISO 9001, ISO 9002 and ISO 9003

In later years three quality system standards have existed in Norway, NS 5801, NS 5802 and NS 5803.

These are now replaced by:

- \* ISO 9001 Quality systems. Quality assurance in design/development, production, installation and servicing (replaces NS 5801)
- \* ISO 9002 Quality systems. Quality assurance in production and installation. (Replaces NS 5802)
- \* ISO 9003 Quality systems. Quality assurance in final inspections and testing.

In addition there is a standard for the choice and utilisation of quality assurance standards, ISO 9000, see fig. 26.

These standards are also accepted as European Standards, under the name EN 29001 - 29003. Several lands, among them Sweden, Denmark, Finland, West Germany, and Great Britain have accepted the same standard series as the national standards.

ISO 9001-03 are applicable to contracts between two parties. It must be emphasised that the quality system requirements demanded by these standards supplement the specified technical requirements of the product or service.

The standards cover external demands of a quality system. Although one could, from a rather narrow view point, claim that some of these demands are rather strict, it is to everyone's advantage that these demands are standardised. Then everyone knows what is required of his management system.

In addition to such external requirements, a company can have its own internal quality assurance requirements. These are requirements that the company demands of its own quality assurance. What standards can the individual company meet in this context? ISO 9000 says:

"After studying this standard both client and supplier should study ISO 9001, ISO 9002 and ISO 9003, to determine which of them is most suited to the contract and which modifications should be made".

It's worth noticing that the use of the standards is a point for negotiation during the drawing up of a contract. Both parties should note this, especially if the supplier is in the process of building up a Quality Management System.

The client should note that although ISO 9001 - 03 are aimed at the suppliers' quality system, many of the requirements also demand that his own organisation functions to satisfaction.

irements also demand that his own organisation functions to satisfaction.

About choice of standards for quality assurance the ISO 9000 says:

- a) ISO 9001: For use when conformance to specified requirements is to be assured by the supplier during several stages which may include design/development, production, installation and servicing.
- b) ISO 9002: For use when conformance to specified requirements is to be assured by the supplier during production and installation.
- c) ISO 9003: For use when conformance to specified requirements is to be assured by the supplier solely at final inspection and test.

A supplying company risks having to satisfy different standards in different contracts. But the company chooses one standard for what it demands of its own internal quality assurance. This standard must be at least the strictest the company can demand of itself, or may have to satisfy according to the terms of a contract. Fig. 27 shows which standards an individual company may be required to satisfy.

<b>Standards that should be satisfied</b>	
<b>Architects, consultant engineers</b>	<b>ISO-9001</b>
<b>Turn key projects</b>	<b>ISO-9001</b>
<b>Tender based projects</b>	<b>ISO-9002</b>
<b>Small projects, contractors</b>	<b>ISO 9003</b>
<b>Wholesalers, material suppliers (the type of items determines possible additional requirements or use of 9001-02).</b>	<b>ISO 9003</b>

Fig. 27  
Quality standards the individual company may have to satisfy.

The supplier must also pass quality assurance demands along to his sub-suppliers. The demands made of these must be adapted to the nature of the delivery, and do not necessarily have to be based on the same standards that the main supplier must satisfy. (see ISO 9001 pt. 4.6.2)

### A short summary of the ISO 9001

The standard is divided into 5 chapters. Chapter 4, which contains the concrete requirements of the quality management system is sub-divided into 20 sub-chapters. See fig.28.

<b>ISO-9001</b>	
<b>4.</b>	<b>Quality System requirements</b>
<b>4.1</b>	<b>Responsibility of management</b>
<b>4.2</b>	<b>The Quality System</b>
<b>4.3</b>	<b>Contract review</b>
<b>4.4</b>	<b>Design control</b>
<b>4.5</b>	<b>Document control</b>
<b>4.6</b>	<b>Purchasing</b>
<b>4.7</b>	<b>Customer supplied products</b>
<b>4.8</b>	<b>Product Identification and traceability</b>
<b>4.9</b>	<b>Process control</b>
<b>4.10</b>	<b>Inspection and testing</b>
<b>4.11</b>	<b>Inspection, measuring and testing equipment</b>
<b>4.12</b>	<b>Inspection and test status</b>
<b>4.13</b>	<b>Control of nonconforming product</b>
<b>4.14</b>	<b>Corrective action</b>
<b>4.15</b>	<b>Handling, storage, packaging and delivery</b>
<b>4.16</b>	<b>Quality records</b>
<b>4.17</b>	<b>Internal quality audits</b>
<b>4.18</b>	<b>Training</b>
<b>4.19</b>	<b>Servicing</b>
<b>4.20</b>	<b>Statistical techniques</b>

Fig. 28  
Aspects covered by the requirements of Chapter 4 in the ISO 9001.

In such a brief description it is impossible to cover all the elements. We shall highlight and comment on just a few of them below. We have chosen to describe ISO 9001 because it is the strictest of the standards. ISO 9002 is very similar to 9001, but does not cover design.

In point 1.1 of the standard, the scope is described thus: "This International Standard specifies quality system requirements for use where a contract between two parties requires the demonstration of a supplier's capability to design and supply product".

We should note that the point of quality assurance in a contractual context is that the client is assured that the supplier can manage the task he has committed himself to.

Chapter 4.1 states that it is the management that has the responsibility of ensuring that the quality management system functions.

Point 4.2 demands that the supplier shall establish and maintain a documented quality system which should include procedures and instructions in accordance with the requirements, and an effective implementation of these. A documented quality system implies that those procedures that are actually in use in the company are recorded. When new written procedures are deemed necessary these are to be added.

Point 4.3 demands that the supplier carries out a contract review. The supplier is responsible for ensuring that the terms of the contract are sufficiently defined and documented. In this way all demands that do not conform with the original demands in the tender should be elucidated and handled. Records from this contract review should be filed.

Point 4.4 concerns design. This is given treatment neither in ISO 9002 or ISO 9003. All contracts which include design are covered by ISO 9001.

Point 4.5 concerns document control. It demands that the pertinent issues of appropriate documents are available where that task is being carried out, and that obsolete documents are promptly removed from all points of both issue and use.

Point 4.6 concerns purchasing. One of the demands made here is that the supplier should assess sub-supplier's abilities in advance, and maintain a record of approved sub-suppliers.

Point 4.9 makes demands of the process control. These demands are of great scope. Here again it is important to choose the most effective degree of documentation: how much should be recorded and how much should be reported must be determined by a technical/economical assessment of the dangers and consequences of non-conformity.

The same sort of evaluation is required for point 4.10, "Inspection and testing".

Point 4.13 concerns non-conformity, defined as "the nonfulfillment of specified requirements", and point 4.14 concerns corrective action, defined as "Action taken to eliminate the causes of an existing nonconformity or undesirable deviation to prevent recurrence".

In practice it works thus: If the firm itself discovers, or the client complains that the product does not conform with the specified requirements, then a control of the nonconforming product is imposed. If non-conformity is found to be a result of a failure in the system corrective action must be taken.

After a contract demanding quality assurance has been signed, the client has the right to demand that the supplier takes corrective action, but he cannot demand that a particular method or system must be used as long as this is not specified in the contract.

Point 4.17 concerns internal quality audits - a main feature of any quality assurance system.

A quality audit can be compared to an accounting audit: it should ensure that everything is carried out correctly, and give as the best possible picture of the actual situation.

An internal quality audit means that the company audits itself. Quality audits should be planned according to the nature/importance of the task/area to be audited. An independent audit means that the person carrying out the audit, and the person responsible for the task/area audited are not identical.

External quality audits occur when a client wishes to inspect a supplying company, or the supplying company wishes to inspect a sub-supplier.

The standards do not cover external quality audits. The possibility of executing such audits, and their scope must be covered by the contract. As a matter of principle a client should be allowed to inspect those procedures that directly effect the fulfillment of the contract, as long as they cannot be claimed to be production secrets. A properly executed audit is to both parties' advantage.

## The authorities demands and guide lines for quality assurance

### Laws and regulations in Norway

The authorities have a series of demands and guide lines for the standard of quality in the building industry. The most important is the Planning and Building Law of 14. June 1985 no. 77. Before building permission is granted, the building authorities should confirm that the plans are in accordance with the directives of this law.

In point 77.1 this law makes a general demand that any construction work should be carried out professionally and in a fashion that is technically justifiable, in materials that are suited to the purpose.

Building regulations make a series of demands on materials, building elements and structures.

The regulations regarding air-raid shelters, drawn up by the Department of Justice, makes demands of the standard of air-raid shelters.

The Establishment Law of 20. February 1976 concerns the construction of industrial buildings.

In addition there exists a law concerning skilled labour, that regulates the modernisation, expansion, alteration etc. of existing buildings.

### Obligatory and voluntary inspections

With legal authority from the Planning and Building Law 77.2 the Labour Department has introduced several obligatory arrangements for inspection and approval:

Obligatory Inspection arrangements:

- \* Approval committee for construction elements. Factory produced elements for buildings.
- \* Concrete products inspection for concrete products.
- \* Building materials and structural components. Fire classified building materials.
- \* Smoke warnings for use in private houses.

In addition there are several voluntary inspection arrangements, among which we find:

- \* NS - issuing of certificates
- \* NBI - design certificates
- \* NBI - issuing of quality certificates
- \* Norwegian door and window inspection
- \* Norwegian laminated wood control

For each inspection or approval arrangement there exist nordic agreements on co-ordination of inspection rules, rules governing the marking of products etc.

The common market countries are working intensively to co-ordinate inspection and approval regulations for building materials. In 1991 the common market's directives for building materials will become operative. Building materials that conform with the directives will be able to be traded freely throughout the common market area. The European Standardising Organisation CEN will work out the new european standards with the aim of harmonising the technical industries of Europe.

### Norwegian standards

Several norwegian standards exist that make quality demands of construction work, with emphasis on the quality of the product.

NS 3420 Standard Descriptions for Building and Construction Work and NS 3421 Standard Descriptions for Installations are important in a quality assurance context. Standard descriptions have eased the transfer of information between parties in the building process. In addition these standards state the tolerances that apply to each process.

The Contract Standard NS 3401 "Usual contract conditions for the execution of building and construction work" contains a number of provisions that effect a company's quality management system, among others: the chronological order of contract documents, transfer of contract responsibility, execution by a sub-contractor, time limits, alterations, quality of the work, inspections, conditions on the building site, handing over, complaints etc.

There is a corresponding standard for the design phase: NS 3403 "Usual contract conditions for the architect and engineer's execution of design and consulting services."

# The contractual demands for quality assurance - and how these are met in practice by the contracting parties

Contractual demands for quality assurance for land based constructions came as a direct result of the oil industry in the North Sea. The oil companies began to demand quality assurance for landing terminals and new buildings on land. Gradually other clients also began to make similar demands for quality assurance.

In the early 1980s this phrase was to be found in several contracts:

"The client demands the best quality, according to NS 5801".

This phrase demonstrates that those who made the demands were not consistent in their use of the word "quality". Quality in NS 5801 was defined as "agreement with specified demands". Here the "good" and "bad" quality of everyday speech was mixed up with the "right" quality of the standards.

These contractual demands have been refined, and can now appear thus:

"The contractor must have an established and documented quality assurance system which satisfies the ISO 9001. To ensure the quality of the work the following areas will be given priority:

- \* self inspection
- \* planning
- \* design
- \* choice of sub-supplier
- \* choice of quality of materials".

The priorities here are actually selected from the list of demands in the ISO 9001. Although all demands must be met, the client has picked out those that are most important for him.

In addition, demands are often made for documentation, special inspections, and a demand for the passing on of quality assurance demands to sub-contractors.

Some clients make demands for documented quality assurance without using the quality assurance standards at all. One example is Bergen og Omegn Boligbyggelag. They supplement their quality assurance demands with a list of areas where experience tells that problems traditionally occur.

There is a developing tendency for more and more clients to demand documented quality assurance. Clients from the public sector seem to lead this trend, together with larger industrial clients.

## Following up the contract demands

Unfortunately contract demands are not always followed

up. Demands for quality assurance receive a lower priority than time factors and questions of economy. This leads to an increasing lack of respect for quality assurance demands.

One can point to several examples where the client has requested extensive quality assurance in the contract, but in practice it has all boiled down to a desire for proper self inspection. Perhaps additional demands are also made of personnel with special tasks, eg. certified welders.

One factor that is often underestimated is that quality assurance also makes demands of the customer's organisation. For example, when the client has demanded a non-conformity system he must himself be able to react fast enough to non-conformity reports for corrective action to be taken. This has shown itself to be a problem.

## How the different parties meet the contractual demands

### The design group and quality assurance

Architects and consultants often meet demands for quality assurance.

Experience shows that it is difficult to assure the quality of the creative part of the work.

Consultants with off-shore experience have long been used to extensive quality assurance requirements. However these requirements have entailed the introduction of extensive systems of inspection and control, with a resource consumption that few clients are willing to pay for. But some consultants have managed to simplify and adapt the system to satisfy similar requirements for buildings on land.

### The production companies and quality assurance

Most large contractors have worked with quality assurance a good while, and can present their customers with documented quality management systems. Several smaller contractors have similar systems. The attitude towards these contractual demands is changing rapidly. Whereas before they were regarded as "paper exercises" to satisfy the customer, they are now exploited in a more assertive fashion.

Quality manager Ragnar Wiig of Aker Entreprenør A.S. asserts that demands for quality assurance have helped

Aker Entreprenør to achieve its quality aims. Such demands focus on quality assurance for all parties, and contribute to the spreading of quality focused attitudes and thinking throughout the company. But it is the contractors who must decide on the premises quality management must be based on, so that they can produce the right product with the least possible consumption of resources.

Many of the larger technical companies can also document their quality assurance systems.

### The situation in the building industry in general

The majority of the companies in the building industry are badly equipped to meet demands for documented quality assurance. Many are still taken by surprise when such demands first occur in a contract. Those companies that have worked seriously to satisfy these demands on their own premises are able to keep records of the benefits gained from the process.

The case of the plumbing company ORAS can illustrate this. The general manager Arne Nilsen expressed the feeling that they were "caught with their trousers down" when they received a demand for documented quality assurance for the building of the second phase of the Aker Brygge complex. At this time ORAS had already been working with an internal quality assurance system for a while, and managed to meet the demands to great satisfaction. ORAS claims that the drawing up of a quality plan for Aker Brygge contributed enormously to the management of the project.

### What should a contract demand?

As mentioned earlier, the demands of the ISO 9001 are extensive. If the client is to follow up all of the elements in this standard he has set himself an enormous job. Even so, he should refer to the standards ISO 9001, -02, or -03 when making quality assurance demands of his suppliers, as this will lead to a more consistent system of demands in the market as a whole. It can, however, be sensible to make a list of the elements in the standard to be given priority.

One should also specify which quality assurance documents should be submitted.



Fig. 29

ORAS felt that they had been "caught with their trousers down" the first time they received contractual demands for quality assurance, and that internal work with quality assurance was a long and steep stairway.

A system description (Q.A. manual) which shows the structure of the company's quality management system is a useful document to be able to submit for pre-qualification, or when presenting a tender.

After the contract has been signed, the supplier should draw up a quality plan. A quality plan is a description of how the quality system for the project is built up and should function. The plan should give a written account, for all parties, of how the supplier will ensure that the terms of the contract will be satisfied.

There is good reason to warn both client and supplier of the dangers of uncritical documentation. A procedure must describe what actually happens, not what the supplier thinks the client wants to happen! This is essential if the quality management system is to contribute to the "right" quality.

Both client and supplier must have given thorough consideration to the question of what documentation is necessary.

In the end it is the abilities of the personnel, not the amount of paper work, that creates the "right" quality.

# Internal Quality Management - ISO 9004

Up to this point all discussion of quality assurance has been limited to the ISO 9001 - 03, which are made for use in contractual contexts. Many have therefore assumed that these standards should also give guidelines for a company's development of its own internal quality assurance system. There is however another standard under preparation, which should be ready for publishing in the course of 1989: "ISO 9004, Quality Assurance. Quality Management and Quality system elements".

ISO 9004 describes the most important elements of a total company system. It gives guidance to those companies that wish to establish, on their own, a quality management system in order to increase competitiveness and efficiency. The user can make use of the whole standard, or select those elements that suit his needs and activities.

The standard is based on the fact that in order to be successful a company must offer products and services that:

- \* meet a defined need, usage or intention.
- \* satisfy the expectations of the customer.
- \* comply with relevant standards and specifications.
- \* comply with legal and other demands from society.
- \* are available at competitive prices.
- \* can be produced at sufficiently low costs to afford a profit.

Since economy is inevitably drawn into the picture, the quality management system must also cover planning and efficient use of human, material and technological resources. At the same time the quality management system is intended to cover all the activities and phases a company covers with its products and services.

ISO 9004 has 20 chapters, see fig. 30.

The standard asserts that the quality system has to cover all phases of the building process. In principle any company can build up a quality system according to the quality loop presented by the standard, see fig. 31.

We shall not describe the contents of the ISO 9004 in detail in this report. We merely wish to draw attention to the fact that it exists, and that it gives an excellent basis for companies wishing to use quality management as an active instrument in the development of their company.

## ISO-9004 - Sub-sections

- 4 Management responsibility
- 5 Quality system principles
- 6 Economics - quality related cost considerations
- 7 Quality in marketing
- 8 Quality in design/specification
- 9 Quality in procurement
- 10 Quality in production
- 11 Control of production
- 12 Product verification
- 13 Control of measuring and test equipment
- 14 Nonconformity
- 15 Corrective action
- 16 Handling and post-production activities
- 17 Quality documentation and records
- 18 Personnel
- 19 Product safety and liability
- 20 Use of statistical methods

Fig. 30

The chapters 4-20 of the ISO 9004

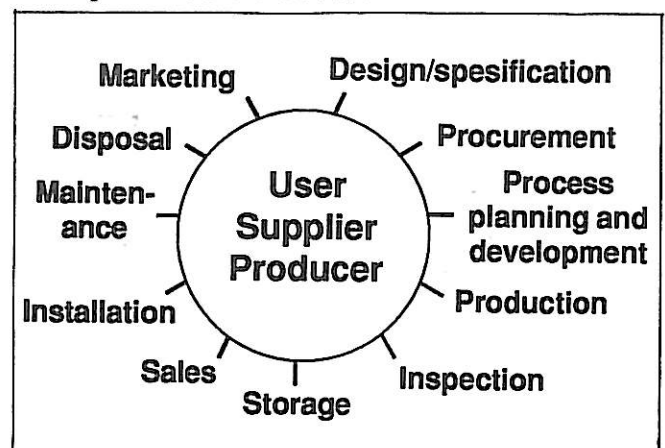


Fig. 31

The quality loop, from the ISO 9004.

# International development of Quality Management in the building industry

## Development in the other nordic countries

### Sweden

In 1986 the National Committee for Swedish Quality started up a program called "Rätt Sätt". The Swedish Quality Union started up a building section in 1987. Building Standards (BST) are now preparing for the use of the ISO 9000 series in the building sector, and are planning guide lines.

According to the Planning and Building Law responsibility for the building process, an extended self inspection can only be granted if certain conditions are fulfilled. The Government Building Management demands that consultants and contractors have a quality policy, a management assigned responsibility for quality, and a quality management system before they can accept larger building projects.

The Fortifications Administration have made a quality hand book for internal use. The terms of their contracts state that suppliers must have their own quality management systems. The Transport Department are working out a quality system for work with roads and bridges. They make similar demands in certain contracts. The Government Testing Service offers a marking system which provides documentation that certain conditions are fulfilled. A quality assurance system for the building of pre-fabricated small houses is under consideration.

Housing Co-operatives are demanding self inspection of their suppliers, and several other clients are also making demands on their suppliers quality assurance.

Sweden's Practising Architects (SPA), and the Society of Consulting Engineers give advice to their members regarding contracts, and arrange courses. SPA has published guide lines for clients and architects. Some architect and consultancy practices have started internal development of quality assurance.

Most of the large contractors are carrying out some form for internal development work. Some start with quality circles, but have experienced that this necessitates a good deal of following up. Otherwise they are working with improvement programs and quality management systems. The contractor's organisation "Building Contractors" organise an annual "Quality Day".

The Building Research Council contribute funds to such development projects. Chalmers Technical University has been granted economic support for a large

field survey of quality costs in co-operation with contractor's companies.

The development in Sweden began with a few contractors, but is now spreading rapidly. Probably Swedish discipline and ability to be systematic will ensure that the ISO standards will be used more and more in the future. But there is an ever present danger that some create systems more to comply with standards than to improve internally, and that the standards are merely imitated. It is possible that certifying of quality management systems for design and production can become swifter and more wide spread than in the other Scandinavian countries.

### Denmark

A Danish regulation from 1986, demanding quality assurance for all types of constructions built with government funds, has had much influence on the development in Denmark the last few years. The reason behind this regulation was the Danish Ministry of Housing's disquiet over large damage from wear and tear appearing in relatively new housing sites. The National Building Agency has published circulars and guide lines on what is required, and how these requirements can be satisfied.

A condition for starting up the system was that the building industry agreed to a guarantee period of 5 years where all the trades involved - designers, production companies and material suppliers - are still responsible for the building.

The most important demand is that all work carried out during the design and production phases is quality assured. In addition both execution and handing over should be properly supervised and inspected. Maintenance and running of the building should follow pre-determined schedules. Before the 5 year guarantee has run out the condition of the building should be evaluated, and a list drawn up of any measures necessary to ensure that the building meets the expected quality.

After positive results from this inspection the risk for future damage is taken over by a building trust, for a period of 15 years, provided that the maintenance fulfills certain conditions. At the present time this applies only to housing. The trust is financed by a payment of 1% of the building cost for all government funded buildings.

This system has resulted in most building trade associations' making models for their members' quality management systems. A number of courses and conferences



have been held on the topic. At the present moment the system seems to be considerably simpler than the demands in the new ISO standards 9001/2. The authorities have also stated that they do not wish a third party to start certifying the quality management systems.

#### Finland

Neither public nor private clients have started to demand quality management systems to any great degree.

A group consisting of four of the largest contractors have, together with the Finnish Research Organisation VTT prepared a report on quality costs and reasons for damage on several housing estates. The reports are internal, but it is public knowledge that the results give great inspiration to start work on preventive measures. Some firms are under way with their quality programs.

At the same time five of the large prefabricated concrete factories engaged VTT to help with the internal development of quality management systems. VTT is to summarise and publish experience that is common to all of them.

VTT has also started a total analysis of the process of maintenance, and will use quality focused ideas to give priority to, and carry out improvement measures.

### The development of Quality Management in some of the common market countries

#### England

For several years England has been granting government funds to stimulate british industry into giving priority to quality in order to be competitive in the common market. As a result many companies have developed formal quality assurance systems. Another driving force has been the so-called third party certifying of quality management systems in relation to the ISO standards.

The British Standards Institution (BSI) has its own section for the certifying and following up of companies' quality management systems, with a special department for the building trade. Special guide lines already exist for certifying and giving advice to contractors and engineers. They are working with a corresponding system for installation and roofing companies. At the present time only a few companies are certified.

Other consultancy practices also offer certifying services similar to those of the BSI, which means that certifying itself has become a competitive market. There is a central system of approval for certifying institutions.

There is resistance to the certifying system in several branches of the industry, and several individual companies. The Contractors' Associations answer is to create their own model system without a third party certificate. The Builders' Union work with an even simpler system.

In the future this will probably lead to closer co-operation between certifying companies and the trade organisations.

#### France

At the present time there is little published on quality management systems. A government funded trial project, Qualité Construction, has resulted in a handbook.

#### Italy

Many italian contractors work abroad under international contracts where demands for quality assurance are usual. The Contractor's Association ISPREDIL has started working with quality assurance.

#### The Netherlands

A government supported organisation, NEHEM, is preparing an initiative to stimulate the building industry into co-operating on quality assurance measures. Some of the larger contractors have started developing and establishing their own systems, aimed at avoiding mistakes in the building process and increasing profits.

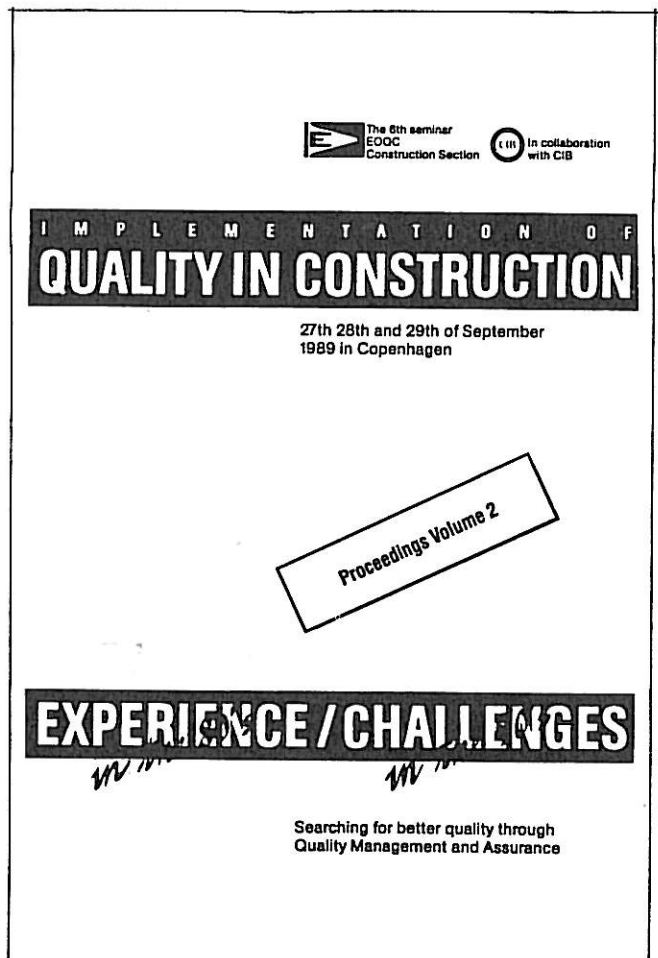


Fig. 32  
EOQC's seminars are the best possibility for keeping orientated on the latest developments in quality assurance in the European building industry.

### International co-operation

The international building research organisation CIB has a special group W88 Quality Assurance. Norway is participating via Byggforsk to collect information and, if possible, contribute to the development. A first status report is published.

The European Organisation for Quality (EOQC) is a co-operative organisation between national quality unions (the Norwegian Union for Quality is the Norwegian member). The European Organisation has a building section that, among other things, arranges seminars for the building industry every other year, see fig. 32.

### Norway's place in the international context

Norwegian contractors, especially, are far ahead in the quality development process. They have managed to turn the original prejudice and negative experience: piles of resource consuming paper work, into something positive: a company development supervised by the management. The weaker market situation in 1989 is resulting in a positive attitude from the employees', where everyone supports any measures that ensure quality and increased competitiveness.

In the Common Market (see fig. 33) it is expected that formal demands on the supplier's quality assurance will become more usual after 1992. These demands will inevitably refer to the ISO standards, and probably various ways of certifying company's individual systems will appear. On the building products side this will happen relatively fast. But, at the same time it is obvious that within the building industry these arrangements will cause a good deal of bureaucracy, and will be enormously demanding to supervise. Therefore to begin with there will be a certain amount of confusion, and conditions will vary. However, after 5-6 years, practical experience will have begun to influence the final form.

At international seminars there has been a good deal of interest for the type of work that various production companies have been carrying out together with Byggforsk. The Norwegian system and method is being evaluated by potential clients in other countries. At the same time it is important that Norway is represented in international fora, so that we can influence future developments in the building industry in Europe.

For Norwegian companies the best strategy still is to develop their own quality management system and quality assurance, based on what they can make use of in their effort to increase competitiveness. One must pay special attention to purchasing, and to the supervising of

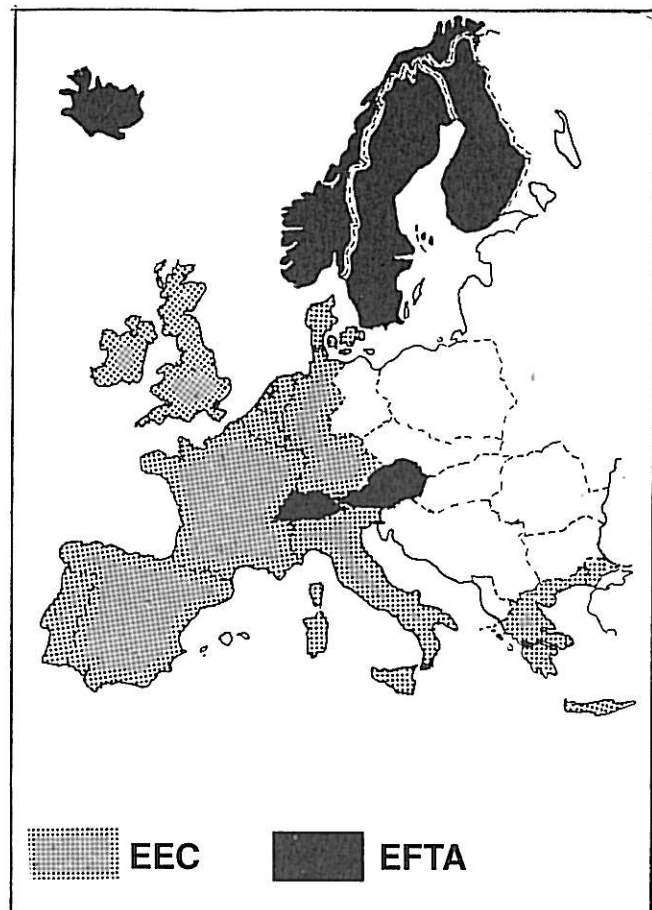


Fig 33. Demands for quality assurance will appear in the common market.

sub-suppliers in a changing market. In addition, contracts for total productions abroad make greater demands on the co-ordination of managing and communications.

When it comes to documentation for a second and third party the quality management system must be flexible enough to allow variations in the scope and content of the documentation, according to the situation. One must be prepared to make editions in other languages eg. English, for parts of the system. At the same time a company under development must make use of the principles of the ISO standards in a practical and sensible way, without getting tied up in the standards' structure and individual paragraphs. The companies must keep a dialogue open between themselves and those who decide on the requirements. Norwegian companies that have already started on their own development along these lines should lead the field when it comes to administration of future co-operation and trade in the Common Market.

## Recommendations for further measures

Quality management in its widest meaning is one of the most effective measures we have today for increasing the efficiency on both company and project levels. Most companies have achieved economic savings and less mistakes and omissions in their work after a planned effort at improving quality management. The topic is important for all parties in the building industry, since each and every company must become more competitive in today's hard business climate at home, and at the same time must prepare for the more open European market. Companies will meet new competition at the same time as the best will have new export markets open to them. It is obvious that quality management will be requested for all deliveries and contract work abroad.

The aim must therefore be to make quality management more widespread, both within the building industry and its permanent clients.

After five years' practical experience on working for better quality management, we know that all development work has to be carefully planned and continuously supervised if one is to achieve permanent improvements and changes. In the same way, measures for improving the entire industry's performance must be carefully prepared and properly motivated. In order to achieve this we should work out a 3-4 year action program. The tasks and the responsibility must be shared, and financial support must be obtained for various special tasks. Several lands are now using government funds for increasing the efficiency of their national industries through the development of quality management.

### Measures that are aimed at the whole building industry

#### Establishing quality management in more companies.

The interest in quality management is increasing in the industry. Many hear of practical and useful results from companies that have already gone in for it. More and more understand that the aim is improvement, and this can only be achieved through a process aimed at permanency and aimed at both the company as a whole and its projects.

One should continue to promote quality management, especially in design and production trades, through trade associations. The experience gained in the last years' work with step-by-step establishment of quality manage-

ment, working in company groups, should be exploited to start up new groups.

At the same time the organisations should call together company representatives from different trades, to elucidate mutual demands and find out what the other party requires of one's own quality management. This involves a collective quality management for the entire building process, that is integrated with the project administration, and is especially vigilant about the transition between phases or work crews.

We must also help smaller companies on their way. Through pilot projects we must work out how to simplify the system and principles we have developed for larger companies and adapt them for smaller company's use.

#### Making use of the existing standards for Quality Management, and ensuring international co-operation

It is important that all parties make use of the ISO quality standards in a way that suits the building industry. One must avoid uncritical copying of formulations, both in a contractual context, and in the context of internal development. Professional building clients must therefore work out practical, project-suited demands of their supplier's quality management. They must also take the consequences of their own demands, and follow up their suppliers.

All central parties and institutions must maintain good contact with nordic and Common Market countries, in order to be able to influence the direction of new regulations and development, and ensure that they are both practical and useful. Good contact also keeps us orientated on what is happening, so that we can at all times be ready to fulfill demands made of us, and make plausible demands of others across the borders.

#### Adapting training and development programs to the changing situation

Quality thinking and techniques must become part of all education of engineers and of any professional training aimed at the building industry. Educational programs and teaching aids that can be fitted into the existing curricula for building orientated subjects must be developed, and we must ensure that the teachers are competent in their use. To strengthen certain of the subject areas, we should systematically encourage individuals to increase their competence through study, eg. by doctor's degrees.

One of the development areas that should be given priority is the management of materials. During its work with quality management the company will gain more insight into its own planning process, and is better equipped to specify time and place for the ordering of goods and materials. Therefore we should give priority to pilot pro-

jects that aimed at ensuring a continuous management of materials from the production of the goods to their installation on the building site. Such a development would stimulate co-operation between the producer of the goods, the distributor, and the production companies, and will lead to considerable savings for all parties.