CERAMIC TILES NEARING THE YEAR 2000: A GLOBAL APPROACH TO QUALITY

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ABSTRACT

It is not easy for the ceramic tile sector to say what quality is: opinions are as varied as the interested «parties» (manufacturers, retailers, tile fixers, and users). Furthermore, ceramic tiles do have technical worth, but must also meet aesthetic requirements (on the basis of market demands), which are even harder to quantify. Finally, tiles are not strictly speaking a finished product: the finished product is the installed ceramic tiling, in which tiles are only the outermost element. The situation is not easy, because the reference documents (laws, standards, codes of practice), in turn, also call upon other «parties». A typical example is standard EN 29002, which concerns the quality system: the tile manufacturer must ensure that his suppliers also have a suitable quality system. The result is that with this linking mechanism, tile quality also means quality of the suppliers of raw materials, facilities and machinery, glaze suppliers, as well as the quality of retailers (who provide customers with full and accurate information), the quality of tile fixers, the quality of producers of adhesives and sealants. All the «parties» interested in tiles must be considered customers by those upstream, and suppliers by those downstream. This paper examines the issues inherent to Quality, with regard to who must supply it as well as to who must demand it, particularly the final user. There are ill-defined areas in which it is not always easy to establish roles and responsibilities. From the point of view of a global approach to quality, it would be useful to have standards drawn up specifying the basis for supply, in which, besides technical specifications, areas and competencies are clearly established

as far as the quality of supplied products and services are concerned.

1. INTRODUCTION

Quality is being widely discussed at the closing of this century, as the end of the second millennium draws near; a new millenarianism seems to approach. At the end of the year one thousand, the end of the world appeared nigh («a thousand and no more than a thousand»), interpretations stemming from falsely religious misunderstandings of a secular phenomenon. A year ended then (the year one thousand happened to arrive), and it seemed that the world must end (religious fundamentalism, and therefore typically anti-scientific). Today, as we near the second millennium, no voices are raised that speak of the end of the world, but on the horizon, new millenarianisms are starting to glimmer.

Among the various fundamentalisms, there also seems to be the fundamentalism of Quality. Everything must be «of quality», quality is «a challenge», «quality must be «global, total, company-wide». And if there are any doubts, do not fear, hundreds of consultants are on hand to explain everything, often quoting models based on Far Eastern philosophies and cultures. A close examination of the situation becomes necessary, even though this may be difficult in a sector like that of ceramic tiles, in which the concept of quality may assume different worths.

In the ceramic wall and floor tile sector, approaching the quality issue is a complex task because the technical aspects (such as those established by current regulations), interlock with the aesthetic characteristics of the finished product: a tile must not only meet technical requirements (that is, be «good and durable»: an objective criterion), but must also respond to the ever changing aesthetic tastes of the market (that is, be «beautiful»: a subjective criterion). It therefore follows that:

- **the manufacturers** strive, according to their company structure, to supply a «quality» product, that is, one which the market finds desirable: in the face of the whole complex of issues relating to quality (and to the references, sometimes ambiguous, to equally ill-defined Japanese models), the manufacturers risk losing their sense of direction.

- **the consumers** are forced to demand «something» (quality), which they hardly understand; they intuitively perceive it is important, but remain unaware of what it means in practice, that is «quality with regard to what»: a typical example is the widespread unacquaintance with regulation compliance markings.

Speaking of consumers, one must be precise: consumers are not just the final users, but also include retailers and tile fixers. It is important to be clear about this, since all these parties are important in a process that leads from raw materials to the actual finished product: this not, in fact, the tile, but the installed tiling. Therefore, tile quality cannot just be considered from an intrinsic point of view, but must include the context of the building or work it is a part of. A second important consideration; all the parties involved in construction are interrelated, and should not be considered as individual entities on their own. Each is the upstream entityís customer and the downstream entityís supplier.

2. WHAT IS QUALITY?

According to standard ISO 8402, Quality «is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs». This definition includes several aspects which in turn stem from different needs:

- for the manufacturer (and also for the retailer), quality implies satisfying customer expectations, by effectively and efficiently making use of all the companyís operations (therefore: no defects);

- for the tile fixer, quality is knowing how to use what correctly, and where to use it (therefore attention to specifications);

- for the user, quality is paying a just price for a product that fulfils his needs: that is customer satisfaction.

These needs imply:

2.1 - That the level of product characteristics or specifications should be clear and definite; in this respect there are three classes of reference documents:

- **laws,** documents with a mandatory value, containing requirements that must be respected, generally in order to watch over the final userís health and safety: among these the EEC Directive 89/106 concerning building products («Construction Products Directive») is particularly important;

-**standards,** documents whose application is voluntary (that is, agreed among the parties); nevertheless, if a manufacturer claims a product meets standard requirements, he assumes responsibility accordingly;

-**codes of practice,** technical instructions for the correct execution of a work (therefore, also voluntary).

2.2 - That the manufacturer be capable of respecting and maintaining product specifications (agreed and implicit). It follows therefore, that only controlling the finished product (which, besides, involves the disadvantage of «holding» the product) is not enough: nor is it possible to analyze/control the whole production to check all the characteristics. The manufacturer must therefore adopt a system (Quality System), which can assure him of qualitatively constant production in time. The reference for a system of this kind is formed by the five Standards of the EN 29000 series (corresponding to the ISO 9000 regulations). Standard EN 29004, together with EN 29000, provide a guide for quality management for all kinds of organizations. The other standards are used for quality assurance or warranty in contract environments, that is, when the commissioning party requests by contract, that certain elements are to be included in the manufacturerís quality system, which influence the manufacturerís ability to fabricate the product uninterruptedly, in accordance with the requested requirements. Specifically:

- standard EN 29001 is used when compliance with specified requirements must be assured by the supplier in the projection/development, production, installation and after-sales assistance stages;

- standard EN 29002 is used when compliance with specified requirements must be assured by the supplier, in the course of manufacturing and installation stages;

- standard EN 29003 is used when compliance with specified requirements must be assured by the supplier, only by means of controls, testing, and final tests.

Once the Quality System has been implemented, the manufacturer can request certification, that is, an attestation that the Quality System complies with regulation requirements, by an independent third party. We are here in the sphere of contractual obligations, which is to say, voluntary undertakings, not compulsory ones. However, the aforementioned Directive 89/106 on construction products, requires, with reference to the essential requisites of the materials, that compliance be attested not just on the basis of tests performed on the product, but also on the manufacturerís ability to maintain product characteristics in time. This entails having a Quality System: the reference to the EN 29000 regulations is therefore logical and inevitable. The certification of the system thus leaves the sphere of voluntary actions and, in fact, becomes compulsory. The implications of this evolution are notable, whether with regard to ceramic manufacture,

or in a wider sense, to all the entities involved in construction.

3. - THE EN 29000 STANDARDS AND CERAMIC MANUFACTURE

Manufacturers in the ceramic sector are generally well informed about the «technical» aspects of quality: the technical standards are well known and applied, quality controls are widespread and are carried out at even the smallest enterprises. There is less awareness of the «management» aspects of quality. Each producer is sure he supplies a «quality» product (even if this is only because the product has a market). The quality can of course be improved, for instance, by innovating production technology, or intensifying controls on semimanufactures and/or finished products. Quality therefore boils down to «Quality Control», performed:

- during the process, following internal control methods;

- on the finished product, according to EN and ISO regulations.

We have already seen that this is not enough, from the viewpoint of a Quality System that focuses on preventing errors rather than correcting them afterwards. This different attitude entails a different company policy: even if the request stems from the customer, the initiative lies with the company. In the first place, top management must define the quality policy, i.e., the objectives and general principles as far as quality is concerned (after the ISO 8402 definition). The reason for the choice must be defined: for example, in order to maintain and improve competitiveness in the market, or to meet specific customer demands.

A logical consequence of the choice is the involvement of the whole company: Quality is not really quality unless everybody actively participates, be it in different areas and varying competencies: as top management must clearly define a Quality Policy, skilled workers at even the lowest levels will consciously participate in the process, whether in the preparation or in the implementation stage.

This engagement at all levels is indispensable because everybody can and must contribute to defining and putting the Quality System into practice, that is, «The organizational structure, the responsibilities, methods, procedures and resources are put to work for quality management» (after the ISO 8402 definition).

One of the first obstacles ceramists encounter is that a Quality System is based on written documents. The need to have written documents has different origins, such as for example:

- the possibility of having a «historical record» of the way the company works, thus leaving behind the concept of technological knowledge as being the exclusive domain of just a few people;

- the usefulness of having available useful instructions for new workers, or for reviewing what is done by company workers.

The problem thus arises of how and where to start. The company faces three options:

-**do everything in the company itself:** the process risks becoming long and complex, even though the necessary resources are made available, as often awareness of what Quality involves is lacking, or affected by preconceived ideas;

-**acquire a prefabricated package** (for example: a standard Quality Manual): this solution is also rather useless in as much as the package, of its own nature, cannot take into account the peculiar characteristics of the company and must therefore be adapted to each actual circumstance, thus

risking becoming a matter of imposed rules that are handed down from above, or at least requiring a long time to implement;

-**do everything in the company with outside guidance/help:** this is the best solution, as it firstly involves self-analysis (and therefore active engagement of workers at all levels) by the company, together with the confrontation with an expert whose task it is to correct/direct/guide.

The company must therefore in practice:

- identify and define all the processes and activities (including the associated responsibilities);

- identify and define the responses (that is, identify how the blocks making up the company structure interact);

- analyze production in detail (what, where, when, why)

- write down the procedures (see what is really done and describe it).

A point to remember: it is useful to consider each production process stage as a customer of the upstream stage and a supplier of the downstream stage: this helps take nothing for granted, requires giving clear instructions and implementing a suitable control plan.

After self-analysis, or parallel to it, the workings of the company must be examined. This examination requires a reference, made up of universally accepted technical standards, which therefore forms a criterion for assessing the goodness or lack of goodness in company workings. It involves an assessment of the compliance or lack of compliance in respect of what is really done, with standard EN 29000.

The Appendix shows an example of adaptation of standard EN 29002 to ceramic production. No sooner have the production process stages been identified in respect of the points in EN 29002, than the problems start. What is the situation as far as the measuring and testing equipment is concerned, which are «critical» in relation to the quality of the final product? This question implies that:

- there is a list of measurement and testing equipment;

- someone has decided which of these instruments are of specific importance for final product quality.

- this «critical» equipment is regularly calibrated;

- there is objective evidence of calibration (documents, notices, labels, etc.)

The third part of the Appendix contains some typical questions that are aimed at verifying the efficiency of the manufacturerís Quality System. These questions do not pretend to fully cover standard EN 29002; they only highlight some of the most common non-conformities found in ceramic manufacture. For example, when considering process controls, the question is not whether controls are performed (the answer would be obvious), but whether they are incorporated within the framework of a Quality System, which involves direct and indirect responsibilities, management flow, procedures laid down in writing (and brought up to date), records, corrective action. The company is not asked to do the impossible, but just what is necessary and sufficient, avoiding the production of useless piles of paper. It is to be observed that after some initial hesitation, ceramic tile manufacturers are becoming increasingly aware of what is involved in Quality Systems.

4. - THE EN 29000 STANDARD AND CERAMIC BEHAVIOUR

One important consequence is that the implementation of a correct quality system in a ceramic manufacturing enterprise has a cascade effect on other sectors upstream and downstream of manufacture.

Raw materials suppliers and suppliers of semimanufactured products (frits, glazes, pigments, additives of different kinds) are obviously involved. There is no point talking about technical standards for these kinds of materials: it is a typical contract situation, in which customer and supplier agree to qualitative requirements and testing procedures. This is, however, not enough, since the supplier must guarantee that he is able to maintain a qualitatively constant product: in other words, he must have a suitable Quality System that his customer can control (or have controlled). The more «critical» the material supplied for final product quality, the more rigorous will this control be. This assessment entails a not insignificant change, as there is a changeover from many suppliers who were chosen for commercial reasons, to a few carefully selected, qualified suppliers.

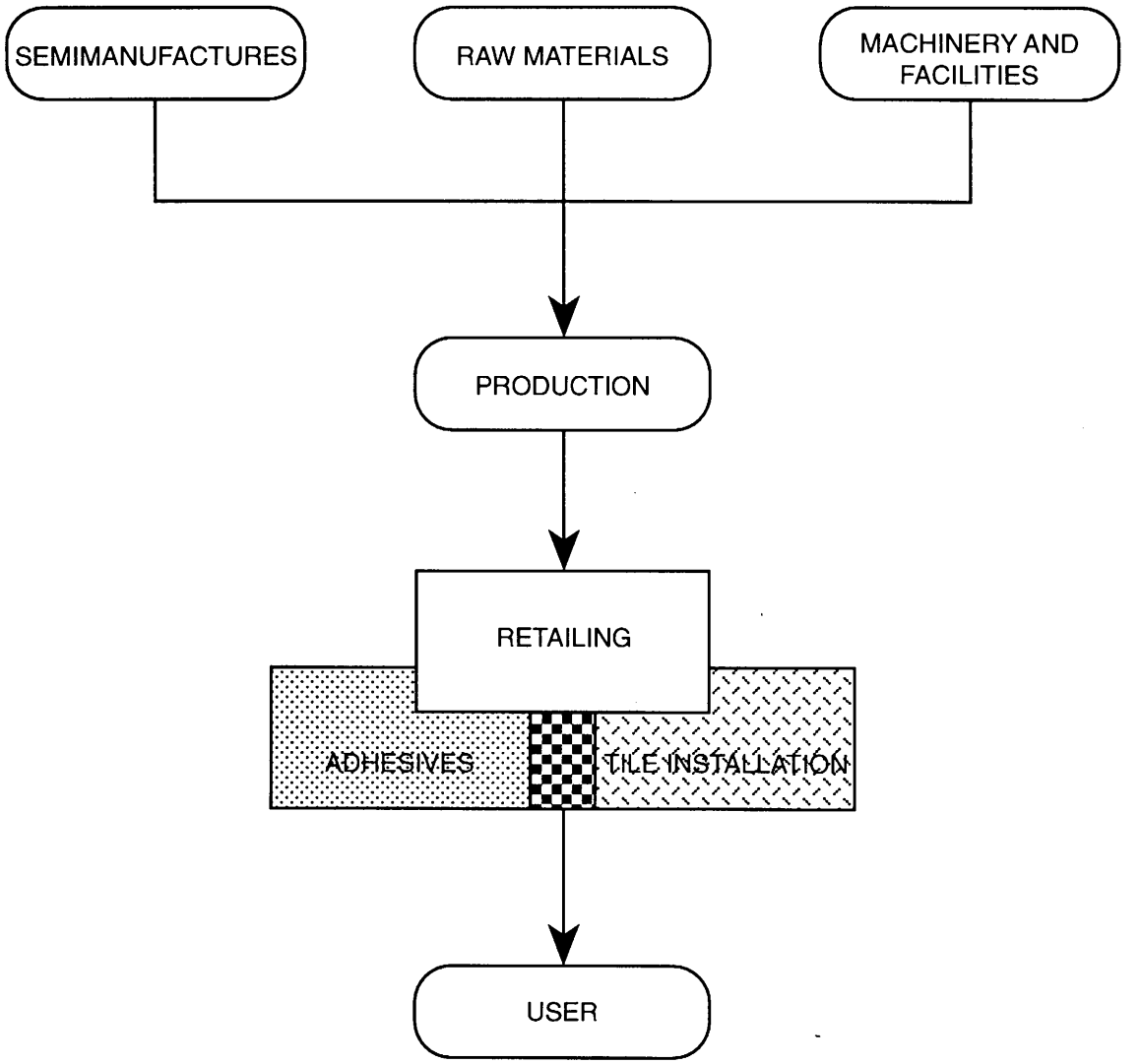
Similar considerations equally apply to suppliers of machinery and facilities, although with certain peculiarities. In this case, it is not a matter of checking the constant quality of a material, but verifying if the criteria of standard EN 29001 have been followed in making the machine (the projection is also critical here). Analysis of this standard for the mechanical-ceramic sector goes beyond the scope of this paper, but the basic issues are always the same. The makers of plant facilities must also check their sub-suppliers, and so on.

An often neglected aspect: machinery and facilities are fitted out with instruments for measurement and control, as a result of which their calibration must also be checked. This is obviously the case of «critical» components (e.g. the thermocouples in a kiln). The instruments for laboratory tests and controls must clearly be calibrated.

Up to this point, the reference has been to upstream entities with regard to ceramic tile manufacture. Let us briefly examine the situation of the entities downstream. These are, in fact, of decisive importance, especially for the final user: thus, if the manufacturer can act as guarantor for the upstream entities, by verification of the applied Quality Systems, this is not the case of the downstream entities. Moreover, the interface with the user is not exactly defined, as:

- the tile retailer can advise using a certain kind of adhesive or recommend a certain tile fixer;

- a tile fixer can directly purchase the adhesives himself and will sometimes recommend a certain kind of tile.



There are then superimpositions (schematic in Figure 1), which make it difficult to exactly determine roles and therefore, responsibilities: in other words, it is not always clear who must control and check what. In a first approximation, we shall examine separately the roles and competencies of the different entities, from the viewpoint of the final user. In order to simplify the analysis, we shall assume the user is a big company.

In this case the retailer must supply suitable guarantees for the product, both in terms of technical specifications and aesthetic appearance: the retailer, then, downstream to the manufacturer becomes his customer and is required to check his Quality System. An audit is not always necessary: a questionnaire may be enough, in which detailed information is requested in order to be able to prepare a list of reliable suppliers (manufacturers), by means of the «vendor rating» system. The user can, in turn, select suitable suppliers, always through the «vendor rating» system. As far as the retailer is concerned, the importance of the accuracy and fullness of the information that he must give the user is always highly stressed. In the first place, therefore, the information the retailer receives from the manufacturer must be accurate and complete (sometimes the catalogues and technical data are incomplete or «optimistic»); besides, the technical training of the retailer is fundamental: he must not just know how to sell, he must sell the right product for that certain use.

With regard to the supplier of products for tile fixing (adhesives, sealants), the above considerations are equally valid. Besides furnishing the suitable materials, exact warranties must be given on the basis

of the Quality System adopted, which allow constant product quality to be maintained. In this case as well, it is advisable to apply the «vendor rating» technique.

And now we come to the tile fixers. The main problem lies in the professional qualification, understood not as technical ability, but as a certification by an independent third party. This certification is difficult, if not for any other reason, simply because professional experience is involved, which is hard to quantify. However, it is considered a form of certification will become necessary: insisting on the Quality Systems of different producers is useless (therefore also on the quality of semimanufactures), if the person called upon to execute the work (the final product), is not subject to any form of preventive examination. The adoption of a Quality System by tile fixing companies is still in its beginnings, but there are already Codes of Practice to which can be referred, to correctly carry out the work; besides, standards in this regard have recently been issued for service companies. These are general standards that will be adapted to specific cases, but it is a necessary task, otherwise the whole quality discourse risks falling apart. Training is also a fundamental aspect for tile fixers, not just as regards tile installation techniques, but also training in the characteristics of the different materials, and more generally, in what is meant by the quality of a service, and what it involves, not just in technical terms, but also from a management point of view.

How should a big company (final user) act in practice with regard to these suppliers? The only possibility is to draw up standards specifying the basis for supply, in which precise quality warranties are required of all the suppliers. Obviously, in drawing up these standards, producers and tile fixers must also be involved (these are contractual relationships), so that all the interested parties can give their specific contribution, in terms of collaboration between customer and supplier. A determining role could be played by the Associations of the parties involved, which often neglect this aspect, focusing more on marketing or advertising; it is also important that the initiative should get the big companies involved, if only because a great number of «case histories» must be dealt with, for which they can provide more general applications and indications. After these standards with their specific basis for supply have been drawn up, the superimpositions shown in Figure 1 will disappear, especially for the small companies or private user: a tile fixer who also looks after the purchase of the adhesives becomes guarantor and responsible for these, while he in turn also performs the corresponding checks at his supplier. Thus, the direct and indirect responsibilities are clear and definite, and there is a chain of referability, making it possible to go back, in an uninterrupted line, from the installed tile to the origins of the product.

There remains one final matter to be cleared up. Ceramic tiling constitutes the outermost element of a building, the element that generally shows any eventual defects, including those that come from the underlying background. Who guarantees the Quality of the building, and consequently that of its projection and execution? We can talk about this at the next QUALICER.

APPENDIX

EXAMPLE OF AN APPLICATION OF STANDARD EN 29002

TO CERAMIC MANUFACTURE

1. PROCESS IDENTIFICATION

The main stages of the manufacturing process are shown with the relevant references in standard EN 29002.

	EN	29002	
1. Raw materials specifications	4.5.2		
2. Raw materials acquisition	4.5.3		
3. Raw materials reception	4.9.1		
4. Raw materials preparation	4.7	4.8	4.11
5. Mixing/milling	4.7	4.8	4.11
6. Shaping	4.7	4.8	4.11
7. Drying	4.7	4.8	4.11
8. Glazing	4.7	4.8	4.11
9. Firing	4.7	4.8	4.11
10. Sorting and packing	4.8	4.9.3	4.11, 4.14.3
11. Storage and shipment	4.11	4.14.3	4.14.5

Note: Raw Materials are understood to be the materials used in preparing either the body, or the glazes and decoration; they are also understood to include any semimanufactures (such as the biscuit, spray-dried powder, etc.), which are supplied by third parties or other firms belonging to the same group.

2. INSPECTIONS AND TESTS IN PRODUCTION

The manufacturer must perform inspections and tests throughout the production process. The main references provided by EN 29002 are as follows:

	EN	29002	
Inspections and tests, records	4.9.2 4.9.4	4.9.3 4.11	4.15
After inspections and tests, tile non-conformities can be identified	4.12	4.13	4.15

Data are obtained from the whole production process, which must be recorded and kept up to date	4.9.4	4.12.1	4.13 4.15
The efficiency of production process controls depends on the accuracy of the measuring instruments used in production and in testing	4.10		
Measuring and testing instruments must be continuously controlled, calibrated and kept in efficient working order	4.10		

3. TYPICAL QUESTIONS THAT CAN BE ASKED TO VERIFY THE EFFICACY AND EFFICIENCY OF THE MANUFACTURERíS QUALITY SYSTEM

3.1 - Raw materials

Is there evidence of raw materials inspections?

Are the raw materials acquired from a supplier approved by the manufacturer? And according to specifications approved by the manufacturer?

Are the facilities suited to the process, do they work satisfactorily, and are they kept in efficient working order?

Are the formulations included in the documented control procedure? (For example, date of issue/ revision, etc.)

3.2 - Process controls

Is tile identification kept according to the quality system set down in writing by the supplier?

Are the responsibilities and competencies at the manufacturerís defined? For example, in the case of production of tile non-conformities, what action is required of the staff?

Are the relevant documents and recording instruments defined in the quality system, to monitor and control the process? Are instructions correctly compiled, used for corrective action when needed, and safely kept for a certain period by the manufacturer?

Is sampling performed according to the set frequency for internal quality control?

Are records kept of tile non-conformities, and used as a basis for analysis to avoid repetition of the problem/s?

Are procedures, set out in writing, followed for entry, handling, packing, storage and shipment.

Is there a list of control instruments used in production or the laboratory (testing equipment)?

Is there a calibration procedure for every measurement and testing instrument, which indicates the expiry date? Is calibration recorded? Does the calibration method guarantee sufficient accuracy/precision? Is

there a system for identifying the calibration date on every measurement/test instrument?

3.3 Personnel training

Are there suitable records of personnel training, detailing qualifications/experience/training?

3.4 Finished product

Are samples taken according to a specified frequency (sampling plan), and are they tested according to applicable EN standards?

3.5 Modifications of existing products/and or new commercial series

Ceramic tiles are subject to continuous change as a result of market demands (new products), the need to improve business performance, or as a result of changes in production technology. Every change must be controlled, using the quality system, to guarantee the product keeps complying with the applicable EN requirements.

- Does the quality system include testing new/modified tiles to check compliance with UNI EN standards before the new products are taken into production?

- Are new specifications drawn up for production control and control of acquisitions?

- Is there a distribution system of new specifications for the interested parties, and a system for withdrawal of obsolescent specifications?

- Are the inspection/testing systems changed, if this is the case, to take modifications into account?

3.6 Top management activities

The points of interest are:

- Top management responsibilities (EN 29002,4.1)

- Quality system (EN 29002, 4.2)

- Documentation control (EN 29002, 4.4)

- Internal quality audits (EN 29002, 4.16)

The above may be considered «self-explanatory».

3.7 Reexamination of the contract

In general, in contracts between suppliers and customers, economic-legal aspects are gone into in detail; the qualitative requirements are based on indications for commercial choices that are inferred from the standard. The producer does not produce to customer specifications, but must comply with the regulations.

Therefore, it is necessary to keep documentation up to date on the qualitative requirements of what is being manufactured, or has been manufactured during a specific period (this is especially so if it has been stored).

To comply with this requirement, the manufacturer must have a production plan (a production program).