Quality assurance in master alloy production

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Master alloys are manufactured in the shape of rod, ingot and splatter. The application of SPC (implemented in 1982) provided the framework for a continuous improvement of the production process. KBM's wish was to head their field with regard to quality and therefore undertook to implement the international quality standard ISO 9001 "Quality Systems – Model for Quality Assurance in Design/Development, Production, Installation and Servicing".

The first step was to appoint a quality assurance "steering" committee (QUAST) to implement ISO 9001. This committee, headed by the Development and Quality Assurance Manager, consisted of middle management representatives from various departments, such as Marketing/Sales, Operations and Quality Control and a secretary with a high degree of accuracy was also appointed. In addition, a consultant with relevant experience was hired to advise the committee.

In June 1989, two years after commencement of the project, Lloyd's Register of Quality Assurance Ltd. carried out a certification audit based on ISO 9001, which lead to formal recognition of KBM's quality system. After certification, further audits by Llody's will be executed every six months. In addition, the management is obliged to perform internal quality audits to verify the proper maintenance of organizational procedures, operating procedures, testing procedures, purchasing, sales, marketing, supplier evaluation, etc.

As a result KBM became the first Dutch Aluminium industry and the first in the worldwide master alloy branch to obtain Lloyd's certification. The lessons learned during this period are highlighted and the basic set-up of the system is described.

Japan's successful and continuous efforts in many fields have always been a point of great interest to the western world and, in particular, to Europe. Japanese culture has proven highly receptive to the theories of Deming and Juran, whereas Europe realized the potential benefits of these theories, particularly with regard to quality management, only in the late 1970's. The basic tools of Statistical Process Control and Statistical Quality Control slowly became more important and have, by now, been widely accepted in the industry. Originating from the military AQUAP standard, quality assurance has now become an issue in Europe and has gained momentum.

The culture change

A programme that has been rather successful in the Netherlands is KOAF: Kwaliteit Op Alle Fronten (Quality on all levels). Similar programmes have been introduced in other European countries. Kawecki-Billiton Metaalindustrie B.B. (KBM) embarked on this programme in 1985, which is still used very effectively.

The basic idea is to follow two cycles, see fig. 1, which is taken from the KOAF manual. The first cycle consists of seven lessons during which problem solving techniques are presented and applied to case histories and internal problems. In the second cycle the basic lessons learned during the first cycle are applied.

During the second cycle relevant department heads present a chapter from the instruction manual. Items such as purchasing, human resource management, development and quality control are covered. After both cycles, KOAF participants will select a topic to solve/evaluate themselves. Parallel with or succeeding KOAF, groups following exactly the same route can be formed. The group leader received external training and acts as a teacher/coordinator.

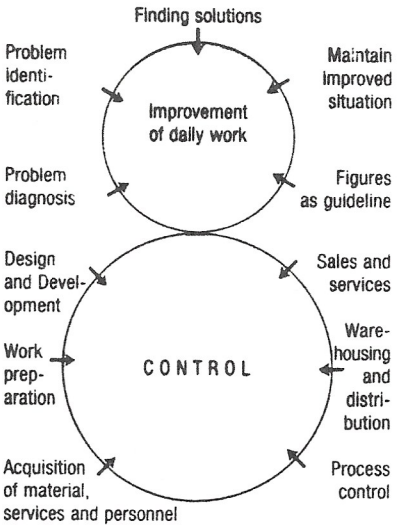

Fig. 1: The 2 cycles used in the KOAF approach, taken from the KOAF manual

The principal advantage of this programme is that the participants (from middle management) will realize that a change in their own approach is necessary. They will also learn what needs to be done to make a company more efficient. As this involves a change of culture, it is obvious that this type of programme needs full management support and, simply, time. This culture change is a requirement to successfully continue with the following, very comprehensive stage of quality management, i.e. a certified quality management system based on the international standard ISO 9000 series.

After careful consideration and preparation, Kawecki-Billiton commenced the certification scheme in 1987. As planned, it took exactly two years to obtain formal certification by Lloyd's Register of Quality Assurance Ltd. (LRQA). LRQA were selected for their large share in the European auditing market and for their worldwide reputation.

Quality Assurance standards

The definition of quality assurance is as follows:

"The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" (taken from ISO 8402)

QUALITY ASSURANCE

International standards — ISO 9000 – series

Published 15th March 1987

	ISO 9001 BS 5750/I	ISO 9002 BS 5750/II	ISO 9003 BS 5750/III	ISO 9004
Design & Development	X			X
Manufacture	X	X		X
Installation, Delivery & Test	X	X	X	X

For Kawecki Billiton – Master Alloys ⟶ ISO 9001/9004

Fig. 2: Quality assurance, international standards ISO 9000-series (published March 15, 1987)

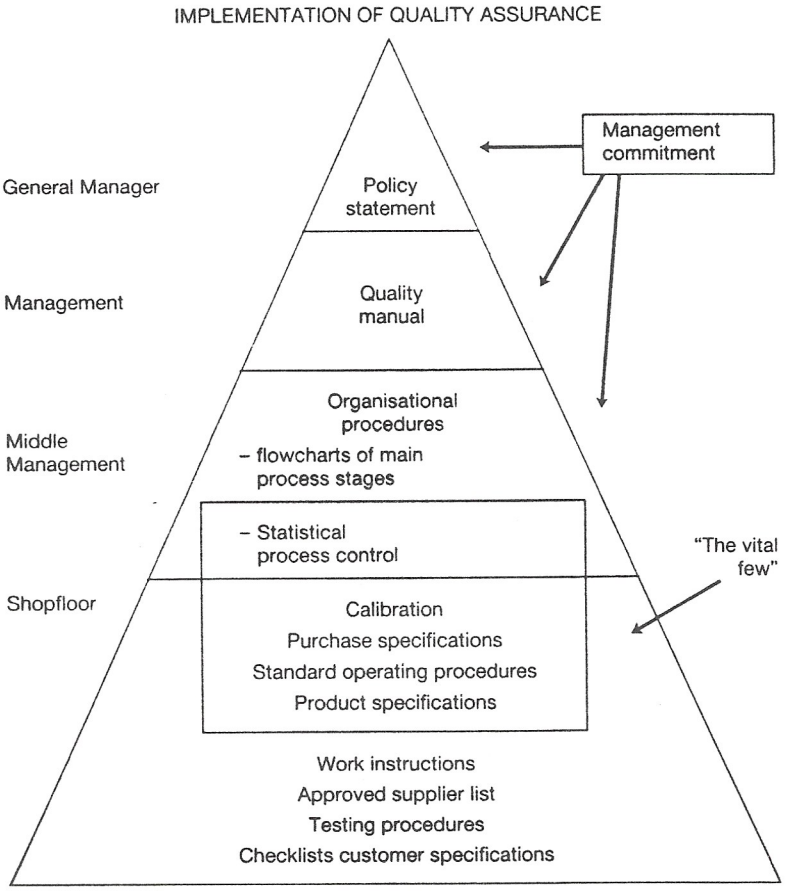

Fig. 3: Implementation of quality assurance

There are several standards for which a company may opt. Basically a choice has to be made between ISO 9001, 9002 and 9003 (identical to BS 5750 parts I, II and III). The scheme indicated in fig. 2 allows a selection of the appropriate standard. Installation, delivery and testing is covered by ISO 9003. Manufacturers that produce according to a fixed design, such as smelters, processing industries, etc. should select ISO 9002. If design and development activities are carried out, ISO 9001 is the appropriate choice. In all cases ISO 9004 is a guideline for the interpretation of ISO 9001, 9002 and 9003.

Certifying institutes, such as LRQA, issue quality supplements in which their interpretation of certain clauses of the ISO standard is given. The certificate applicant is assessed on the appropriate ISO standard and on the quality supplement. For the aluminium industry LRQA has issued Q.S. 2100, entitled "For use in industries converting raw materials to semi-finished products and processing semi-finished products", including metallurgical processes and metal manufacture.

Actively involved in product development, it was considered mandatory to incorporate these activities in the quality management system. This lead to select ISO 9001, being the most comprehensive quality standard for development, manufacture and supply of aluminium based master alloys.

Getting started

The basic activities providing a good platform for any quality assurance programme are indicated in fig. 3. The activities include:
- application of statistical process control,
- purchase specifications (accepted throughout the company),
- standard operating procedures for production personnel,
- product specifications.

It must be realized that quality assurance focusses on the organization rather than on the products per sé. An essential requirement for a successful and timely completion of the certification scheme is, therefore, that the production process is controlled technically. With these items secured, the following hurdles had to be taken:

Awareness

The time consuming process of the above mentioned culture change was guided by means of the KOAF scheme and resulted in a positive attitude towards the need to initiate and support the certification scheme throughout the company.

Consultancy

Consultancy prevented the obvious mistakes and lead to a significant

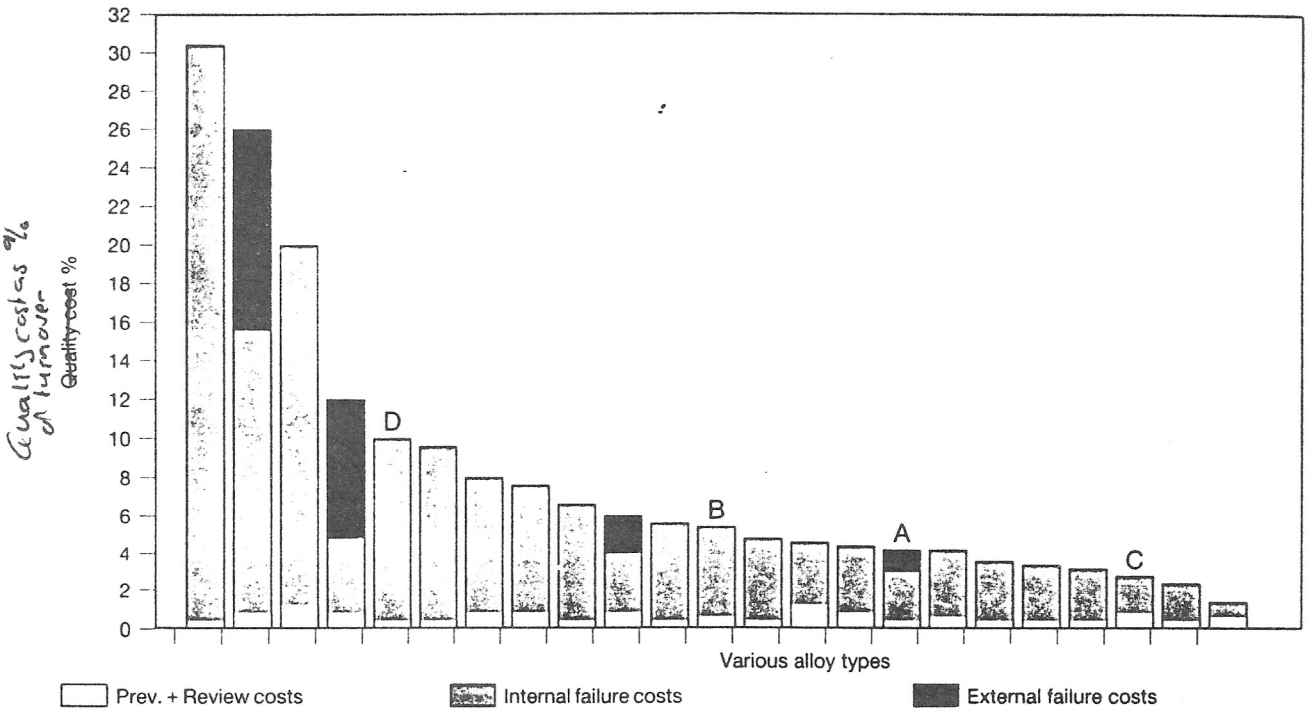

Fig. 4: Quality cost per product (expressed in turnover % of that product)

reduction in implementation time. Kawecki-Billiton, being one of the first companies in the Netherlands to engage in quality assurance, had to make a choice between hiring a management consultancy bureau (with limited relevant know-how at the time) or hiring a consultant with hands-on experience. For obvious reasons, a person who had worked inside a certified organization was preferred.

Organization

In conformity with the standard, an independent quality assurance manager was appointed and made responsible for the implementation of the entire certification scheme. The Q.A. Manager chaired the quality assurance taskforce and was also made responsible for all quality control activities. The taskforce, with representatives from the departments of Quality Control, Production and Marketing, was supported by the consultant and an accurate secretary. All taskforce participants were selected for their ability to "write". Both Management and Middle Management were represented in this taskforce. Practice proved that the secretary had to devote all her time to handling the generated paperwork.

Communication

The programme officially started when the General Manager wrote the company's policy statement, explaining the objective and scope for the taskforce. In addition, all employees were briefed on purpose and planning in small groups (max. 6). All employees were kept informed of programme progress at regular intervals.

Appraisal of non performance cost

Quality cost consists of appraisal cost (fixed salaries of quality control personnel), prevention cost (e.g. maintenance of quality assurance system), internal (e.g. remelts) and external failure cost (return shipments, rebate, etc.). Appraisal of non performance costs (quality cost registration, which was started early 1987, prior to the QA programme) during the QA implementation period, enabled KBM to formulate and monitor quality plans on a quarterly basis. Product quality was improved by means of technical and organizational adjustments, which were monitored and expressed in "money saved" (opportunity costs). Relative quality cost (in % of turnover per product) and absolute quality cost (in money) are analyzed and reported. Action programmes, affecting the entire quality assurance system, are defined in order to meet previously set targets. On several occasions we found that a potential quality cost reduction justified investments.

Fig. 4 presents a schematic representation of relative quality costs, which is an account of internal and external failure costs. Absolute quality cost (in money) can be calculated in a similar way and is related to total turnover. Following the Pareto rule, major hurdles are to be removed first.

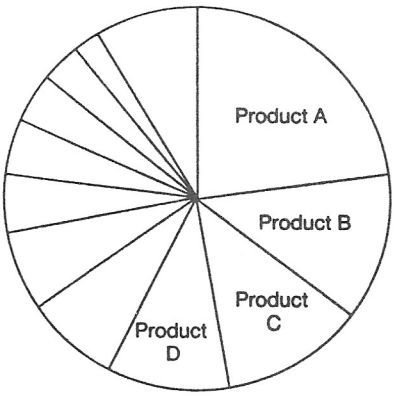

Fig. 5: Absolute quality cost contribution per product (expressed in % total quality cost)

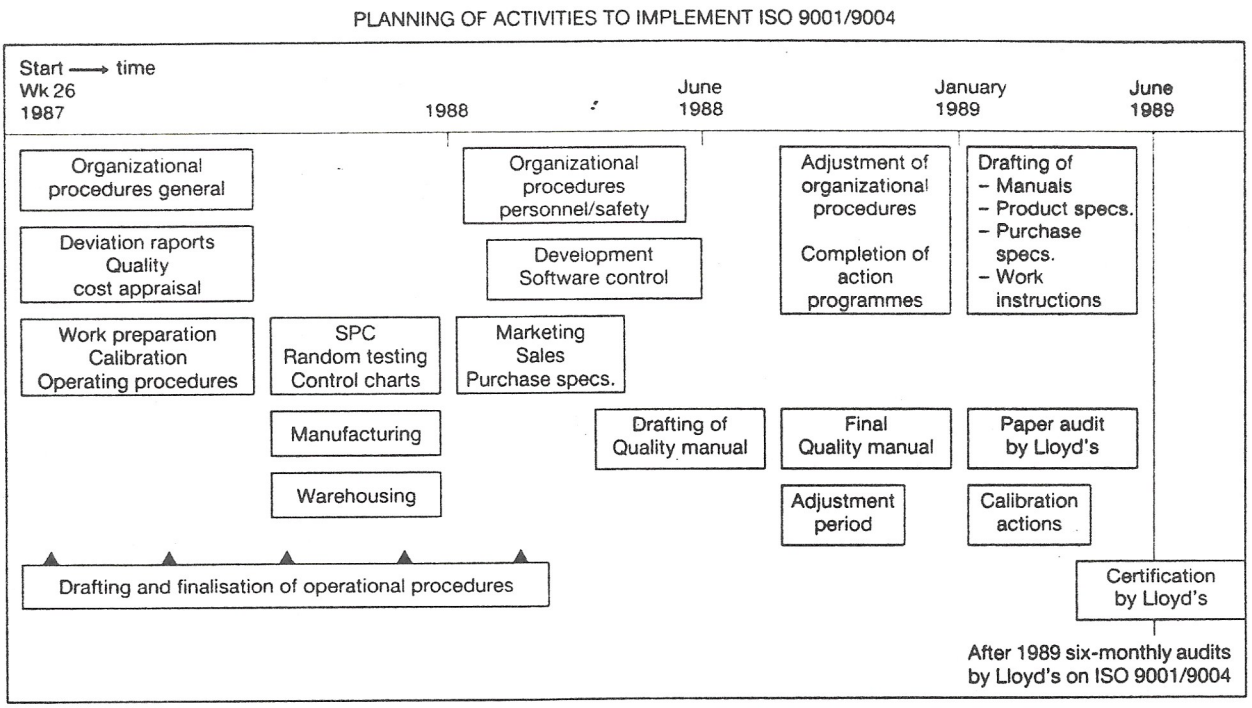

Fig. 6: Planning of activities to implement ISO 9001/9004

Although A, B, C and D do not seem to be the highest non-performers, the absolute value in money involved presents a different graph, see fig. 5. This graph shows that product A, although low in relative quality costs, comprises the largest part of total quality costs. This product should obtain the highest priority in an improvement programme.

Elements of the Quality Assurance system

Planning

Planning activities are shown in fig. 6. The drafting of process flow diagrams (fig. 7) gave insight in the amount of work instructions, related to equipment operation, to be drafted. Based on these diagrams, a preliminary list of required work instructions was drafted, enabling precise planning and indicating the relevar t document writer.

The implementation of procedures and instructions proved to be most effective if its contents were discussed in detail with middle management involved (groups of max. six persons). All participants received the same information and agreed to the procedure. To keep people informed and to create a full understanding of the quality assurance system, these discussions were repeated several times. A similar approach proved very effective to solve problems with regard to the implementation process, as participants could propose solutions which were implemented in the revised versions of documents.

Document control structure

The documents essential for the quality assurance system are kept up-to-date using a system of controlled copies. A controlled copy can be identified by the presence of a red or dry stamp. A copy, devoid of the stamp, has not been subject to control and, consequently, may not be used by KBM employees. Alterations to controlled copies may be carried out by assigned employees only. Persons receiving new or revised documents are notified of the alterations in writing. Old versions are destroyed. A problem that lingered for more than six months was that uncontrolled copies from private files were used instead of the new controlled copies. Constant attention had to be paid to this problem by removing uncontrolled copies, which finally lead to a practical system consisting of controlled copies only.

Inspection incoming material

Supplier performance is registered and revised twice a year. Based on this system a list of approved suppliers is maintained. Incoming materials are checked and compared to KBM purchase specifications. Approved materials are released, using green strips "RELEASED". A product release form accompanies the material until it has been processed.

Process control

Prior to actual production, a work specification checklist enables control of:

- availability of approved raw materials,
- adequate quantities of packaging materials,
- handling of special customer requests,
- correct identification of standard operating procedures,
- instructions for packaging.

After completion of the checklist, the testing and fabricating plan (week planning) is reviewed and updated. Reference is made to:

- time related work instructions,
- work instructions on site,

- shut-down procedures,
- maintenance,
- start-up procedures.

The principal manufacturing steps for all major process routes are identified and a booklet with 5 to 10 relevant work instructions can be found within 25 meters of such a "step". Operators have access to work instructions related to:

- testing criteria,
- general machine settings,
- general instructions.

Daily chemical analyses are reported. Averages and ranges are calculated to provide feedback for control charts, using X-R charts for Statistical Process Control (SPC) and include:

- SPC X-R charts on production parameters such as elongation, diameter of AlTiB rod and critical process parameters;
- SQC X-R charts on all chemical analyses, calibration samples, cleanliness and grain refining efficiency.

Specified control limits enable the steering of the nominal value of each parameter, which ultimately leads to cost saving. Plant utilization ratio's and production / consumption target are also reported and checked daily.

Batch forms accompany the heat during processing in order to ensure complete traceability and to indicate the inspection status at all stages. To keep a firm grip on trend developments, the results of daily control charts are incorporated in weekly and monthly average charts. These charts date as far back as 1982, when the SPC programme was first introduced. As a result of this trend analysis, based on SPC, grain size of AlTiB 5/1 rod is constantly met and cleanliness continuously improved (figs. 8a and b).

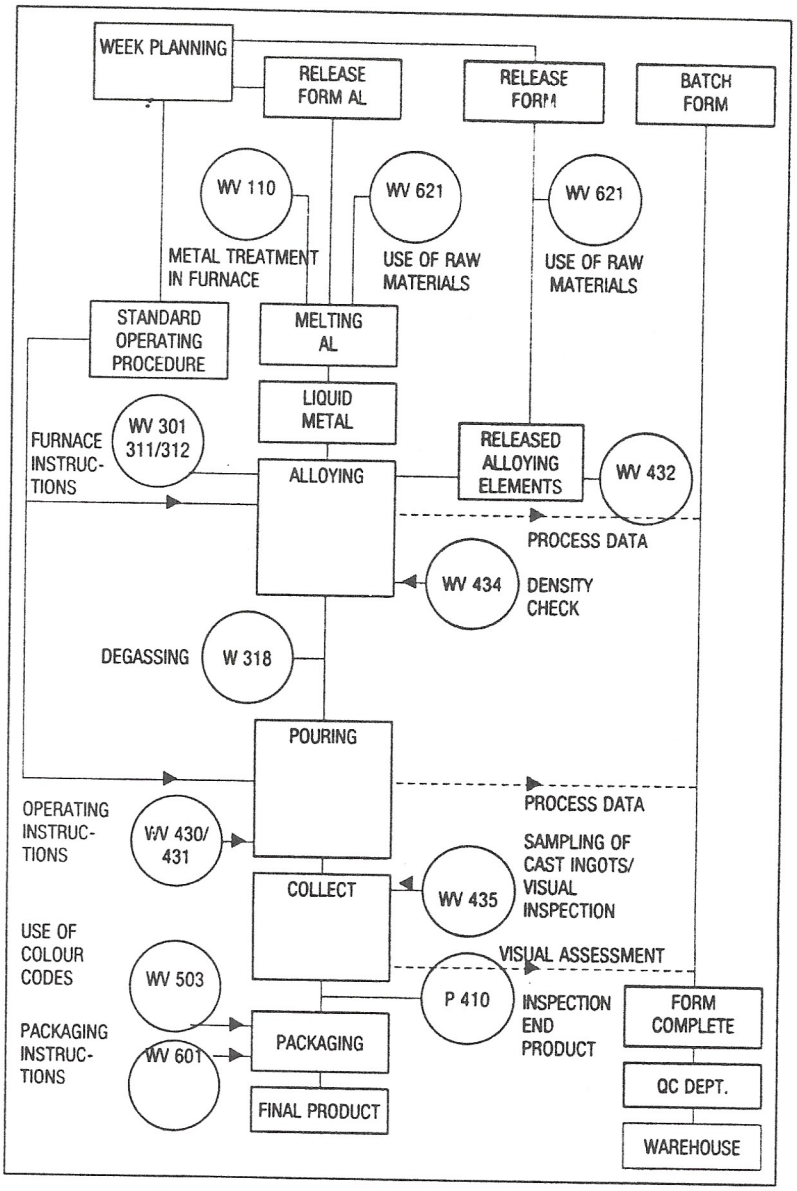

Fig. 7: Example of a flow chart of major processing steps and identification of relevant work-instructions for Ingot casting route

Final inspection and product handling

A system has been developed to indicate the final control status. Non-standard products (not meeting KBM product specs.) are rejected and subject to a reject control procedure. Costs made are accounted for in KBM's quality cost appraisal system. Some products are processed further, e.g. AlTiB coil is recoiled or chopped to meet customer requirements. Products meeting all criteria are approved and labelled accordingly. An analytical report accompanies all shipments. Before final release it is checked by the Quality control department, using checklists drafted by the Commercial Department. These checklists are related to customer specifications.

Calibration and maintenance of test equipment

All test equipment has been registered by the Development & Quality Assurance department and can be identified by a unique 7 digit number. A PC controlled recall system has been established to ensure the accuracy, availability and traceability of test equipment.

The primary calibration standards are stored in the calibration room. These standards are to be used for calibration and certification of secondary and/or working calibration standards. The primary standards are compared to standards traceable to the Dutch National Physical Laboratory "NKO" (Nationale Kalibratie Organisatie, previously "IJkwezen") or other institutes at established intervals.

All secondary and working standards as well as the test equipment used during assembling and testing of our products shall be checked and calibrated at the intervals stated in calibration instructions (fig. 9). The calibration/maintenance status of equipment is indicated by the relevant stickers.

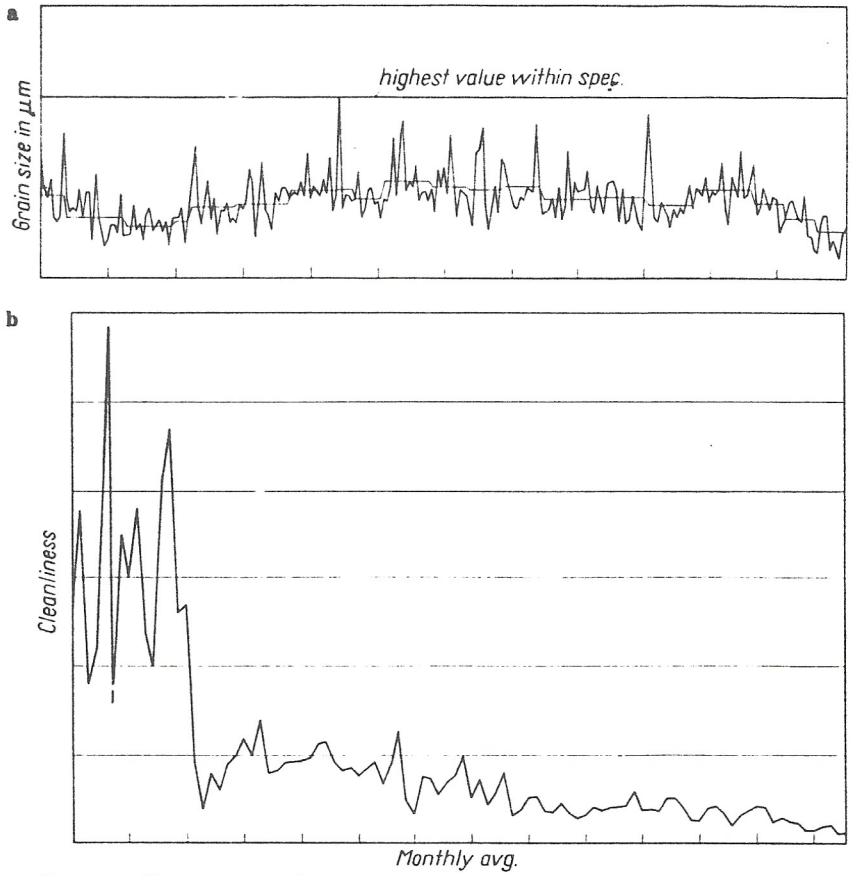

Fig. 8a and b: 10 year performance of AlTiB 5/1 rod grainrefining performance, (fig. 8a) and cleanliness figure (fig. 8b)

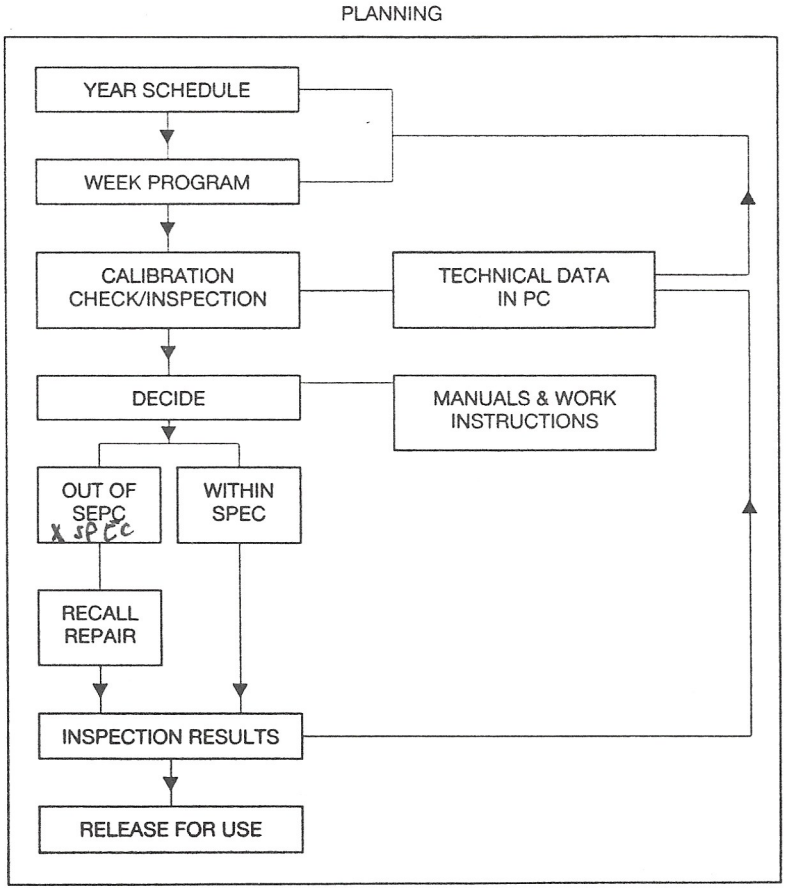

Fig. 9: Recall system for calibration of equipment

Control of non conforming product

In case of deviations from purchase specifications or product specifications the "non compliance committee", with representatives from Marketing, Quality Control, Production, Warehousing and Maintenance, discusses preventive and corrective measures. Deviating material is isolated by means of red strips "GEBLOKKEERD" (withheld) until the committee makes a decision. Material marked with a green strip "VRIJGEGEVEN" (released) has been released.

Internal audits

The quality policy is reviewed bi-annually and, if necessary, adjusted. Monthly internal quality audits are carried out on all procedures. Points for improvements are identified and discussed during staff meetings. Internal auditing is supported by check lists containing queries on performance according to the quality system.

Training and personnel

All employees have job descriptions formulating responsibilities and authorities. Training needs are identified annually and, if necessary, training programmes are adapted. The training history of each employee is filed. New production personnel receive a safety training and attend technical training programmes, for a period of 1 to 2 years. Equipment manuals and site related work instructions are incorporated in the examinations.

Documentation for external use

A large number of general brochures, specific Technical Information Sheets (TIS) and Safety Information Sheets (SIS) to provide customers with adequate and up-to-date documentation on product chemistry, practical aspects and trends. In addition the technical literature database provides literature data on specific areas of interest, which is available for customers on request.

The certification audit

Initially, a one day "paper" audit is held by LRQA to check whether the

paperwork is complete. Planning for the final audit, listing time and place of all items to be covered, is prepared. LRQA have developed a very strict and effective system to find noncompliance points ("yellow cards"). The people interviewed are asked to tell what they do. During the interview LRQA request examples and documented proof, which has to be supported by controlled copy documents and procedures. By taking random samples from files, noncompliances, if any, can be discerned easily. After the audit all noncompliance elements are recorded. On approval, this record is signed by the company. Depending on the level of severity, these noncompliance items are either registered as minor ongoing improvements ("yellow cards") or as hold points ("red cards"). Ongoing improvements will be subject to inspection during the next "maintenance" audit (every six months) or during audits especially carried out to examine noncompliance elements.

Having established a certified QA system, a firm basis is obtained for continuous improvement of the organization. Human motivation, being the motor of the quality management system, remains essential.

Authors

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