THE QUALITY ASSURANCE SYSTEM FOR QUARTZ CRYSTALS AND CRYSTAL OSCILLATORS

SEIKO EPSON CORPORATION
Quartz Device Operations Division, QD Quality Assurance Department
January 10, 1995

INTRODUCTION

The Quartz Device Division of Seiko Epson Corporation received ISO-9001 certification in September 1992. In this division, we promote quality assurance activities for the customer using ISO-9001 standards as a base in all phases of business, including design, production, quality assurance, after sales service, etc.

CONTENTS OF THE QUALITY ASSURANCE SYSTEM

1. Quality Policy

At Seiko Epson, we promote quality assurance activities through the establishment of a quality policy. The company's management philosophy serves as a base for the quality policy.

Seiko Epson Corporation's Management Philosophy:

We shall strive to be a "good company," trusted in every part of the world, by placing the customer first, respecting the individual, and displaying collective strength.

A "good company" is one that:
1. Secures fair and reasonable profit.
2. Has employees who are constantly creative and meet challenges with confidence and pride.
3. Can meet the future expectations of both its employees and society.

A company that pursues these goals will enjoy continual growth and development.

To "place the customer first" means for "each employee to accurately identify who his customer is and what his customer wants and to constantly rethink and improve his work in order to build quality in."

The QD Division's Quality Policy:

1. To produce worthwhile, customer-pleasing products
2. To continue to turn the PDCA control cycle in every area of operations for continued improvement
3. To experience the pleasures of manufacturing through the collective contribution of the wisdom and strengths of all employees

3. Quality Assurance System
The "Quality Assurance System Outline" is applied to all aspects of business, from product research to sales and service.

QUALITY ASSURANCE SYSTEM OUTLINE

Product Proposals	Product Proposal Draft ↓ Meeting to Consider Product Commericialization
Product Research and Development	Meeting to Consider R&D ↓ R&D Prototype
Product Planning	Product Planning Draft ↓ Product Planning Meeting
Design • Prototype	Establishment of Target Date for Manufacturing ↓ Mass Production Design ↓ Design Review ("DR") ↓ Start Engineering Sample ("ES") Prototype ↓ DR for ES Prototype ↓ Meeting to Approve ES Prototype
Preparation for Mass Production	Start Initial Mass Production ↓ DR for Shift to Mass Production ↓ Meeting to Approve Mass Production
Mass Production	Mass Production ↓ DR for First Products Shipped ↓ Meeting to Approve First Products Shipped ↓ Shipping Inspection ↓ Shipping
Sales • Service	DR Summary

4. Design Review and Qualification
In the QD Division, design reviews are performed at each step in the product development process based on the requirements of the quality assurance system. These design reviews capitalize on our technology and experience in various areas to expose problems before they occur and contribute to smooth start-ups, problem prevention, and achievement of quality, cost, delivery, and product safety objectives.

Implementation Summary

(1) The Philosophy of DR and qualification
DR and qualification will be classified and clearly differentiated as described in the flow chart below.

① DR
- Relevant departments will carefully test and conduct total maintenance checks for the procedural methods, philosophy, and results (including product quality) of each principle step of the quality assurance system. Accordingly, they will review the next step and determine the direction it should take.

② Approval Meeting
- From an overall management standpoint, the above DR results are used to determine whether or not it is possible to advance to the next step, next process, or ship to market.

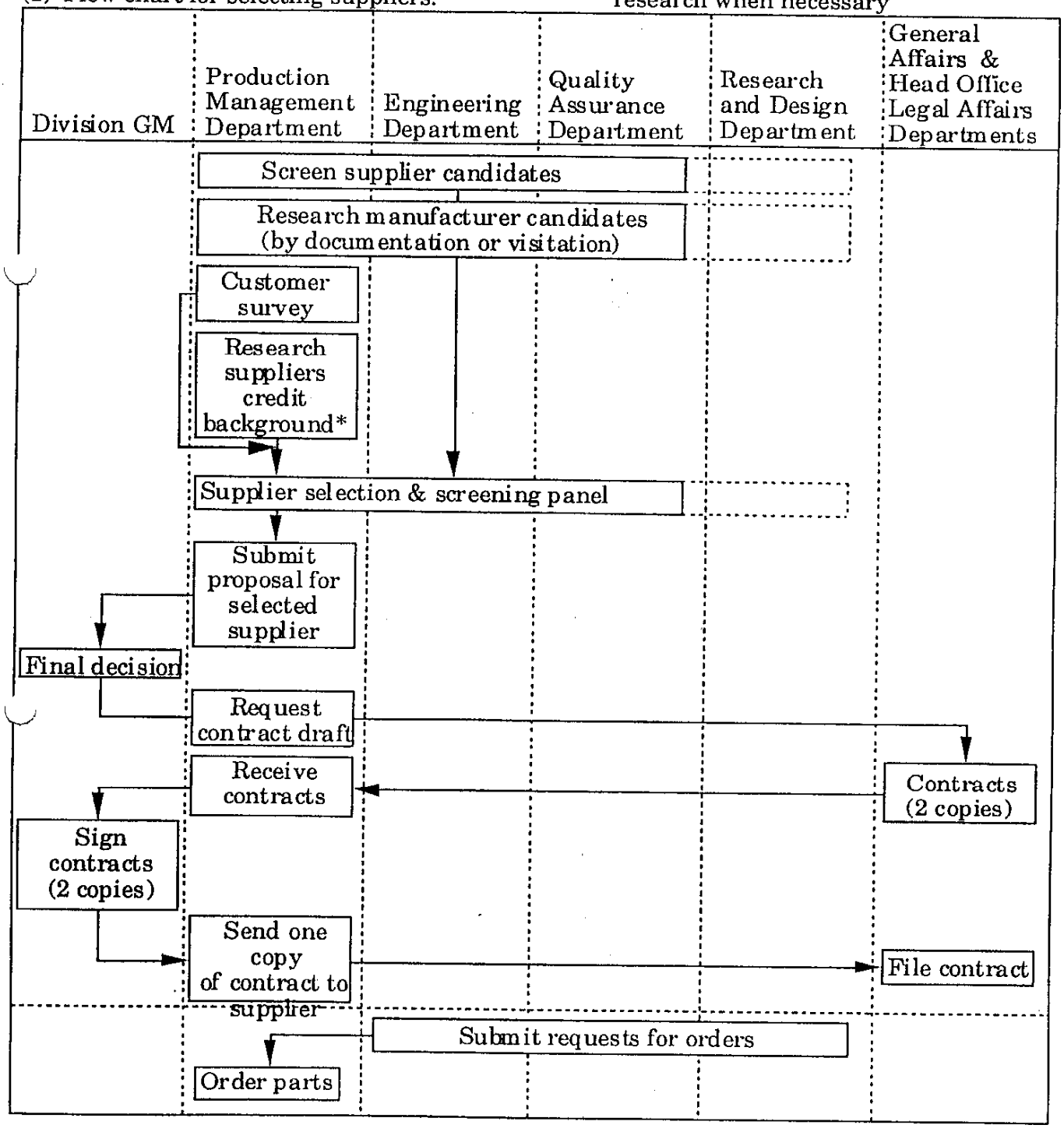
(2) When there are meetings held for the DR and approval of each step of production, from product planning to the initial mass production, the following flow chart is applied.

Steps	Operations Content	Department in Charge
Set Up DR Meeting	·Prepare DR data package ·Issue DR meeting notice	supervisory dept.
Implement DR	·Check and decide on the "data package" and each item and based on the "DR Checklist"	supervisory dept. and related departments
NG Decision	·Overall decision	supervisory dept.
GO Compile DR Results	·Compile DR checklist and reports ·Clarify method for proceeding after failures and unsatisfactory results (date, person(s) in charge, etc.)	supervisory dept.
Qualification meeting	·Issue notice of approval meeting ·Consideration and decision based on DR results report	supervisory dept. and related departments
NG Qualification	·Approve or reject	Division GM and GM from department responsible for decision
GO Issue notice of qualification	·Compile results of the approval meeting and distribute to related departments	supervisory dept.

5. Purchasing Control

Suppliers are chosen using the division's "Supplier Selection Criteria" as a guide. Transactions take place after the interested parties sign and exchange such things as basic agreements, quality assurance standards, and purchasing specifications.

(1) Flow chart for selecting suppliers: *research when necessary



(2) Issuing Quality Assurance Standards
Parts are divided into two ranks by their level of importance. The Quality Assurance Standards are applied accordingly.

Rank	Criterion	Submit Standards	Follow-up
A	① Custom products ② Important parts in the system ③ Poor quality manufacturer judging from past performance ④ Manufacturer with which we have not done business before	Necessary	·Implement receiving inspection in accordance with the quality level for initial production and during mass production
B	① Parts used often as standard parts ② Important parts, but similar parts are available and quality can be estimated to a certain degree. ③ Companies with which we have had a long business relationship ④ Manufacturers that have a reliable QA system (have passed a publicly recognized inspection, etc.)	Not Necessary	·Follow-up when a problem occurs

Implementation Steps

	Production Control Department	Engineering Department	Quality Assurance Department	Manufacturing Department
Selection	Select Supplier			
Opening of Business		Submit specifications (plan) ·Present Quality Assurance Standards		
Prototype Production	Prepare prototype sample	Evaluate prototype sample, discuss specifications, establish specifications		
Trial Production	Make preparations for trial production		Establish receiving inspection methods (entire lot, audit results, no inspection) detailed inspection of pre-production items	
Mass Production	Prepare parts		Receiving inspection (when necessary)	Follow-up on usage situation

(3) Philosophy Behind the Receiving Inspection

1) As a general rule, the division will not conduct receiving inspections, as every manufacturer has quality assurance for raw materials and parts. However, there are in reality parts that have questionable quality. Because there are items that would benefit from an inspection, an optional receiving inspection is established as an initial function to support the general policy of not conducting these inspections.
2) When there is no inspection and the actual strengths and capabilities of a manufacturer are unknown, a system for understanding their process capabilities and assurance systems is implemented at the time business first begins and at set intervals while business is being conducted.
3) When there is a good quality record for delivered goods and it is determined that there is no fear of quality trouble occurring in the division's manufacturing process or in the marketplace, there will either be an abbreviated form of the inspection or no inspection.

6. Process Management (Operations Management)
At Seiko Epson, control is based on the principle of "building quality into the process."

(1) Manufacturing Process
"Process Standards" established by the engineering section managers are established for the entire manufacturing process, from the introduction of parts and raw materials to the final inspection.

(2) Work Instructions
The responsible engineering department issued engineering standards (process instructions, external appearance samples, etc.) to the responsible manufacturing department. These standards specify methods for building in product quality as well as the methodology for process inspections and final inspections. Based on these standards, the manufacturing department drafts necessary operations standards and performs operations and inspections.

(3) Identification of Defective Goods
To prevent defective goods found in the manufacturing process or process inspections from being mixed with good products, defective goods are placed in containers (boxes, bags, sticks) marked in red.

(4) Control of Non-conforming Products
Standard values for judging quality problems in each process are established. When a problem is discovered, it is dealt with according to the "Standards for Disposition of Non-conforming Products" and actions are taken to prevent recurrence.

(5) Control of Work Environment and Conditions
Standards are established to control environmental conditions such as dust, static electricity, etc. These conditions are also controlled through daily and cyclical inspections.

7. Inspections

(1) Independence of the Inspection Organization
The independence of the inspection organization is specified by "Departmentalization." Inspections are carried out by the quality assurance department's inspection team, which is independent from the manufacturing department.

(2) Registration of Inspectors
Registered shipping inspectors are individuals who have successfully completed the training prescribed in the "Standards for the Inspector Registration System" and have been approved by the general manager of the Quality Assurance Department.

(3) Inspection Criteria
The manager of the Quality Assurance Group establishes the inspection criteria and physical samples for each product. Inspection instructions are then given to the inspection team.

(4) Inspection Frequency
In general, every lot is subjected to a shipping inspection. However, depending on process capabilities and yield conditions, the responsible inspection manager may use the inspection control standards as a base to set inspection plans and direct inspections accordingly.

(5) Recording and Storage of Inspections and Testing
The responsible inspection manager is responsible for the safekeeping of the results of shipping inspections and other administered inspections for a period of seven years.

8. Quality Assurance Audit
The following audits are intended to help maintain and improve the level of quality assurance.

(1) Product Audit
Products are checked based on a biannual audit plan to see if manufacturing activities are going according to plans and to see if products meet set standards.

(2) Internal Quality Audit
Checks based on a biannual audit plan are conducted to see if required ISO 9001 criteria are being met as well as to see if the division's established quality assurance system is being implemented.

(3) QA System Audit (Suppliers)
Once a year, or whenever deemed necessary, the QA system that we have asked suppliers to use is checked to see that is being implemented properly. The same audit schedule is also applied to see that each process (manufacturing, inspections, etc.) is being conducted as instructed.

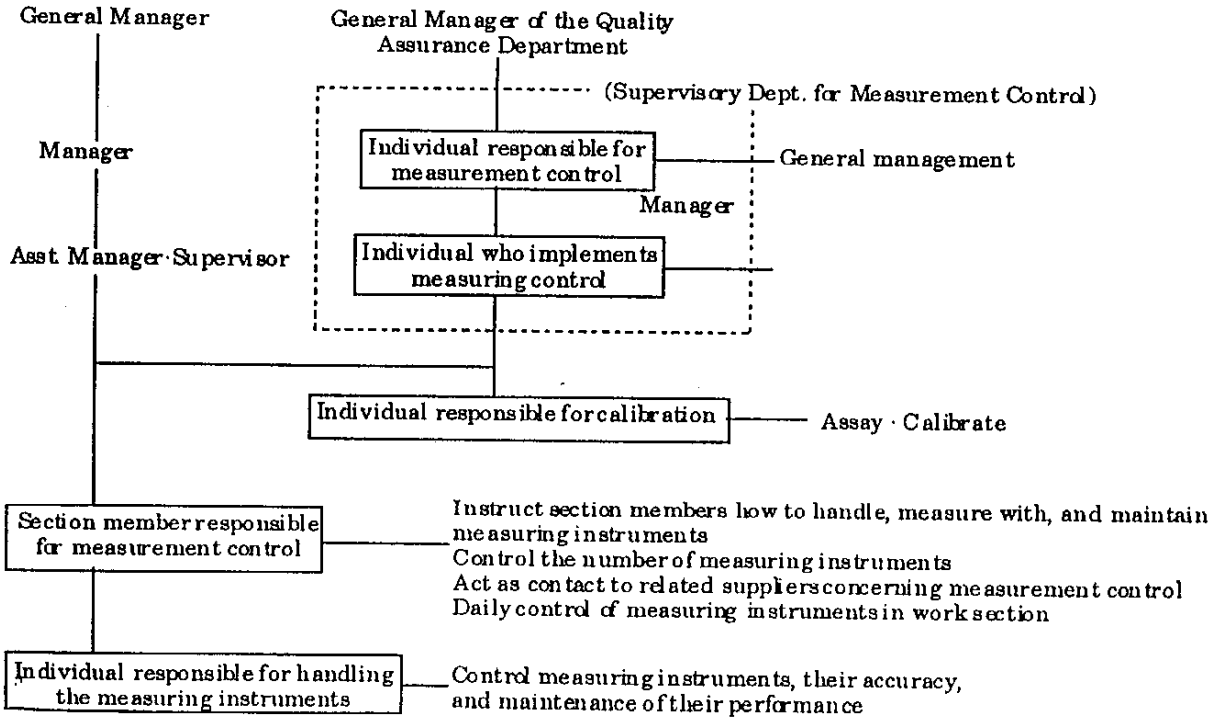
9. Management of Packing, Storing, and Shipping Activities
To maintain the quality of products during transport and storage, product packing and handling is specified by "Packing Control Standards." The engineering department establishes specific details.

10. Manufacturing Equipment Control
"Manufacturing Equipment Maintenance Control Standard" are established for the purpose of maintaining and improving equipment performance and product quality, as well as to provide for safe operating conditions.

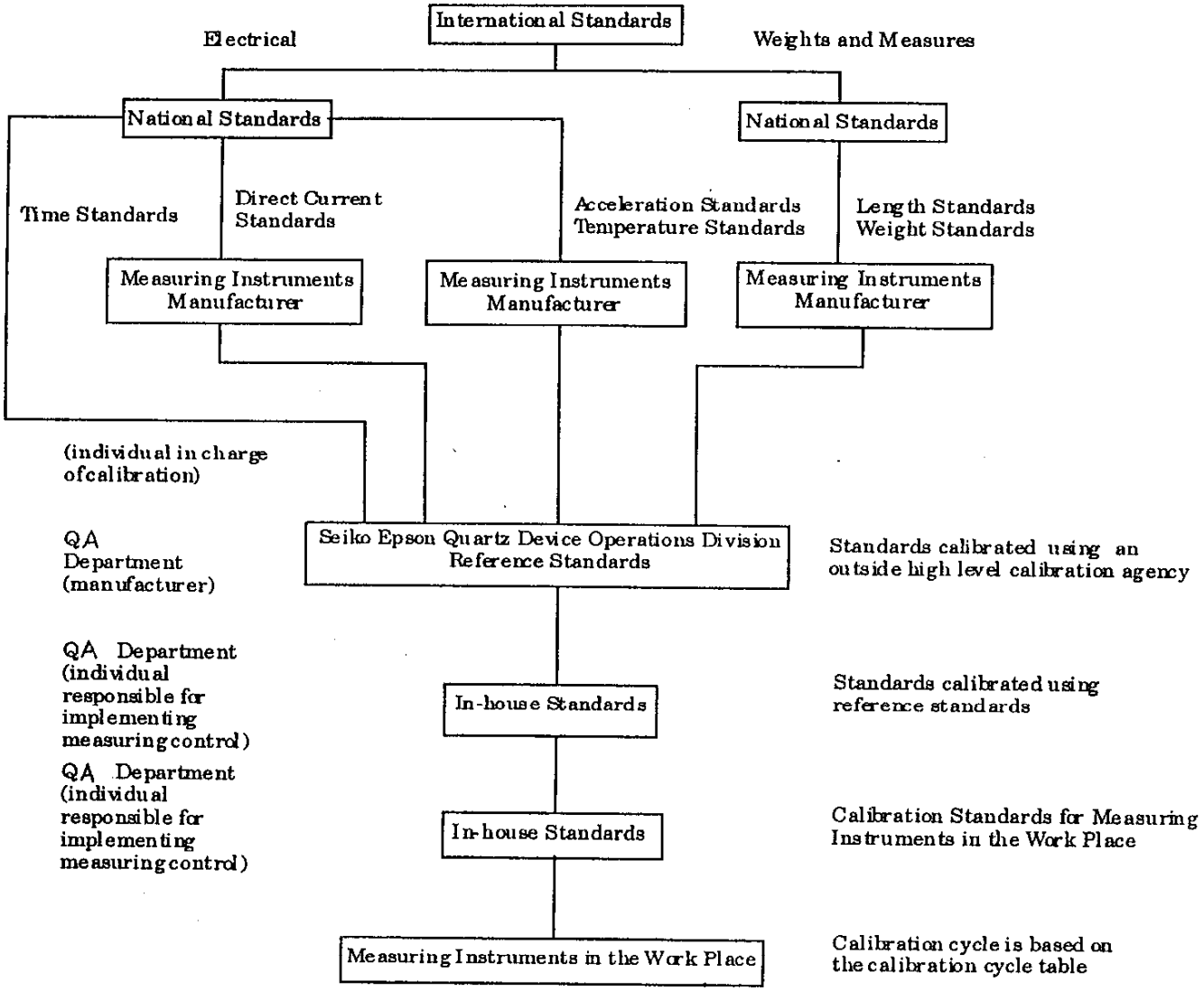
Main control criteria
① The number of pieces of equipment is controlled using the "Manufacturing Equipment Control Ledger" provided by the top manager in the workplace.
② Equipment is managed by appointing an individual to be responsible for maintaining and controlling each piece of equipment.
③ "Daily Maintenance Checks" as well as "Specific and Periodic Independent Inspections and Periodic Inspections" are conducted to ensure that they can be used in good conditions at all times.
④ The history of maintenance checks, inspections, failures, repairs, and modifications, etc. are recorded and kept on file.

11. Management of Measuring Instruments
Measurement accuracy is an important part of assuring the maintenance of quality and reliability.
At Seiko Epson daily maintenance, calibration, and equipment maintenance, etc. are carefully controlled in accordance with "Standards for Control of Measuring Instruments." Inspection jigs are controlled in the same manner as measuring instruments. Details are provided in the "Appendix to the Standards for the Control of Measuring Instruments."

《Measurement Control System》



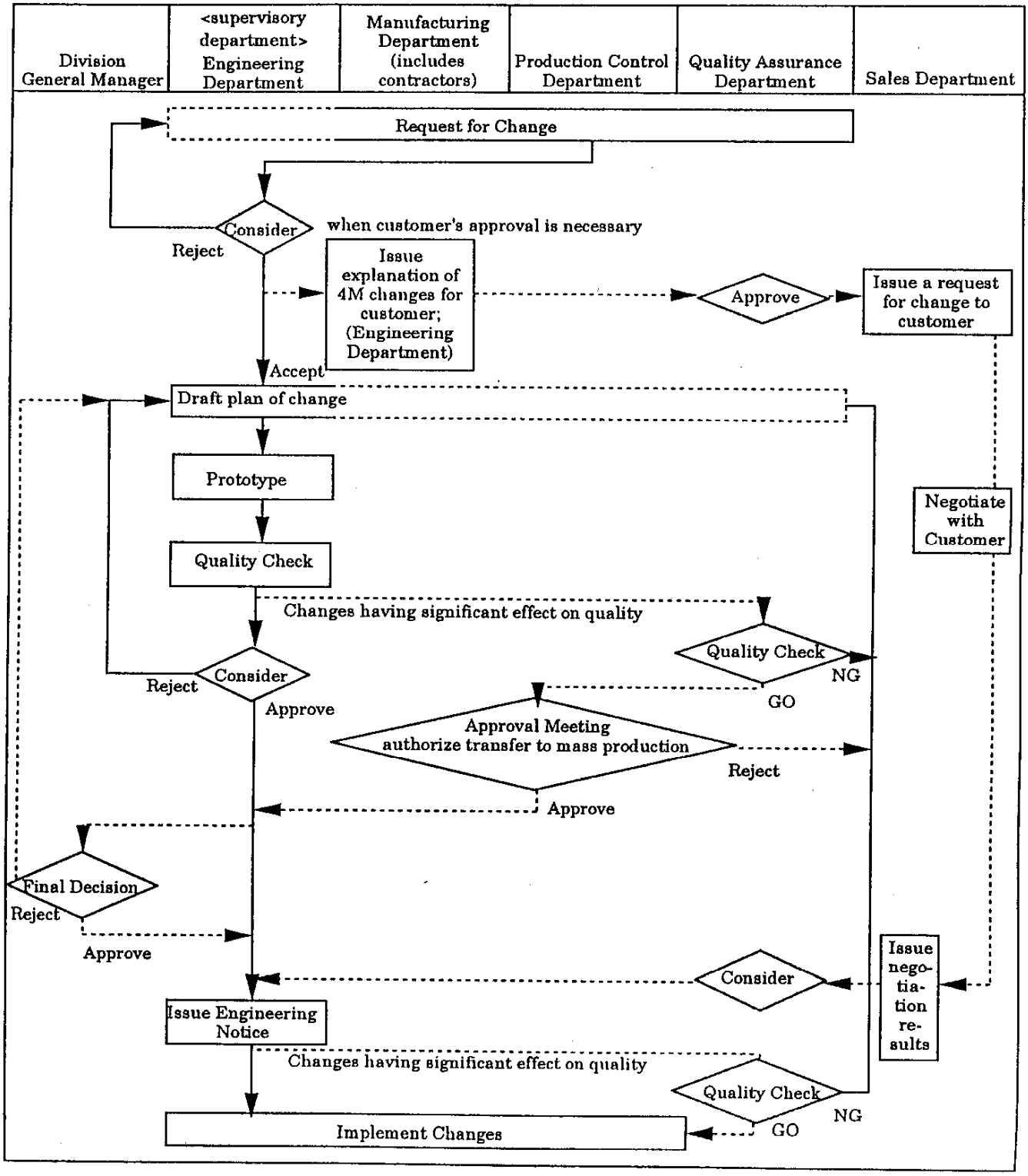
<Calibration System for Measuring Instruments>



12. Management of 4M Changes

In manufacturing, changes in "man, machine, materials, and method" (hereafter collectively referred to as 4M) may occur. In order to prevent changes in product quality and to maintain stable quality, 4M changes are managed in accordance with "Standards for Managing 4M Changes."

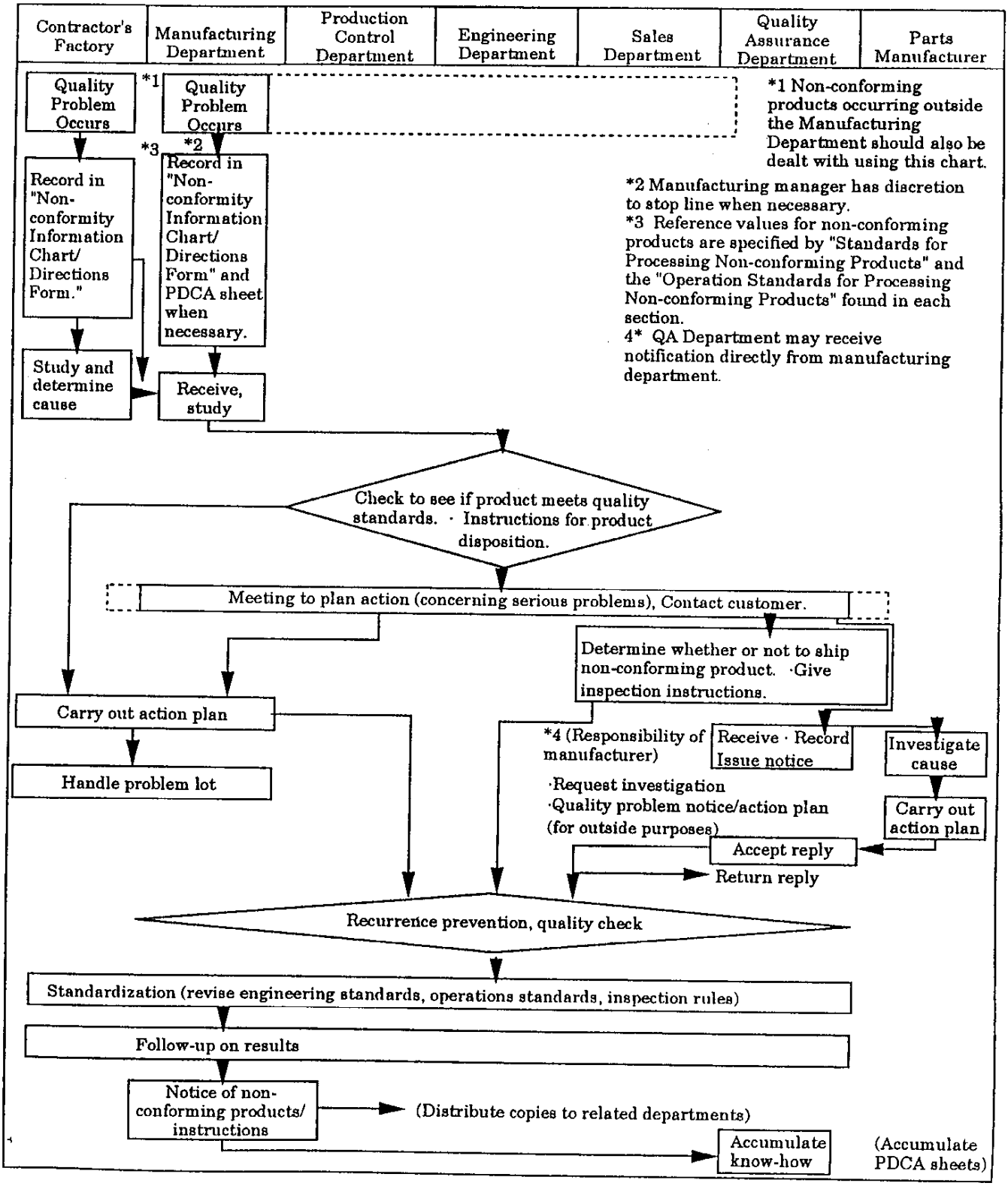
Dealing with 4M Changes



13. Non-Conforming Products

Non-conforming parts are products are handled in accordance with the following flow chart to maintain and improve the quality level as well as prevent recurrence.

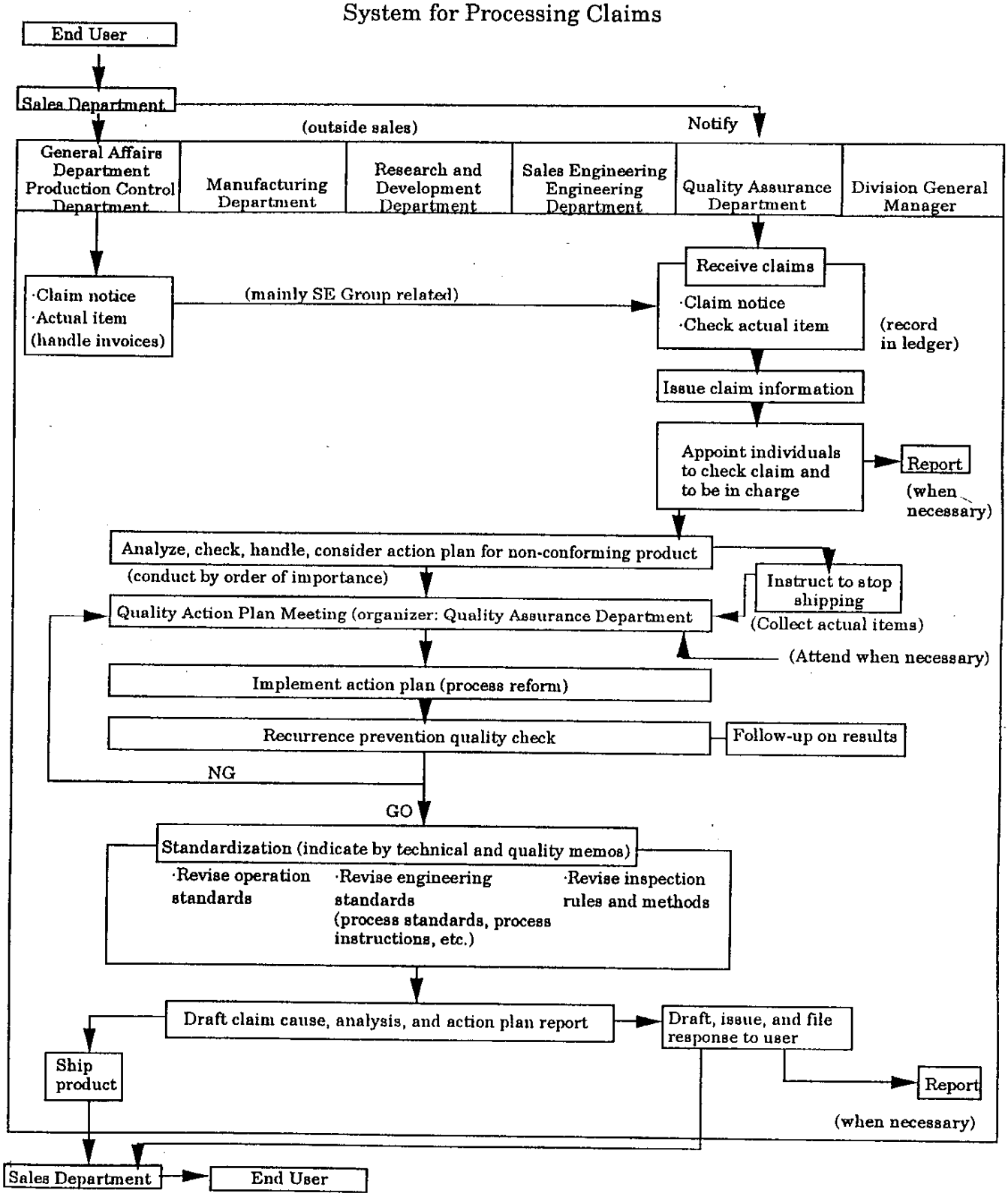
Route for Processing Non-Conforming Products



14. Processing Claims

Claims are processed according to "System for Handling Claims," which is based on "Standards for Handling Claims."

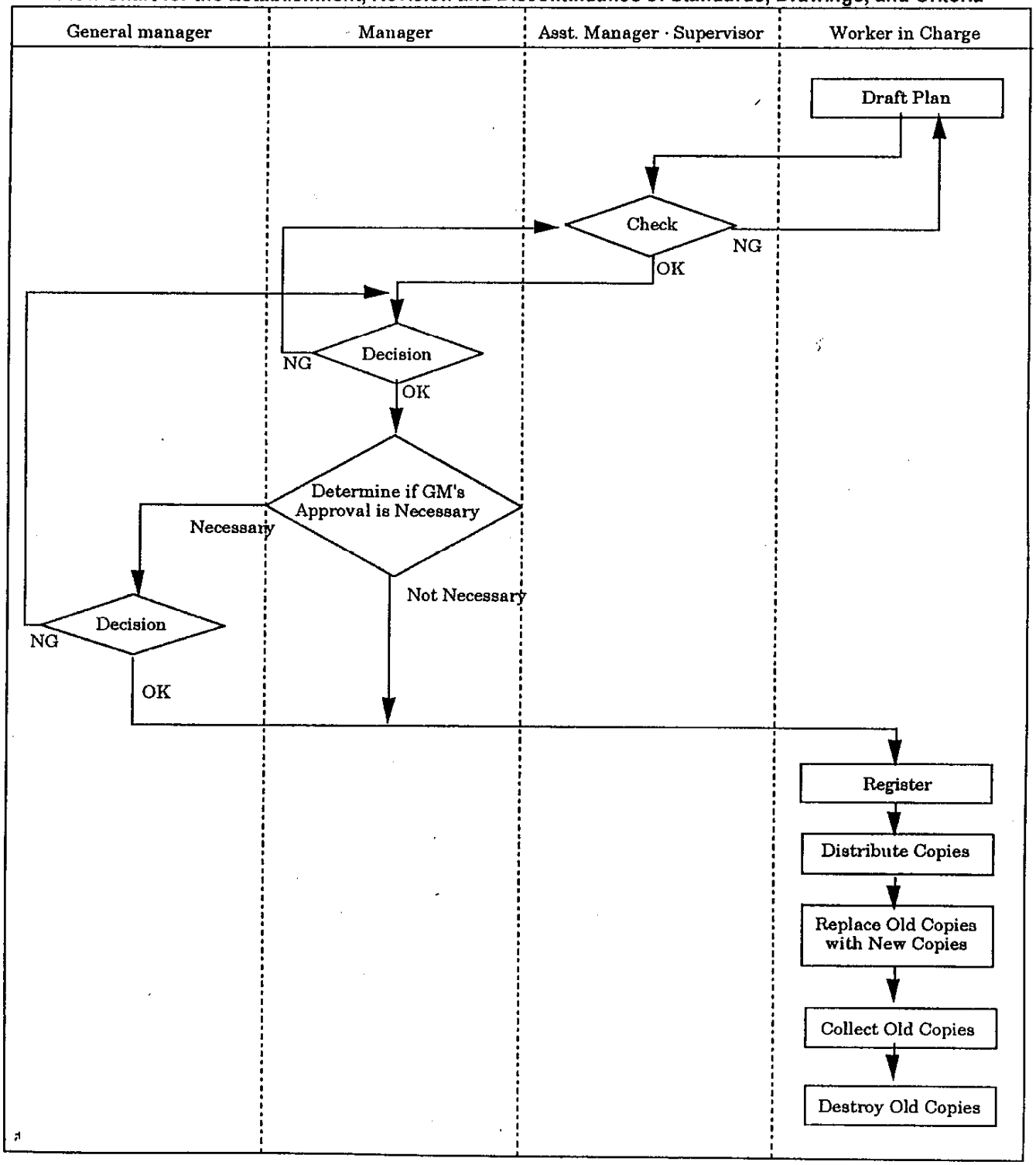
System for Processing Claims



15. Document Control

The method of making changes in the quality assurance system as well as in such things as drawings, standards and other documents is specified in "Division Control Standards" and "Control Document Handling Standards", which provide details for such things as revisions, issuance, receiving, collection, and destruction. This control prevents outdated documents from being used by mistake.

Flow Chart for the Establishment, Revision and Discontinuance of Standards, Drawings, and Criteria



16. Quality Information

In order to maintain and improve quality, we strive for efficient activities by clearly identifying the organization of quality information concerning all phases of business, from prototypes to finished products and after-sales service. We also strive to accurately grasp, convey and control the quality situation.

Quality Assurance System Table

Step		Information Item	Relevant Criteria
Prototype		1. Prototype process capability information 2. Prototype quality evaluation results 3. Results of meeting to check quality of prototype	DR and Qualification Criteria
Trial Production		4. Trial production process capability information 5. Trial production quality evaluation results 6. Results of quality qualification meeting to decide whether to move to mass production	DR and Qualification Standards *Inspection Control Standards
Initial Mass Production		7. Results of receiving inspection for parts 8. Shipping inspection data from parts manufacturer 9. Initial mass production process capability information 10. Initial mass production quality evaluation results 11. Results of meeting to check initial shipment	Inspection Control Standards DR and Qualification Standards
Mass Production	Parts	12. Information table for non-conforming parts received 13. Shipping inspection data from parts manufacturer 14. Waiver (concession)/notices 15. Monthly receiving inspection reports 16. Notice of quality problems	Inspection control standards *Supplier quality assurance standards Standards for Processing Non-conforming Products
	Manufacturing	17. Notice of non-conforming products 18. Monthly manufacturing reports 19. PDCA Sheet	*Standards for Dealing with Non-conforming Products Manufacturing Management Standards
	Inspection	20. Notice of non-conformity/ action plan 21. Periodic reliability evaluation reports 22. Monthly inspection reports	*Inspection Control Standards *Reliability Control Standards
Market		23. Monthly quality reports 24. Claim cause analysis and action plan 25. Quality survey request forms/ response forms 26. Market quality reports (monthly)	*Standards for Processing Claims
Overall		27. QA diagnosis report	*Standards for Quality Assurance Audits

(*Standard Quartz Division Format)

17. Employee Training

① The chart below outlines the content of quality-related training for employees.

Classification	Employee Level	Training	Content	Dept. in Charge
Quality Control Education	Middle Management	QC Circle Facilitator Training	·The roles of QC circles and facilitators ·Methodology of examination and review (includes exercises)	SE Head Office
	Lower-level Management	QC-C Course	·Defines QC circles ·QC story ·7 QC tools ·New QC tools ·10 principles for buying and selling	SE Head Office
		QC-A Course	·Statistical techniques ·Inspections ·Process control, Process analysis ·Case study	SE Head Office
	Supervisory Level	QC-B Course	·Statistical testing and estimation ·Analysis of serious recurrence ·Reliability ·Correlation and recurrence ·Process management ·Process analysis ·Experiment planning methods ·Inspections	SE Head Office
		QC Circle Leader	·QC circle trends ·Mock experiential study ·Problem-solving ·Group discussions	SE Head Office
Training by Employee Level	Upper Management	Upper Management Seminar	·Training courses with top trainers in various fields	SE Head Office
	Middle Management	Manager Training (LDP)	·Group discussion based on survey of actual conditions of the work place, self-analysis and clarification of personal action plan	SE Head Office
	Lower-level Management	Manager Basic Training (MBC)	·Management principles ·Skills and philosophy of training others through OJT (on-the-job-training)	SE Head Office
	Supervisory Level	Staff Training (SBC)	·Promote consciousness in the work place by understanding the roles, responsibilities, standpoint of the supervisor	SE Head Office
		Female Leader Training	·Human relations and labor management in the work place ·Work philosophy ·Leadership, membership	SE Head Office
	New Employees	New Employee Follow-up Training	·Discuss the first 3 months of employment and set personal goals	Ina Division
		New Employee Training	·Company manners ·Corporate rules, salary system ·Receiving instructions and reporting	Ina Division
Technical Certification	All Employees	Technical and Skill Trainings	·Various engineering and technical certification	SE Head Office
Other	Shipping Inspectors	Inspector Registration Education	·Inspector training text, Reliability, Product knowledge, etc.	SE Head Office

There are also other trainings conducted by outside training institutions.

② The following are some of the main trainings by outside institutions.
Quality control: General Manager Course, Basic Course, TQC Promotion Leader Course, Introduction to the 7 New QC Tools
Reliability: Professional Course, Basic Course
Reliability Technique Practice Course: FMEA and FTA, Design Review, Reliability Testing

18. Management of Suppliers

(1) Selecting Suppliers
Suppliers used by this division are chosen on the basis of "Standards for Selecting Contracting Manufacturers." We make an overall assessment of their technical abilities, ability to meet cost requirments, manufacturing capabilities, and quality assurance. We select suppliers that can satisfy our quality, cost, and delivery needs.

(2) Quality Assurance Guidance
"Standards for Quality Assurance" are provided to suppliers when business relations are initiated so that the supplier can attain an understanding of the division's basic philosophy regarding quality assurance. Items we wish to be implemented for the quality assurance of the supplier's products are identified.

<Basic Items to be Implemented for Quality Assurance>

1. Quality assurance responsibility system
2. Quality control for manufacturing processes
3. Specification change control
4. 4M change management
5. Initial product control
6. Lot control
7. Control of manufacturing equipment and measuring instruments
8. Shipping inspections
9. Processing of non-conforming products and recurrence prevention
10. Management of secondary contractors
11. Waivers (concessions)
12. Environment and physical control
13. Control of public standards
14. Management and use of quality information
15. Quality assurance auditing
16. Drawing, specification and document control