CHECKLIST FOR QUARTZ CRYSTALS

MANUFACTURER AND LINE SURVEY

ESCC Basic Specification No. 2023501

Manufacturer :
Location :
Survey Team Leader :
Date of Survey :
Crystal Unit Type(s) :

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DCR No.	CHANGE DESCRIPTION
68	Specification upissued to incorporate technical changes per DCR.

TABLE OF CONTENTS

1. INTRODUCTION

This checklist is intended for use during the initial survey of a Manufacturer's ability to produce high quality articles, his management organisation, production facilities, test facilities and technical know-how. When completed, this checklist should enable the party interested in procurement of the subject components to assess the ability of the Manufacturer concerned to successfully execute a contract for the supply of high reliability space hardware.

2. SURVEY CHECKLIST

2.1 INTERVIEW ON ARRIVAL OF SURVEY TEAM

(a) Introductory Remarks by Team Leader (Explanation of purpose of survey, procedures to be followed, time limitations, etc.):-

(b) Notes (Atmosphere during reception, willingness to co-operate, interest shown, comments on personnel, general remarks):-

2.2 MANUFACTURER AND SURVEY TEAM INFORMATION

(a) Survey requested by :

Survey Team Leader :

Team Members :

(b) Key personnel of Manufacturer interviewed:-

Name	Function	Tlph. Ext.
1.		
2.		
3.		
4.		
5.		

(c) Type of Company (Private company, limited company, etc.)

Affiliated with any other company? If so, which:

No. of employees:

- Total number :
- Production :
- Quality Assurance :
- Q.A. Inspection :
- Prod. Engineering :
- Design Engineering :
- Reliability Control :
- Other :

(d) Number of shifts :

(e) Plant area :

(f) General production line :

(1) Device types manufactured:

(2) Will flow diagrams of steps to produce quartz crystal units be available to Survey Team?
YES NO

Are specifications, if any, referenced in the flow diagrams?
YES NO

(g) Principal Government and industrial customers:-

1.
2.
3.
4.
5.

(h) The Manufacturer's Quality System is organised in accordance with:

Comments

(i) Manufacturer's Government Service Inspection:

DCAS Inspector, resident/non-resident

(j) National Inspectorate:

(k) Is the Manufacturer's quartz crystal unit production

(1) Continuous?	YES	NO
(2) Pilot production?	YES	NO
(3) Advanced R&D, limited?	YES	NO

(l) The Manufacturer has adequate experience in the production of the following hi-rel parts:-

2.3 MANAGEMENT ORGANISATION

(a) What is general policy/attitude of the Management regarding quality/reliability programme?

(b) Which level of Management participates actively in orientating policy towards space component production?

(c) Which organisation, if any, reviews and monitors all work involved in space component production?

(d) Is work related to space components (contracts) regarded as "normal business" or as belonging to the "unique order" category?

(e) What is the general policy concerning proprietary rights?

(f) Has the "Reliability" department the same authority from Management as the "Engineering" and "Production" departments? Does this mean direct responsibility for reliability of products in the line?

(g) Has the Q.A. Manager direct authority for implementation of quality policy and actions related to the line?

(h) Does a system exist for the regular supply of quality report summaries to Management?

Does this system lead to (corrective) actions being taken in respect of the production line?

(i) Are key management staff notified of persistent out-of-control conditions?

(j) What is length of service and experience of key management personnel (Q.A., Reliability, Production, Engineering Design)?

(k) How would contract for space components be organised?

(l) How can original requirements from Orderer (Space Agency or end-user) be assumed to be correctly translated into internal instructions?

(m) How can information necessary to the Orderer (corrective actions, deviations, notification of inspections and/or problem areas) be assumed to be issued and channelled to the Orderer?

2.4 QUALITY ASSURANCE SYSTEM AND ORGANISATION

(a) To whom does Q.A. Manager report?

	YES	NO
(b) Does the company reflect a positive attitude towards Quality Assurance?	___	___
Comments		
(c) Has the Q.A. group sufficient authority in relation to its position within the company's organisation (see organigram)?	___	___
Comments		
(d) Are areas of responsibility within the Q.A. group clearly defined?	___	___
Comments		
(e) Are corrective actions to which Q.A. management is committed delegated to responsible staff or does Q.A. management have direct authority regarding the line?	___	___
Which?		
(f) Is there a periodic and comprehensive quality data reporting system which covers all operational phases?	___	___
Comments		

(g) What is the relationship between Q.A. and Reliability?

(h) Is a Q.A. manual or equivalent document supplied to all levels of appropriate supervisory personnel?	___	___
Is such document kept updated?	___	___
Comments		

	YES	NO
(i) Are written procedures available for identification and positive control of accepted/rejected materials?	___	___
Comments		

(j) What is ratio Q.A. inspectors : personnel directly involved in production?

(k) Is inspection (acceptance sampling or sorting) performed by Q.A. personnel:-

On receipt?	Sampling ___	Sorting ___	None ___
During processing?	Sampling ___	Sorting ___	None ___
During final testing?	Sampling ___	Sorting ___	None ___

Comments

(l) Are written procedures kept and used in areas for:-		
Receiving inspection?	___	___
In-process inspection?	___	___
Fabrication processing?	___	___
Final testing?	___	___
Comments		

(m) Does Q.A. maintain a system of written procedures for statistic controls (control chart, lot plot, etc.) in any of the following areas?		
In-process inspection?	___	___
Fabrication processing?	___	___
Final inspection?	___	___
Comments		

(n) Is Q.A. responsible for determination of need for, and the conducting of, quality training?	___	___
Comments		

(o) Are training programmes provided for special process personnel?	___	___
Comments		

	YES	NO
(p) Do employees have to pass tests:-		
After training?	___	___
Periodically?	___	___
Comments		
(q) Are production operators provided with visual aids and working instructions?	___	___
Comments		

2.5 CALIBRATION

(a) Does Manufacturer maintain calibration facilities and standards?	___	___
Is this service purchased?	___	___
If so, from whom?		
(b) Do calibration personnel have written procedures for control and a time schedule for measurement frequency?	___	___
Comments		
(c) Is there an effective calibration record control system?	___	___
(d) Are calibration procedures adhered to and up-to-date?	___	___
Comments		
(e) Are decals used for equipment identification to show that units have been calibrated; when next calibration date is due and calibrator identification?	___	___
Are decals up-to-date?	___	___
(f) Are adjustments of calibrated equipment required to be sealed and tamper-proof?	___	___
(g) Who is in charge of initiating calibration steps?		
User	___	___
Calibration personnel	___	___
Q.A.	___	___

	YES	NO
(h) Do calibration procedures provide for removal of any equipment not maintained or calibrated according to established schedules?	___	___
Comments		
(i) Have calibrating personnel up-to-date certification records reflecting date, traceability to NBS and identification of calibrator?	___	___
(1) Mechanical standard?	___	___
(2) Electrical standard?	___	___
(j) Is modified and/or repaired equipment calibrated prior to release?	___	___

2.6 DRAWING AND CHANGE CONTROL

(a) Has Manufacturer adequate written procedures for control of specification and contract changes?	___	___
Comments		
(b) Does Manufacturer's system provide for documented change control guaranteeing availability of required drawing at relevant manufacturing or inspection step?	___	___
Do flow documents show current revisions?	___	___
Comments		
(c) Are drawings furnished by ESTEC and contract changes adequately controlled?	___	___
Comments		
(d) Does Q.A. review all drawings and changes therein prior to their becoming effective?	___	___
Comments		
(e) Has Manufacturer established a procedure for notifying his Supplier of changes in drawings?	___	___
Comments		
(f) Are current specification revisions shown on prints of drawings?	___	___

		YES	NO
2.7	RELIABILITY		
	(a) Is structure of Reliability organisation clearly defined?	___	___
	Has Reliability same authority in respect of the line as Production or Engineering management?	___	___
	Comments		
	(b) Is there a direct feed-back of information between Reliability, Design Engineering and Q.A. groups to ensure timely notification of all relevant data?	___	___
	Comments		
	(c) Does Reliability respond promptly and efficiently to unexpected and/or newly detected failure modes?	___	___
	Comments		
	(d) Are line failures (types and causes) analysed and reported to those responsible for corrective actions?	___	___
	(e) Are corrective actions resulting from failure analysis agreed with the Q.A. group involved or Reliability if parts or process changes must be made?		
	Q.A. Group	___	___
	Reliability	___	___
	Comments		
	(f) Has Reliability right to approve test specifications, data tabulation, parts or process changes?	___	___
	(g) Is there a system for in-process failure analysis?	___	___
	End-item failure?	___	___
	Reporting?	___	___
	Comments		

	YES	NO
(h) Are following items submitted to failure analysis as a matter of routine?		
- Production line rejects	___	___
- Lots with a high rejection rate	___	___
Define:-		
- Items returned by Orderer	___	___
- Items returned by Orderer with special request for failure analysis	___	___
(i) Has Manufacturer a failure analysis laboratory or an equivalent facility?	___	___
Comments		
(j) Are failure analysis procedures:-		
(1) Available?	___	___
(2) In use?	___	___
(3) Adequate?	___	___
Comments		
(k) Is failure analysis equipment:-		
(1) Available?	___	___
(2) In use?	___	___
(3) Adequate?	___	___
Comments		
(l) Are there special personnel for failure analysis?	___	___
Comments		
(m) Are failure analysis reports:-		
(1) Available?	___	___
(2) Adequate?	___	___
Comments		
(n) Has Reliability a programme to ensure reliability of discrete device designs prior to release thereof?	___	___
Comments		

	YES	NO
(o) Has Reliability access to all pertinent development and production data of discrete devices for analysis purposes?	___	___
Comments		
(p) Is reliability data available of discrete devices from the line(s) which the Manufacturer wishes to be approved?	___	___
Comments		
(q) Has Manufacturer an evaluation laboratory for determination of product characteristics?	___	___
(r) If Manufacturer has an evaluation laboratory:		
- Does it operate according to an established programme? or	___	___
- According to special requests?	___	___
Comments		
(s) Give examples of problems investigated by evaluation laboratory		
(t) Are laboratory results available on request?	___	___
(u) Are data sheets based on these results?	___	___

2.8 CONTROL OF PROCUREMENT SOURCES

(a) Has Manufacturer adequate written procedures for purchase control of materials, components and services?	___	___
Comments		
(b) Has Manufacturer an effective vendor rating system?	___	___
Comments		

	YES	NO
(c) Does rating system provide for effectiveness of written corrective actions received from Suppliers?	___	___
Comments		
(d) Do purchase documents require delivery of test reports if such reports are specified in the relevant ESA contract?	___	___
Comments		
(e) Is there a means of channelling information when specification changes require modification of current purchase orders?	___	___
Is "Receiving Inspection" notified of changes in purchase orders?	___	___
Comments		

2.9 CONTROL OF INCOMING MATERIALS (Performed in situ)

(a) Are Manufacturer's written standard inspection procedures adequate for control of incoming materials and services received?	___	___
Do inspectors know how and when to apply these procedures?	___	___
Comments		
(b) Are materials received in a controlled area from which removal prior to inspection is impossible?	___	___
Comments		
(c) Are materials properly handled and protected during the receiving process?	___	___
Comments		
(d) Does Receiving Inspection use drawings and purchase orders?	___	___
If so, do these documents show Quality Control review?	___	___
Comments		
(e) Are test reports from Suppliers being reviewed?	___	___
Comments		

	YES	NO
(f) Are accepted materials adequately identified?	___	___
Do documents show evidence of acceptance?	___	___
Comments		
(g) Are rejected materials adequately identified and segregated?	___	___
Comments		
(h) Which materials are subject to limited shelf life limitations?		
Comments		
(i) Are shelf life and cure date materials properly identified and controlled?	___	___
Comments		
(j) Do records indicate traceability of units, lots and sublots to applicable documents (specification, revision letter - if any - and inspection record)?	___	___
Comments		
(k) Are materials stored in a controlled area under the responsibility of an authorised Custodian?	___	___
Comments		
(l) Are suitable inspections and tests, including physical and chemical tests, performed on raw materials?	___	___
Comments		
(m) Are such tests performed:		
- In-house?	___	___
- At other locations?	___	___
Comments		

	YES	NO
(n) Are storage containers, racks, bins, etc. adequate for type of material stored?	___	___
Comments		
(o) Is lot traceability maintained?	___	___
Comments		
(p) Is "first in/first out" method applied?	___	___

2.10 IN-PROCESS INSPECTIONS AND TESTS

(a) To whom does In-process Q.A. Inspection report?		
(b) Are inspection and/or operation travellers used sequential to performance and control of all operations and processes?	___	___
Comments		
(c) Do travellers refer to inspection procedures?	___	___
Do inspectors know how and when to use them?	___	___
Comments		
(d) Do travellers refer to controlled specifications?	___	___
Do specifications show current revision status?	___	___
Comments		
(e) Does Q.A. have written in-process procedures to control acceptance of products?	___	___
Comments		
(f) Does the manufacturer test for early failures as part of in-process controls?	___	___
(g) Does the manufacturer maintain and document standard screening tests as part of their own in-process controls?	___	___

	YES	NO
(h) Does the manufacturer review the in-process control test results against the screening tests requirements defined in the relevant Generic Specification?	___	___
(i) Is type and quantity of available inspection equipment adequate for type of work being accomplished?	___	___
Comments		
(j) Are documentation and instruments used by inspectors subject to calibration control?	___	___
Is calibration evident and up-to-date?	___	___
Comments		
(k) Is there a specific material review procedure?	___	___
Comments		
(l) Do in-process Q.A. inspectors summarise quality experience on the basis of specific process stages?	___	___
Do they issue quality reports on a regular basis?	___	___
Do reports result in assistance and/or action?	___	___
Comments		
(m) Are requests for corrective action issued in writing?	___	___
Are such requests answered?	___	___
Does corrective action ensue?	___	___
Comments		
(n) Does Q.A. maintain any statistic controls (X&R, etc.) in the in-process area?	___	___
Are these controls up-to-date and at individual process stations?	___	___
Comments		
(o) Is lot identification maintained throughout processing?	___	___
Comments		

	YES	NO
(p) Are there documents describing in-process manufacturing procedures and controls?	___	___
Comments		
(q) Are there documents describing in-process inspections?	___	___
Do inspectors know how and when to use them?	___	___
Comments		
(r) Are there specific standards for handling, cleanliness and care of materials, parts and equipment?	___	___
Comments		
(s) Are calibrations evidenced and up-to-date?	___	___
(t) Has Q.A. authority to stop production flow in case of out-of-control conditions?	___	___
Is a written material review procedure in use?	___	___
Comments		
(u) Are records maintained of training and competence of operators for welding, soldering, radiography, radiflo and plating?	___	___
Comments		
(v) Are certified operators identifiable by means of a card or badge on their clothing?	___	___
Comments		

2.11 SURVEY OF MANUFACTURING LINE

This review shall be performed in 2 phases:-

(1) Identification of the various steps listed in the flow chart to define the corresponding operations and collect all relevant information.

(2) Actual line survey (indicate if inspection was performed).

If different technologies are applied, the inspection results shall be supplied on separate sheets.

2.11.1 Manufacturing Environment

(a) Which phases of manufacture are carried out under controlled environmental conditions?

(b) Give details of conditions.

2.11.2 Preparation of Crystal Element

(a) State type of quartz used (natural/synthetic).

(b) State source of quartz.

(c) State method of optical axis location.

(d) Which method is used to slice into individual elements?

(e) How are edges of crystal elements finished?

(f) Which method is used for adjustment of frequency and angle of cut?

(g) Describe method of finishing crystal elements, i.e. etching, polishing, etc.

(h) Which method is used to locate and mark the optical axis of individual elements?

2.11.3 Application of Electrodes

(a) Describe the cleaning technique used for elements prior to application of electrodes.

(b) Which electrode materials are used?

YES NO

(c) Which method of application is used?

(d) Describe method used for final adjustment to desired frequency.

(e) How is this monitored?

2.11.4 Mounting of Crystal Element

(a) State material and plating of mounting tabs or wires and method of attachment to connecting leads.

(b) State method of attachment of crystal element to mounting tabs.

(c) Which type of bonding cement is used and how are quality of material and application controlled?

(d) Which method of curing is used for bonding cement?

2.11.5 Crystal Enclosure

(a) Is there any additional environmental control used for the enclosure process? ___ ___

(b) Which material and plating is used for the enclosure and connecting leads?

(c) Describe cleaning techniques for enclosure parts prior to sealing.

(d) State method of sealing and enclosed atmosphere.

(e) Which tests are used for fine/gross leak detection?

	YES	NO
(f) State criteria for radiographic inspection.		

2.11.6 Visual Inspection - General

Following relevant operations in Para's. 2.11.1 to 2.11.5:-

(a) Are visual aids and criteria provided for inspection purposes? If so, state for which operations:	___	___
(b) Are visual aids applied to the production line? If so, state for which operations:	___	___
(c) Are visual aids and criteria adequate?	___	___

2.11.7 Final Test Area and Screening Facility

(a) Are they separate operations?	___	___
(b) Are final production tests (see ESA/SCC specification) performed by personnel under Q.A. monitoring? or	___	___
Are they performed by Q.A. personnel?	___	___
Comments		
(c) Are written inspection and test procedures for product classes on the line available for the final test (Q.A.)?	___	___
Comments		
(d) Do inspectors use assigned stamps to indicate inspection status on materials and accompanying documents?	___	___
Comments		
(e) Are requests for corrective action made in writing?	___	___
Are such requests answered?	___	___
Comments		

	YES	NO
(f) Are rejected devices identified and segregated in a controlled area?	___	___
Comments		
(g) Are records of accepted and rejected material maintained?	___	___
Are these records identifiable with such materials?	___	___
Comments		
(h) Are device failures analysed?	___	___
Are device failure analyses summarised and reported by final Q.A.?	___	___
Comments		
(i) Is a summary inspection and test report sent regularly to quality management (lot acceptance, percentage of defects, types of failure)?	___	___
Comments		
(j) Is a testing laboratory or equivalent facility available for quality assurance purposes?	___	___
Which of the following tests are performed in the laboratory or facility?		
(1) Electrical tests	___	___
(2) Mechanical tests	___	___
(3) Chemical tests	___	___
Comments		
(k) Are statistical controls of device parameter distribution maintained?	___	___
Are they reported to Q.A. or Reliability?	___	___
Comments		
(l) Is an environmental test facility maintained in-house?	___	___
If not, state where:		

	YES	NO
Are the following tests performed at this facility?		
(1) Temperature (high, low, cycle)	___	___
(2) Shock (mechanical, thermal)	___	___
(3) Acceleration	___	___
(4) Vibration (fixed, variable)	___	___
(5) Moisture resistance	___	___
(6) Altitude	___	___
(7) Radiographic	___	___
(8) Hermeticity tests	___	___
(a) Fine leak, if applicable	___	___
(b) Gross leak or penetrant dye	___	___
(9) Lead fatigue	___	___
(10) Life tests - operating	___	___
Comments		
(m) Is available equipment used:		
- For production?	___	___
- In R&D?	___	___
- For Quality Control on a sample basis?	___	___
- For screening?	___	___
(n) Are charts provided for the monitoring of environmental test equipment?	___	___
Comments		
(o) Is test equipment adequate for fulfilment of specification requirements?	___	___
Comments		
(p) Is final external visual inspection performed on 100% of the devices?	___	___
Comments		
(q) Are devices stored in a limited access area?	___	___
Comments		

	YES	NO
(r) Are devices adequately identified to Customer requirements? Comments	___	___
(s) Are there provisions for lot identification? Comments	___	___
(t) How many burn-in positions are available:		
- At room ambient temperature?		
- At specified ambient temperature?		
- At specified case temperature (cooled hot plate)?		
(u) Does burn-in require soldering of leads? Comments	___	___
(v) What precautions are taken to maintain solderability of leads after burn-in? Comments		
(w) How does Manufacturer ensure that failed devices are separated from processed lots of:		
- SCC Level 'B'		
- SCC Level 'C'		
(x) Has Manufacturer all test equipment necessary to perform all qualification tests:		
- In-house?	___	___
- In nearby facility?	___	___
Specify equipment and its location:		

	YES	NO
- In remote location	___	___
Specify equipment and its location:		

2.12 PRESERVATION, PACKING AND SHIPPING

(a) Are there adequate written procedures for control of shipping?	___	___
Comments		
(b) Are materials designated for shipment properly identified, handled and protected?	___	___
Comments		
(c) Do copies of Customer's purchase order and evidence of inspection acceptance accompany materials from end of final test up to the time of shipment?	___	___
Comments		
(d) Do Q.A. personnel perform audits of all outgoing lots?	___	___
Comments		
(e) Do shipping documents reflect inspection status or evidence of inspection, identification and similar shipping requirements?	___	___
Comments		
(f) Does Manufacturer verify conformity of devices and invoices with purchase order?	___	___
Comments		
(g) Does Manufacturer implement special packaging methods for hi-rel devices?	___	___
If so, which of following methods is used?		
- Individual packages	___	___
- Mechanical protection	___	___
- Environmental protection	___	___
- Special warning labels	___	___

	YES	NO
(h) Is shipping method designed to allow official inspection by Customs without actual removal of protective material?	___	___
Comments		
(i) Do instructions prohibit the use of substandard packaging methods for shipment of hi-rel devices?	___	___

2.13 SUMMARY OF INSPECTION RESULTS

Indicate inspection results per manufacturing and testing area, whereby:
V = Adequate.
O = Insufficient or non-adequate.
– = Not checked or not applicable.

	1	2	3	4	5	6	7
Environmental conditions:							
Cleanliness							
Temperature control							
Humidity control							
Occupancy							
Procedures available:							
Travellers							
Calibration							
Segregation of rejects							
Inspection evidence							

Area No.

1 =
2 =
3 =
4 =
5 =
6 =
7 =

2.14 GENERAL OBSERVATIONS (Not to exceed 2 pages)