REQUIREMENTS FOR PROCESS CAPABILITY APPROVAL

ESCC Basic Specification No. 25600

Issue 2	October 2018

Document Custodian: European Space Agency – see https://escies.org

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DCR No.	CHANGE DESCRIPTION
1050	Specification upissued to incorporate changes per DCR.

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1 PURPOSE AND SCOPE

The purpose of this specification is to define the requirements for the Process Capability Approval (PCA) of suppliers involved in the manufacturing, assembly and test operations necessary for the provision of electrical, electronic, or electromechanical (EEE) components intended for space application.

The certification given to a supplier for Process Capability Approval does not include nor enable the ESCC Qualification of his products. The ESCC Qualification of products may be achieved through methodologies specified in ESCC documents No. 20100, 24300 and 25400.

1.1 APPLICABLE DOCUMENTS

The following ESCC Specifications form part of, and shall be read in conjunction with, this specification. The relevant issues shall be those in effect on the date of commencement of the PCA of the Manufacturer.

ESCC 20200	Component Manufacturer Evaluation.
ESCC 21300	Terms, Definitions, Abbreviations, Symbols and Units.
ESCC 22700	Requirements and Guidelines for the Process Identification Document.
ESCC 22800	ESCC Non-Conformance Control System
ESCC 23100	Recommendations on the Use of the ESCC Specification System for the Evaluation and Procurements of Unqualified Components.
ESCC 24600	Minimum Quality Management System Requirements

The applicable ancillary Basic Specifications for PCA.

2 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

2.1 DEFINITIONS

For the purposes of this specification, the terms and definitions defined in ESCC 21300 shall apply.

2.2 ABBREVIATIONS

PCA	Process Capability Approval

3 INTRODUCTION

ESCC Process Capability Approval (PCA) is the status granted to a supplier, for a specified Process Capability Domain, after the successful completion of a PCA programme. Such programme will establish certified manufacturing lines where the materials and processes used will have been evaluated and certified to establish their suitability for producing high quality space grade components.

The PCA programme shall in general consists of four phases:

1. Definition of the process capability domain and its boundaries.

2. Evaluation of the supplier.

3. Evaluation of the process capability domain.

4. PCA testing.

The ESCC PCA is intended for application to those manufacturing lines where materials and processes are stable and repetitively used.

This specification is to be read in conjunction with the applicable ancillary ESCC Basic Specification providing further requirements for a particular component technology. The qualification approval of actual components produced on the process capability approved manufacturing line is not the object of this - nor the ancillary- PCA specifications.

The implementation of a PCA programme shall be performed in accordance with this specification and the applicable ancillary specification in the following order of precedence:

1. Ancillary PCA specification for a particular technology or process
2. This specification

4 DEFINITION OF THE PROCESS CAPABILITY DOMAIN

4.1 CAPABILITY ABSTRACT

The supplier shall prepare a Capability Abstract to describe, in a comprehensive manner, the scope and extent of the process capability domain for which approval is sought.

The document shall be prepared to the satisfaction of the ESCC Executive. It shall contain information suitable for publication by the ESCC and contain no commercially sensitive material.

4.2 PROCESS IDENTIFICATION DOCUMENT

A PID for the process capability domain to be approved shall be prepared by the supplier to the satisfaction of the ESCC Executive. In terms of general content, lay-out and configuration control the PID shall fulfil all requirements of ESCC Basic Specification No. 22700.

Test structures required for evaluation of the process capability domain and its boundaries shall be produced strictly in accordance with the specifications contained in the PID.

Test structures required for PCA testing shall be produced strictly in accordance with the specifications contained in the PID. The test structures shall be designed so as to demonstrate that the final domain boundaries, as specified in the PID and Capability Abstract, may be reliably met.

On completion of the PCA testing programme, the supplier shall update the PID if and as required and place it under full configuration control. The PID shall be sent to the ESCC Executive for final review and acceptance. Any subsequent changes shall be made in accordance with the requirements herein and those of ESCC Basic Specification No. 22700.

5 EVALUATION OF THE SUPPLIER

5.1 GENERAL

The purpose of the evaluation of a supplier is to assess the capability and the adequacy of the organisation, plant and facilities and to ascertain the supplier's ability to provide EEE components or services related to the design, manufacturing and test of EEE components in accordance with the appropriate ESCC specifications. For a PCA this means the ability to meet the requirements of this specification and the applicable ancillary specification for the particular component technology or process.

The exercise shall be performed by the ESCC Executive in accordance with the requirements given in ESCC Basic Specification No. 20200. Additional attention shall be given to the design facilities, as detailed herein, to the extent that component design affects the utilisation of the materials and processes within the process capability domain.

5.2 SUPPLIER'S DESIGN FACILITIES

Where applicable, the supplier's facilities for design and his methods of design verification of components to be manufactured under the PCA shall be assessed. The review shall appraise data as appropriate to the process capability domain and identify any design limitations imposed by the selected materials and processes. The review shall also include all relevant computer tools for design including software quality assurance and configuration control.

The description of the design facilities and their control shall form part of the process capability domain and its boundaries and be included in the PID.

6 EVALUATION OF THE PROCESS CAPABILITY DOMAIN

6.1 GENERAL

The evaluation of the process capability domain shall verify that the chosen technology, i.e. a selection of materials and processes, can suit the manufacturing of high reliability components for space application. The evaluation programme shall:

- support the final definition of the process capability domain and its boundaries as reflected in an updated and final PID.
- give a high level of confidence in a successful outcome of the PCA testing (phase d).

The exercise shall be performed by the supplier. The evaluation shall be in accordance with the applicable ancillary specification for the particular component technology and include, but not be limited to, the following:

- Review of existing data and/or test results relating to the process capability domain.
- Establishment of an evaluation test programme.
- Evaluation testing performed on test structures.
- Definition of any corrective actions that may be required and their implementation prior to commencement of PCA testing (phase d).
- Final definition of the process capability domain and its boundaries, to be contained in the PID and the Capability Abstract.

6.2 EVALUATION TEST STRUCTURES

The test structures shall be designed so as to enable the domain boundaries to be established together with their technological margins.

The ESCC Executive shall have the right to witness the manufacturing and testing of the test structures. The types and quantities shall be as specified in the evaluation test programme.

On completion of evaluation testing, the disposition of the test structures utilised shall be as directed by the ESCC Executive.

6.3 COMPLETION OF EVALUATION

On completion of the evaluation of the process capability domain, the supplier shall:

- establish a PCA test programme.
- complete the PID.
- collect all the relevant data and documentation in the form of a process capability evaluation test report.

The three documents shall be sent to the ESCC Executive for review and acceptance.

7 PROCESS CAPABILITY APPROVAL TESTING

7.1 GENERAL

Before starting PCA testing, the process capability domain and its boundaries shall be fully defined in the Capability Abstract and the PID. In addition the documentation contained within the PID essential for operating the manufacturing line and the testing of test structures, used for PCA testing, shall be available and approved by the ESCC Executive.

In addition, the following documentation shall be available to the ESCC Executive:

- Specifications for the test structures.
- The PCA test programme giving all tests and test sequences, sample sizes, accept/reject criteria and conditions for all test structures. The test programme is intended to assess the quality, including reliability, of the constructional elements of the test structures. It shall fulfil the requirements of the applicable ancillary specification for the particular component technology.
- A cross reference relating all tests to the relevant areas and boundaries of the process capability domain and verifying that the tests and test structures fully represent the domain.

Prior to commencement of PCA testing, the supplier shall compile a schedule covering the production and testing of the test structures. This schedule shall show by date and duration when all major processing operations and inspections are to take place.

7.2 TEST STRUCTURES FOR PCA TESTING

Specific test structure designs or structures which form the basis for real components may be utilised for PCA testing. Test structures used for evaluation may be reused for PCA testing if it can be shown that these structures will exercise the domain and its boundaries appropriately.

The ESCC Executive shall have the right to witness the manufacturing of these test samples. The types and quantities shall be as specified in the PCA test programme.

On completion of testing, the disposition of the test structures utilised shall be as directed by the ESCC Executive.

7.3 PROCESS CAPABILITY APPROVAL TESTING

PCA testing shall be performed by the supplier in accordance with the applicable ancillary specification for the particular component technology. The ESCC Executive shall have the right to witness the testing and to review the test data. The testing may be performed at the supplier's facility or any facility mutually agreed with the ESCC Executive.

7.4 TEST REPORT

On completion of the PCA testing programme, the supplier shall collect all the relevant data and documentation in the form of a PCA test report. This report shall be sent to the ESCC Executive for review and acceptance.

7.5 ESCC CERTIFICATION AND LISTING

On completion of the PCA programme and acceptance of the PCA test report, an application to ESA, as the Certification Body, will be prepared by the ESCC Executive.

Once formally approved by ESA, the ESCC Executive will provide a PCA certificate to the Manufacturer. The ESCC Executive will make the status achieved by the supplier public through a publication in the relevant area of https://escies.org.

8 PROCEDURES

8.1 REQUEST FOR PROCESS CAPABILITY APPROVAL

To obtain PCA the supplier shall submit a formal application to the ESCC Executive to undertake a PCA by utilising the appropriate form, available from ESCIES, together with supporting documents.

As a minimum the application shall contain:

- Reference to this specification and the applicable ancillary specification for the particular component technology.
- A preliminary definition of the process capability domain and its boundaries.
- A description of the manufacturing, inspection and test facilities.
- A description of the supplier's organisation.
- A preliminary PID including all flow charts.
- Existing data and test results from structures or components manufactured within the process capability domain.
- Representative samples suitable for constructional analysis.
- A description of the quality assurance system.

The ESCC Executive will review the application and the documentation and samples provided. If considered necessary the supplier may be requested to provide further information or material. Once the application has been accepted by the ESCC Executive, the supplier will be advised and the first phase of the PCA programme will be initiated.

8.2 VALIDITY OF PROCESS CAPABILITY APPROVAL

A PCA established in accordance with this specification and the applicable ancillary specification for the particular component technology shall be valid for the period specified in the ancillary specification from the date of certification, or for such period as determined by the ESCC Executive and approved by the Certification Body, ESA.

The following conditions for validity of PCA shall be fulfilled:

- All design aspects, materials, constructional elements and processes used on the certified EEE manufacturing line shall be fully and only within the approved process capability domain.
- Detailed records of all structures or components manufactured on the certified manufacturing line and within the approved process capability domain shall be available to the ESCC Executive.
- On receipt of an alert from the ESCC Executive concerning the process capability domain, or a structure or component manufactured using the certified manufacturing line, the supplier shall, as a matter of urgency, carry out the necessary investigations and inform the ESCC Executive of the findings and suggested corrective actions. In the case where an alert leads to the identification of a non-conformance to any aspect of the certified PCA the Manufacturer shall initiate an ESCC non-conformance in accordance with the requirements of ESCC Basic Specification No. 22800.

8.3 EXTENSION OF PROCESS CAPABILITY APPROVAL VALIDITY

A valid PCA may have the validity extended for a further period, as specified in the applicable ancillary specification for the particular component technology, from the date of certification expiry, or for such period as determined by the ESCC Executive and approved by the Certification Body, ESA, if:

- All changes (see Para. 8.7) to the process capability domain and its boundaries, if any, have been fully updated in the PID and the PID has been approved by the ESCC Executive.
- PCA Testing (see Para. 7.3) has been successfully performed for maintenance purposes within the last six months of the current validity period.
- A PCA Testing report has been prepared by the Manufacturer and provided to the ESCC Executive for review and acceptance.
- When a PCA validity is extended the validity period of the subsequent certificate will be reduced by the same amount.

If structures or components, that contain materials or processes from within the process capability domain and which exercise the domain boundaries, have been manufactured and tested in the same period but independent of the maintenance PCA testing, then these tests may be substituted for corresponding tests within the PCA test programme with the agreement of the ESCC Executive.

All relevant documentation, including records of structures or components manufactured on the certified manufacturing line, shall be available for review by the ESCC Executive.

8.4 ESCC RE-CERTIFICATION AND LISTING

On completion of the PCA maintenance programme and acceptance of the PCA Testing report, an application to ESA, as the Certification Body, will be prepared by the ESCC Executive.

Once formally approved by ESA, the ESCC Executive will provide a new PCA certificate to the supplier and will make a publication in the relevant part of https://escies.org as an acknowledgement of the status achieved by the supplier in this respect.

8.5 LAPSE OF PROCESS CAPABILITY APPROVAL VALIDITY

A PCA shall be considered to be lapsed from the day following the expiry date of the existing PCA certificate, if a certificate extending the approval has not been issued.

When a PCA has lapsed, a supplier may not refer to the PCA in any certificate of conformity to accompany components manufactured on the previously certified line.

The corresponding entry in the PCA list will be removed in the issue following the lapse of certificate.

8.5.1 Renewal after Lapse of Process Capability Approval

If there has been an extended period of lapse or shutdown of the certified manufacturing line, the ESCC Executive may require the performance of an assessment to ensure that the PCA is still valid. The ESCC Executive will advise if any additional evaluation or testing, supplementary to the standard requirements for extension of validity, is required for renewal.

The ESCC Executive may agree the extension of validity of the current certificate for up to 6 months without a new certificate. This reduces the validity period of the subsequent certificate by the same number of months.

Failure by the supplier to satisfy the ESCC Executive regarding renewal will necessitate a completely new PCA.

8.6 LOSS, RESTRICTION OR SUSPENSION OF PROCESS CAPABILITY APPROVAL

Loss of PCA occurs and formal approval will be withdrawn when a supplier is no longer able to meet the original requirements pertaining to the certified PCA.

The supplier shall immediately notify the ESCC Executive of any fault likely to affect the validity of the PCA certification.

If any aspect of the PCA becomes deficient, the approval may either be fully suspended or allowed to continue with the approval of the ESCC Executive provided that the use of the certified manufacturing line is restricted to the remaining areas of the PCA not affected by the deficiency.

The PCA shall be withdrawn:

- If the deficiency is not corrected within three months.
- At the supplier's request.

8.7 REDUCTION, EXTENSION AND CHANGE OF PROCESS CAPABILITY APPROVAL

When a supplier wishes to reduce, extend or change his process capability domain or its boundaries, the supplier shall provide detailed information to the ESCC Executive together with an assessment as to whether the reduction, extension or change is considered minor or major. It is the responsibility of the ESCC Executive to decide on the final minor or major classification.

A minor change shall have no or only little impact on the process capability domain and its boundaries and must be backwards compatible (previously designed structures or components must still be able to be manufactured without redesign or changes to their specification). A major

change is a change which affects one or more of the following aspects of structures or components manufactured using the certified manufacturing line:

- quality.
- reliability.
- form, fit or function.
- the margins with which the process capability domain boundaries are achieved.
- backwards compatibility is not maintained (previously designed structures or components cannot now be manufactured without redesign or changes to their specification).

In case of doubt changes shall be classified as major.

In the case of a major change the supplier shall support the change with appropriate testing on test structures following the requirements defined herein for both evaluation and PCA testing and agreed with the ESCC Executive.

In the case of a minor change the supplier shall record the change after confirmation of the classification by the ESCC Executive.

The PID shall be updated and approved accordingly as required in ESCC Basic Specification No. 22700.

8.8 QUALITY CONFORMANCE REQUIREMENTS

8.8.1 Certificate of Conformity

For orders received by the supplier, which stipulate the design, where applicable, and the manufacture of a component within an ESCC certified PCA, an ESCC certificate of conformity shall be prepared. Such a certificate of conformity shall be provided with each delivery or partial delivery of components which are manufactured fully within the process capability domain on the certified manufacturing line.

The certificate may be the standard company certificate but must contain, as a minimum, the information given in Appendix A of this specification.

8.8.2 Records

The supplier shall maintain detailed records of all structures and components, within the process capability domain, processed on the certified manufacturing line. A record of all such structures or components, found to be defective during testing by the supplier, shall be separately maintained.

These records shall be made readily available for inspection by the ESCC Executive.

8.8.3 Failures

When requested by the ESCC Executive, the supplier shall perform failure analysis to the depth necessary on defective structures or components to identify the failure mechanisms and such defects as are due to design, poor process control, workmanship or mishandling, misuse, etc.

When requested by the Orderer, the supplier shall undertake similar failure analysis of components failing while in use.

As a result of failure analysis, any repetitive defect attributable to any aspect of the PCA shall be brought immediately to the attention of the ESCC Executive by the supplier. Failure to do so may lead to suspension of the PCA.

8.8.4 Alert Procedure

The Alert procedure applicable to PCA is a procedure for urgently notifying the ESCC Executive, for consideration of the impact on PCA, of any problem concerning a test, material or process which could result in unsafe conditions or adversely affect the reliability of structures or components processed on the certified manufacturing line.

When such a problem is identified by, or brought to the attention of the supplier, he shall, as a matter of urgency, carry out any necessary action or investigation. Information about the problem, together with the supplier's assessment, shall be circulated, as and if required, to any organisation using components delivered under a certificate of conformity to the PCA.

8.8.5 ESCC Non-Conformance System

In the case of a non-conformance within the process capability domain, the supplier shall initiate the non-conformance control system in accordance with ESCC Basic Specification No. 22800.

9 ADDITIONAL DOCUMENTATION

Detail Requirements for Process Capability Approval

Ancillary Specifications numbered in the ESCC 2XXXXXX series shall be read in conjunction with this specification and define the detail requirements for PCA for the particular component technology.

They address the technology specifics of the following topics:

- Process capability domain and boundaries.
- PCA evaluation and test programme.

9.1 ANCILLARY SPECIFICATIONS

The following supplementary specifications have been issued:

2566000 Process Capability Approval of Hermetic Hybrid Manufacturing Lines

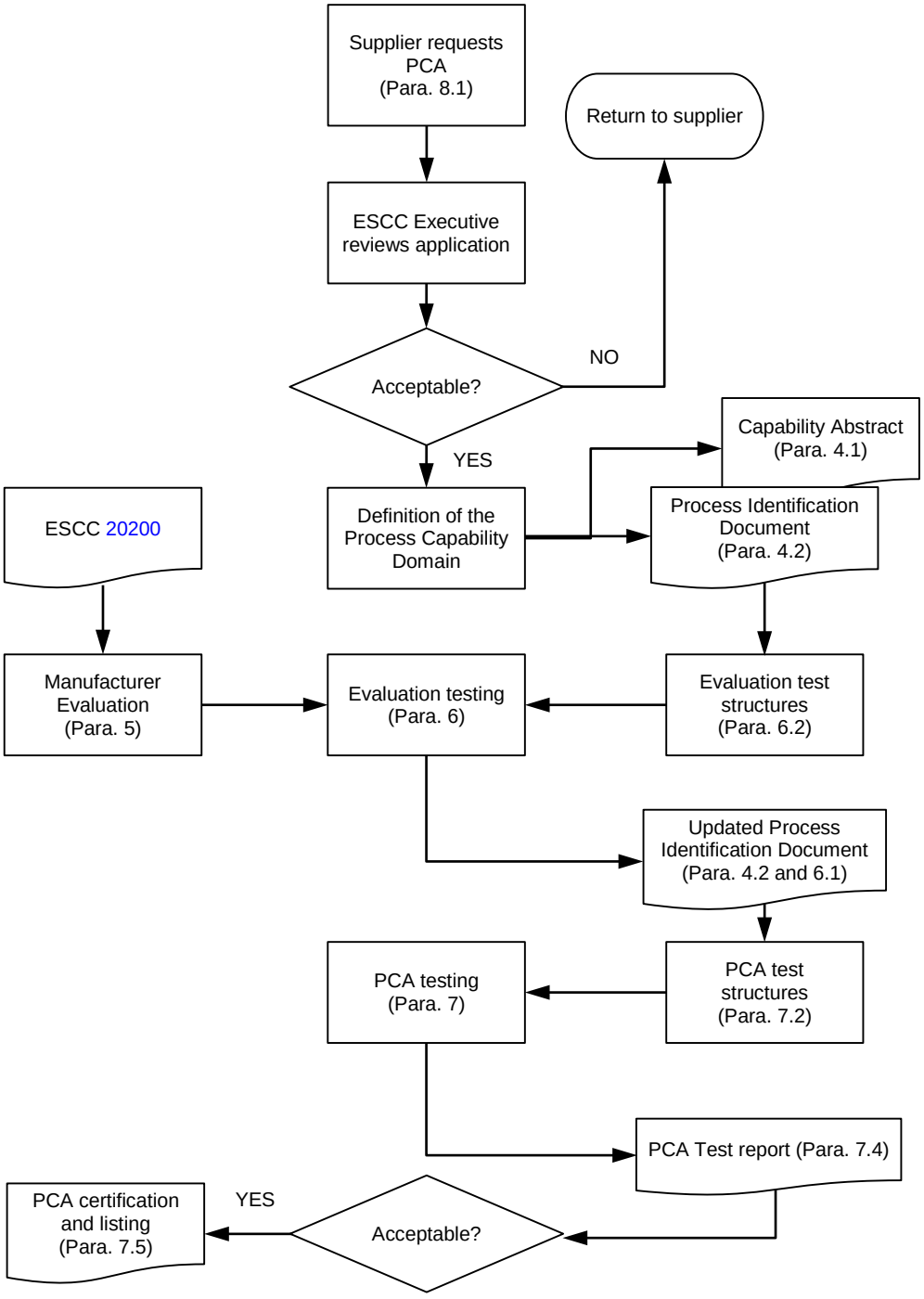
9.2 FORMS AND TEMPLATES

Inter alia, the following can be found in the ESCC Forms section of ESCIES (https://escies.org):

- Application to undertake an ESCC Process Capability Approval

10 CHARTS

10.1 PROCESS CAPABILITY APPROVAL FLOW CHART



APPENDIX A
CERTIFICATE OF CONFORMITY

The following minimum information shall appear on an ESCC Certificate of Conformity:

- "ESCC Certificate of Conformity"
- Name of Company
- Address
- Component type
- Component number
- Lot identification
- Quantity
- Order number
- "This is to certify that the above mentioned components have been manufactured and/or tested, as applicable, with Materials and Processes suitable for producing space grade components, and as acknowledged by currently valid ESCC Process Capability Approval (PCA) in accordance with ESCC Basic Ancillary Specification No. 2XXXXXX
- "The components subject to this Certificate of Conformity were manufactured at our plant located at:" Plant location
- "Certified by:" Name and Title, the latter to be either the "ESCC Chief Inspector" or "Deputy ESCC Chief Inspector"
- Date

NOTES

The text above in quotations is intended for literal use on the ESCC Certificate of Conformity.