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ICS 49.140

**Raumfahrtproduktsicherung –
Allgemeine Beschaffungsanforderungen an Hybride;
Englische Fassung EN 16602-60-05:2014**

Space product assurance –
Generic procurement requirements for hybrids;
English version EN 16602-60-05:2014

Assurance produit des projets spatiaux –
Exigences génériques d'approvisionnement des composants hybrides;
Version anglaise EN 16602-60-05:2014

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DIN-Normenausschuss Luft- und Raumfahrt (NL)

Nationales Vorwort

Dieses Dokument (EN 16602-60-05:2014) wurde vom Technischen Komitee CEN/CLC/TC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-10-01 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Dieses Dokument (EN 16602-60-05:2014) basiert auf ECSS-Q-ST-60-05C Rev. 1.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von EN 16602-60-05:2014.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischer Norm, da es denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

3 Begriffe und Abkürzungen

3.1 Begriffe aus anderen Normen

Für die Anwendung dieses Dokuments gelten die Begriffe nach ECSS-S-ST-00-01.

3.2 Für diese Norm spezifische Begriffe

3.2.1

Zulassungsbehörde

Organisation, die das Zertifikat für die Zulassung ausstellt

ANMERKUNG In Europa ist das ESCC-System die Zulassungsbehörde für Bauelemente von Raumfahrtssystemen.

3.2.2

Hersteller der Kategorie 1

Hersteller mit einem Technologiebereich, der zugelassen ist oder dessen Zulassung durch die **Zulassungsbehörde** anhängig ist

3.2.3

Hersteller der Kategorie 2

Hersteller mit einem Technologiebereich, der nicht von der **Zulassungsbehörde** zugelassen ist

3.2.4

Hybrid auf der Qualitätsstufe des Ingenieurmodells (EM)

Hybrid, der aus denselben Teilen (Typen, Quellen und Gestaltung), Werkstoffen und Prozessen wie Flugmodelle hergestellt wurde, wo bei der Sichtprüfung oder der Überprüfung während der Beschaffung oder Herstellung jedoch eine niedrigere Qualitätsstufe akzeptiert wird

3.2.5

Hybrid

siehe „hybrider Mikroschaltkreis“

3.2.6

hybrider Schaltkreis

siehe „hybrider Mikroschaltkreis“

3.2.7

hybrider Mikroschaltkreis

Kombination von Bauelementen (Verbindungssubstrat, darauf aufgesetzte aktive oder passive Chips), die sich in einem geschlossenen Gehäuse befinden, um eine elektronische Funktion zu erfüllen

ANMERKUNG 1 Verbindungssubstrate (z. B. dicke Folie, dünne Folie, Co-Feuerung, direkt gebondete Kupferverbindung (en: *direct bonded copper*, DBC)) können mit oder ohne integrierten passiven Bauelementen (Widerstände, Spulen, Kondensatoren) vorkommen.

ANMERKUNG 2 Aktive Teile können monolithisch oder voneinander getrennt sein, Chips oder Bauelemente im Gehäuse.

ANMERKUNG 3 Elektronische Funktionen, die von Hybridbauelementen durchgeführt werden, umfassen digitale oder analoge Funktionen, Funktionen mit Niederfrequenz oder mit Hochfrequenz, mit Kleinleistungs- oder Hochleistungsfunktion. Diese Funktionen können entsprechend der Anwendung gemischt vorkommen.

ANMERKUNG 4 Die Begriffe „**hybride Schaltkreise**“ und „**Hybride**“ sind Synonyme für „hybride Mikroschaltkreise“.

3.2.8

Prozessidentifizierungsdokument

Dokument, das den zugelassenen Technologiebereich festlegt, den Verweis auf den Zulassungsstatus und das die Konfiguration der Fertigungslinie und des zugelassenen Bereiches festhält

3.2.9

Prozessleistungsindex

die Prozessfähigkeit über einen längeren Zeitraum, welche die Qualitätsfähigkeit des Prozesses und die Variabilität hinsichtlich der Spezifikationsanforderungen wiedergibt

3.2.10

Produktionslos

Anzahl der Einheiten eines einzelnen Bauelementetyps, der während eines nicht unterbrochenen Zeitraumes innerhalb derselben Produktionslinie unter Anwendung derselben Produktionstechniken und nach derselben Gestaltung der Bauelemente oder Teile sowie mit denselben Chipslosen und denselben Werkstoffen gefertigt wird

3.2.11

repräsentatives Produktionslos

Los, das mehrere **Produktionslose** repräsentiert, das Produkte aus derselben Familie umfasst, die von einem Standard-Prüfschaltkreistyp (SEC-Typ) abgedeckt werden, der während eines nicht unterbrochenen Zeitraumes innerhalb derselben Produktionslinie und unter Anwendung derselben Werkstoffe und Prozesse hergestellt wurde

3.2.12

Standard-Prüfschaltkreis

Bauelement, das eine Produktfamilie repräsentiert, wobei dieselben Werkstoffe und Verfahren verwendet werden, und das in derselben Produktionslinie mit derselben Fertigungsausrüstung und denselben Werkzeugen verarbeitet wird

3.2.13

Technology-Review-Board

formale Gruppe auf Herstellerebene, die sich aus den Verantwortlichen für Gestaltung, Werkstoffe, die Beschaffung von Teilen, die Herstellung, Zuverlässigkeit und Qualitätssicherungsfunktionen zusammensetzt

3.3 Abkürzungen

Für die Anwendung dieses Dokuments gelten die Abkürzungen nach ECSS-S-ST-00-01 sowie die folgenden Abkürzungen.

Abkürzungen	Bedeutung
CECC	CENELEC-Ausschuss für Elektronische Bauteile (<i>en: CENELEC Electric Components Committee</i>)
CTA	Bauartzulassung des Schaltkreises (<i>en: circuit type approval</i>)
COC	Konformitätszertifikat (<i>en: certificate of conformance</i>)
DCL	deklarierte Bauelementeliste (<i>en: declared component list</i>)
DRD	Dokumenten-Anforderungsdefinition (<i>en: document requirements definition</i>)
DBC	Direkt gebondete Kupferverbindung (<i>en: direct bonded copper</i>)
DPA	zerstörende physikalische Analyse (<i>en: destructive physical analysis</i>)

Abkürzungen	Bedeutung
EM	technisches Modell, Engineering-Modell (<i>en: engineering model</i>)
ESA	Europäische Weltraumorganisation, Europäische Raumfahrtagentur (<i>en: European Space Agency</i>)
ESCC	Europäisches Koordinierungsprogramm für Raumfahrtkomponenten (<i>en: European Space Components Coordination</i>)
ESD	elektrostatische Entladung (<i>en: electrostatic discharge</i>)
FM	Flugmodell (<i>en: flight model</i>)
FMECA	Fehlerart-, auswirkungs- und -kritizitätsanalyse (<i>en: failure mode effects and criticality analysis</i>)
HTIF	Formular zur Identifizierung hybrider Schaltkreistechnologie (<i>en: hybrid circuit technology identification form</i>)
LAT	Los-Abnahmetest (<i>en: lot acceptance test</i>)
MMIC	monolithischer mikrowellenintegrierter Schaltkreis (<i>en: monolithic microwave integration circuit</i>)
MIP	verbindlich vorgeschriebener Prüfpunkt (<i>en: mandatory inspection points</i>)
NCR	Nichtkonformitäten/Fehler-Bericht (<i>en: nonconformance report</i>)
PA	Produktsicherung (<i>en: product assurance</i>)
PAD	Teilezulassungsdokument (<i>en: part approval document</i>)
PDA	Zulässige Fehlergrenze (<i>en: percent defective allowable</i>)
PDR	Vorläufiges Design-Review (<i>en: preliminary design review</i>)
PID	Prozessidentifizierungs-Dokument (<i>en: process identification document</i>)
PIND	Geräuschpartikelerfassung (<i>en: particle impact noise detection</i>)
Ppk	Prozessleistungsindex (<i>en: process performance index</i>)
RFD	Abweichungsantrag (<i>en: request for deviation</i>)
RFW	Antrag auf Sonderfreigabe (nach Realisierung) (<i>en: request for waiver</i>)
SAM	Akustisches Mikroskop (<i>en: scanning acoustic microscope</i>)
SEC	Standard-Prüfschaltkreis (<i>en: standard evaluation circuit</i>)
SEM	Elektronisches Mikroskop (<i>en: scanning electronic microscope</i>)
SPC	Statistische Prozesslenkung (<i>en: statistical process control</i>)
TCV	technologische Parameter-Teststruktur (<i>en: technological characterization vehicle</i>)
TRB	Technology-Review-Board (<i>en: technology review board</i>)

— Leerseite —

English version

Space product assurance - Generic procurement requirements for hybrids

Assurance produit des projets spatiaux - exigences
génériques d'approvisionnement des composants hybrides

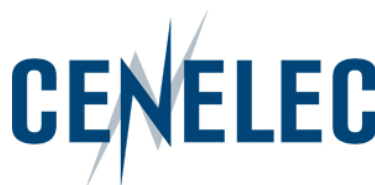
Raumfahrtproduktsicherung - Allgemeine
Beschaffungsanforderungen an Hybride

This European Standard was approved by CEN on 13 March 2014.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CEN-CENELEC Management Centre:
Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 16602-60-05:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16602-60-05:2014) originates from ECSS-Q-ST-60-05C Rev. 1.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

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Introduction

The objective of this Standard is to define the requirements for the procurement of hybrid microcircuits for use in space systems.

This Standard covers the following requirement domains:

- Validation procedure for a hybrid microcircuit manufacturer.
- Design of hybrid microcircuits.
- Procurement of active and passive chips.
- Procurement of materials and piece parts.
- Screening of hybrid microcircuit lots.
- Lot acceptance tests for hybrid microcircuits.
- Customer involvement, key inspection points.
- Repair provisions.
- Hybrids and data package delivery.

1

Scope

The procurement requirements for hermetic hybrid microcircuits for use in space projects are defined in this Standard.

This Standard also provides details concerning the documentation requirements and the procedures relevant to obtain approval for the use of hybrid microcircuits in the fabrication of space systems and associated equipment.

The provisions of this Standard apply to all participants in the production of space systems, at all levels and are applicable to manned and unmanned spacecraft, launchers, satellites, payloads, experiments, and their corresponding organizations.

This standard may be tailored for the specific characteristic and constraints of a space project in conformance with ECSS-S-ST-00.

2

Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system — Glossary of terms
EN 16602-60	ECSS-Q-ST-60	Space product assurance — Electrical, electronic and electromechanical (EEE) components
EN 16602-60-12	ECSS-Q-ST-60-12	Space product assurance - Design, selection, procurement and use of die form monolithic microwave integrated circuits (MMICs)
EN 16602-30-11	ECSS-Q-ST-30-11	Space product assurance — Derating - EEE components
EN 16602-70	ECSS-Q-ST-70	Space product assurance — Materials, mechanical parts and processes
	MIL-STD-883G	Tests methods and procedures for microelectronics
	MIL-STD-750D	Test method standard for semiconductor devices
	ESCC 20600	Preservation, packaging and despatch of ESCC components
	ESCC 2043000	Internal visual inspection of capacitors
	ESCC 2044000	Internal visual inspection of resistors
	ESCC 2045010	Internal visual inspection of microwave devices
	ESCC 2049010	Internal visual inspection of monolithic microwave devices
	ESCC 2053000	External visual inspection of capacitors
	ESCC 2054000	External visual inspection of resistors
	ESCC 2093000	Radiographic inspection of capacitors
	ESCC 2094000	Radiographic inspection of resistors

Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this standard, the terms and definitions of ECSS-S-ST-00-01 apply.

3.2 Terms specific to the present standard

3.2.1 approving authority

organization supplying approval certificate

NOTE In Europe the approving authority for space systems components is the ESCC system.

3.2.2 category 1 manufacturer

manufacturer with a technology domain approved or pending approval by the approving authority

3.2.3 category 2 manufacturer

manufacturer with a technology domain not approved by the approving authority

3.2.4 EM quality level hybrid

hybrid manufactured with the same parts (types, sources and design), materials, and processes as flight models but with acceptance of a lower quality level for visual inspection or screening during procurement or manufacturing

3.2.5 hybrid

see "hybrid microcircuit"

3.2.6 hybrid circuit

see "hybrid microcircuit"

3.2.7 hybrid microcircuit

combination of elements (interconnection substrate, added active or passive chips) sealed inside a package in order to perform an electronic function

NOTE 1 Interconnection substrate (e.g. thick film, thin film, co-fired, DBC) can be with or without integrated

passive components (e.g. resistors, inductors, capacitors).

NOTE 2 Active parts can be monolithic or discrete, chips or packaged components.

NOTE 3 Electronic functions that are performed by hybrids include digital or analog, low frequency or radiofrequency, low power or high power functions. These functions may be mixed according to the application.

NOTE 4 The terms “**hybrid circuits**” and “**hybrids**” are synonymous for “Hybrid microcircuits”.

3.2.8 process identification document

document that defines the approved technology domain, the reference of approval status, and one that freezes the configuration of the manufacturing line and the approved domain

3.2.9 process performance index

the long-term capability of the process which reflects the process centering and the variability with respect to specification requirements

3.2.10 production lot

number of units of a single device type manufactured on the same production line using the same production techniques, in one uninterrupted period, according to the same component or part design and having the same chips lots and the same materials

3.2.11 representative production lot

lot that represents several **production lots** grouping products from the same family, covered by one SEC type, manufactured on the same production line, in one uninterrupted period, using the same materials and processes

3.2.12 standard evaluation circuit

device that represents a family of products using the same materials and processes and which is processed on the same production line with the same manufacturing equipment and tools

3.2.13 technology review board

formal group at manufacturer level where design, materials and parts procurement, manufacturing, testing, reliability, and quality assurance functions are represented

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
CECC	CENELEC Electronic Components Committee
CTA	circuit type approval
COC	certificate of conformance
DCL	declared component list
DRD	document requirements definition
DBC	direct bonded copper
DPA	destructive physical analysis
EM	engineering model
ESA	European Space Agency
ESCC	European Space Components Coordination
ESD	electrostatic discharge
FM	flight model
FMECA	failure modes effects and criticality analysis
HTIF	hybrid circuit technology identification form
LAT	lot acceptance test
MMIC	monolithic microwave integrated circuit
MIP	mandatory inspection points
NCR	nonconformance report
PA	product assurance
PAD	part approval document
PDA	percent defective allowable
PDR	preliminary design review
PID	process identification document
PIND	particle impact noise detection
Ppk	process performance index
RFD	request for deviation
RFW	request for waiver
SAM	scanning acoustic microscope
SEC	standard evaluation circuit
SEM	scanning electronic microscope
SPC	statistical process control
TCV	technological characterization vehicle
TRB	technology review board

4

Sequence of procurement activities

The sequences of activities involved in the procurement of hybrid microcircuits are illustrated in Figure 4-1. A more detailed illustration is further provided in Figure 4-2.

The initial steps in the process are the selection and validation of the manufacturer and the technology.

The technology of a hybrid circuit is defined as the set of processes and materials used to manufacture the hybrid, i.e.

- the substrate network and material: thick film or thin film;
- integrated components, i.e. resistors, capacitors and inductors used in the network;
- processes and materials for the attachment and connection of the added-on components (active and passive chips);
- packaging type and material.

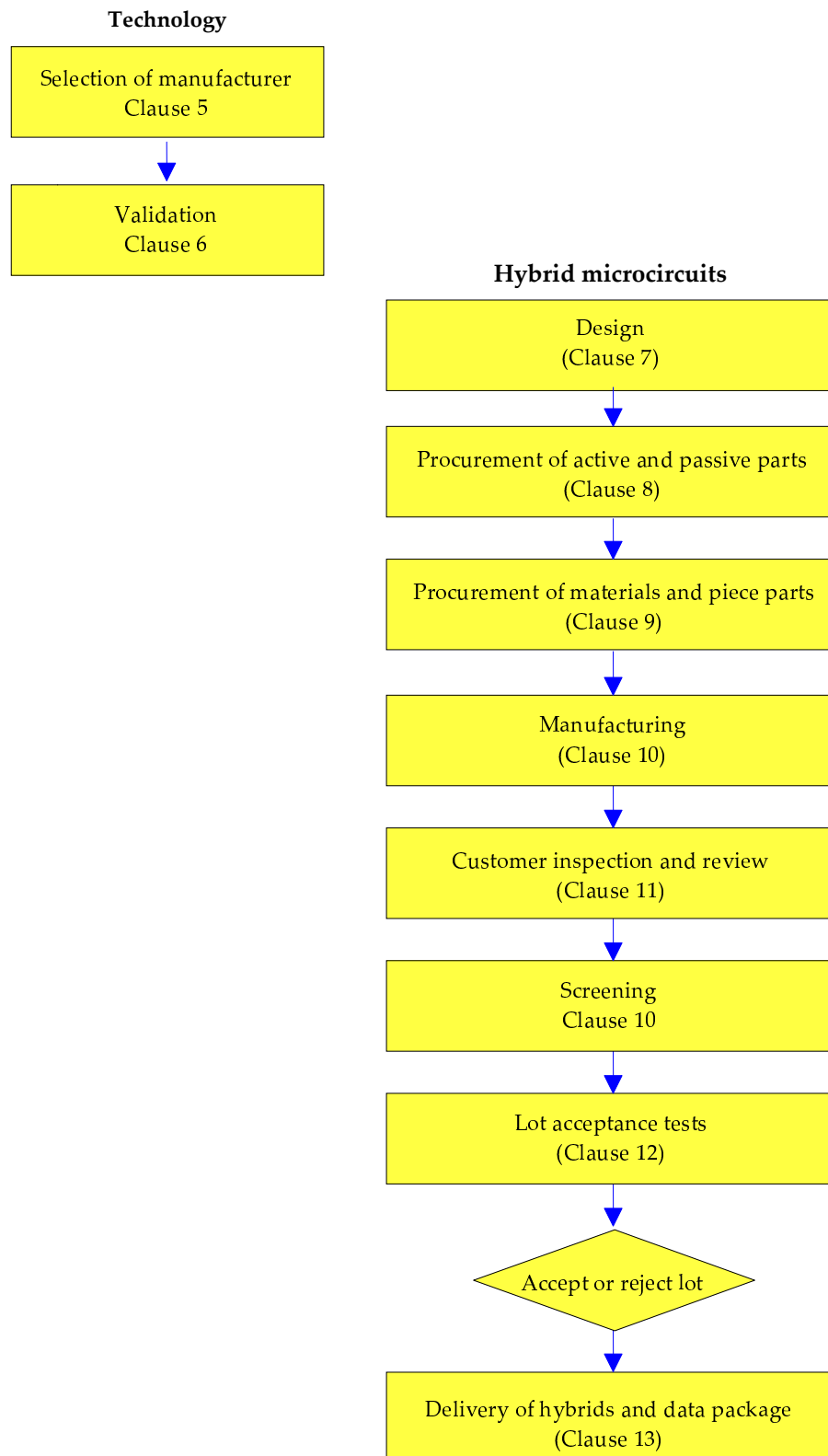


Figure 4-1: Sequence of activities in the procurement of hybrid microcircuits

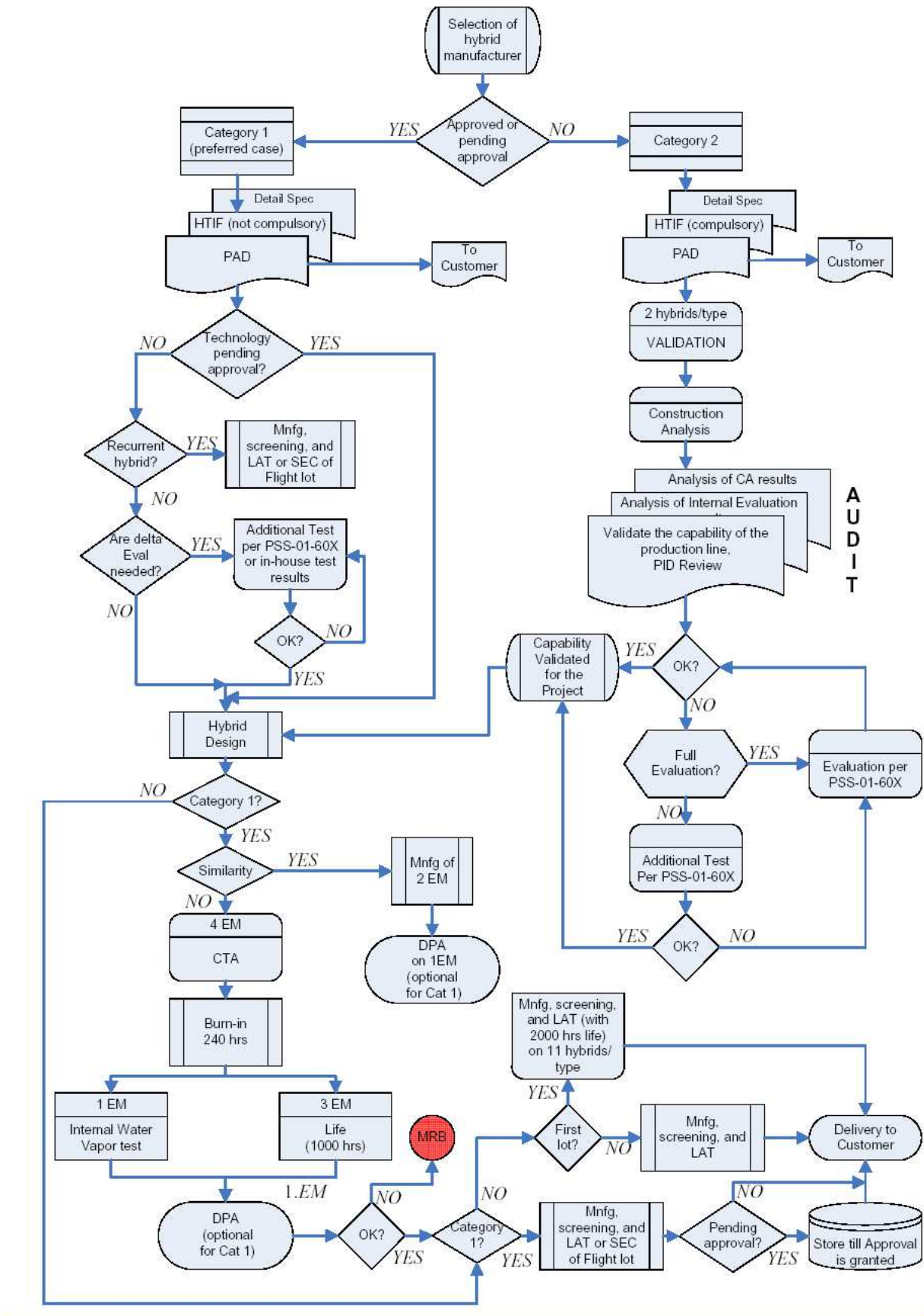


Figure 4-2: Hybrids procurement flow

5

Selection of hybrid microcircuit manufacturer

5.1 General

- a. All manufacturers that are selected for producing hybrids shall be validated as described in Clause 6.

5.2 Hybrid microcircuit manufacturer categories

5.2.1 Category 1 manufacturer (preferred case)

- a. A supplier who wishes to use (or manufacture) hybrid circuits for a space project shall procure (or produce) them from a production line that has been approved or is pending approval by the approving authority.
- b. All hybrid circuits shall be manufactured using the basic processes and materials, and in conformance with the manufacturing and inspection procedures as described in the PID that has been approved by the approving authority.
- c. The PID shall contain as a minimum:
 - 1. the manufacturing and inspection flow chart;
 - 2. the list of applicable documents with approved revision;
 - 3. the general organization of the production line;
 - 4. the approved domain: authorized parts, materials, processes and reworks;
 - 5. the list of manufacturing, inspection and failure analysis equipment;
 - 6. the list of hybrids manufactured in conformance with the approved PID.

5.2.2 Category 2 manufacturer (non-preferred case)

- a. A supplier wishing to use (or manufacture) hybrid circuits from a production line that has not been approved by the approving authority shall:
 - 1. justify its requirements to the customer (especially if this involves developing a new circuit), and
 - 2. satisfy the validation conditions described in Clause 6.

6

Validation procedure for a hybrid microcircuit manufacturer

6.1 General

- a. Validation of manufacturers and production lines shall be conducted jointly by the supplier using the hybrid circuit and the customer, and involving upper level customers where relevant.
- b. In the case of confidential information, these activities may be conducted with the support of the approving authority.

6.2 Hybrid circuit technology identification form (HTIF)

6.2.1 General

- a. Whatever his status (category 1 or 2) regarding the capability approval, a manufacturer wishing to produce or use hybrid circuits shall complete a hybrid circuit technology identification form (HTIF) for each circuit, in conformance with Annex A.
- b. For category 2 manufacturers, this form shall be included with the part approval document (PAD) as described in 6.2.4.

NOTE The format of the PAD is defined in ECSS-Q-ST-60, Annex A.

6.2.2 HTIF for approved manufacturers (category 1)

- a. With justification, it is not mandatory, for a category 1 manufacturer, to deliver the HTIF to the customer.
- b. A category 1 manufacturer shall issue a CoC to the customer to confirm that the proposed hybrid circuit conforms to the domain approved by the approving authority.
- c. As a minimum, the HTIF reference and CoC shall be included in the PAD with reference to the applicable PID.

- d. If the technologies used are not entirely covered by the applicable PID, the manufacturer shall carry out additional (delta-)evaluation tests or prove that he has adequate in-house test results.

NOTE See the relevant PSS evaluation plans in ESA-PSS-01-605, ESA-PSS-01-606, and ESA-PSS-01-612.

- e. This (delta-)evaluation programme shall be referenced in the PAD.
- f. The test results shall be approved by the first level supplier.
- g. The manufacturer shall supply these circuits according to the procurement rules defined for the project as per the requirements in this standard.

6.2.3 HTIF for manufacturer pending capability approval by the approving authority (category 1)

6.2.3.1 Overview

Manufacturers of hybrid circuits are considered to be pending capability approval by the approving authority when:

- they have successfully completed the “evaluation” phase,
- their PID has been approved, and
- they have begun the “approval” phase (see ESA-PSS-01-605, ESA-PSS-01-606, and ESA-PSS-01-612).

6.2.3.2 Requirements

- a. Manufacturers shall only use the technologies that have been tested in the evaluation phase and are referenced in the PID.
- b. Manufacturers may manufacture circuits while the approval phase is being carried out in conformance with the PID.
- c. Manufacturers shall not deliver these circuits until capability approval has been formally acquired.

6.2.4 HTIF for manufacturer not approved by the approving authority (category 2)

6.2.4.1 Overview

For category 2 manufacturers, the review and validation activities for the production lines are described in clause 6.3.

6.2.4.2 Requirements

- a. The review and validation activities for the production lines for category 2 manufacturers shall be implemented at the PDR milestone of the project.

- b. A category 2 manufacturer shall supply an HTIF in conformance with Annex A and include it as part of the PAD.
- c. In case of confidentiality of particular materials or processes, claimed by category 2 manufacturers, the HTIF attached to the PAD may leave undisclosed the confidentiality elements, provided that these aspects are covered and discussed during the quality and technical audit as described in clause 6.3.3.
- d. The HTIF shall be in conformance with the technological domain validated for the project.
- e. The manufacturer shall produce the hybrid circuits for the project which conform to the same common requirements as for category 1 manufacturers and additional requirements as defined in this Standard.

6.3 Validation of category 2 manufacturers

6.3.1 General

- a. Category 2 manufacturers shall be validated in conformance with the requirements in this clause 6.3.

6.3.2 Construction analysis on representative samples

- a. Two circuits per hybrid type shall be supplied by the supplier for construction analysis.
- b. The quality level of these circuits shall be the same as the one specified by the project.

6.3.3 Quality and technical audit

- a. After construction analysis, a quality and technical audit shall be carried out by the supplier as follows:
 - 1. Present the results of the construction analysis.
 - 2. Analyse the results of internal evaluations of the technologies implemented by the manufacturer. Compare these previously obtained results to the tests defined in the evaluation plans (see ESA-PSS-01-606, ESA-PSS-01-605, and ESA-PSS-01-612), and apply the following criteria.
 - (a) If the results of the tests are successful, consider the manufacturer “validated”, but only for the project.
 - (b) If only some of the results are successful, perform additional tests pertaining to the failures (see the evaluation plans ESA-PSS-01-606, ESA-PSS-01-605, and ESA-PSS-01-612).