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CTAO Configuration Management Plan

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Abbreviations	
ACRV	Acceptance Review
AD	Applicable Document
EDMS	Electronic Documentation Management System
CCB	Configuration Control Board
CDR	Critical Design Review
CI	Configuration Item
CIDL	Configuration Item Data List
CM	Configuration Management
CMS	Configuration Management Specialist
CR	Change Request
CTAO	Cherenkov Telescope Array Observatory
IKC	In-Kind Contributor
PM	Project Manager
RAM	Reliability, Availability, and Maintainability
RD	Reference Document
RFW	Request for Waiver
SE	Systems Engineering
WP	Work Package

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1 Introduction

Configuration refers to the interrelated functional and/or physical characteristics of a product defined in configuration documents. Furthermore, a *Configuration Item (CI)* is any product, service component, infrastructure element, software application or other item that needs to be managed to ensure a successful and traceable delivery of products or services.

Configuration Management (CM) is the collection of processes that are applied over the life cycle of a project to provide visibility, control, and traceability of its functional, performance and physical attributes. CM consists of five key processes:

- Configuration management planning
- Configuration identification
- Configuration control
- Configuration status accounting and traceability
- Configuration verification

1.1 Purpose

This plan describes the Configuration Management (CM) responsibilities and processes that support the design and implementation of the Cherenkov Telescope Array Observatory, as outlined in section 5.4 of [AD01].

Configuration management is applied throughout the entire life cycle of the product and allows one to¹:

- know at any time the valid technical description of a product using approved documentation,
- record and control the evolution in the technical description of a product (e.g., system and its products),
- provide traceability of the evolution of the product's technical description,
- ensure the consistency of the interfaces,
- verify and demonstrate to all actors that documentation is and remains the exact representation of the products it describes,
- identify the current configuration baseline and the as-built configuration of a product, to record discrepancies detected during production, delivery or operation and dispositioned for further use,
- enable any actor to know the operational capabilities and limitations of each product item and, in case of nonconformance, to know which items are affected.

¹ Ref.: ECSS standard ECSS-M-ST-40C Rev. 1

1.2 Scope

The term *CTA Configuration* refers to all those documents that define the project. For the purpose of *Configuration Control*, the CTA documents are divided into four groups (see section 5.4 of [AD01]):

1. Council-level documents
2. Project-level documents
3. IKC-level documents
4. Non-controlled documents

This plan describes the processes that shall be followed for all approvals and changes of project-level configuration item documentation, which is defined as described in section 5.4.1 of [AD01]. The same approach shall also be used for controlled IKC/work package-level² documents, but its implementation and tools can be chosen more flexibly by the corresponding IKC/work package manager(s) as long as standard configuration management methods and procedures are used. It should be noted that all documents defined as *deliverables* (related to reviews, acceptance, hand-over processes) shall follow the CTAO rules for documentation control (approval, storage, etc.) described in [AD02].

This plan does NOT cover the control of Council-level documents, which is described in section 5.4.1 of [AD01].

1.3 Applicable documents

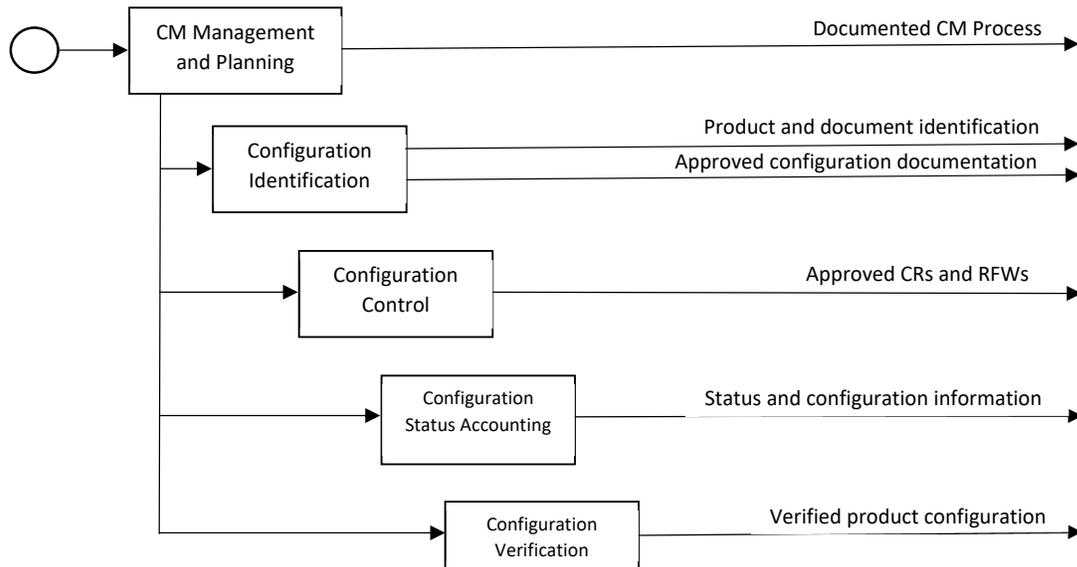
The documents listed below form part of this plan to the extent specified and described herein, and the latest version shall apply unless specified otherwise:

AD01	CTA Project Management Plan (CTA-PLA-MGT-000000-0003)
AD02	Documentation Control Plan (under preparation)
AD03	CTA Product Breakdown Structure (under preparation)
AD04	Asset-naming Convention (CTA-STD-SEI-00000-0004)

² See section 3.3 of [AD01] for a more detailed description of the CTA work package schemes

2 Overview

The following figure gives an overview of the processes related to configuration management (CM), including their interaction and related output:



Each CM process can be summarized as follows:

- **Management and Planning of CM activities** involves the due allocation of resources, tools, and facilities, as well as guidance and training of involved personnel.
- **Configuration Identification** is the process that uses the CTA system decomposition as an input to select configuration items (CIs) and to define their configuration documentation for a set of established configuration baselines.
- **Configuration Control** is the process by which proposed changes are reviewed and approved (or rejected). It ensures that the technical, cost, schedule, and risk impacts of each change are considered before approval is granted. CI documentation shall be kept under configuration control after initial release (see [AD02] for details related to document approval and release).
- **Configuration Status Accounting** refers to establishing the organization necessary for performing configuration management and to provide the source of configuration information to support the different project disciplines and activities. This includes maintaining records of the approved configuration information and of all related changes requests and their status, as well as the tracking of the implementation of changes.
- The **Configuration Verification** process ensures that the current hardware and software configurations match the intended design by verifying the implementation of each approved change through project reviews and/or through configuration audits, if/as deemed appropriate.

3 Organization and Responsibilities

3.1 Organization

To be effective, CM processes need to be performed and followed rigorously by all teams that contribute to the Cherenkov Telescope Array Observatory. The implementation of the CM processes within an IKC/work package is flexible in terms of tools and internal organization, but the concepts outlined in this plan shall be applied (see also sections 3.3 and 5.4.3 of [AD01]). It should be noted that all documents defined as *deliverables* (related to reviews, acceptance, and hand-over processes) shall follow the CTAO rules for documentation control (approval, release, storage, etc.) described in [AD02].

In case IKC/work package teams prefer to use an alternative reference for their internal configuration management, for example a corresponding international standard or an existing approach within the IKC organization, this is possible but should be described (or this plan be made an applicable document) in the corresponding IKC Agreement.

The CTAO shall establish a Configuration Management Specialist role (or its equivalent) that supports the CTAO Project Manager and the CCB Secretary with the implementation of the CM processes. This role also interacts with the IKC/work package managers (or delegates) on CM related matters and action items, aiming at establishing effective teamwork within the broader CTA organization (see also section 4.3 of [AD01]).

3.2 Responsibilities

CM is the responsibility of the CTA Project Office and must be supported by all CTA team members.

Responsibility for the management of configuration items is delegated to the level of management that is consistent with the scope of the item. For the CTAO Construction Project, four levels of change control authority that correspond to four levels of scope have been defined (see also [AD01]):

- A. Council-level documents: it is the responsibility of the CTAO Director to implement changes approved by the Council, but the related process is not part of the scope of this plan (see section 5.4.1 of [AD01] for details).
- B. Project-level configuration items are identified by the CTAO Project Manager, with support from the Lead Systems Engineer, the Project Scientist, and the Safety Engineer. See section 4.1.4 for a list of related documents. For any changes to the project/system-level baselines the CTAO Configuration Control Board (CCB) shall be involved (see section 4.2.1).
- C. IKC-level configuration items are defined by the corresponding IKC/work package manager(s), who shall ensure that these items remain consistent with all applicable project-level documents. Work packages can also include construction contracts. The presented CM processes in this plan shall also be implemented within the groups, but there is flexibility with the use of tools and with the specific implementation.

- D. Non-controlled³ configuration items/documents are any items that have not been selected during the configuration identification process (see section 4.1), and usually they refer to internal memoranda, minutes of meeting, guidelines, or publications. Even when not under configuration control, it is recommended to follow a document control approach (versioning, review & approval steps, and document storage considering appropriate access rights) also for non-controlled documents. Non-controlled documents are not part of the scope of this plan.

Specific management responsibilities at the CTAO include:

- The **CTAO Project Manager (PM)** has the overall responsibility for CM and for ensuring that all project CIs are identified and controlled. The PM is responsible for the Configuration Control Board (CCB) administration, including acting as the Chairperson of the CCB, but part of this role can be delegated to a CCB Secretary role.
- The **CTAO Lead Systems Engineer (LSE)** is responsible for the execution, technical oversight, and coordination of configuration control activities.
- The **CTAO Configuration Management Specialist role** supports the PM and LSE with the coordination of the CCB, with configuration status accounting and with configuration verification.

4 Configuration management activities

This section lists and describes the different configuration management activities, including the related roles and responsibilities, that shall be implemented within the CTA Observatory.

4.1 Configuration identification

Configuration identification is the ongoing process of identifying and documenting the CTA's functional, performance and physical characteristics, thereby ensuring the continuous integrity of the product configuration.

4.1.1 System decomposition

The CTA system decomposition described in [AD03] shall be used as reference at time of identifying configuration items at project-level. Also, the decomposition at IKC/work package-level (or equivalent architecture documents) shall be kept under project-level configuration control and shall be defined by the corresponding IKC/work package teams, with the involvement of the CTAO Systems Engineering group.

³ *Controlled* are all documents that describe a specific configuration item (CI), and a list of examples is listed in section 4.1.4. Other documents that are generated part of the work coordination are therefore *non-controlled* documents.

4.1.2 Configuration items

Configuration item (CI) is any product, service component, infrastructure element, software application or other item that needs to be managed to ensure a successful delivery of products or services⁴. Typical examples are physical devices or systems, software applications, as well as computing and network infrastructure, and facilities, among others.

CIs are selected through the top-down system decomposition process described in section 4.1.1, which divides the total system into a set of logically related elements that describe the system. Project-level CIs shall be identified by the CTAO Project Manager with support from the CTAO Lead Systems Engineer, while IKC/work package-level CIs shall be identified by the corresponding IKC/work package manager(s), with support from CTAO Systems Engineering. The lists of configuration items shall be kept under configuration control upon their first release.

4.1.3 Configuration baselines

Configuration baselines represent the approved status of requirements and design at key milestones of the project and provide the point of departure for further evolution. These configuration baselines are applicable to both hardware and software. A configuration baseline is comprised of the documentation that describes the characteristics of a product (see section 4.1.4 for a list of related documents).

At CTA system-level, the configuration baselines shall be elaborated in the following sequence:

- The **Requirements Baseline** is the initially approved set of documents that describe the high-level CTA system requirement specifications. The Requirements Baseline includes formal definition of the CTA system configuration, requirements consistency check, and traceability.
- The **Design Baseline** is established at the Critical Design Review (CDR) based on the formal definition of the CTA system design. This baseline contains design specifications that will be used to build the CTA system.
- The **Product Baseline** is established at the Acceptance Review (ACRV), and it documents the “as-built” configuration that reflects the completed system. It is the result of the changes that have been made to the original design specifications.

At project-level, the CTAO Project Manager shall define which documentation shall constitute each configuration baseline, with support from the CTAO Lead Systems Engineer. At IKC/work package-level this should be done by the corresponding IKC/work package manager(s), with support from CTAO Systems Engineering.

⁴ For the CTA system decomposition please refer to [AD03].

4.1.4 Configuration documentation

All functional, performance and physical characteristics of a configuration item shall be documented within the defined configuration baselines (see section 4.1.3). Related documentation includes, among others:

- Requirement specifications
- General specifications (e.g., environmental, design references, etc.)
- Architecture/design descriptions
- External and internal interface control documents
- Design/product specifications
- RAM analysis reports
- Safety compliance reports and hazard analysis
- Engineering drawings/models
- Verification plans
- Test/verification specifications/procedures/reports
- Installation/user/operating/maintenance manuals
- Change Request (CRs) and Request-for-Waiver (RFW) records
- Verification and compliance matrices
- Configuration Items Data List (CIDL)

CI documentation shall be kept under configuration control (see section 4.2) after initial release (see [AD02] for details related to document approval and release).

4.1.5 Identification marking

Any configuration item (CI) shall be identified and marked (if applicable) with a unique identifier to guarantee its traceability throughout the project life cycle. The identification marking methods applied shall be compatible with the product's operational environment. See also [AD04] for further guidance on this matter.

The following identification marking baseline shall be considered, however deviations can be agreed with (or defined by) the CTAO:

For hardware configuration items, the following information shall be included:

- CI-identifier
- Part/model identifier
- Serial number
- Manufacturer identifier
- Product name or abbreviation⁵

For software configuration items, the following information shall be included:

- CI-identifier
- Software system/subsystem identifier
- Version and revision number (or equivalent⁶)
- Release identifier and date

⁵ See [AD04] for related details

⁶ For example, commit ID and release tag

- Developer identifier⁷
- Product name or abbreviation

For configuration items that are off-the-shelf standard products, the following information shall be included:

- Part/model identifier
- Serial number
- Manufacturer identifier
- Product name of abbreviation

4.2 Configuration control

Configuration documents enter a more protracted process than all other documents, as they directly impact the requirements, design and/or product baselines of the observatory. For this purpose, a change procedure is defined, which aims at making sure that all technical, cost, schedule, and/or risk impacts of a change are considered before approval is granted.

4.2.1 Configuration control board (CCB)

For the assessment and approval of project-level configuration items, a corresponding Configuration Control Board (CCB) shall be established. The CCB consists of the following permanent members:

- **CTAO Project Manager (Chairperson)**
 - Focuses on the impact of changes with respect to schedule, resources and/or risks.
- **CTAO Lead Systems Engineer**
 - Focuses on the technical completeness and correctness of the received change requests and its technical impact on the system.
- **CTAO Project Scientist**
 - Focuses on the impact of the proposed changes on the overall scientific performance of the system.
- **CTAO Product Safety Engineer**
 - Focuses on the impact of the proposed changes on the safety conditions for personnel and/or equipment.

In addition to the permanent members, the CCB Chairperson shall involve also the following temporary CCB members:

- **Affected IKC/Work Package Managers, Task Coordinators, and/or Systems Engineers**

It is anticipated that most actions will be carried out by consensus of the CCB members. If efforts to reach consensus fail, a vote of the members will be necessary. Meetings and votes of the CCB can be carried out in any manner selected by the CCB Chairperson including, but not limited to face-to-face meetings, audio or video teleconference, email correspondence or telephone polling.

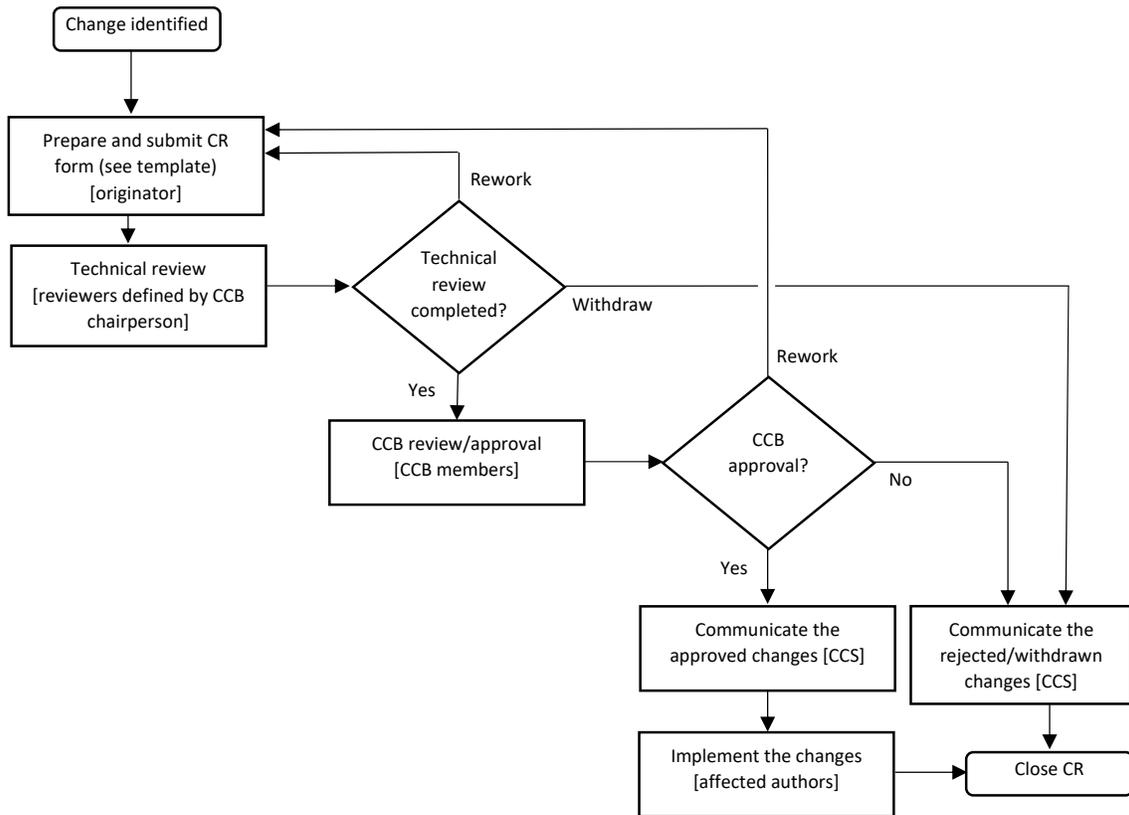
⁷ For example, name of the group, institute and/or contractor responsible for a certain software package

The CTAO Project Manager can also delegate part of his/her responsibilities as Chairperson to a CCB Secretary role. In this case the delegation and its precise scope shall be communicated to all members of the CCB.

For IKC/work-package level configuration items, it is the responsibility of an In-Kind Contributor (or the Work Package Manager, also including construction contracts) to manage changes at IKC level in consultation with the CTAO Project Office. This means that any intended IKC level change will be communicated by the In-Kind Contributor to the Project Office while it follows an IKC internal process for raising, evaluating, and approving a change request. In any case, an IKC-level change needs to follow the relevant IKC Agreement and be consistent with all applicable project-level documents. The establishment of a configuration control process via an internal CCB is recommended.

4.2.2 Change requests (CR)

A Change Request (CR) can be raised by any CTA IKC/work-package manager, contractor, or systems engineer, and by CTAO members who are related to configuration management. The following workflow, which is managed by CTAO Systems Engineering (SE) with the support from the Configuration Management Specialist (CMS), provides an overview of the process that shall be followed when changes to configuration item documentation are identified:



Once the need for a change has been identified, the change shall be requested formally. The request shall then be reviewed technically, analyzing the technical, performance, schedule, and cost impacts of the proposed change. For the technical review corresponding subject-matter experts shall be identified and involved by the Lead Systems Engineer, in coordination with the CCB Chairperson, including representatives from all parties affected by the proposed change. In addition, the permanent members of the CCB shall be informed. Also, the approvers of all documents that would have to be changed as a consequence of the CR should be consulted. If deemed necessary by the initiator based on the feedback received, the CR might have to be re-worked and the technical review be repeated, or the CR could be withdrawn. In case of disagreements, these shall be escalated to the Configuration Control Board (CCB, see section 4.2.1) for resolution.

In case of a positive outcome of the technical review, i.e. that the proposed change is technically consistent and that the lists of identified impacts and affected documents are complete, or if the CR has been escalated to the CCB for resolution, the CR is handed over to the CCB for making a decision concerning the change. Also here, if deemed necessary by the CCB, the CR might have to be re-worked, or it could be approved or rejected. The corresponding outcome of the process shall be communicated to all affected parties, and then changes shall be implemented. Once all documentation has been updated, the CR process has been completed.

For a template of a CR form please refer to Appendix A. Once prepared, a CR form (MS Word or text format) shall be submitted via e-mail to the Configuration Management Specialist to initiate the process.

4.2.3 Request for waiver (RFW)

If during the manufacturing process an item, or a subset of items, is found to depart from specified requirements but is still considered suitable for use, a Request for Waiver (RFW) can be issued to seek authorization to accept the item(s) as-is or after repair by an approved method. The review and approval process of a RFW follows the same steps that are defined for Change Requests (see section 4.2.2), with corresponding adaptations.

It is noted that RFWs shall be applied for a small number of affected items only, but in case a larger number of deviating items is detected, and if these are still deemed suitable for use as-is, the respective requirement(s) shall be modified via a corresponding Change Request.

For a template of a RFW form please refer to Appendix B. Once prepared, a RFW form (MS Word or text format) shall be submitted via e-mail to the Configuration Management Specialist to initiate the process.

4.2.4 Tools to perform change/waiver control

For project-level Change Requests (CRs) and Requests-for-Waivers (RFW) today the process is managed manually, but the implementation of the workflow using a tool will be evaluated. CR or RFW forms (see Appendix A and B, respectively) shall be submitted via e-mail in MS Word or text format to the Configuration Management Specialist to initiate the process. The use of collaborative tools to facilitate the related discussions should be explored.

For change control at IKC/work package-level, alternative tools can also be considered if they allow for the consistent implementation of the processes described in this plan.

4.3 Configuration status accounting

Configuration status accounting comprises the creation and organization of all configuration information and data. As a minimum, the following information shall be reported and maintained for each CI by its owner⁸:

- Records of all related, approved configuration documentation
- The status of proposed changes from the established configuration
- The status of discrepancies and actions arising from technical reviews
- The implementation status of approved changes
- The actual configuration of all units related to the CI

For this purpose, a Configuration Item Data List (CIDL) shall be generated by the corresponding configuration item (CI) owner that summarizes the configuration status of each CI. This document shall be maintained up to date throughout the lifecycle of the development.

At project-level, the Configuration Management Specialist shall oversee the items described above, monitor their status, and proactively interact with the teams on the implementation of the approved changes.

At IKC/work package-level, the corresponding manager(s) should also allocate resources and define roles to assure due configuration status accounting.

4.4 Configuration verification

Configuration verification is the process to verify the current configuration status of an analyzed product/deliverable. This activity is performed as a minimum during the different, technical reviews, but additional verification activities can be defined, as/if deemed appropriate.

At project-level, the CTAO Lead Systems Engineer (or his/her delegate) shall define the necessary verification steps and/or audits, which shall then be coordinated by the Configuration Management Specialist. The CTAO reserves its right to perform audits of the proper application of Configuration Control procedures when deemed necessary.

At IKC/work package-level, the corresponding manager(s) should also define and execute the configuration verification steps deemed necessary for their context, with support from CTAO Systems Engineering if desired.

⁸ The *owner* of the CI is CTAO for project-level configuration documents, and the corresponding IKC/work package managers for IKC-level configuration documents.

5 Appendix A: Change request form

(Please send the described information in MS Word format or in text form to the Configuration Management Specialist.)

Change Request (CR) Form

CR document number: *(to be inserted by CTAO)* Date:

CR Title:

Requested by:

Work-Package:

Affected subsystems:

Affected document(s) to be revised:

Impact on:

Requirements Science Cost/Resources Schedule Safety Technical Operation

Other:

CR Description:

- Detailed description of proposed change:
<Describe what exactly should be changed, and how; if new formulations are considered, please include the proposed wording already here>
- Justification:
<Describe the rationale for this change – why is this change needed?>
- Impact statement(s):
<If this change is made, which parts of the system are affected, and how? List here all anticipated impact items individually, per affected sub-system or work package.>
- Summary of impact (state concerns and/or merit per impact area):
<Include a summary of your concerns and/or merits related to the above-mentioned impact items.>
- Risk of approving/not approving the change:
<Are there any relevant risks for the observatory related to approving or not approving this CR?>
- Affected products to be modified:
<Include a list of products and/or documents that would have to be modified if the proposed change would be approved.>
- Any other information:
<Include here any other information deemed relevant for the assessment of this CR.>

CCB disposition: *(this information will be added during the process)*

Signatures: *(approval signatures will be defined and acquired during the process)*

6 Appendix B: Request-for-waiver form

(Please send the described information in MS Word format or in text form to the Configuration Management Specialist.)

Request-for-Waiver (RFW) Form

RFW document number: *(to be inserted by CTAO)* Date:

RFW Title:

Requested by:

Work-Package:

Product name:

Product identification:

<part/model/software system identifier, manufacturer/developer, serial/release/version number>

Requirement(s) that cannot be met, or deviation(s) from configuration documentation:

Impact on:

Requirements Science Technical Operation RAM Security Safety

Other:

RFW Description:

- Detailed description of the request for waiver:
<Describe exactly the deviation and the non-conformance; elaborate on the possibilities to address the deviation.>
- Justification:
<Describe the rationale for this waiver – why is this the best choice of the alternatives?>
- Impact if waiver if approved (state concerns and/or details per impact area):
<List here all anticipated impact items individually, per affected sub-system or work package.>
- Impact if waiver is not approved (impact on cost/resources and/or schedule):
<List here impact on cost/resources and/or schedule if the waiver is not approved, per affected sub-system or work package.>
- Any other information:
<Include here any other information deemed relevant for the assessment of this RFW.>

CCB disposition: *(this information will be added during the process)*

Signatures: *(approval signatures will be defined and acquired during the process.)*