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User Manual

CAD Manual 01 - Instruction for Use and Introduction

This document serves as an introductory guide to the CAD Manual, and an instruction for its correct usage. It describes concepts and principles that are referenced throughout the manual, to orient readers and to facilitate their navigation of the content. It also describes the main areas of CAD activities and associated tools. It includes an overview of how the CAD Manual is organized and lists some general rules for working in certain CAD tools that are common to several categories of CAD work described in later chapters. It also describes the process to be applied for changes to the CAD Manual.

Approval Process			
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Change Log			
CAD Manual 01 - Instruction for Use and Introduction (AHFDDK)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v0.0	In Work	04 Oct 2024	
v1.0	Signed	08 Oct 2024	For consistency check by authors of other CAD Manual chapters
v1.1	Signed	08 Jan 2025	Updated with review comments taken into account
v1.2	Signed	08 Jan 2025	Updated with review comments taken into account Previous comments and change tracking cleaned
v1.3	Approved	24 Mar 2025	Minor changes to take into account comments of v1.2 review Change process for CAD Manual added in Section 10
v1.4	Approved	04 Apr 2025	Purpose and Scope sections updated to reinforce the requirement to apply the CAD Manual TDTC table updated

Table of Contents

1 Purpose

This document serves as an introductory guide to the CAD Manual, and an instruction for its correct usage. Adhering to the requirements set forth in the manual will ensure compliance with mandatory quality standards for CAD deliverables. **Consequently, it is imperative to follow the CAD Manual when producing CAD deliverables for IO, because non-conformance may result in rejection of the submitted work.**

The manual is organized in chapters, each dedicated to a specific discipline and a range of software tools. This document establishes foundational concepts and principles that are referenced throughout the CAD manual, and orients readers to facilitate their navigation of the content.

2 Scope

This document describes the main areas of CAD activities and associated tools. It gives an overview of how the CAD Manual is organized and the process to be applied in case of changes. It also lists some general rules for working in certain CAD tools that are common to several categories of CAD work described in later chapters of the manual.

The CAD Manual is to be applied by all ITER internal and external Contributors producing, handling or making usage of ITER CAD Data.

3 References

1. Procedure for the CAD management plan (2DWU2M)
2. CAD Execution Procedure (U348G8)
3. Procedure for the Usage of the ITER CAD Manual (2F6FTX)
4. ITER System Design Process (SDP) Working Instruction (4CK4MT)
5. ITER_D_2MU6W5 - ITER Abbreviations

4 Definitions

For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations

For a list of CAD-related terminology, used throughout the CAD Manual, see ITER_D_CAXHWX - CAD Manual 02 : Definitions and Abbreviations

4.1 What is the ITER CAD Manual?

The CAD Manual describes the rules, processes and methodologies to be applied by all those handling CAD data in the IO CAD platforms and for preparation of CAD data for delivery into the IO CAD platforms. (See ref [3])

The rules and processes outlined herein are designed to translate project MQP requirements and industry standards into effective methodologies for each CAD tool. Methodologies are tailored to the capabilities of specific software, drawing on industry best practices and accumulated project experience.

The CAD Manual provides a basis for the processes which guide and support the production of CAD deliverables (models, drawings,..), such as Quality Control, Training and Certification, User Support. It is also the foundation for further documentation, such as How-To guides which

detail the step-by-step execution of specific tasks and PBS CAD Handbooks, which document system-specific implementation of CAD Manual rules.

It is not within the scope of the CAD Manual to define the requirements for the engineering content of CAD deliverables. This aspect is covered by the associated Technical Document Type Card.

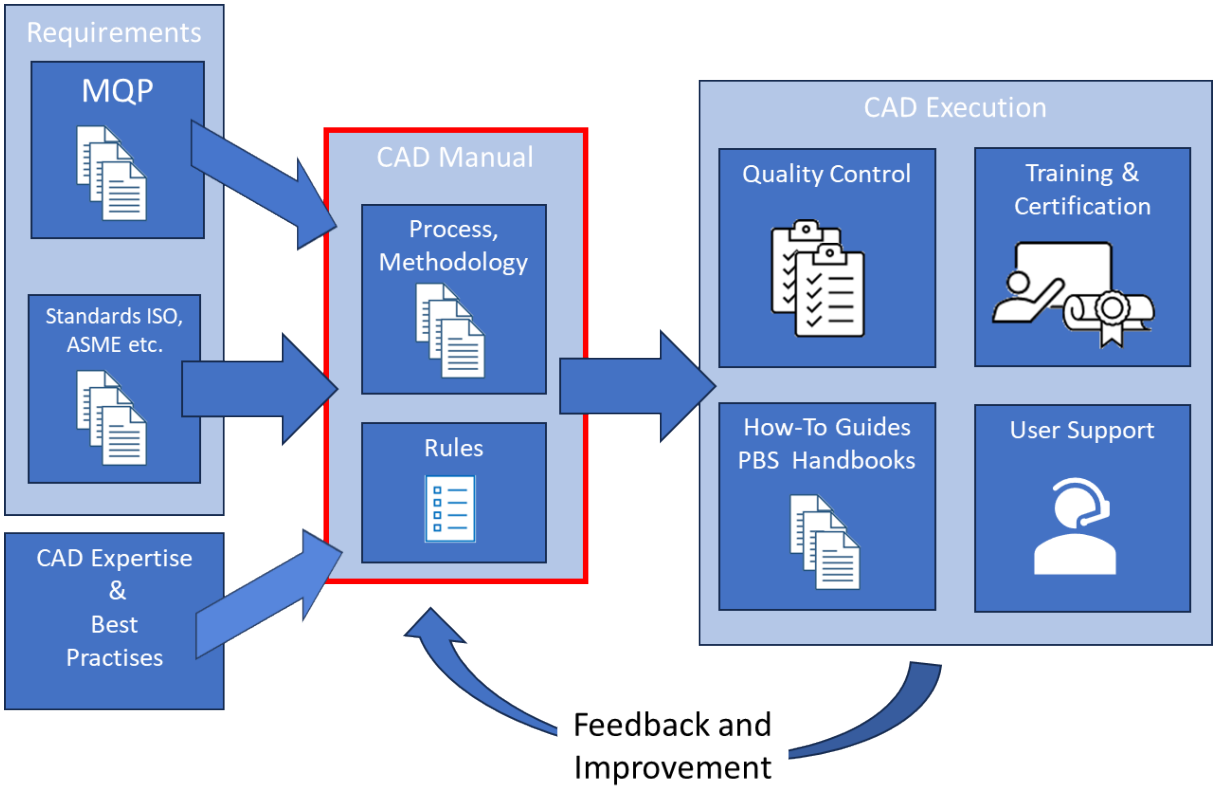

Fig1: CAD Manual dependencies and flow of information

4.2 Documentation Related to the CAD Manual

4.2.1 CAD Manual upstream/driving documents

- Driving MQP documents and standards are referenced in each CAD Manual chapter
- Access to the full list of MQP Documents is available through the Sharepoint portal https://sharepoint.iter.org/qa/SitePages/Home.aspx

4.2.2 CAD Manual downstream/driven documents

- Related How-To documents are linked in each section of the CAD Manual
- A full list of How-To documents is available on IDM: https://user.iter.org/?uid=29FSJP
- Checklists and automated checking tools. For example:
  - TDTC Checklists (6R3EU8)
  - Q-Checker rules
  - …

4.2.3 PBS CAD Design Handbook

Application of the rules and methodologies of the CAD Manual leads to a largely common organization of CAD data throughout all ITER systems. Differences nevertheless exist, because of the need to optimize according to specificities of individual systems. It is the purpose of the CAD Design Handbook of each system to document processes and methodologies specific to a PBS.

The PBS Design Handbooks are intended for reference by CAD designers of each system, in particular for orientation of those who are new to the system. Handbooks contain information about:

- Global design process, design status, design goal
- Structure of PRC, assembly structure, instances
- Organizations involved in the design
- Positioning
- Skeleton
- Interfaces
- ITER methodologies
- Other specific methodologies
- Drawings

CAD Design Handbooks are available in IDM in the folder https://user.iter.org/?uid=3URXHL

4.3 CAD Manual Contents

4.3.1 Reading Guide: How the CAD Manual is written

4.3.1.1 General Principles and Tool-specific methodology

While the chapters of the CAD Manual cover a wide range of topics, each is organized around a set of fundamental principles:

Each chapter begins by outlining general rules and guiding principles, in each main area of the chapter's scope. These rules are applicable across all CAD tools, but are explained without reference to specific methodology of any individual tool.

Subsequent sections are organized by CAD tool. These build upon the general principles, detailing software-specific methodologies that reflect industry best practices and lessons learned from real-world project experience.

4.3.1.2 Golden Rules

Rules are extracted from each CAD Manual chapter. Each rule appears within the main body of the text, to emphasize and reinforce key points that have been explained. Additionally, the same rule is included in a table at the beginning of the manual, serving as a quick-reference guide.

Rules are organized in tables as follows:

- A table of general rules drawn from the chapter's general section

- Individual tables, extracted from each tool-specific section.

For easy identification when referenced externally, Golden Rules are codified as follows:

Chapter #	***Chapter Title***	***Rules Code***
1	Introduction	GEN
3	CAD Data Structure	STR
4	ITEM Identification	IID
5	BOM and Lists	BOM
6	Mechanical Design	MEC
7	Plant Design	PLT
8	Diagrams	DGM
9	Drawings	DWG
10	Access and Support	ACS
11	Collaboration	COC
12	Validation, Promotion & Publication	VAL

Each rule is categorized as either Mandatory (M) or Recommendation (R)

4.3.2 List of Chapters

#	**Chapter Title**	**Contents/Abstract**
01	Introduction	*This document*
02	Definitions & Abbreviations	Guide to terminology used throughout the CAD Manual
03	CAD Data Structure ITER_D_7T8PNG	Describes the rules for organization of ITER CAD Data. Presents general rules and tool-specific methodologies for managing product trees, CAD files and metadata.
04	ITEM Identification ITER_D_9UULHZ	Covers the propagation of the Identification & Control process in CAD
05	BOM and Lists ITER_D_CAXZ4S	Describes the different types of BOMs and Lists with relationship to CAD used on the project
06	Mechanical Design Methodology ITER_D_87HJ6W	Covers modelling techniques to be used by all designers working on detailed 3D models of ITER components (Mechanical Design)
07	Plant Design Methodology ITER_D_CAXG7K	Covers modelling techniques to be used by all designers working on 3D models of ITER plant system layout (Plant Design)
08	Diagrams ITER_D_9ZY3WC	Covers general procedures, rules and best practices for creating and maintaining ITER Diagrams and component management.

09	Drawings ITER_D_9UB2J6	Covers procedures, general rules and tool-specific methodologies for creating and maintaining ITER 2D drawings
10	CAD Access and Support ITER_D_9XJU3X	Describes the processes and tools used to facilitate and regulate the usage of CAD tools and access to CAD data.
11	CAD Collaboration ITER_D_CAXGBH	Covers the different types of collaboration schemes and guidance for any contracts implying CAD inputs and/or deliveries
12	Validation, Promotion and Publication ITER_D_CAXGRC	Provides rules and guidelines for preparation of CAD data for controlled dissemination, following the completion of a design task.

5 Design Office Missions

Main missions of the ITER Design Office are, as defined in [2]:

- Coordination and execution of Mechanical and Plant CAD and engineering design activities at IO and DAs
- CAD data management, including Quality Control
- Maintenance and development, according to project needs, of ITER CAD infrastructure
- Support of CAD tool users, including methodology definition, training and certification.

6 Mechanical Design and Plant Design

The terms Mechanical Design and Plant Design are commonly used to describe areas of the overall ITER design process. CAD deliverables, tools and methodology are broadly divided according to these two categories, so it is important to understand the terminology:

6.1 Mechanical Design

Mechanical Design refers to the design and engineering of individual mechanical components or systems within the ITER plant. This applies to the majority of tokamak systems, comprising one-of-a-kind components, such as magnets, vacuum vessel and divertor cassettes.

In this context, the main CAD deliverables are the detailed models and drawings which serve as the basis for manufacturing and assembly processes. (see Section 7)

The main CAD tool for 3D and 2D mechanical design is CATIA. Rules and methodologies are described in CAD Manual 06 - Mechanical Design (87HJ6W)

6.2 Plant Design

Plant Design encompasses the layout, design, and engineering of entire ITER plant systems, such as the cooling water system, the tritium system and the vacuum system. Because individual

components are largely off-the-shelf, design work is focused on how they are arranged and integrated within piping, electrical or instrumentation networks, to achieve the requirements of the system as a whole.

The main 2D CAD deliverables of plant design are:

- Diagrams describing the system in terms of functions and process (Process Flow diagrams, Piping and Instrumentation diagrams, electrical distribution diagrams,..) or interconnection of equipment (cabling diagrams, one-line diagrams, instrumentation-loop diagrams,..)
- Drawings describing the plant layout, such as general arrangement drawings or piping isometric drawings

3D plant models serve to ensure physical integration and optimize space utilization, and as a basis to generate the 2D deliverables.

For more detail and more examples of CAD deliverables, see Section 7

Several CAD tools are used for ITER plant design:

- CATIA Equipment and Systems (EnS) and AVEVA (E3D) for 3D design
- AVEVA Engineering for data collection related to AVEVA Diagrams and E3D
- SEE System Design (SSD) and AVEVA Diagrams for 2D diagram production
- SEE Electrical Expert (SXP) for the detailed design of electrical components (I&C Cubicles, Power Distribution boards, etc.)

Rules and methodologies for 3D plant design are described in CAD Manual 07 - Plant Design (CAXG7K). Rules for diagrams are to be found in CAD Manual 08 - Diagrams (9ZY3WC)

7 CAD Data and Deliverables

7.1 CAD Data Definition

As defined in ref [1], CAD Data is defined at ITER as data which:

i. *Provides the physical and engineering representation or contributing to the functional representation of a system or component, produced through Computer Aided Design software and forming Diagrams, 3D Models and drawings used in the definition of the ITER plant and products, in their native format or through a conversion to neutral format*
ii. *Has a unique identifier delivered by the ITER CAD databases, allowing its unambiguous identification, control and traceability along the ITER supply chain.*

7.2 CAD Deliverables as Technical Documents

All ITER CAD data fall into the broader data category of **Technical Documents**. A Technical Document is defined [2] as a container of technical information which:

i. *gives information about the technical aspects and technical management of system and enabling systems for each lifecycle phase,*

ii. *is subject to versioning and applicability, as well as to a given workflow towards approval*
iii. *can be easily allocated to one of the Technical Document Types (TDTC)*

The Technical Document Type Card defines the minimum information to be represented in a Technical Document by the end of each lifecycle phase of the system to which it belongs.

7.3 CAD Deliverable TDTC

The table below lists TDTC and Technical Document types pertaining to CAD deliverables, as of publication of this document revision. Note that the current, compete list of TDTC may be found through IDM at https://user.iter.org/?uid=B9YZ49.

IDM Ref	TDTC Title
CBU322	TDTC_Assembly Drawing
C7YW7M	TDTC_Cabling Diagram
BZR68H	TDTC_Circulation/Evacuation Drawing
WA46NH	TDTC_Configuration Management Model
CARXYB	TDTC_Control Logic Diagram
BK6VFR	TDTC_Cubicle Internal Definition
WAD2SF	TDTC_Detailed Model
BK6V8E	TDTC_Detailed Wiring Diagram
B63C7C	TDTC_Functional Block Diagram-FBD
CBU468	TDTC_Hook-up Drawing
CBU2MH	TDTC_Installation Drawing
CBU2KJ	TDTC_Instrument Loop Diagram
C8D6LA	TDTC_Instrumentation and Control Architecture Diagram
5J6TAX	TDTC_Interface Drawing
CBU2QX	TDTC_Machine Assembly Configuration Drawing
CCSWZC	TDTC_Machine Assembly Requirement Drawing
CBU38X	TDTC_Machine Component Drawing
5J6T44	TDTC_Manufacturing Drawing
BXDHWH	TDTC_Multi-System General Arrangement Drawing
WAD9FG	TDTC_Part Drawing
C7Z4TS	TDTC_Piping and Instrumentation Diagram
CBU3LR	TDTC_Piping Isometric Drawing
BK6T9E	TDTC_Process Flow Diagram
C7Z3TJ	TDTC_Single Line Diagram
W9ZKZY	TDTC_Site and Building Drawings
CBU3KA	TDTC_Support Drawing
BZQQ3G	TDTC_System Layout Drawing
CAF274	TDTC_Zoning Drawing

8 CAD Tools

Main CAD tools of the IO Design Office are listed below:

CATIA V5: Dassault Systèmes software for 3D and 2D product design. Used primarily for mechanical design.

Enovia V5: Dassault Systèmes' Product Data Management (PDM) system. CATIA V5 is integrated in ENOVIA V5, which supports concurrent design and product lifecycle management.

CADENAS: Catalog management software for creating, managing, and sharing digital parts catalogs for use in CATIA.

AVEVA E3D: Software for 3D design of plant systems, integrated with 2D design produced through AVEVA diagrams.

AVEVA Diagrams: Software for creation of intelligent schematics and diagrams for 2D plant system design. Integrated with E3D

AVEVA Engineering: Software for integration and management of engineering data across various design tools, primarily AVEVA E3D and Diagrams

SEE System Design (SSD): Software for creation of intelligent schematics and diagrams for 2D plant system design.

SEE Electrical Expert (SXP): Software specialized for design of complex electrical systems, including creation of schematic, cabinet layout, and wiring design.

Delmia V5: Dassault Systèmes software for CAD digital manufacturing: simulation of assembly and maintenance processes and associated kinematic devices.

ZWCAD: CAD software used at ITER for creation of 2D drawings

AutoCAD: CAD software used at ITER for creation of 2D drawings

Navisworks: Autodesk multi-CAD viewing tool for visualization and integration checking of 3D models.

For further information about currently used CAD tools, including details of software versions, please see the CAD Fact Sheet (249WUL v7.0) (current)

9 General Rules

Each chapter of the CAD Manual details the rules applicable within its own scope of CAD discipline and tools. The rules gathered in the tables below are common to all chapters.

9.1 Naming and Writing Convention

Rule No	Rule	Cat
GEN-G-001	All naming, descriptions and other information filled in CAD metadata shall be in English.	M
GEN-G-002	Every CAD document (model, drawing, diagram..) shall be assigned a name that clearly and concisely describes what it represents.	M
GEN-G-003	Objects shall be named using full words, without abbreviations, unless prevented by limits on the length of the text string	M
GEN-G-004	Where necessary, due to constraints on length of the name property, the name may be shortened to combine words and abbreviations	R
GEN-G-005	Use only abbreviations from the ITER abbreviations list. (ITER_D_2MU6W5)	M
GEN-G-006	The first character in the name shall be a letter (A to Z)	M
GEN-G-007	Use only the following characters for naming and other metadata ✓ Upper and lower case, non-accented letters of the Roman alphabet (A to Z, a to z) ✓ Numbers 0 to 9 ✓ Dot . ✓ Equal = ✓ Minus sign – ✓ Plus sign + ✓ Underscore _ ✓ Blank space	M
GEN-G-008	Do not use other characters, such as accented characters (è,ü,..) or non-Roman characters	M

9.2 General Rules for use of CATIA

Rule No	Rule	Cat
GEN-C-001	Part names shall be no longer than 45 characters	M
GEN-C-002	The following elements of CATIA Parts shall be named according to the above naming convention, with a name of between 4 and 60 characters	M

	○ Part design bodies ○ Important geometrical elements, features and sets ○ Published elements names shall start with: 3D, 2D or letters.	
GEN-C-003	Do not use default naming for the above elements (Ex “Plane.X”, “Face.X”, “Line.X”)	M
GEN-C-004	Following colours are forbidden: • Red (220,0,0 – 255,0,0) • It is the default colour of an update request • Orange (220,120,0 – 255,170,0) • It is the default colour of selected or highlighted elements • Khaki (190,180,110 – 220,210,130) • It is used for other CATIA functionalities as dimmed 3D geometry	R
GEN-C-005	The following CATIA functions are forbidden. ITER uses different methodologies and/or ENOVIA cannot save the entities created by these functions. A. Inside a Work package (WP) the following functions are forbidden : • ASSEMBLY DESIGN + ASSEMBLY FEATURES details (except for STEEL STRUCTURE DESIGN and REUSE PATTERN) • ASSEMBLY DESIGN + SYMMETRY • COMPONENTS+NEW COMPONENT (except for CGR files) • WELD DESIGN B. For structure exposed assemblies: • All kinds of application and assembly features are forbidden.	M
GEN-C-006	Links between CATParts shall only be built with CCP = CATIA Copy Paste methodology not as CIP = Context Import Links. This type of Link is completely forbidden in mechanical design and in Equipment and Systems design, with the exception of three specific cases: ○ CIP links are accepted inside a Work Package (WP) in three cases: ○ Secondary structure. ○ Flexibles made in Conduit design workbench. ○ Harness design. ○ CIP links shall never be created between WP	M

9.3 General Rules for use of AVEVA

Rule No	Rule	Cat
GEN-A-001	Part names shall be no longer than 50 characters	M
GEN-A-003	The following AVEVA functions are forbidden. • Copy/paste on SUPPO object via command line • Copy/paste on REVI object via command line • CableWay module	M

10 CAD Manual Change Management

10.1 Aims of the Update Process

The rules and methodologies outlined in the CAD Manual are defined according to evolving project needs and constraints, including MQP processes, working instructions, and the capabilities of CAD software. To ensure relevance and effectiveness, the manual must function as a 'living document,' subject to regular review and updates that also reflect software tool advancements, user feedback, and return of experience from training and coaching. A structured change process is essential to allow updates at a frequency that supports continuous improvement while maintaining control and stability.

The CAD Manual update process is described below. In outline, it comprises:

- Collection of inputs
- Analysis and classification by priority
- Periodic or punctual update of the manual
- Communication to stakeholders

10.2 Definitions:

CAD Manual User: in the context of this process, the term "CAD Manual User" refers broadly to any individual working at ITER who interacts with the CAD Manual. This includes, but is not limited to, IO Staff, DA Staff, IPAs, Interim staff and contractors who consult or apply the CAD Manual in their work; authors of the CAD Manual chapters; and owners or contributors of interfacing processes or related documentation.

Major Change: modifications that significantly impact the meaning or scope of an existing rule, introduce new mandatory rules, or affect multiple chapters/sections. Examples include: the addition, or deletion of a chapter or paragraph; the creation of a new mandatory rule; changes affecting multiple sections or requiring immediate attention.

Minor Change: modifications that clarify, refine, or correct the document without altering the intent or scope of its rules. Examples include: typos, rewording, or grammar fixes; adding examples to illustrate a rule; the creation of a new "recommended" rule.

10.3 CAD Manual Update Process

The process is presented graphically in Fig2 and detailed in the text that follows

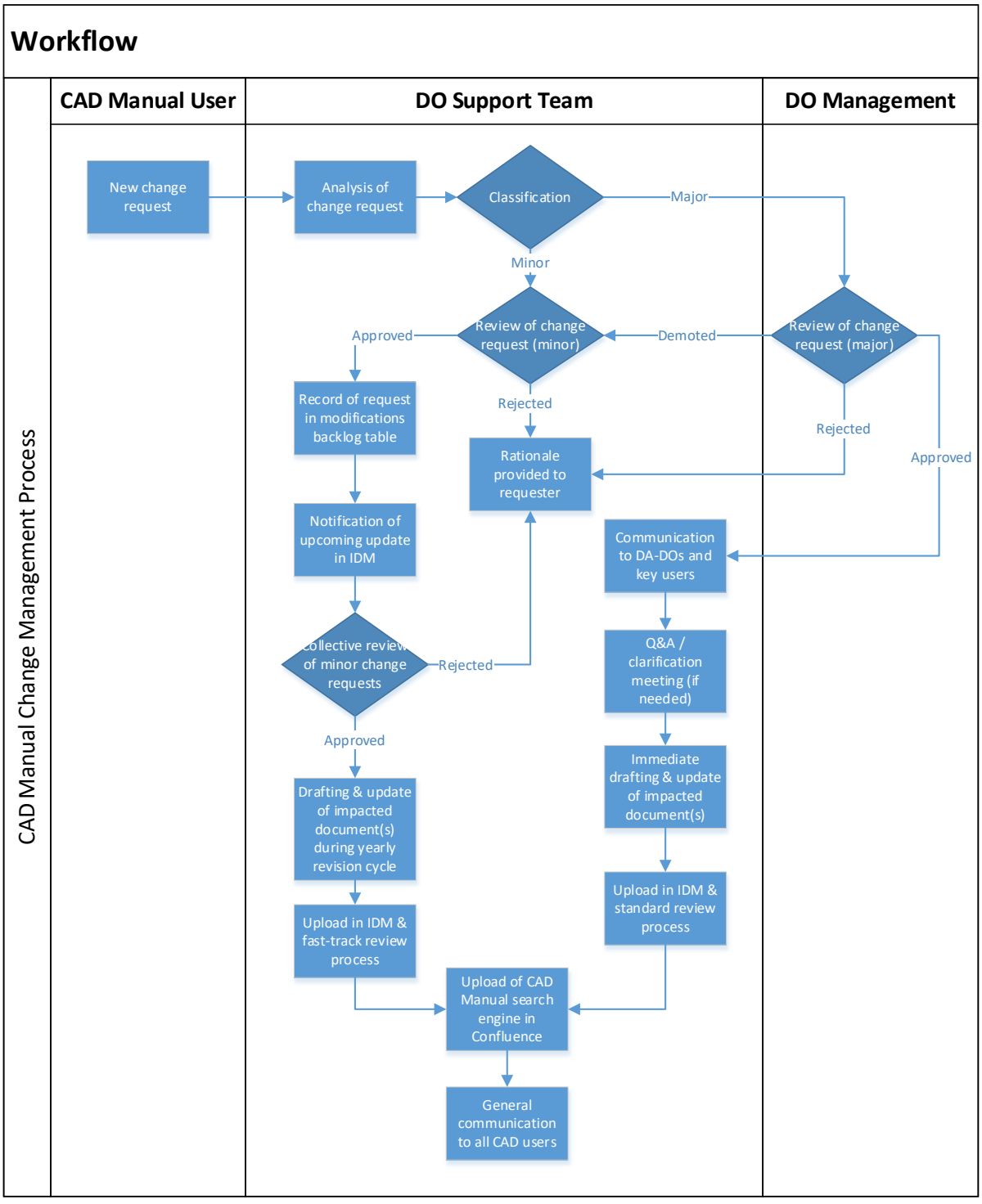

Fig2: CAD Manual Update Process

10.3.1 New Change Request

Any CAD Manual User can propose a change via the IO CAD Ticket System, by selecting the DO queue “CAD Manual” and DO service “change request”.

The request must include:

- The CAD Manual chapter, paragraph and/or rule involved.
- A description of the proposed modification.
- The rationale or justification for the change.

10.3.2 Analysis of Change Request

The DO Support Team analyses:

(1) The proposed change, in the context of the targeted CAD Manual chapter;

(2) Impact on, or consistency with, other CAD Manual chapters;

(3) Changes required to linked documents (How-to docs, training materials,..);

(4) The classification of the change (minor or major).

The findings of this analysis are shared with DO management.

10.3.3 Review of Change Request

10.3.3.1 ***Review of Requests for Major Changes***

Requests for major changes are reviewed by DO Management, who can decide to:

(a) Approve the request, which then proceeds for implementation;

(b) Demote the major change to a minor change request;

(c) Reject the request; in this case, the rationale for rejection is documented and communicated to the requester. The request is archived but can be resubmitted with additional information.

10.3.3.2 ***Review of Requests for Minor Changes***

Requests for minor changes are reviewed by the DO Support Team, who can decide to:

(a) Approve the request, which then proceeds for implementation;

(b) Reject the request; in this case, the rationale for rejection is documented and communicated to the requester. The request is archived but can be resubmitted with additional information.

10.3.4 Implementation

10.3.4.1 Implementation of Major Changes

Major changes are immediately communicated to DA-DOs and key users.

A meeting can be organised on demand to answer questions and/or provide clarifications to stakeholders.

Following this communication, the impacted document(s) is/are updated and uploaded in IDM. Once published, the document(s) go through the standard review process.

10.3.4.2 Implementation of Minor Changes

Minor changes are recorded in the modifications backlog table for a future update.

Stakeholders are informed of an upcoming update with a notification on the IDM page(s) of the impacted document(s).

At the start of the yearly revision cycle, all minor change requests are reviewed collectively. The DO Support Team may decide to reject a change request if inconsistent with other requests or no longer valid (e.g., if superseded by another request, merged into another change…). In this case, the rationale for rejection is documented and communicated to the requester.

Other minor change requests proceed as planned. The impacted document(s) is/are updated and uploaded in IDM. Once published, the document(s) go through a fast-track review process.

10.3.4.3 Formal Notification of Changes

The CAD Manual search engine on the Design Office Confluence page is updated with the latest version of the CAD Manual.

A general communication is sent to all CAD users to inform them of the change(s). This communication includes a list of the updated document(s), a summary of the modifications and their impact.