

Doc 9906
AN/472



Quality Assurance Manual for Flight Procedure Design

Volume 1 Flight Procedure Design Quality Assurance System

Approved by the Secretary General
and published under his authority

First Edition — 2009

International Civil Aviation Organization
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AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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1. Preface

The *Quality Assurance Manual for Flight Procedure Design* (Doc 9906) consists of six volumes:

Volume 1 — *Flight Procedure Design Quality Assurance System*;

Volume 2 — *Flight Procedure Designer Training (Development of a Flight Procedure Designer Training Programme)*;

Volume 3 — *Flight Procedure Design Software Validation*;

Volume 4 — *Flight Procedure Design Construction (to be developed)*;

Volume 5 — *Validation of Instrument Flight Procedures*; and

Volume 6 — *Flight Validation Pilot Training and Evaluation (Development of a Flight Validation Pilot Training Programme)*.

Instrument flight procedures based on conventional ground-based navigational aids have always demanded a high level of quality control. The implementation of area navigation and associated airborne database navigation systems, however, means that even small errors in data can lead to catastrophic results. This significant change in data quality requirements (accuracy, resolution and integrity) has led to the need for a systemic quality assurance process (often part of a State Safety Management System). The *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) Volume II, Part 1, Section 2, Chapter 4, *Quality Assurance* refers to this manual and requires that a State take measures to “control” the quality of the processes associated with the construction of instrument flight procedures. To this end, this manual has been assembled to provide guidance in attaining these stringent requirements for quality assurance in the procedure design process. All four volumes address crucial areas related to the attainment, maintenance and continual improvement of procedure design quality. Data quality management, procedure designer training, and validation of software are all integral elements of a quality assurance programme.

Volume 1 — *Flight Procedure Design Quality Assurance System* provides guidance for quality assurance in the elements of procedure design, such as procedure design documentation, verification and validation methods, and guidelines about the acquisition/processing of source information/data. It also provides a generic process flow diagram for the design and implementation of flight procedures.

Volume 2 — *Flight Procedure Designer Training* provides guidance for the establishment of flight procedure designer training. Training is the starting point for any quality assurance programme. This volume provides guidance for the establishment of a training programme.

Volume 3 — *Flight Procedure Design Software Validation* provides guidance for the validation (not certification) of procedure design tools, notably with regard to criteria.

Volume 4 — *Flight Procedures Design Construction* (to be incorporated later).

Volume 5 — *Validation of Instrument Flight Procedures* provides guidance for the implementation of a validation process of instrument flight procedures.

Volume 6 — *Flight Validation Pilot Training and Evaluation* provides guidance for the establishment of a flight validation pilot training programme.

Note.— In the independent volumes, when a reference is made to the term “manual” in the context of this document, without any further specification, it is presumed to refer to this volume of the Quality Assurance Manual for Flight Procedure Design.

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3. Abbreviations

AIP	Aeronautical Information Publication
AIRAC	Aeronautical information regulation and control
AIS	Aeronautical information service
ANS	Air navigation services
ANSP	Air navigation service provider
ATC	Air traffic control
ATCO	Air traffic control officer
ATM	Air traffic management
ATS	Air traffic services
CAA	Civil aviation authority
CAD	Computer aided design
CNS	Communication, Navigation and Surveillance
COTS	Commercial off the shelf
CVSM	Conventional vertical separation minimum
DBS	Distance-based separation
FAA	Federal Aviation Administration
FPD	Flight procedure design
HMI	Human machine interface
ICAO	International Civil Aviation Organisation
IFP	Instrument flight procedure
ILS	Instrument landing system
ISO	International Standards Organisation
MAC	Mid-air collision
MASPS	Minimum aircraft system performance specification
OAS	Obstacle assessment surface
OJT	On-the-job training
QMS	Quality management system
RNAV	Area navigation
RNP	Required navigation performance
RT	Radiotelephony
RVSM	Reduced vertical separation minimum
SARPS	Standards and Recommended Practices
SKA	Skills, knowledge and attitude
STCA	Short-term conflict alert
TBS	Time-based separation
TLS	Target level of safety
TR	Training record
WVE	Wake vortex encounter

4. Definitions

Consultation. A conference between two or more people to consider a particular question.

Conceptual design. High-level graphical and/or textual description of the designer's interpretation of the stakeholders' requirements.

Designer. A person adequately trained who performs the design of an instrument flight procedure.

Flight procedure design. The complete package that includes all the considerations that went into the development of an instrument flight procedure.

Flight procedure design process. The process which is specific to the design of instrument flight procedures leading to the creation or modification of an instrument flight procedure.

Instrument flight procedure. A description of a series of predetermined flight manoeuvres by reference to flight instruments, published by electronic and/or printed means.

Instrument flight procedure process. The overarching process from data origination to the publication of an instrument flight procedure.

Integrity (aeronautical data). A degree of assurance that an aeronautical data and its value has not been lost or altered since the data origination or authorized amendment.

Process. A set of interrelated or interacting activities which transforms inputs into outputs (see ISO 9000:2000 *Quality management systems — Fundamentals and vocabulary*, section 3.4.1); hence “flight procedure design (FPD) process” or “instrument flight procedure process”.

Procedure. A specified way to carry out an activity or a process (see ISO 9000:2000 *Quality management systems — Fundamentals and vocabulary*, section 3.4.5).

Quality record. Objective evidence which shows how well a quality requirement is being met or how well a quality process is performing. Quality records normally are audited in the quality evaluation process.

Review. An activity undertaken to determine the suitability, adequacy and effectiveness of the subject matter to achieve established objectives (see ISO 9000:2000 *Quality management systems — Fundamentals and vocabulary*, section 3.8.7).

Validation. Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled (see Annex 15 — *Aeronautical Information Services*). The activity whereby a data element is checked as having a value that is fully applicable to the identity given to the data element, or a set of data elements that is checked as being acceptable for their purpose.

Verification. Confirmation, through the provision of objective evidence, that specified requirements have been fulfilled (see Annex 15). The activity whereby the current value of a data element is checked against the value originally supplied.

5. Foreword

5.1 OVERVIEW

The International Civil Aviation Organization (ICAO) is charged with the duty of promoting the safety, efficiency and economy of international air transportation. The instrument flight procedure (IFP) is an essential component of the aviation system. Every day and during every flight, thousands of aircraft around the world are flying instrument departure, arrival or approach procedures to airports in every country. The safety and quality of these procedures is often taken for granted by aviation professionals. The flying public assume that they will get to their destination safely, and for the most part, do not even realize that IFPs exist. Flight procedures are such an integral part of everyday flight operations that their quality cannot be left to chance. Every State's Air Navigation Services Safety Management System must give consideration to this critical element of the system.

This document addresses two levels of processes. A high-level process, called the instrument flight procedure process, covers all elements from initiation to publication of the procedure and the relevant maintenance, safety, validation and flight inspection activities. The process does not end with publication. Feedback from users must be considered in the improvement process. A second specific process, for the design of the instrument flight procedure — the flight procedure design (FPD) process — is part of the IFP process.

Although not always specifically mentioned in the document, all process steps are followed by a verification and validation step in order to guarantee the quality of the resulting elements of each step.

The implementation of procedures is the responsibility of Contracting States. This means that the State authorities have the final responsibility for the procedures published within their territory. The FPD process may be carried out by States themselves or by delegation from States to third parties (Air Navigation Service providers (ANSPs), private companies, another State, etc.). The *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) requires that the State take measures to control the quality of the process used to apply procedure design criteria. These measures must ensure the quality and safety of the procedure design product through review, verification, coordination and validation at appropriate points in the process, so that corrections can be made at the earliest opportunity.

States must establish a quality system for the entire IFP process. This system may consist of an overall quality assurance, including all steps from origination to final publication, as well as a more focused quality assurance process for the design of procedures. For any portion of the IFP process that is accomplished by a third party, an adequate quality system is required.

In all cases, including when third parties are involved in the IFP process, the State carries the ultimate responsibility for the procedures published in its national Aeronautical Information Publication (AIP).

This manual has been produced to provide guidance to Contracting States in developing a system to ensure the quality of the flight procedures they publish. The manual provides one means, but not the only one, for quality assurance implementation throughout the FPD process. The manual may also be of interest to any person or organization involved in the procedure design domain.

5.2 THE NEED FOR QUALITY

With the advent of new navigation systems, the IFP process and its products have become key enablers of the worldwide air traffic management (ATM) system. They must therefore be managed effectively to ensure that quality-assured procedures are provided in support of ATM operations.

The quality of an IFP is flight critical. The en-route structure, departure, arrival, holding and approach procedures are derived from an IFP process which covers various steps from collection of user requirements to State publication to the integration into airborne systems. In consequence, the FPD and the resulting IFP, from data origination through publication to incorporation into an end-user system, must be quality assured.

Note.— This chain involves various organizations which should apply quality assurance processes as stated in the existing applicable Standards, notably Annex 15, for the origination of data and EUROCAE ED-76 / RTCA DO-200() for the processing and release of aeronautical data (see Figure 1).

The development of an IFP follows a series of steps from the origination of data through survey to the final publication of the procedure and subsequent coding of it for use in an airborne navigation database (refer to Figure 2). There should be quality control procedures in place at each step to ensure that the necessary levels of accuracy and integrity are achieved and maintained. The main steps in the development process are illustrated in Figure 3.

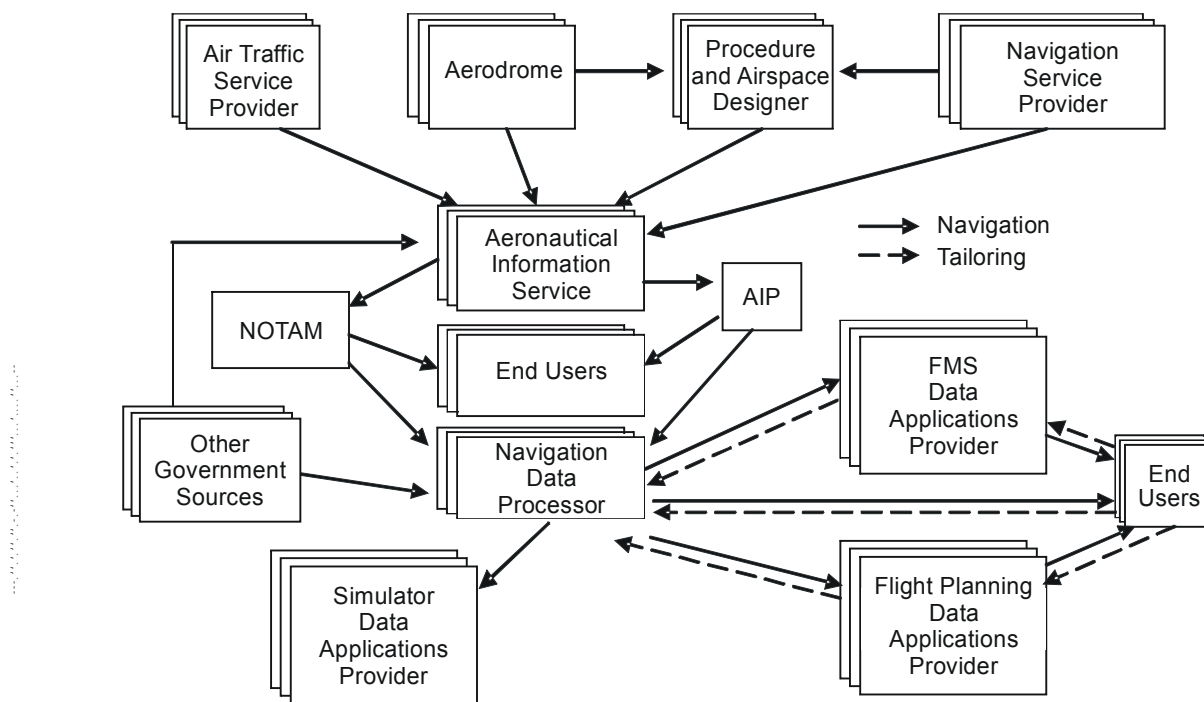
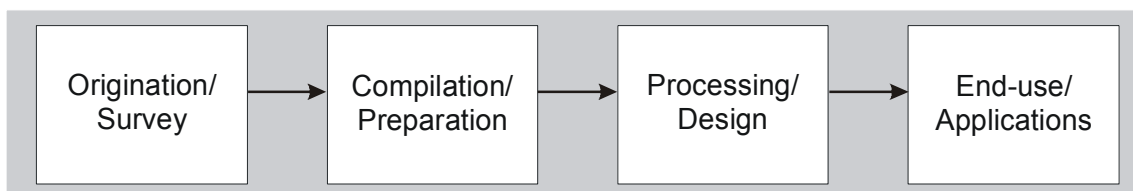


Figure 1. Participants in the development of an IFP.

The procedure design chain is as follows:



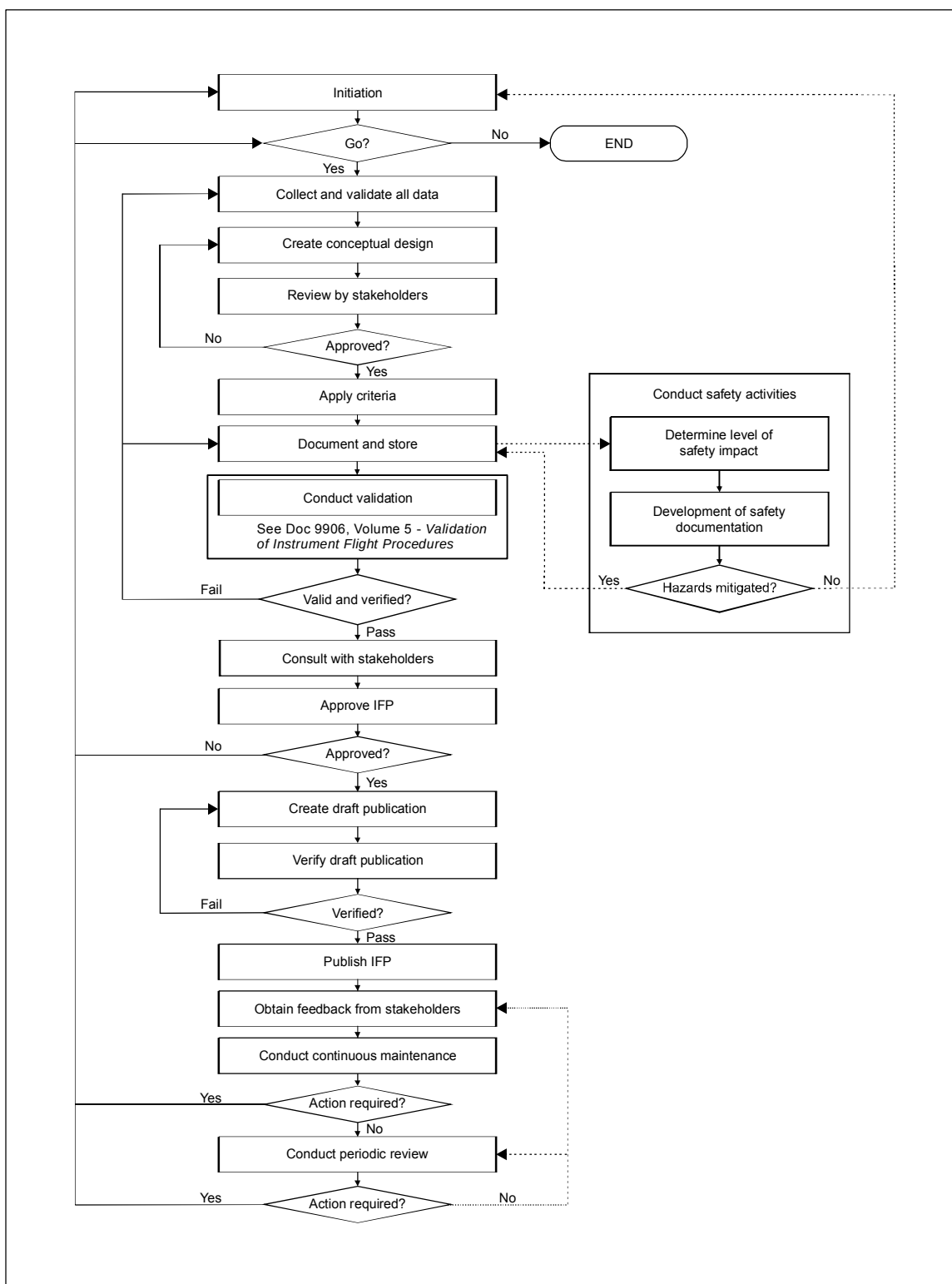


Figure 2. IFP process flow diagram.

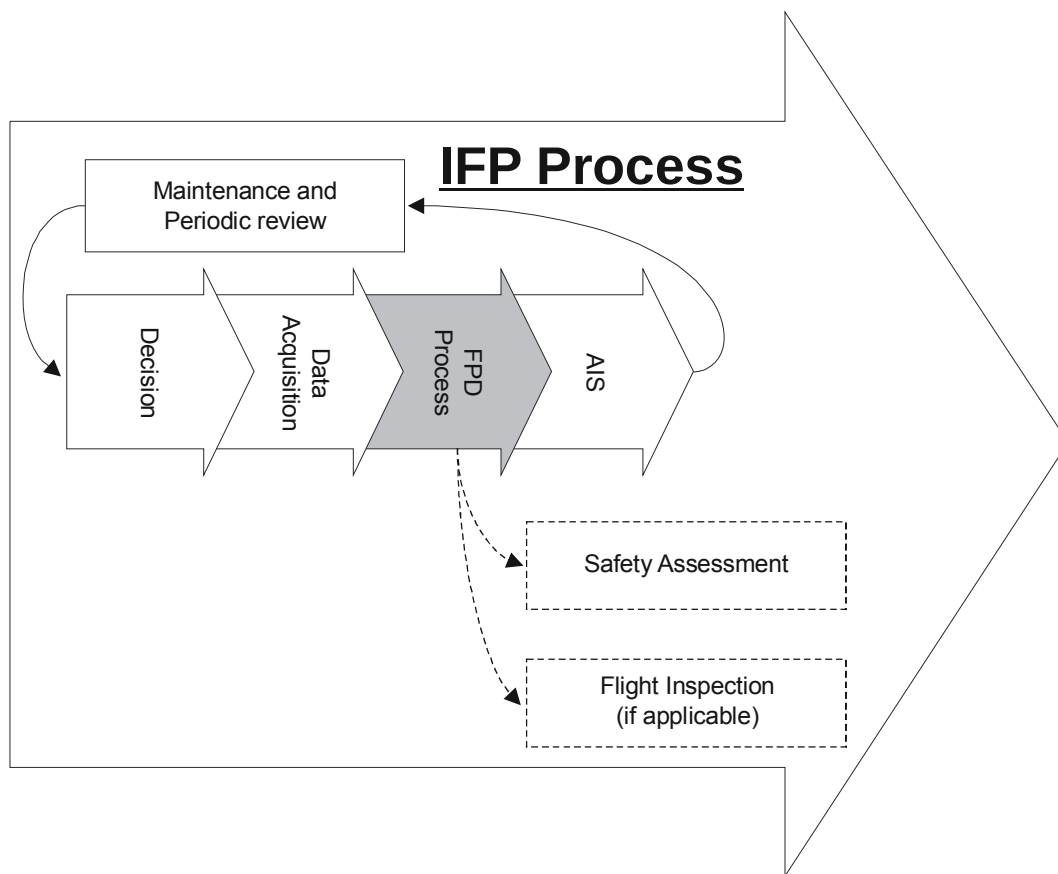


Figure 3. IFP development process.

Checks must be carried out throughout the whole chain by each “participant” (organization) to ensure that the final procedure meets quality requirements. In particular, the accuracy, resolution and integrity of data elements, together with any changes to the data, need to be addressed. The preferred method for the transmission of the data elements is by electronic means, as this preserves the integrity of the data.

5.3 PURPOSE AND SCOPE OF THE MANUAL

As stated in Annex 15, area navigation (RNAV) implementation, i.e. the development of area navigation applications, has a significant impact on the role and importance of aeronautical information and data, which become an essential part of the overall safety of air navigation. Annex 15 recognizes this trend as follows: “The role and importance of aeronautical information/data changed significantly with the implementation of area navigation (RNAV), required navigation performance (RNP) and airborne computer-based navigation systems and data link systems. Corrupt or erroneous aeronautical information/data can potentially affect the safety of air navigation.”

Among the most critical information/data are those derived from the FPD process. In order to support air navigation operations in the context of the CNS/ATM concept, it is thus necessary to ensure that both the IFP and FPD processes

are consistently quality-assured. To this end, ICAO decided to develop a quality assurance manual to assist States in implementing quality assurance in the IFP process.

This volume provides a detailed description of a quality-assured IFP and an FPD process, including requirements for procedure design documentation, verification and validation methods, and guidelines about the acquisition of source information/data.

6. Instrument Flight Procedure Process

6.1 OVERVIEW

Flight procedure design should not be seen as a stand-alone process. It should be coordinated with all relevant stakeholders and integrated into a State's airspace design process, taking into account air traffic flows, separation issues, airspace user requirements, etc.

The instrument flight procedure process encompasses: the initiation and collection of requirements and constraints, the acquisition of data, the FPD, ground validation, flight validation and flight inspection (when required), approval and publication.

This process includes review, verification and validation processes which are necessary to minimize the possibility of errors. It considers the safety analysis necessary prior to implementation. The process also incorporates the periodic review of data, criteria and feedback from operational implementation.

The process covers the entire lifespan of an IFP, from the initial development up to the withdrawal, recognizing that some of the process steps, such as AIP publication and procedure regulation, might belong to other organizations.

It is recommended this process be periodically reviewed to ensure continuous improvement, particularly after the release of updates to the reference material.

This process, supported by the other volumes of the Quality Assurance Manual for Flight Procedure Design, and properly applied, should provide consistent results with an appropriate level of quality.

6.2 OUTPUT OF THE QUALITY PROCESS

Although the process covers the entire life cycle of an IFP, from the original requirement to final withdrawal, the aim of the process is not the decommissioning of IFPs.

The decommissioning of the IFP is the termination of the quality process (except for the archiving requirements).

Throughout the life cycle of the procedure, several outputs are generated and evolve to a next level in the "production line".

Listed below from the beginning of the process, the main outputs are:

- conceptual design, including planned implementation dates, and resources needed to achieve the task;
- the FPD, including the procedure layout, the relevant calculation outputs, coordinates and a textual description of the intended procedure;
- validation and verification reports for the IFP;
- approval of the procedure by the regulatory authority;
- documentation throughout the various stages from the input through the publication process; and