Brief Introduction into "Developing and Improving Preventive Maintenance"

ASD/AIA Spec S4000P

S4000P – International specification for developing and continuously improving preventive maintenance

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Abstract-No: **A#29**

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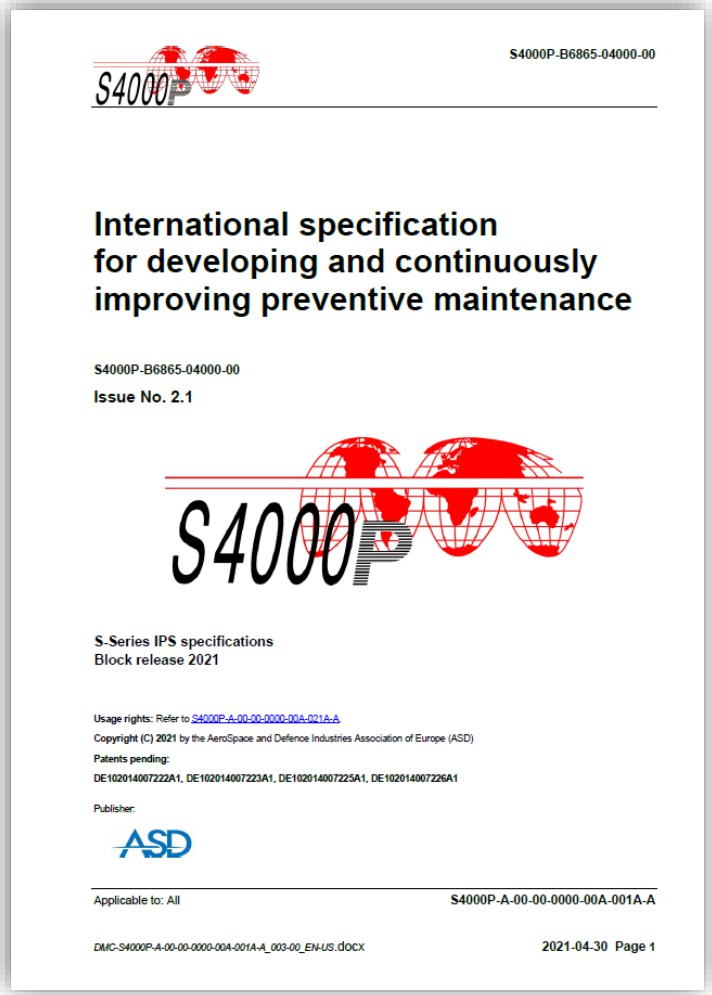
- ASD S4000P in the context of engineering and IPS
- Background of ASD S4000 and Comparison with other Standards / Specifications
- General Approach of the ASD S4000P
- Development of PMTR according to ASD S4000P chapter 2
- Continuous improvment of PMTR according to S4000P chapter 3
- Summary


S4000P-B6865-04000-00

International specification for developing and continuously improving preventive maintenance

S4000P-B6865-04000-00

Issue No. 2.1

S4000P

S-Series IPS specifications
Block release 2021

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Patents pending:
DE102014007222A1, DE102014007223A1, DE102014007225A1, DE102014007226A1

Publisher:
ASD

Applicable to: All S4000P-A-00-00-0000-00A-001A-A

DMC-S4000P-A-00-00-0000-00A-001A-A_003-00_EN-US.docx 2021-04-30 Page 1

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Introduction and Objective - Challenge of product supportability

Cost optimized and effective **support concept** for complex and long living technical products

Preventive maintenance

Corrective maintenance

Servicing and operational support

Consideration of upgrades and overhaul

Each complex technical product requires an

optimized support concept

Throughout the whole life cycle

... to guarrantee a ***smooth and safe product operation*** and

... to implement an applicable and effective ***maintenance concept***

considering ***corrective*** maintenance as well as ***preventive*** and/or ***predictive*** maintenance (if applicable)

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Introduction and Objective - Maintenance

TRAINING & TRAINING DEVICES

MAINTENANCE-PLANNING

TECHNICAL DATA

Preventive Maintenance

Corrective Maintenance

Activities,
carried out to **reset** a faulty or damaged **item to full functionality**

S3000L

Predictive Maintenance

A proactive maintenance technique that **uses real-time asset data** (collected through sensors), **historical performance data,** and advanced analytics to **forecast when asset failure will occur.**

Design & Development

Activities to **timely identify and/or eliminate potential Failure Cause(s)** (FC) **or** the consequence of a **damage prior to a functional failure** (FF) of the affected item or zone

S4000P

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Introduction and Objective - Objective of ASD S4000P

S4000P

addresses the

development
and
optimization

of an **effective** preventive maintenance program.

Requirement A:

I want to operate my product ***smoothly*** and ***safely*** with the required ***availability***

It assists you in the **interpretation of engineering data** and helps you to **ask the correct questions** and **make the right decisions**

Requirement B:

I want a ***cost effective*** maintenance concept

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Introduction and Objective - PREVENTIVE DETECTION AND/OR ELIMINATION OF FAILURE CAUSES

Product–inherent Deterioration/degradation processes, faults

External impacts on the Product (environment, accident(s))

FUNCTIONAL FAILURES (FF) due to FAULURE CAUSES (FC) in Product systems, on structure and/or in zones with the following FUNCTIONAL FAILURE EFFECT CODE (FFEC) allocations:

Evident or hidden FUNCTIONAL FAILURES

SAFETY RELEVANT	LAW RELEVANT	AVAILABILITY RELEVANT	MAINTENANCE EFFORT AND COST RELEVANT
DANGER FOR HUMAN BEINGS	(INCL. ENVIRONMENTAL INTEGRITY)	(PRODUCT MISSION AND/OR OPERATION)	(LIFE CYCLE COST = LCC)

RELEVANT FOR AUTHORITIES OR OTHER RESPONSIBLE BODIES

RELEVANT FOR THE PRODUCT USER AND/OR MAINTAINER

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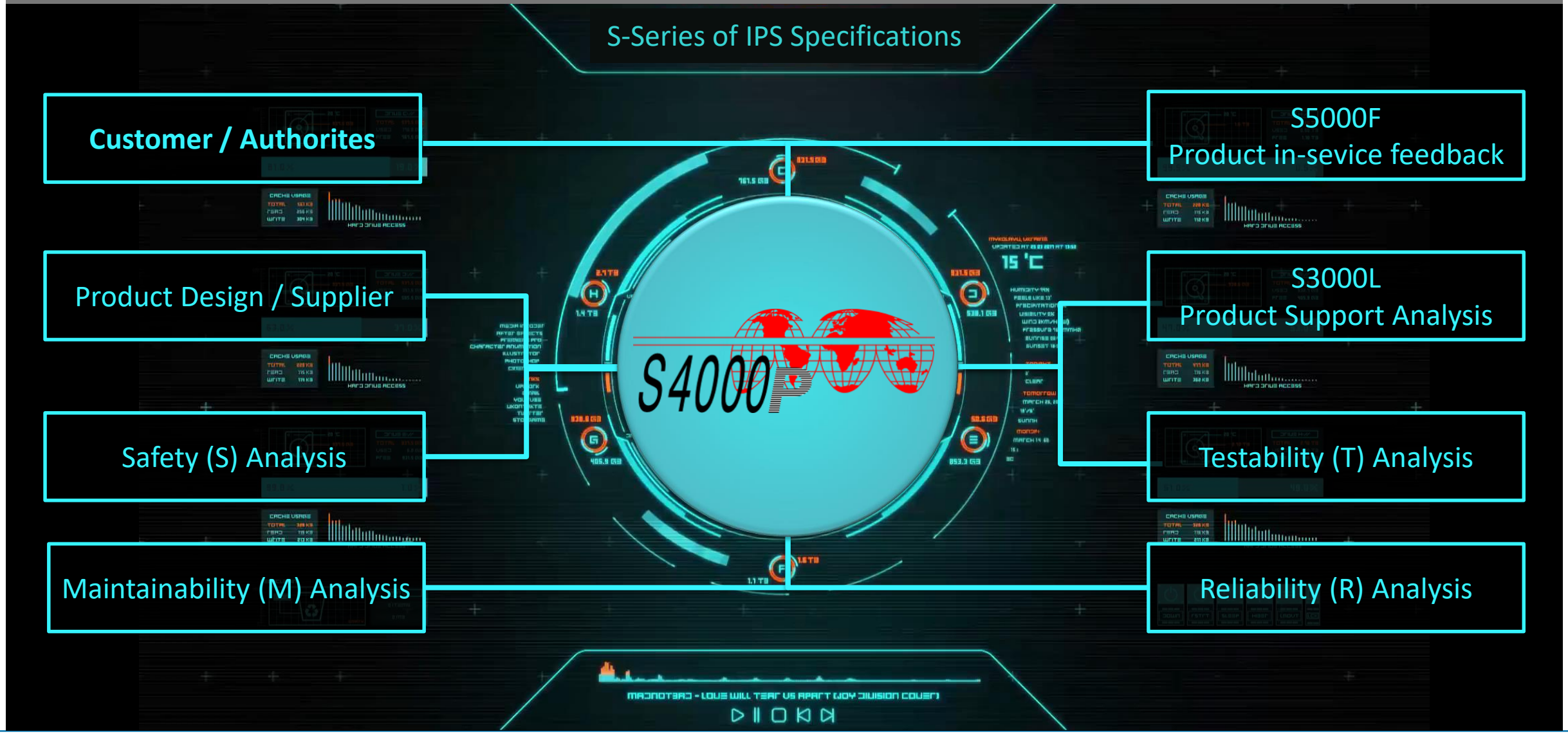
Introduction and Objective - ASD S4000P in the context of engineering and IPS



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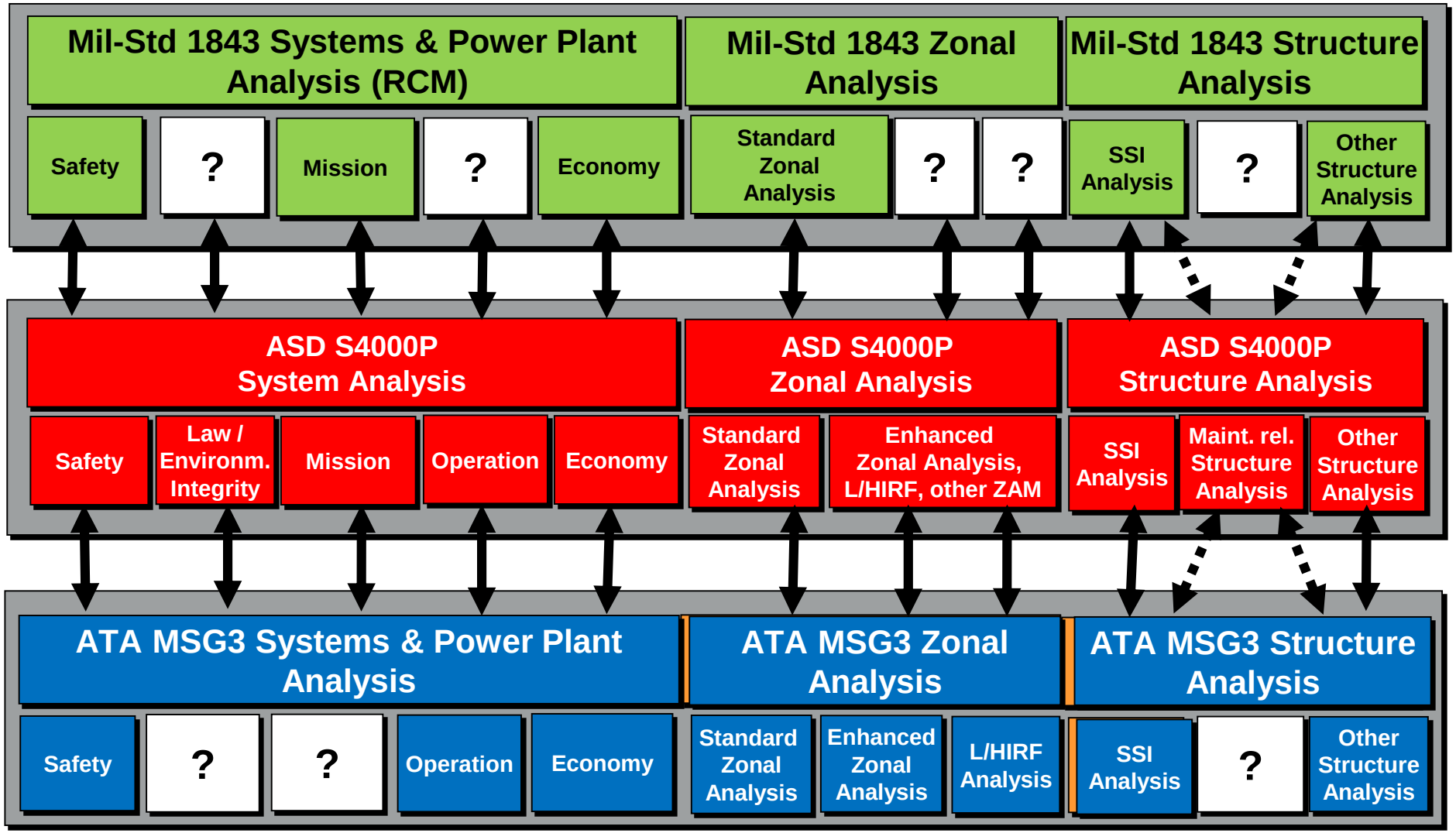
Background of ASD S4000 and Comparison with other Standards / Specifications



The Preventive Maintenance Analysis (PMA) is not a new invention of the ASD S4000P but a **further development.**

- It is applicable both in the military and the civil world.
- It closes open gaps.
- Has improved and further developed analysis logics.

The Preventive Maintenance Optimization (PMO) is a new concept introduced with the ASD S4000P.

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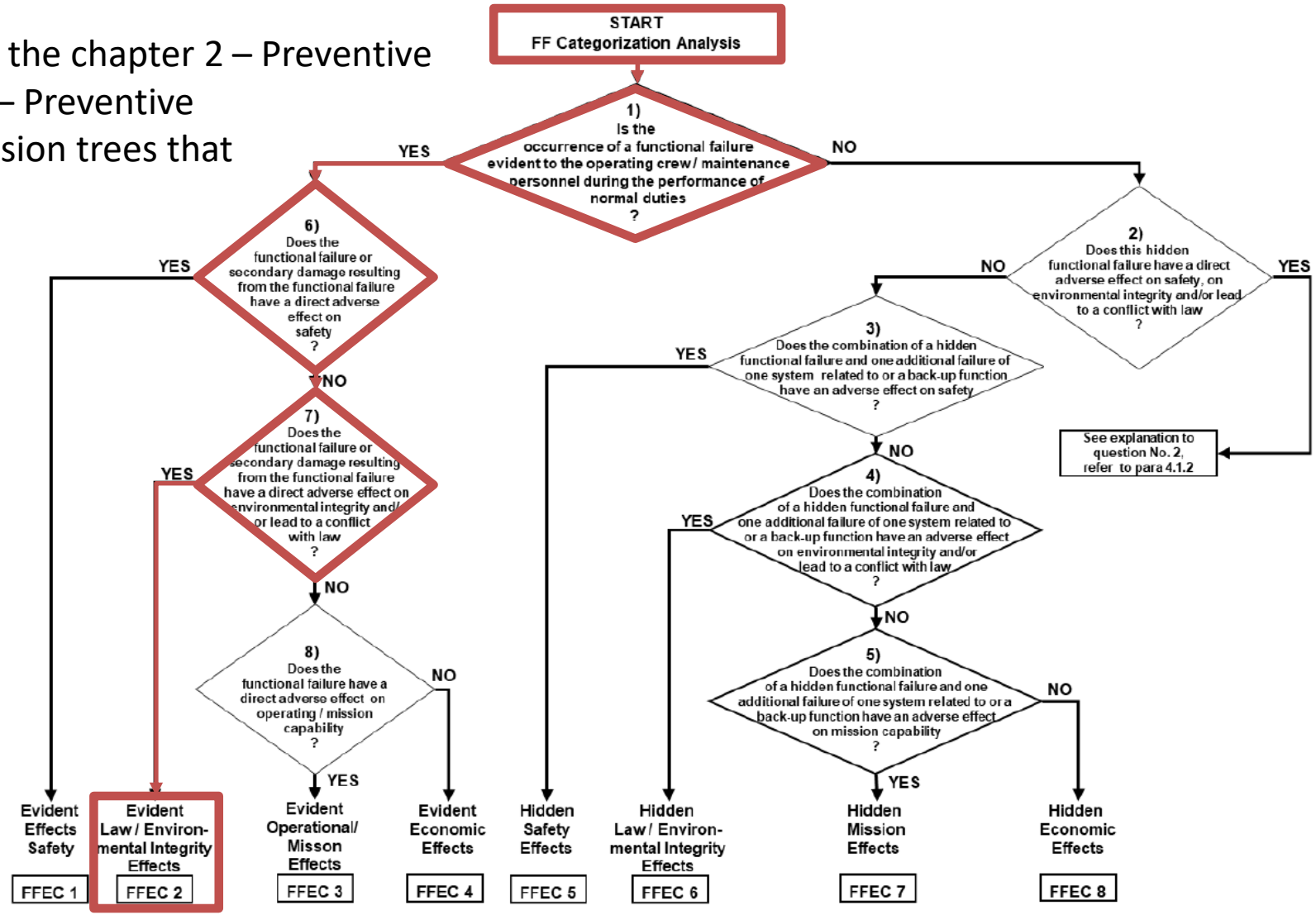
General Approach of the ASD S4000P – Decision Trees

The biggest part of the ASD S4000P, both in the chapter 2 – Preventive Maintenance Analysis and in the chapter 3 – Preventive Maintenance Optimization consists of decision trees that

- guide the analyst through the different analysis aspects
- helps the analyst to ask the right questions and to interpret the answers correctly
- to make the right decisions



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General Approach of the ASD S4000P – PMTRI & PMTRE

Preventive Maintenance Tasks

in a Product maintenance program

…with repetitive scheduled intervals

…applicable and effective for special events

…are mainly based on **PMTR**

(= Preventive Maintenance Task Requirements)

PMTRI

(= Preventive Maintenance Task Requirements with repetitive scheduled Intervals)

S4000P Issue 1.0 (PMTR=PMTRI)

PMTRE

(= Preventive Maintenance Task Requirements for special Events)

since S4000P Issue 2.0

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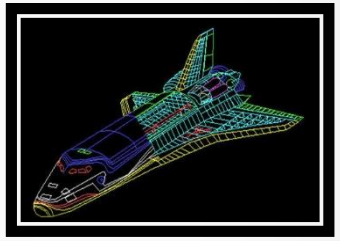
General Approach of the ASD S4000P – PMA & PMO

Chapter 2: Preventive Maintenance Analysis (PMA)

Chapter 2 of the ASD S4000P describes the process of the **development of Preventive Maintenance Task Requirements** during the **development phase** of the product.

It addresses the



- **System Analysis**
- **Structure Analysis**
- **Zonal Analaysis**
- **Special Event Analysis**
- **Consolidation & Harmonization of PMTR**

Chapter 3: Preventive Maintenance Optimization (PMO)

Chapter 3 of the ASD S4000P addresses the **improvement of Preventive Maintenance Task Requirements** based on feedback collected during the in-service phase of the product.

It analyses

- **the applicability and effectivity ofdeveloped PMTR**
- **the feedback of the maintenance organizations**

It's not about making maintenance cheaper, but making it more effective!

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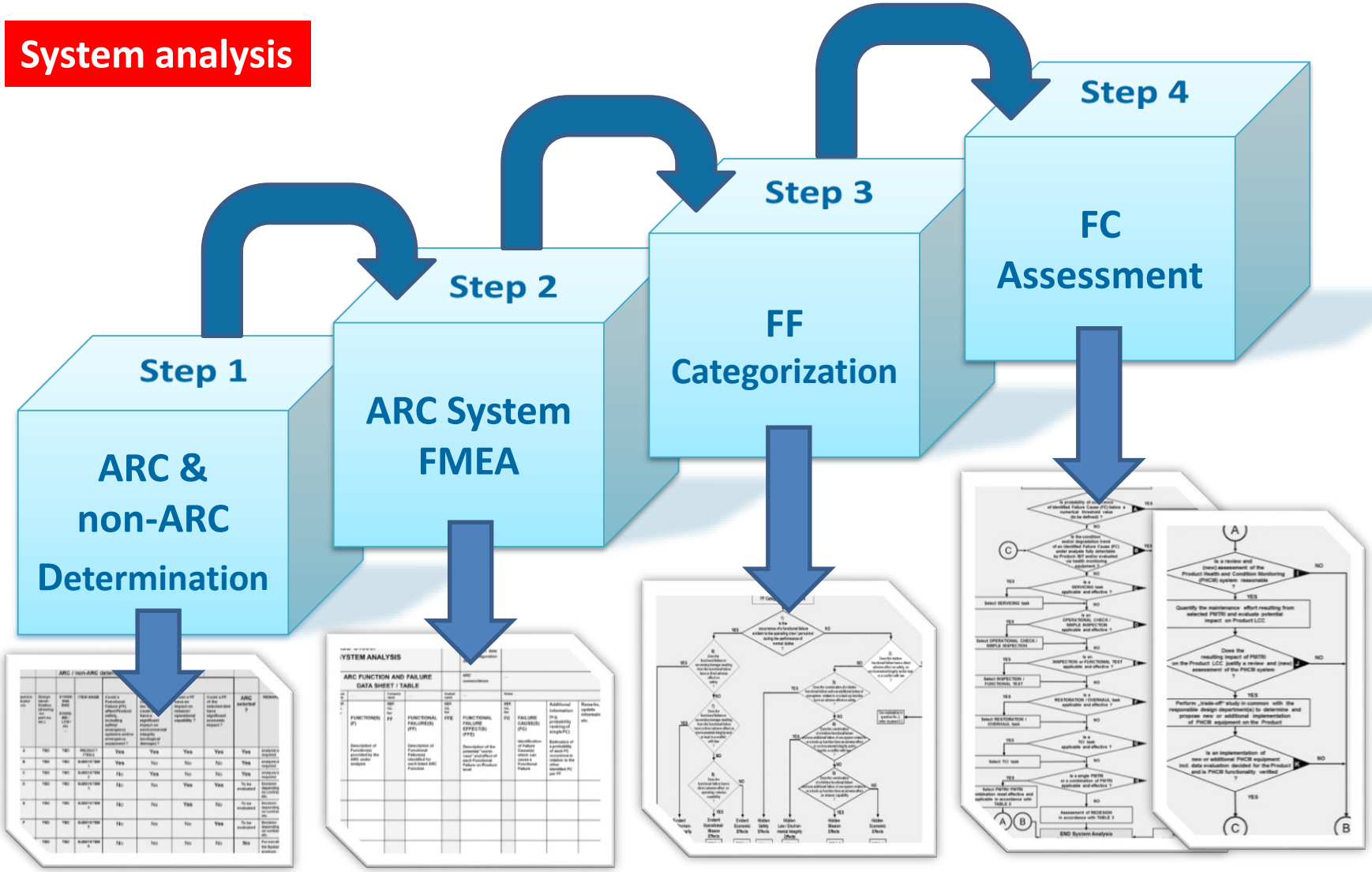
Development of PMTR according to ASD S4000P chapter 2 – System Analysis

System analysis



Step 1:
Identify the Analysis Relevant Candidates (ARC) answering a questionnaire

Step 2:
Analyze Functions, Functional Failures (FF) and their Causes (FC)

Step 3:
Categorize the criticality of the identified functional failures based on a decision tree

Step 4:
Identify PMTRI to prevent the relevant Functional Failures (FF) supported by decision trees.

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Development of PMTR according to ASD S4000P chapter 2 – Structure Analysis

Structure Analysis

Collect all **structure relevant information**, drawings, hardware breakdown, etc..

Analyze **Structure Significant Items (SSI)** and identify **Structural Details (SD)**, when required (e.g. due to different environments)

Conduct **material specific analyses** based on material specific decision trees. S4000P also supports the analysis of compound materials.

Develop and consolidate PMTRIs based on the previously conducted analyses.

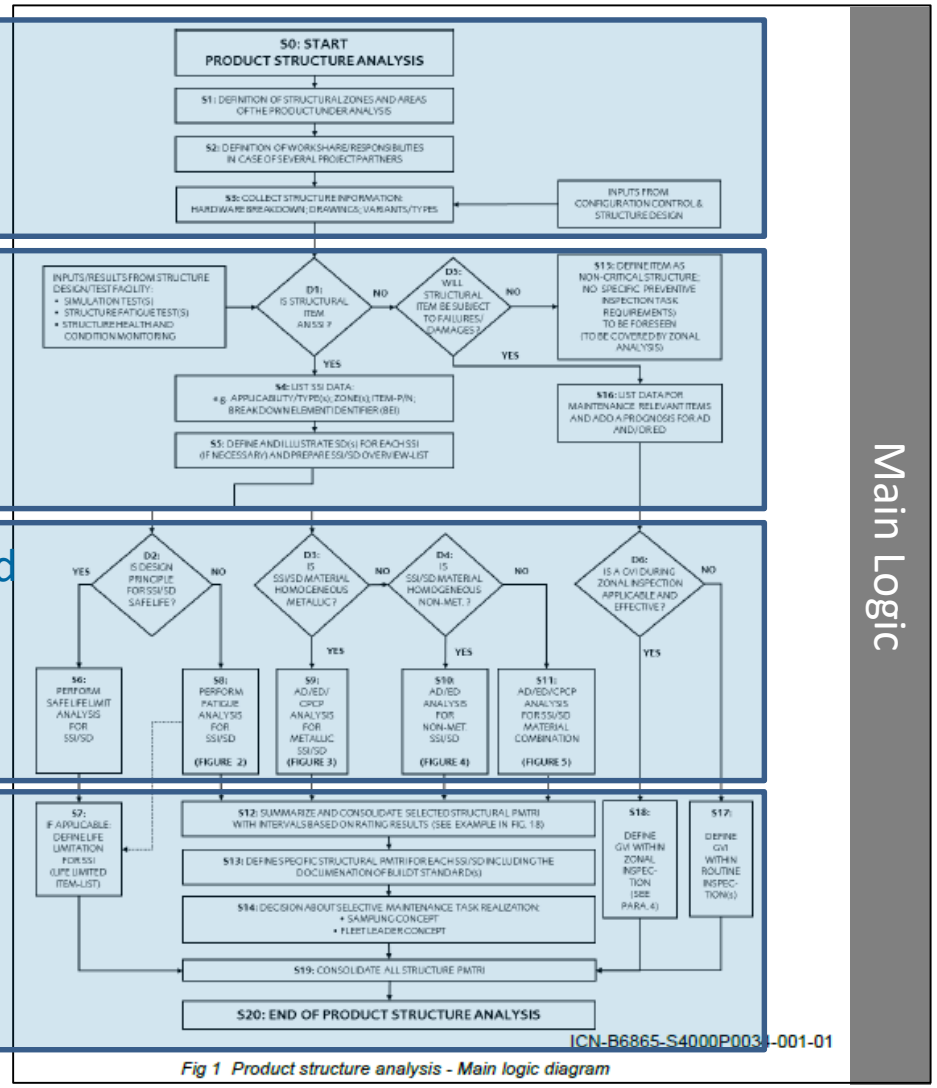

Fig 1 Product structure analysis - Main logic diagram

Main Logic

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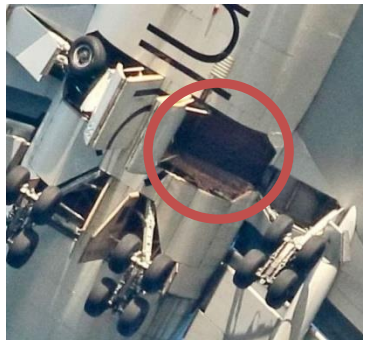
Development of PMTR according to ASD S4000P chapter 2 – Zonal Analysis

Zonal Analysis



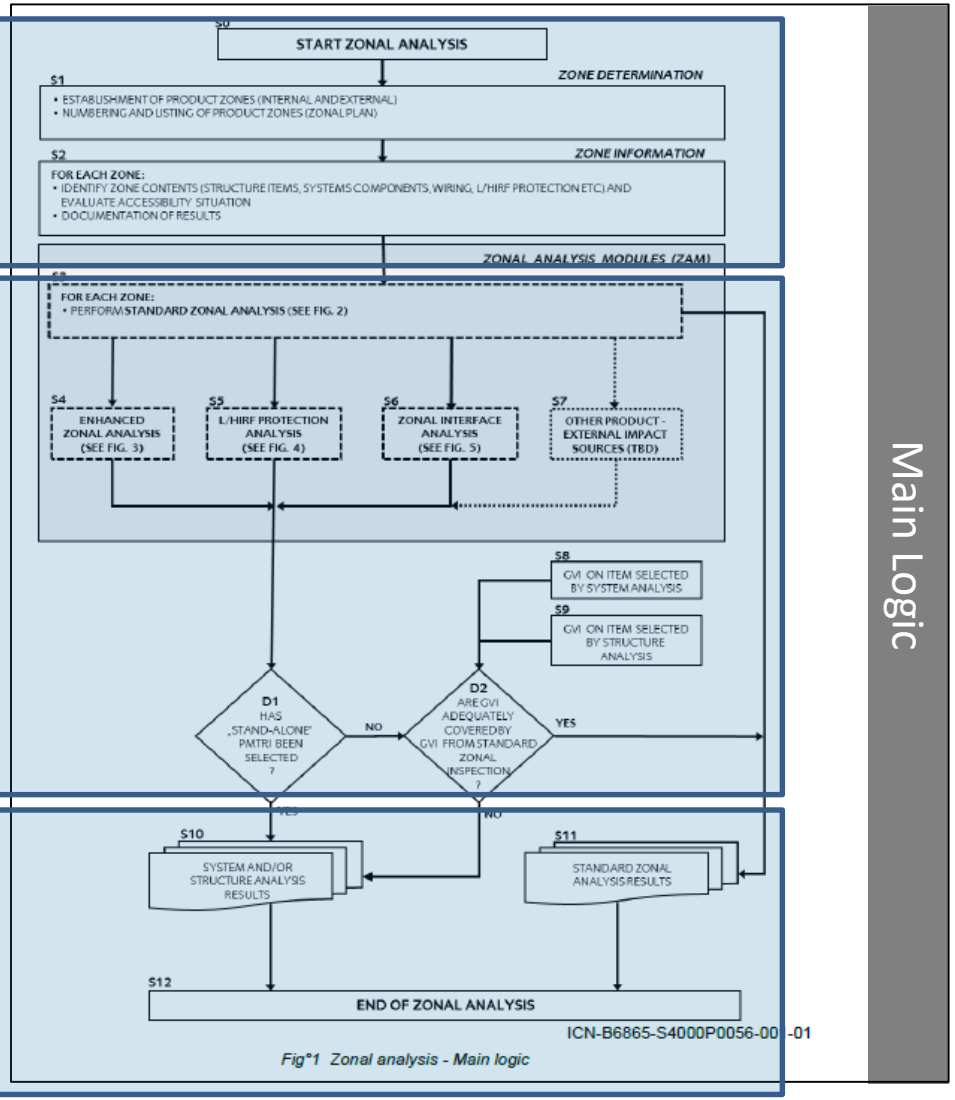
For **each zone**, identify content (**structure items, components. wiring, L/HIRF protection** and assess **accessibility**.
Detail zones, when required.

For each relevant zones conduct, depending on the zonal content the according **Zonal Analysis Module (ZAM):**

- ZAM1: **General** Analysis
- ZAM2: **L/HIRF Protection** Analysis
- ZAM3: **Zonal Interface** Analysis
- ZAMn: **Project specific** Analysis

Develop according PMTRs.

Transfer the resulting PMTRI related to systems or structural items into the results of the **System or Structure Analysis**.
Integrate **Standalone General Visual Inspections (GVI)** into **Standard Zonal Inspections.**



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Fig°1 Zonal analysis - Main logic

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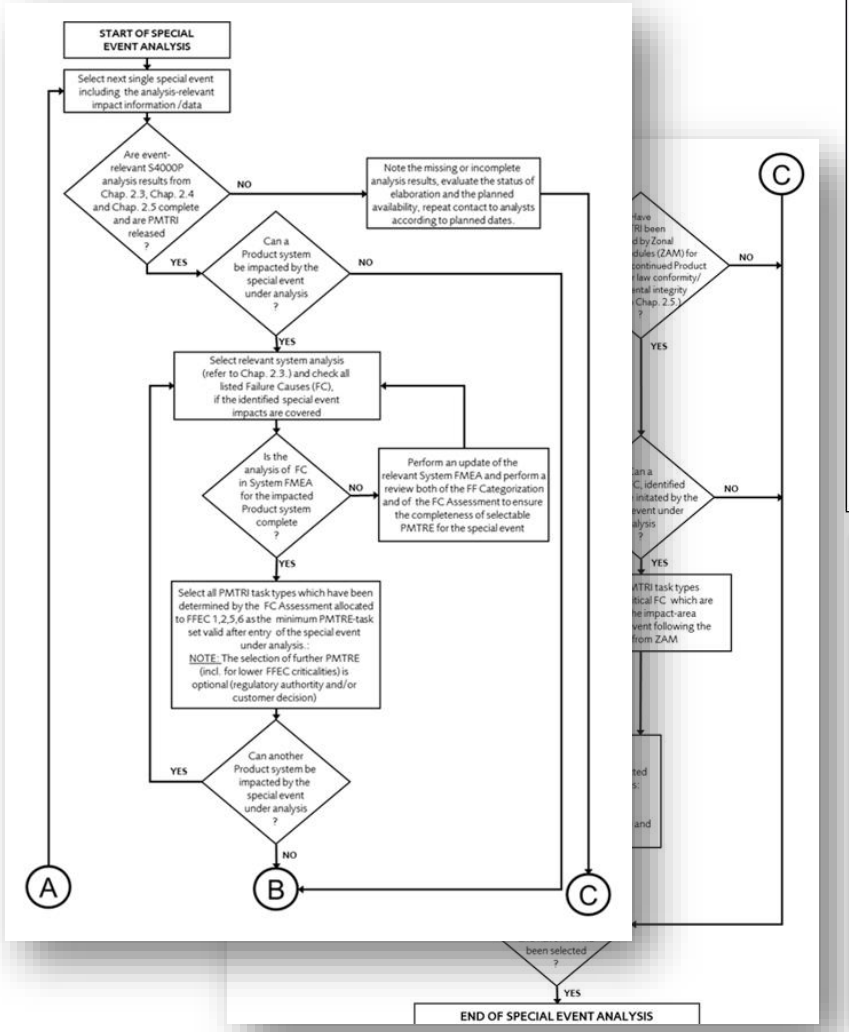
Development of PMTR according to ASD S4000P chapter 2 – Special Event Analysis

Special Event Analysis

Results of **System Analysis**

Results of **Structure Analysis**

Results of **Zonal Analysis**



Special Events may require the conduction of Preventive Maintenance Tasks to verify, that the product **still operates as intended after the occurrence of a special event**. In ASD S4000P the Special Event Analysis is also **supported by Decision Trees** and **reuses** the **results of the other analyses**. The results are **PMTRE**.

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Development of PMTR according to ASD S4000P chapter 2 – Consolidation & Harmonization

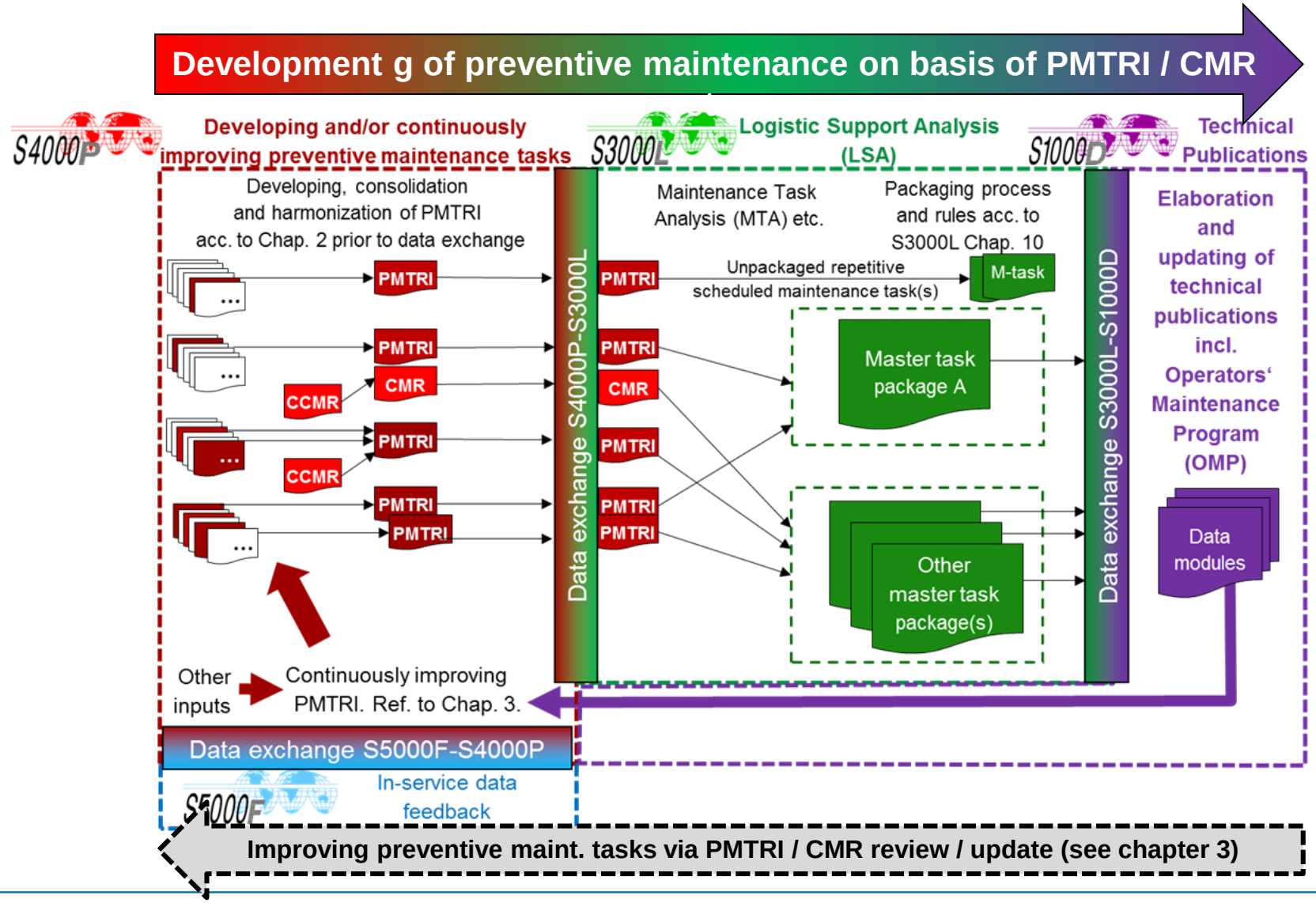
Before delivering the result of the different analyses as PMTRs, including PMTRIs and PMTRs, these must be harmonized and consolidated and harmonized.

1. Consolidation

Grouping of similar and eliminating of identical PMTRIs within a traceable process.

2. Harmonization

Final Harmonization with other preventive maintenance requirement sources, like e.g. Certification Maintenance Requirements.



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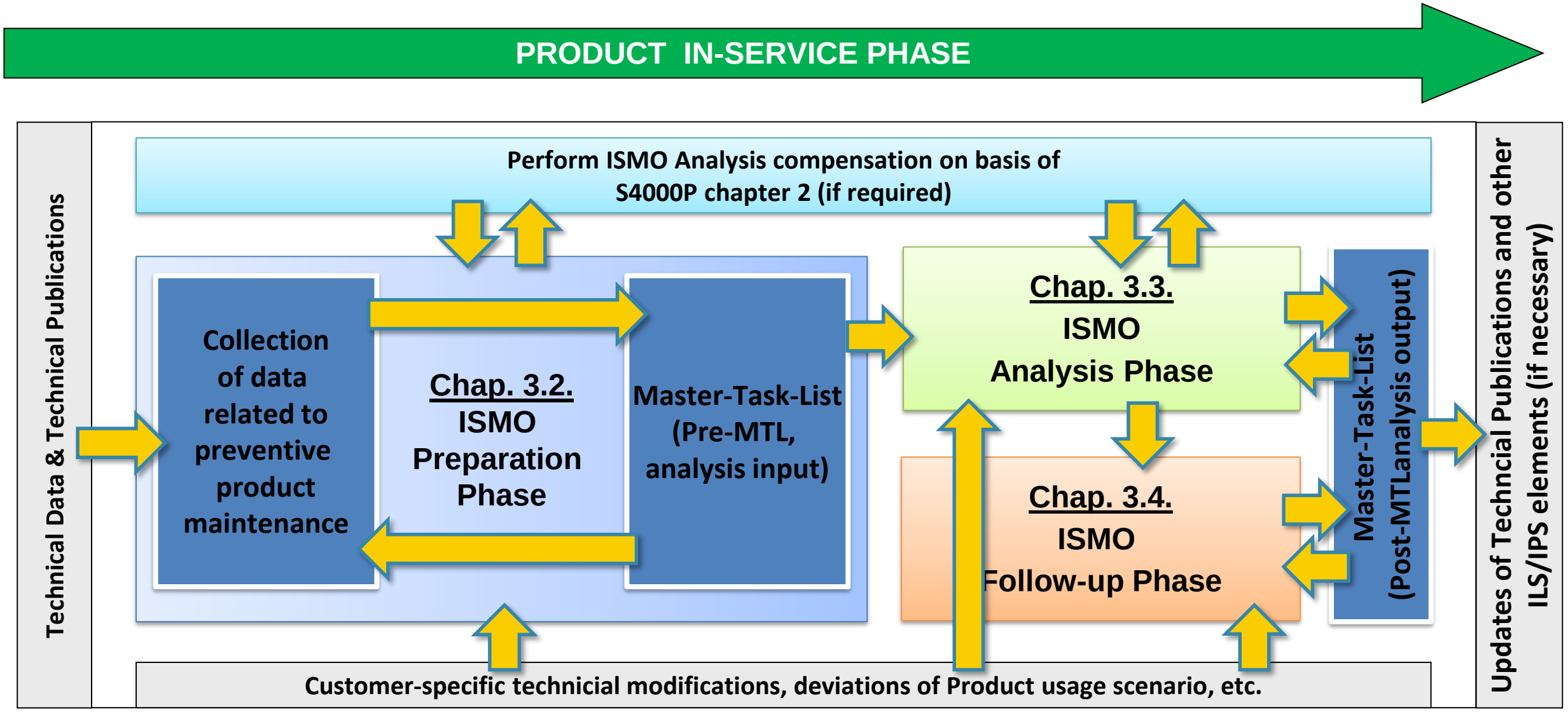
Continuous improvement of PMTR according to S4000P chapter 3



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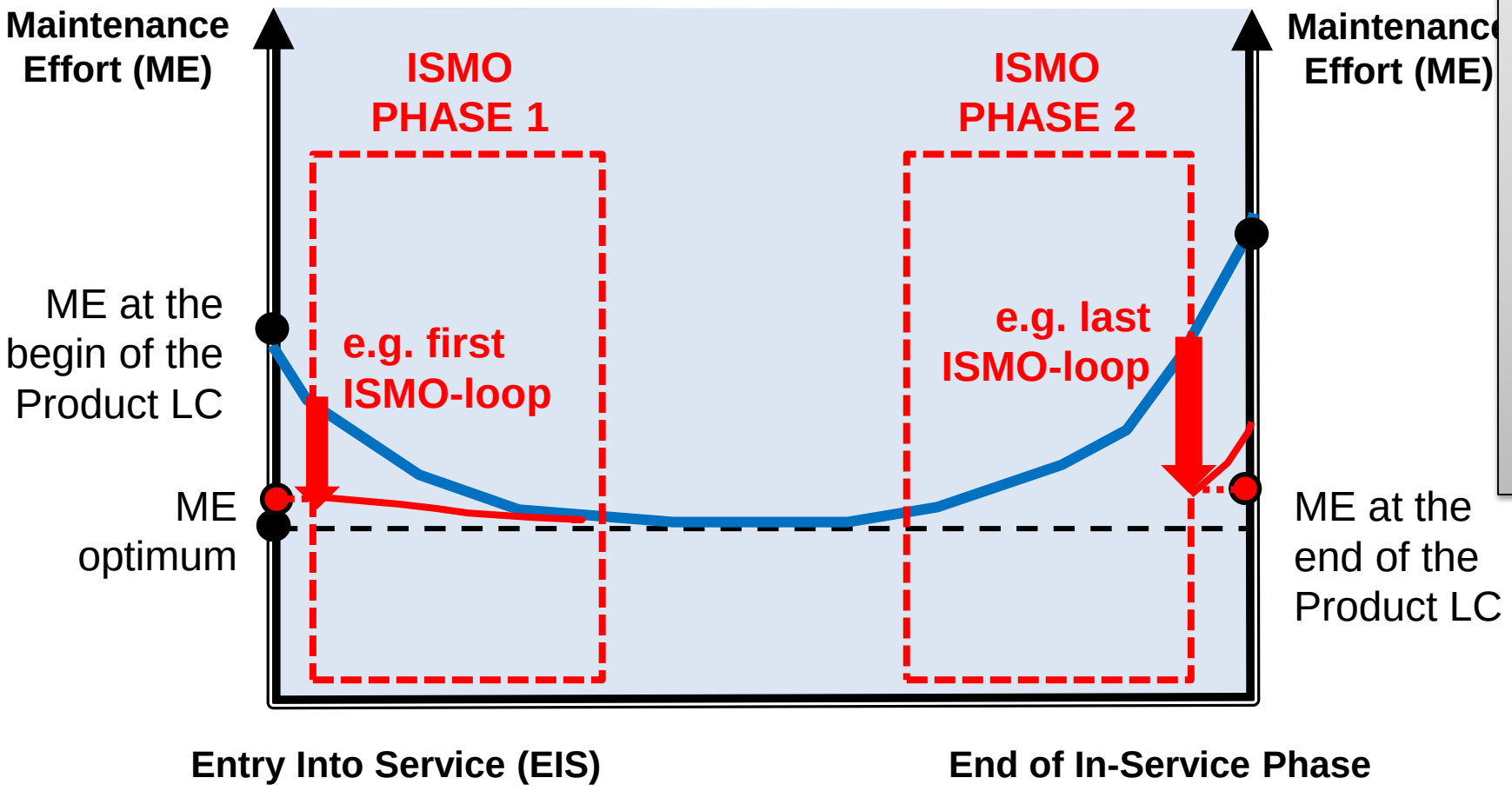
Continuous improvement of PMTR according to S4000P chapter 3 – Maintenance Effort

…in combination with the characteristic „bath tub curve“ of a complex technical Product during its Life Cycle (LC)



The main scope of the ISMO process includes:

- **Reduction of risks** that could lead to certification-relevant consequences (including Product safety)
- Ensuring that **environmental integrity** and the **conformity with national laws are** adhered to increase Product availability
- Reduction of **Product LCC**
- etc.

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Thank You

for your attention!

Questions?

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