



Politecnico  
di Torino

# La QUALITÀ nell'AEROSPACE

Le sfide e i risultati

4-5 MAGGIO  
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Space, Defense, Security: challenges & opportunities

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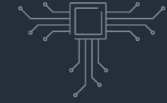
# LA QUALITÀ NEL AEROSPACE

## Space, Defense, Security: challenges & opportunities

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Politecnico di Torino

Torino – 04 Maggio 2023



Electronics



Helicopters



Aircraft



Cyber & Security



Space



Unmanned Systems



Aerostructures

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## 2023: Industries as is

The scientific challenges within Aerospace are becoming more strong for density and involved technologies:

- Artemis
- Mars Sample Return
- Galileo II Generation
- Jupiter Icy Moon Explorer (JUICE)
- Meteosat Third Generation Imager
- Cosmo SkyMed
- Iris



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## 2023: The Space economy

The 2023 shows the major western Institutions fully aware of the effective becoming of the Space Economy.

- The international relations have moved to the Space: Communications, Commerce, Defense.
  - Satellite Communications: critical infrastructures;
  - Titanium, Lithium, Silicon, Helium-3, Water, Oxygen
  - A detailed observation of the territories
  - Routes and extra-atmosphere Spaces
- The race for the Space has been open again
  - 2020 USA DoD released «Defense Space Strategy»
  - 2023 March 10<sup>th</sup>: Communication to EU Parliament relevant to «European Strategy for Security and Defense»



# 2023 March 10<sup>th</sup>: European Strategy for Security and Defense

Some very brief points:

- Space Domain: «**The space domain includes any element relevant for the functioning of space systems and the delivery of space-based services in the EU and the Member States...**»
- To **enhance the level of security** and resilience of space operations and services in the EU...
- By mid- 2024, the Commission, in close coordination with EDA under the authority of the High Representative and with ESA, will propose **a roadmap to reduce strategic dependencies on technologies** that are critical for ongoing and future space projects in the EU and EU space programmes
- The Commission will take space and **defence needs systematically into account in future initiatives**, including assessing the need to establish industrial alliances
- When developing future EU space programmes, the **Commission will take into account long-term military requirements** (time horizon 2035) for space-based defence services with the support of EDA.
- The Commission will consider **military needs and requirements** when defining **of the service portfolio of IRIS**
- By the end of 2024, the High Representative and the Commission, with the support of EDA, EUSPA and ESDC, should improve the skills of public administration and industry **to further develop space services for security and defence**, including through: the mapping of space security and defence training activities, and the skilling of downstream space industry, including through the establishment of a new large-scale partnership
- The High Representative and the Commission **will develop cooperation with NATO** in space security.



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# Industry and Aerospace Programmes

- For the Industry and its processes a very fluid scenario is arising with a strong multidisciplinary growth;
- Products and developments as:
  - Space Situation Awareness
  - Innovative weapon as LDEW
  - Electronic warfare & Countermeasure
  - Crypto communication
  - Cyber resilience

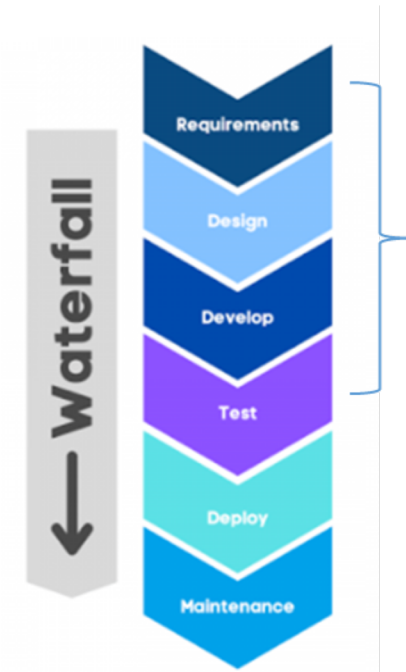
It requires an integrated approach between various disciplinary segments that is agile and structured at the same time  
An answer to these challenges that need a merger and a trade off between different approach can be:

- **AGILE Working Framework**
- **Advanced Product Quality Planning (APQP)**



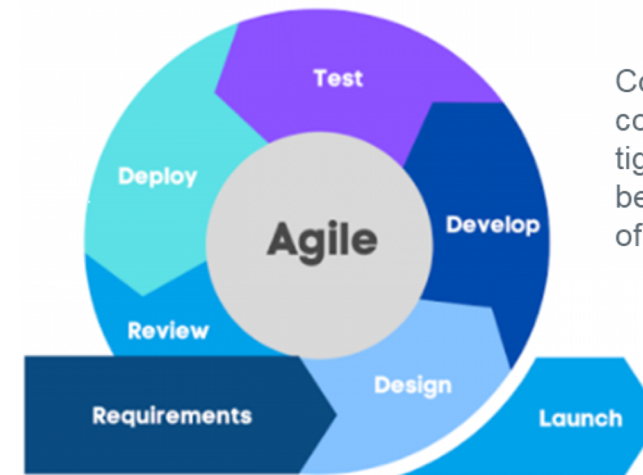
# Agile Working Framework (1/2)

- The current LCM model for product development is the Verification and Validation model (V-model). It is an extension of the waterfall model which considers a linear sequence of events to be managed, ideal for projects where the required end result is clearly defined from the beginning of the project.
- The Agile methodology was developed as a response to Waterfall's more rigid structure, allowing iterative evaluation, verification and agreement on product requirements. As a result, it requires a more flexible approach to project management whilst maintaining the need to plan and monitor progress in a reliable and predictable manner.
- A product development projects can take many years to complete and technology can change significantly during that time. Agile provides a flexible method that where appropriate allows change to be incorporated even at a late stage in the programme.



Potentially years apart creating a disconnect between:

- The intent of the requirement and the testability
- Disciplines



Continuous collaboration and tighter timescales between each phase of development

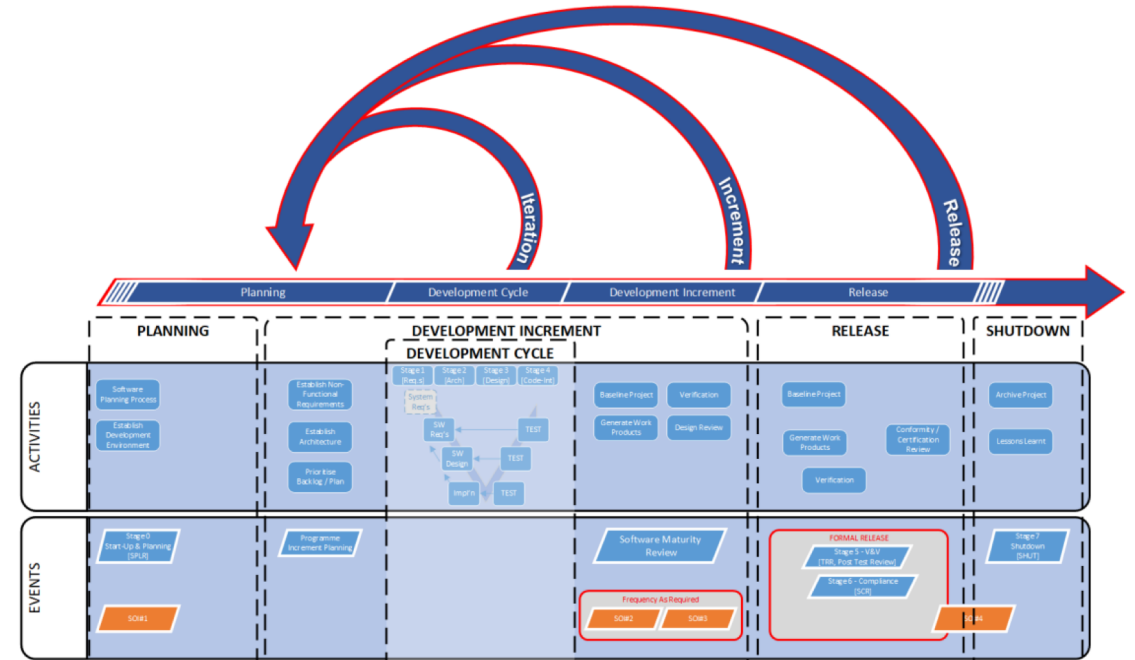


# Agile Working Framework (2/2)

- Compared to the V-Model, in Agile, the team will work on a number of phases of the project concurrently, against short-term deadlines. Additionally, the team defines the short term objectives, rather than the project manager

A strong KPI suite is implemented

- Scrum Team Metrics – these focus on the predictable delivery of working product (software for example) to the customer.
- Kanban Metrics – these focus on the workflow, organising, prioritising of work and getting it down.
- Lean Metrics – these focus on ensuring a flow of value from the organisation to its customers and concentrates on eliminating wasteful activities.



ECSS-E-HB-40-01A  
Agile Software Development Handbook





# 9145 Standard and APQP/PPAP



**APPLICABLE TO:**

- NEW PRODUCTS
- DESIGN CHANGE
- NEW PROCESSES
- PROCESS CHANGE
- WORK TRANSFER

EN 9145 defines the requirements for the application of the **Advanced Product Quality Planning (APQP) methodologies and Production Part Approval Process (PPAP) to the PRODUCT DEVELOPMENT PROCESS**

- **APQP** drives a **multidisciplinary team** focused approach, use of a **phased planning process** with specific **deliverables**, while highlighting and mitigating **risks** as they are identified.
- **PPAP** is an **output** of APQP, confirming that the whole process has demonstrated the potential to produce **products that fulfill all requirements** while operating **at the customer demand rate**



Production Part Approval Process (PPAP) Element	
1.	Design Documentation
2.	Design Risk Analysis (e.g., DFMEA); only applicable to design organization
3.	Process Flow Diagram
4.	Process Failure Mode and Effects Analysis (PFMEA)
5.	Production Control Plan
6.	Measurement System Analysis (MSA)
7.	Initial Process Capability Studies
8.	Packaging, Preservation, and Labelling Definition
9.	First Article Inspection Report (FAIR)
10.	Customer PPAP Requirements
11.	PPAP Approval Form (or equivalent)

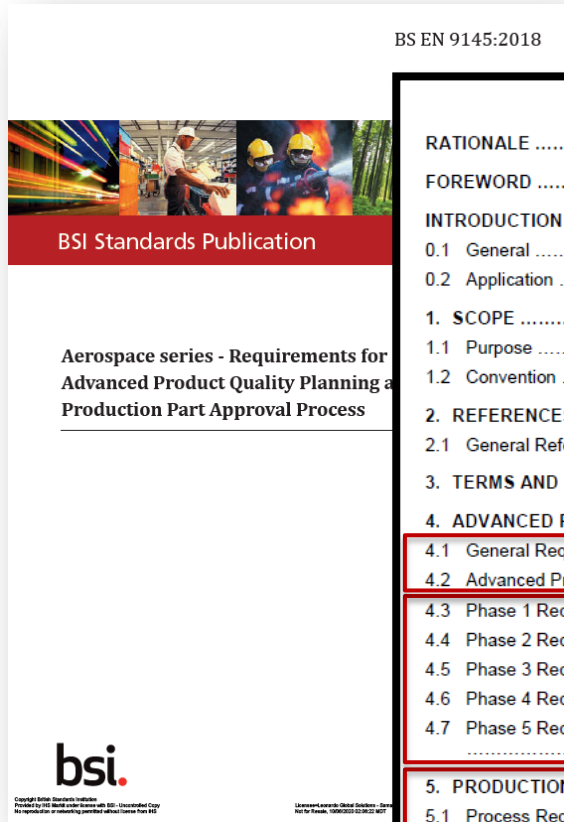
**§ 0.2 APPLICATION:** *This standard (APQP and PPAP) is applicable to the following:*

- *Product Development* (New Products - final or selected levels of parts - Design Changes)
- *Manufacturing Process Development* (New Processes, Process Changes)
- *Work Transfers* (Change of site, Change of source)
- *The same principles can also be applied to Services*

*The standard is generally not applied to sourced standard parts or Commercial-off-the-Shelf (COTS) items.*



# APQP Insight



BS EN 9145:2018

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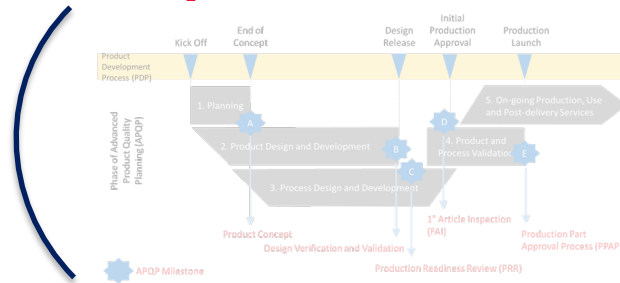
Define STRUCTURAL NEEDS for effective implementation of the APQP principles

Define ACTIVITIES AND DELIVERABLES expected for each APQP phase

Define PPAP REQUIREMENTS AND SUBMISSION formal steps



# APQP Requirements



Cross-functional teams definition and engagement is key to:

- ❑ builds **unity of purpose** across the business
- ❑ **ensures effective communication** across the various business functions
- ❑ supports commitment and **alignment with project timing**



Adopt an effective project management structure to:

- ❑ Schedule tasks, assign responsibility and drive **on-time completion**
- ❑ Cascades program key targets throughout the **whole value stream**
- ❑ Manage the **risks** and mitigation actions
- ❑ Ensure management of product/process **changes**



Top management demonstrates commitment through:

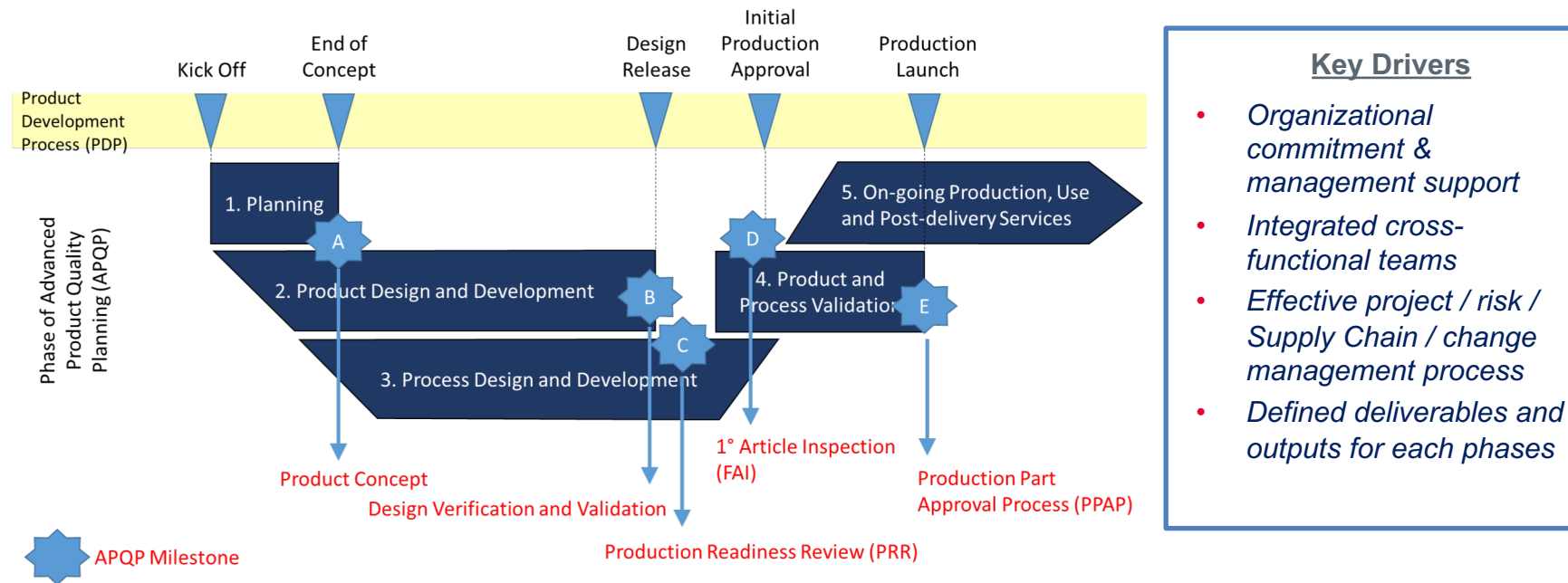
- ❑ Completing specific **APQP training**
- ❑ **Allocating** appropriate **resources**
- ❑ Leading **periodic reviews**
- ❑ Removing roadblocks
- ❑ Standardizing APQP practices



# Overview on APQP: Advanced Product Quality Planning

The APQP structure:

5 phases strongly integrated each other and within the Product Development Process:



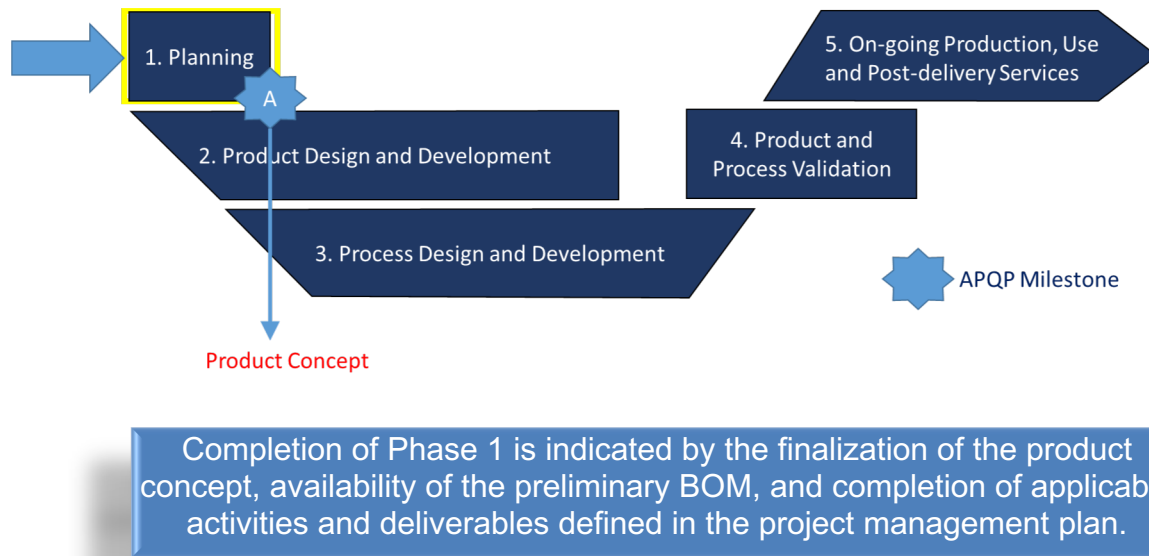
- Each phase is characterized by elements that produce specific **deliverables**
- Deliverables and key milestones for each phase are established, monitored, and tracked to closure, while highlighting and mitigating **risks** as they are identified.
- The **applicability** of each phase and related elements / deliverables has to be evaluated for each APQP project



# APQP Phase 1: Planning

From EN 9145, § 0.1 General:

*“The goal of this phase is to capture customer inputs, benchmark data, lessons learned, regulatory requirements, technical specifications, company know-how and strategy into a **product concept and realization plan**. This includes identification of the high-level technical, quality and cost targets.”*



Deliverables:

1. **Product Design, Production, and Post-delivery Service Requirements**
2. **Project Targets – Safety, Performance, Quality/Manufacturability, Reliability, and Service Life**
3. **Preliminary BOM**
4. **Preliminary Applicability Risk Assessment**
5. **Preliminary Supply Chain Management Plan**
6. **Preliminary Production Preparation Plan**
7. **Project Management Plan**

Main outputs:

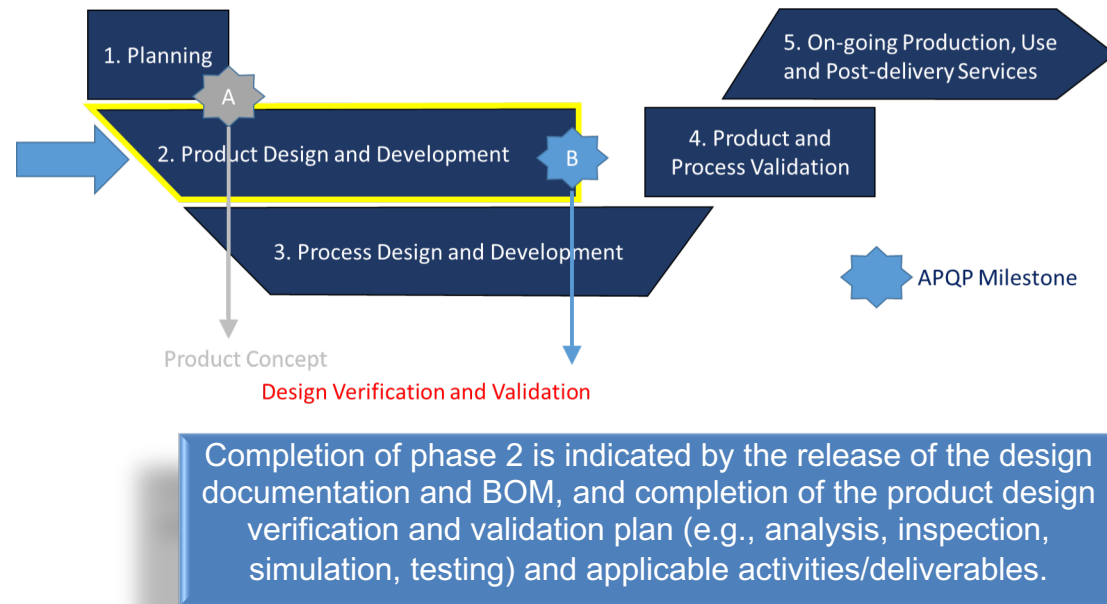
- The product concept is finalized (**milestone A**) and a pre-design is available
- The project management plan includes all the applicable APQP deliverables



# APQP Phase 2: Product design and development

From EN 9145, § 0.1 General:

*“The goal of this phase is to translate the technical, quality and cost requirements into a controlled, verified and validated product design.”*



Deliverables:

1. **Design Documentation and BOM\***
2. **Design Risk Analysis\***
3. **Special Requirements, Including Product KCs and CIs Listings**
4. **Tolerance Analysis**
5. **Packaging Specification**
6. **Product Design Verification and Validation Plans, and Associated Results**
7. **Supply Chain Management Plan**
8. **Feasibility Assessment**

*\* This is an element of the PPAP file and can be required for the PPAP submission*

Main outputs:

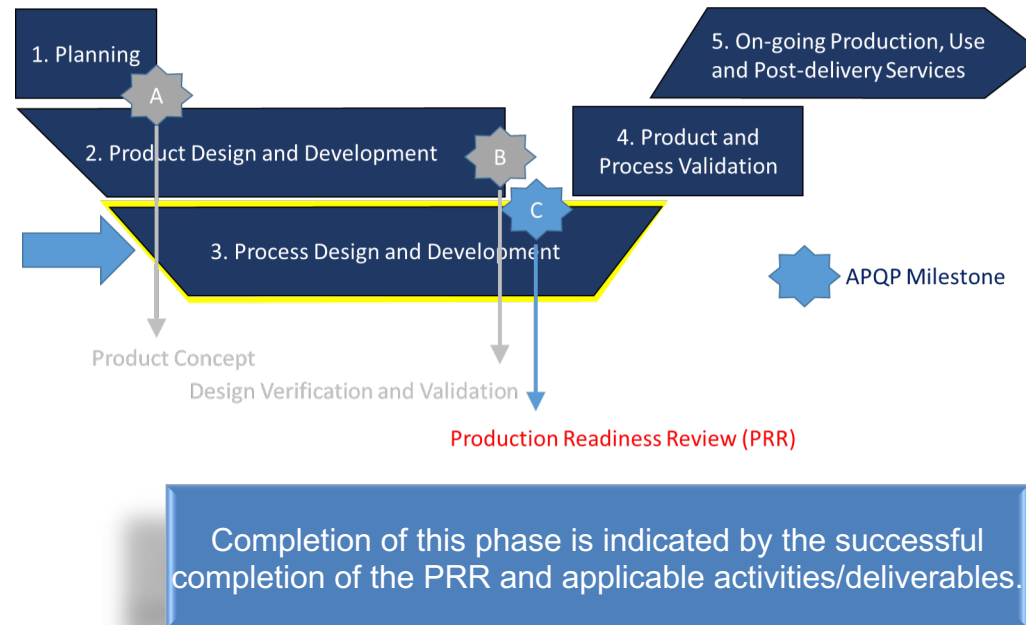
- Design documentation and BOM are available
- The product design is verified, validated, and released (**milestone B**)



# APQP Phase 3: Process Design and Development

From EN 9145, § 0.1 General:

*“The goal of this phase is to design and develop the **production processes** needed to produce product that consistently fulfill technical, quality, and cost requirements while operating at the customer demand rate.”*



Deliverables:

1. **Process Flow Diagram\***
2. **PFMEA\***
3. **Process KCs**
4. **Pre-launch Control Plan**
5. **Production Preparation Plan**
6. **Workstation Documentation**
7. **Measurement Systems Analysis (MSA) Plan**
8. **Packaging, Preservation, and Labelling Definition\***
9. **Supply Chain Risk Management Plan**
10. **Production Readiness Review (PRR) results**

*\* This is an element of the PPAP file and can be required for the PPAP submission*

Main outputs:

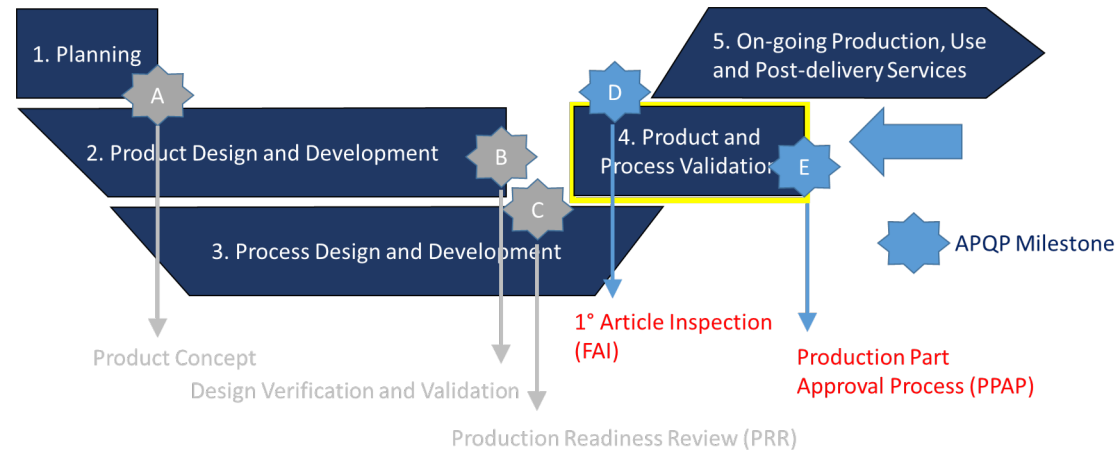
- Production process defined and deployed
- Successful completion of the PRR (**milestone C**)



# APQP Phase 4: Product & Process Validation

From EN 9145, § 0.1 General:

“The goal of this phase is to validate that **product** fulfills the design requirements and the **production processes** have demonstrated the capability to consistently produce conforming product at the customer demand rate.”



Completion of Phase 4 is indicated by the successful completion and approval of PPAP, including FAI and all Phase 4 activities and deliverables.

Main outputs:

- Validation that intended manufacturing process and the associated product conforms to specified requirements
- Approved FAI (**milestone D**) and Approved PPAP (**milestone E**)

Deliverables:

1. **Product from Production Process Run(s)**
2. **MSA\***
3. **Production Control Plan\***
4. **First Article Inspection Report (FAIR)\***
5. **Initial Process Capability Studies\***
6. **Capacity Assessment**
7. **PPAP File and Approval Form\***
8. **Customer specific PPAP requirements\***
9. **Product Verification and Validation Results**

*\* This is an element of the PPAP file and can be required for the PPAP submission*

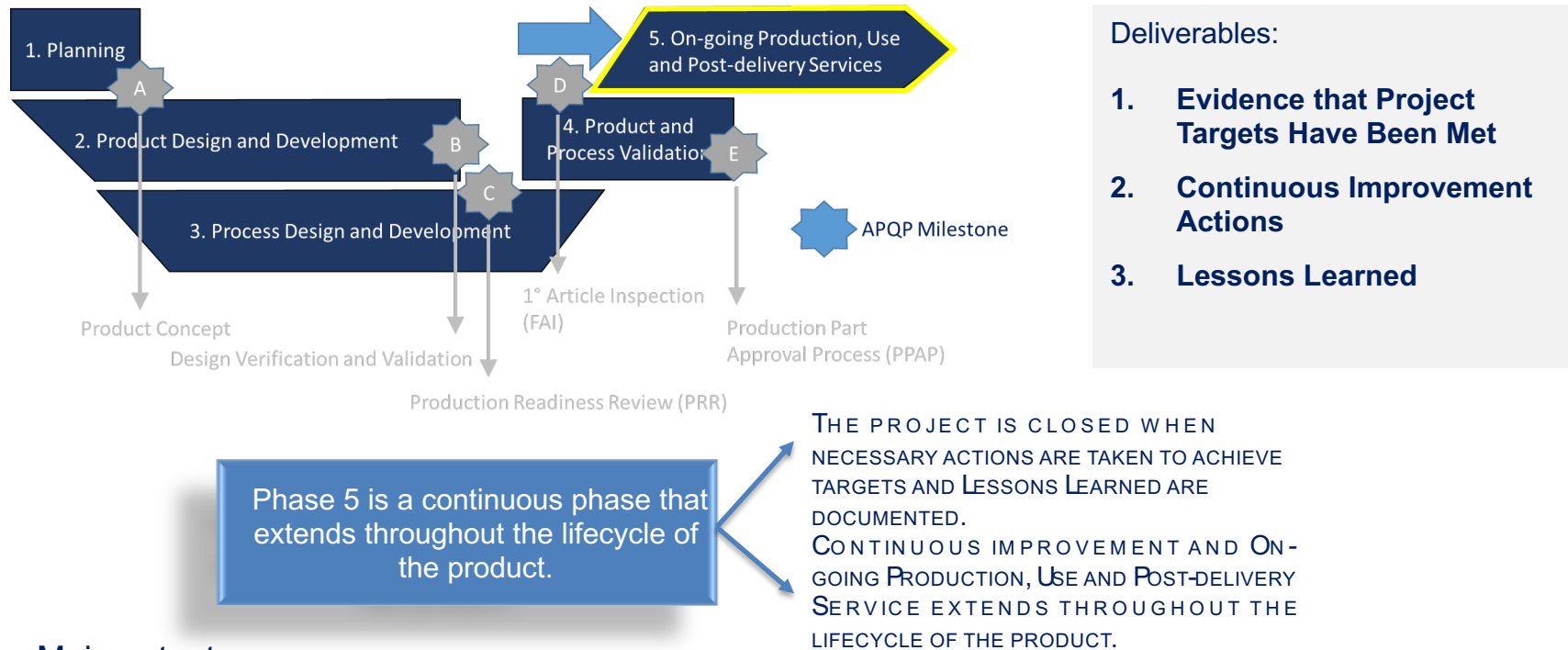




# APQP Phase 5: On-going Prod., Use, and Post-delivery Service

From EN 9145, § 0.1 General:

*“The goal of this phase is to ensure customer requirements are continually fulfilled through the use of process control, lessons learned, and continuous improvement.”*



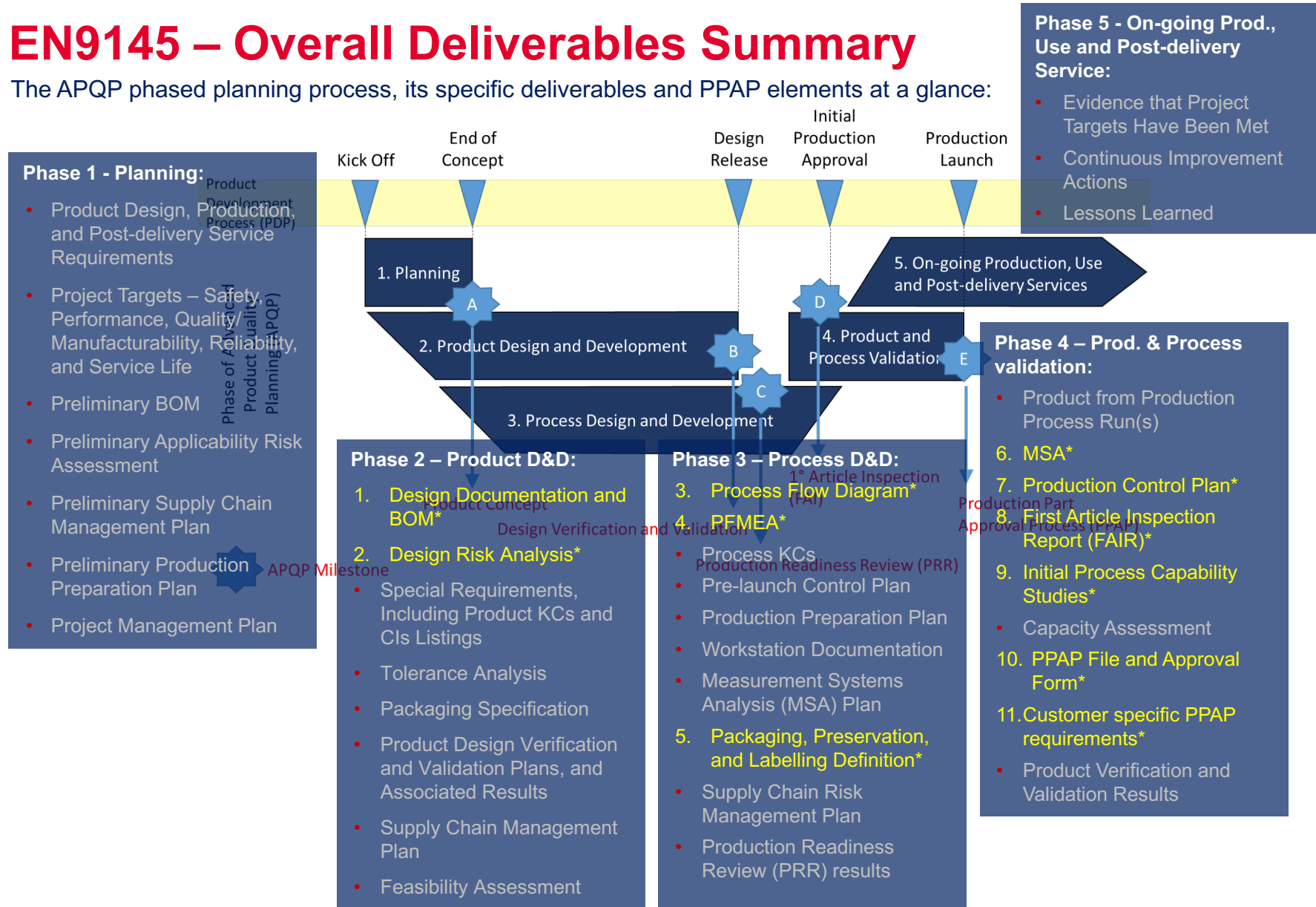
Main outputs:

- Project closure
- Continuous Improvement metrics
- Lessons Learned Recorded



# EN9145 – Overall Deliverables Summary

The APQP phased planning process, its specific deliverables and PPAP elements at a glance:



\* This is an element of the PPAP file and can be required for the PPAP submission

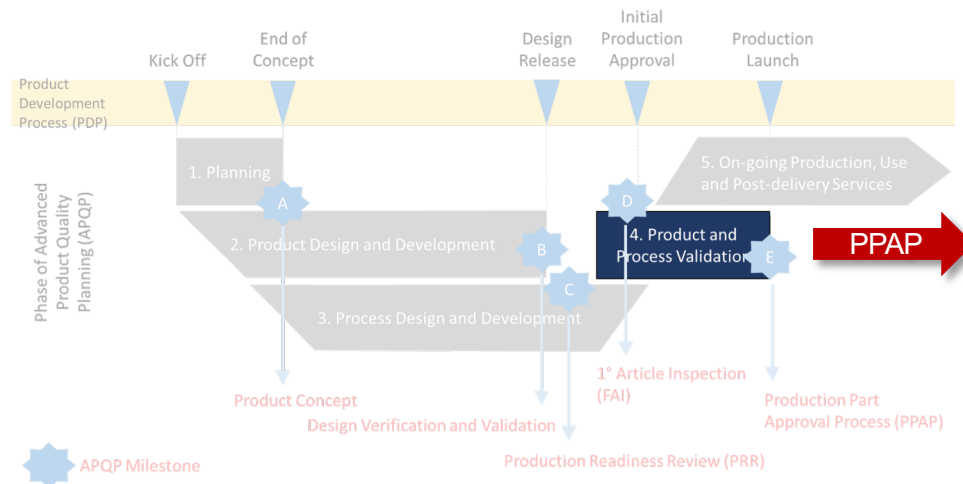


# PPAP Elements

## EN9145 - § 5 PPAP requirements

*'[...] The PPAP, incorporated in phase 4, is designed to demonstrate the readiness for serial production.*

*The PPAP step in the APQP process is designed to create the baseline for all future changes to the product requiring a PPAP resubmission. ...*



Production Part Approval Process (PPAP) Element	
1.	Design Documentation
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9.	First Article Inspection Report (FAIR)
10.	Customer PPAP Requirements
11.	PPAP Approval Form (or equivalent)

- PPAP confirms that the process is capable of providing a **product that meets all requirements** and objectives at the required demand rate
- It demonstrate that **all the RISKS have been identified and managed**
- The PPAP step at the end of APQP phase 4 is designed to create the **baseline for all future changes** to the product and the manufacturing process





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