U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – ARMAMENTS CENTER

MIL-STD-31000 Update to Support Additive Mfg. (AM)

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DISTRIBUTION STATEMENT A: Unlimited Release

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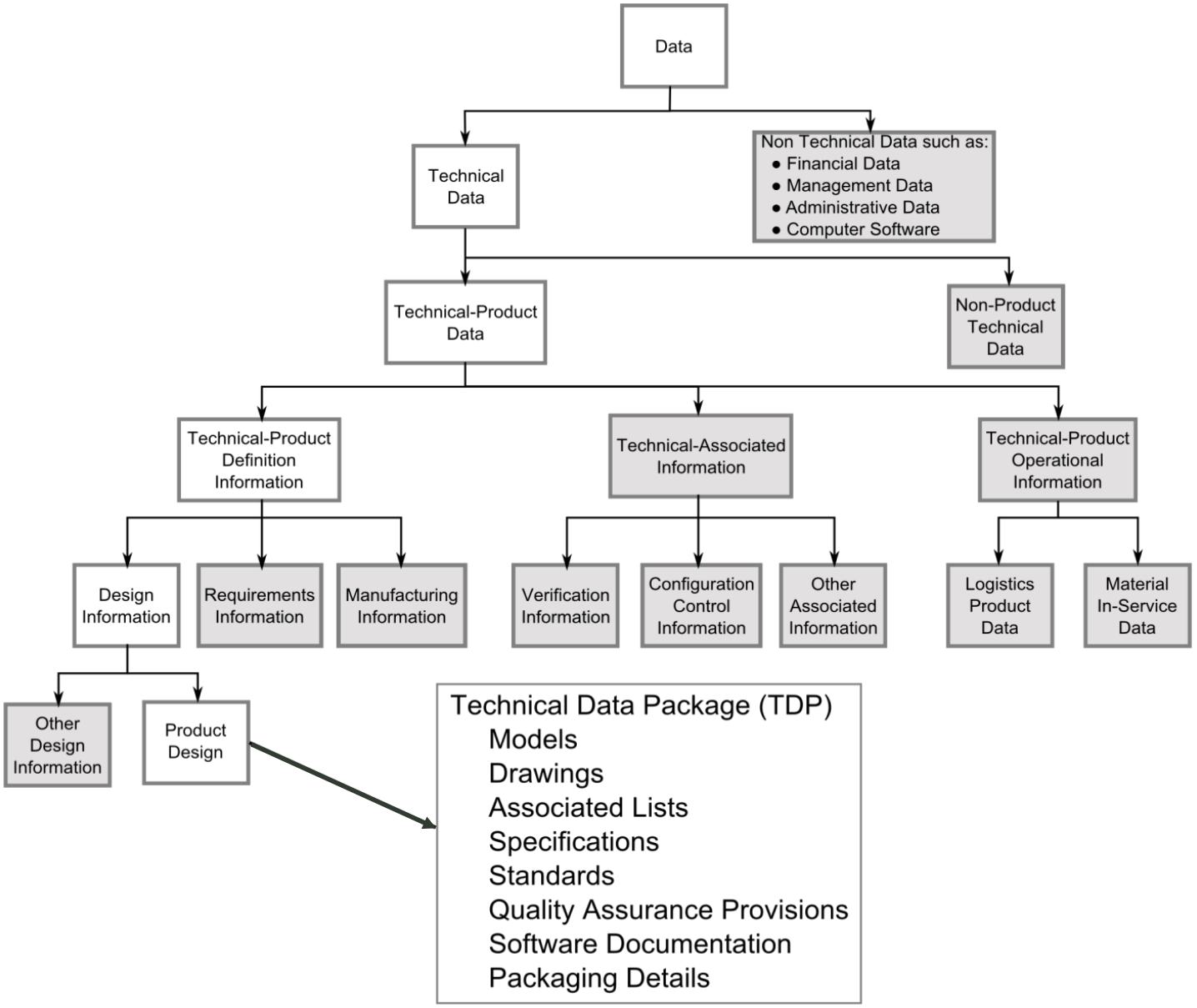
OVERVIEW

1. Technical Data Package Overview.

2. Review of MIL-STD-31000.

3. Recent changes to MIL-STD-31000 related to Additive Mfg.

TYPES OF DATA



TDP DEFINITION

Technical Data Package (TDP)

The authoritative technical description of an item. This technical description supports the acquisition, production, inspection, engineering, and logistics support of the item.

Source: MIL-STD-31000C

TDP PURPOSE

- **Common Myth:** The TDP exists for purposes of manufacturing the item.

- **Fact:** The TDP exist for purposes of defining the item.
  - **Its an engineering document, not a manufacturing document.**

- As the single authoritative engineering definition of the item, it has many uses:
  - Manufacturing
  - Engineering analysis
  - Program management
  - Contractor oversight
  - Configuration control
  - Interface control
  - Logistics planning/support
  - Government control of the design
  - Future procurement / Competitive procurement
  - Quality Control/Inspection

TDP BACKGROUND

- TDPs provide a technical description of an item which is **clear**, **complete** and **accurate**, in a **form** and **format** adequate for its intended use.

- TDPs define the **physical** and **functional** characteristics of the accepted configuration of the item and its subordinate assemblies, subassemblies, and parts.

- TDPs consist of a **level** and **type** and one or more **elements** as specified in the contract and TDP Option Selection Worksheet.

Source: Para 4.1 MIL-STD-31000B

MIL-STD-31000 BACKGROUND

1. MIL-STD-31000 provides the definition and requirements for the TDP.

2. MIL-STD-31000:

    a. Defines what a TDP is, to include its constituent parts (elements),
    b. Establishes how a TDP is ordered on a developmental contract, and
    c. Provides products to manage and control how a TDP is created during a development process.

3. It is a high-level document, detailed instructions are left to other standards (primarily ASME Y14 Series).

4. Current revision “B” released Oct 2018. Revision C to be released …

MIL-STD-31000 & ASME DRAWING STANDARDS

The TDP is defined primarily by MIL-STD-31000 and the ASME drawing standards below:

ASME Y14.1	Decimal Inch Drawing Sheet Size and Format
ASME Y14.1M	Metric Drawing Sheet Size and Format
ASME Y14.24	Types and Applications of Engineering Drawings
ASME Y14.34	Associated Lists
ASME Y14.35	Revision of Eng. Dwgs. and Associated Documents
ASME Y14.46	Product Definition For Additive Mfg.
ASME Y14.47	Model Organization Practices
ASME Y14.5	Dimensioning and Tolerancing (GD&T)
ASME Y14.100	Engineering Drawing Practices

TDP LEVELS

Three Levels:

1. **Conceptual level:** Defines design concepts; consists of only simple sketches/models, artist's renderings, and/or basic textual data.

2. **Developmental level:** Supports the analysis of a specific design approach, the fabrication of prototype materiel for test or experimentation, and limited production by, or with assistance from, the original design activity.

3. **Product level:** Contains information necessary to fully define the item and enable the procurement or manufacture. Defined to the extent necessary for a competent manufacturer to produce an item.

(Pre-milestone A to B) (Milestone B-C) (Milestone C and later)

TDP TYPES

Two Types:

- 2-dimensional line drawing based

- 3-dimensional solid model based
  a) 3D native CAD models
  b) 3Di viewables derived from 3D native CAD
  c) Neutral files derived from 3D native CAD
  d) 2D drawings derived from 3D native CAD

Source: MIL-STD-31000B

TDP ELEMENTS AND DATA MGT PRODUCTS

TDP ELEMENTS REV B: a. Engineering Design Data and Associated List b. Special Inspection Equipment (SIE) design data and associated lists. c. Special Tooling design data and associated lists. d. Specifications. e. Software documentation. f. Special Packaging Instruction (SPI) documents, design data and associated lists. g. Quality Assurance Provisions (QAPs).	

TDP PURPOSE

- According to MIL-STD-31000 the TDP is to be manufacturing agnostic, i.e., define the item, not how to create the item.
- This does not mean you can divorce the TDP from the manufacturing methodology. The manufacturing approach will greatly influence the design.
- An exception to the manufacturing agnostic requirement is the Required Mfg. Process Description (formerly called Critical Mfg. Process Description).
    1. Safety critical
    2. Hard to mfg.
    3. Mfg. method affects performance

REVISION C OF MIL-STD-31000

WHAT IS HAPPENING WITH THE NEW REVISION C CHANGES?

- Primarily the incorporation of additive manufacturing information into the TDP.

ADDITIVE MFG. ASSUMPTIONS

1. AM capability has evolved rapidly over the last 10 years. We can expect it to continue to improve significantly in the near/medium term.

2. AM offers design options not available with traditional manufacturing.

3. AM can produce parts on-demand and on-location. This is a game-changer logistically. (This eliminates many of the concerns of the supply community, e.g., Average Monthly Demand, Parts on Hand, Administrative and Production Lead Time, Transportation Issues.)

4. AM makes it easier to customize design for the user.

AM IMPLICATIONS

1. AM only applies to a small percentage of parts currently. Three things will increase the percentage of parts made via AM:
   - AM technology will continue to improve. Improve in accuracy, materials/material properties, speed, build volume, and reduced cost.
   - As new items are developed, parts will be designed with AM as the intended manufacturing approach.
   - Increase in familiarity with use of AM and its capabilities and limitations.

2. AM is a digital data driven technology. It requires a 3D CAD model.

3. Establishing the information infrastructure / data flow is necessary to the success of AM in DOD.

WHAT IS DRIVING THE RECOMMEND CHANGE TO -31000?

1. Other manufacturing technologies have been implemented with no changes to MIL-STD-31000 or to TDP content.
   - Why are changes being proposed to -31000 to accommodate AM?
   - Is AM fundamentally different than these other manufacturing technologies?

2. AM is fundamentally different in the following ways:
   - The AM process requires a 3D model.
   - The AM process reduces the distinction between engineering/design and manufacturing.
   - AM allows production of components in the field far more than other manufacturing technologies.

3. If the above is true, then it makes sense to modify -31000 to accommodate AM, and establish how engineering data will be structured to support AM, i.e. establish the concept of operations.

AM ISSUES

1. Three manufacturing approaches to take into account:
   - **Traditional** – Can't use AM
   - **Traditional or AM** – Can use either traditional mfg. or AM to make the part
   - **AM only** – AM is the only viable way to make the part

2. Three additive manufacturing locales to consider:
   - **Organic base** (e.g., Arsenal/Depot/Shipyard)
   - **Industrial base** (e.g., OEM/lower tier suppliers)
   - **Field produced parts** (e.g., on-ship/on-post/forward operating base)

3. Several sets of information necessary to support AM:
   - **TDP** (as we know it currently)
   - **Additive Mfg. Data File** (3D model file)
   - **Required Manufacturing Process Description (for AM)** (in some cases)

REVISION C CHANGES

- Revision C to MIL-STD-31000 created primarily to incorporate additive manufacturing information into the standard.
- Adds the Additive Mfg. Data File (AMDF) as an element of the TDP.
- Changes the name of "**Critical Mfg. Process Description**" to "**Required Mfg. Process Description**". In addition, makes the Required Mfg. Process Description an explicit element of the TDP.
- New DID created: "***Required Mfg. Process Description for Additive Mfg.***"
- Other changes involved new definitions added and other administrative changes.

AMDF INCORPORATION IN TDP

1. Makes the AM Data File (AMDF) officially part of the TDP as a defined element. This gives the AMDF a “home” and places it under the same level of configuration control as the rest of the TDP. Distribution falls under normal TDP distribution procedures.

2. AMDF is required only for items the design activity designates as an AM item.

3. Proposed format of the AMDF within the TDP is STEP or NATIVE+STEP (unless otherwise specified).

4. Default is to attach the AMDF to the underlying document (drawing or 3Di viewable) or provided as a separate document linked to the TDP.

5. Creation of the .stl or other 3D print file type would be left to the manufacturing organization.

TDP ELEMENTS AND DATA MGT PRODUCTS

TDP ELEMENTS REV B:	TDP ELEMENTS REV C:
a. Engineering Design Data and Associated List b. Special Inspection Equipment (SIE) design data and associated lists. c. Special Tooling design data and associated lists. d. Specifications. e. Software documentation. f. Special Packaging Instruction (SPI) documents, design data and associated lists. g. Quality Assurance Provisions (QAPs).	a. Engineering Design Data and Associated List: 1. End item and lower components 2. Special Inspection Equipment (SIE) 3. Special Tooling b. Specifications. c. Software documentation. d. Special Packaging Instruction (SPI) documents. e. Quality Assurance Provisions (QAPs). f. Additive Mfg. Data File (AMDF) g. Required Mfg. Process Description

CURRENT STATUS

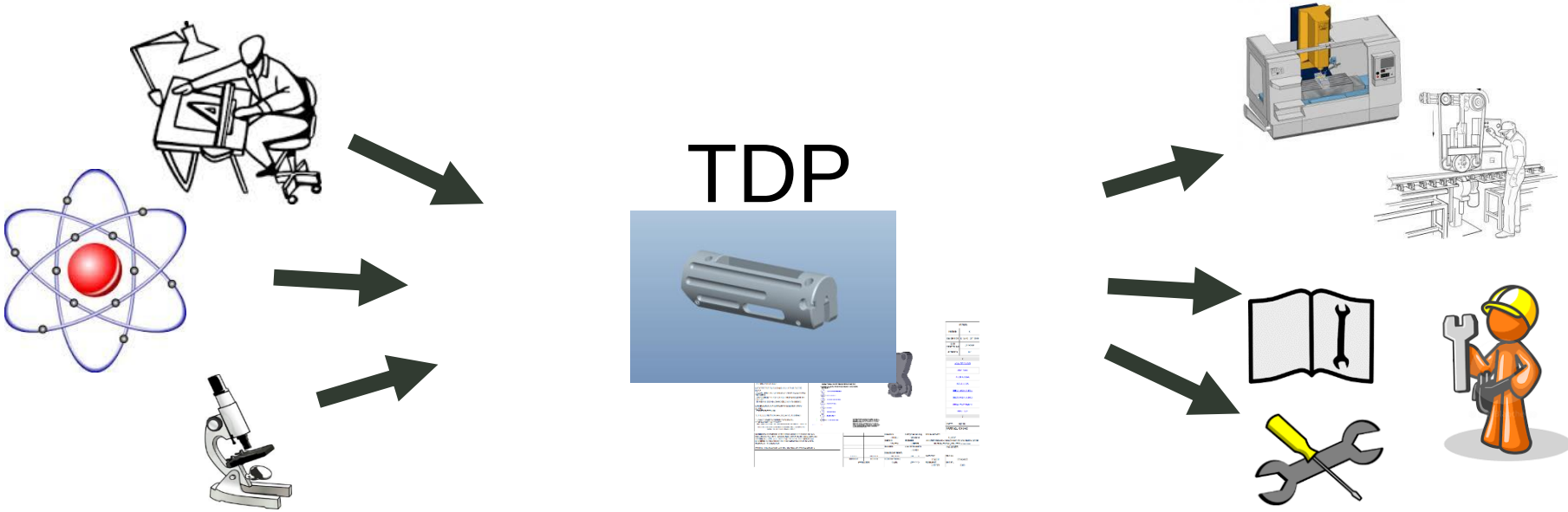
- MIL-STD-31000 Revision C published in ASSIST on XXXXXX.
- New Required Mfg. Process Description for Additive Mfg. also published in ASSIST.
- New Option Selection Worksheet will be released as a DD Form (DD 2554).

QUESTIONS

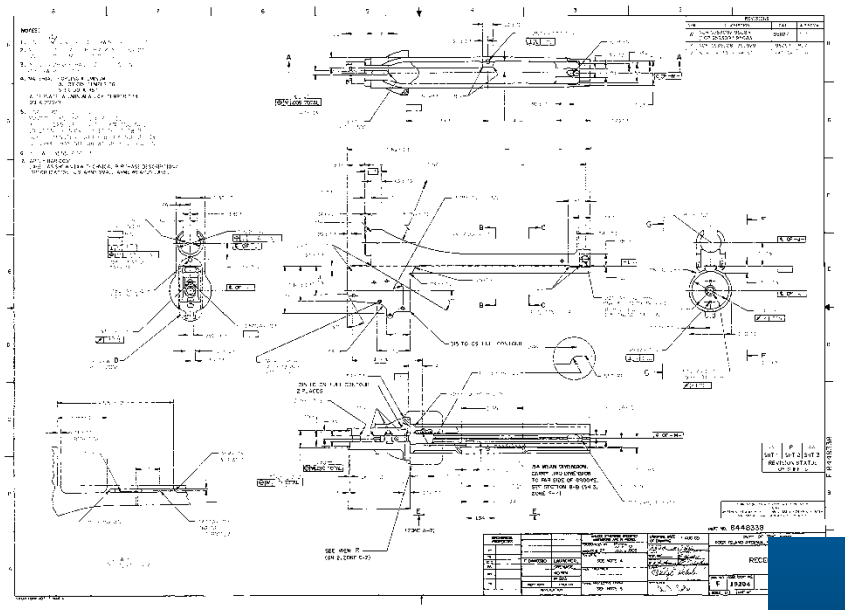
TDP BACKGROUND

- The TDP is the single authoritative definition of the product.
- It is the culmination of the science, engineering and design efforts that came before it...,

  ... and is source data for all mfg., logistics, and acquisition activities which comes after it.

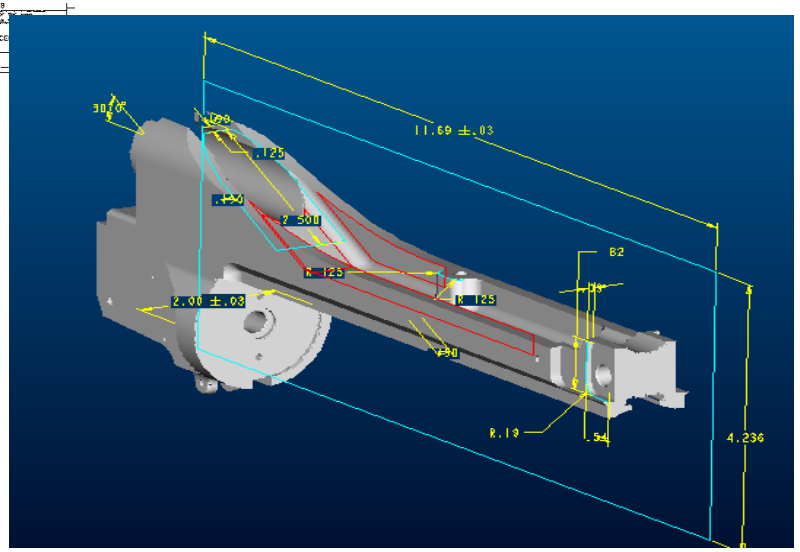


ACCORDING TO -31000: WHAT IS IN A TDP?



- Engineering Design Data (Drawings)
- 3D Models
- Parts Lists (PL)
- Quality Assurance Provisions
- Packaging (Drawings/SPIs)
- Specifications
- Standards
- Gage Drawings
- Test Fixtures
- Inspection Equipment List
- Approved Engineering Changes

•TDPL is the index of all items in a TDP



3D CAD TERMINOLOGY

FORMAT

Native
- -CREO
- -CATIA
- -SolidWorks
- -NX
- -Solid Edge
- -AutoCAD Inventor

-Authoring software.
-Can generate Neutral and Viewable (directly or via third party software.)

or

Neutral
- -STEP
- -IGES
- -STL

-High fidelity model.
-Typically, non-annotated.
-Can be imported into Native.
-Typically intended for Machine-Machine transfer.

or

Viewable
- -3Di pdf
- -JT
- -X3D
- -2D pdf drawing

-Lightweight.
-Typically, fully annotated.
-Widely available and/or free viewer.
-Typically intended for human readable.

ORIGIN

Master

-Source for all other data.
-File from which all changes must originate.
-Almost always Native format.

or

Derivative

-Generated from Master.
-Cannot be directly changed.

VALIDATION STATUS

Authoritative

-Validated to be correct.
-Can “build to” and ”Inspect to”.
-Implied warranty as good data.

or

Reference

-For Information only.
-Can not ”Inspect to”.
-No Implied warranty.

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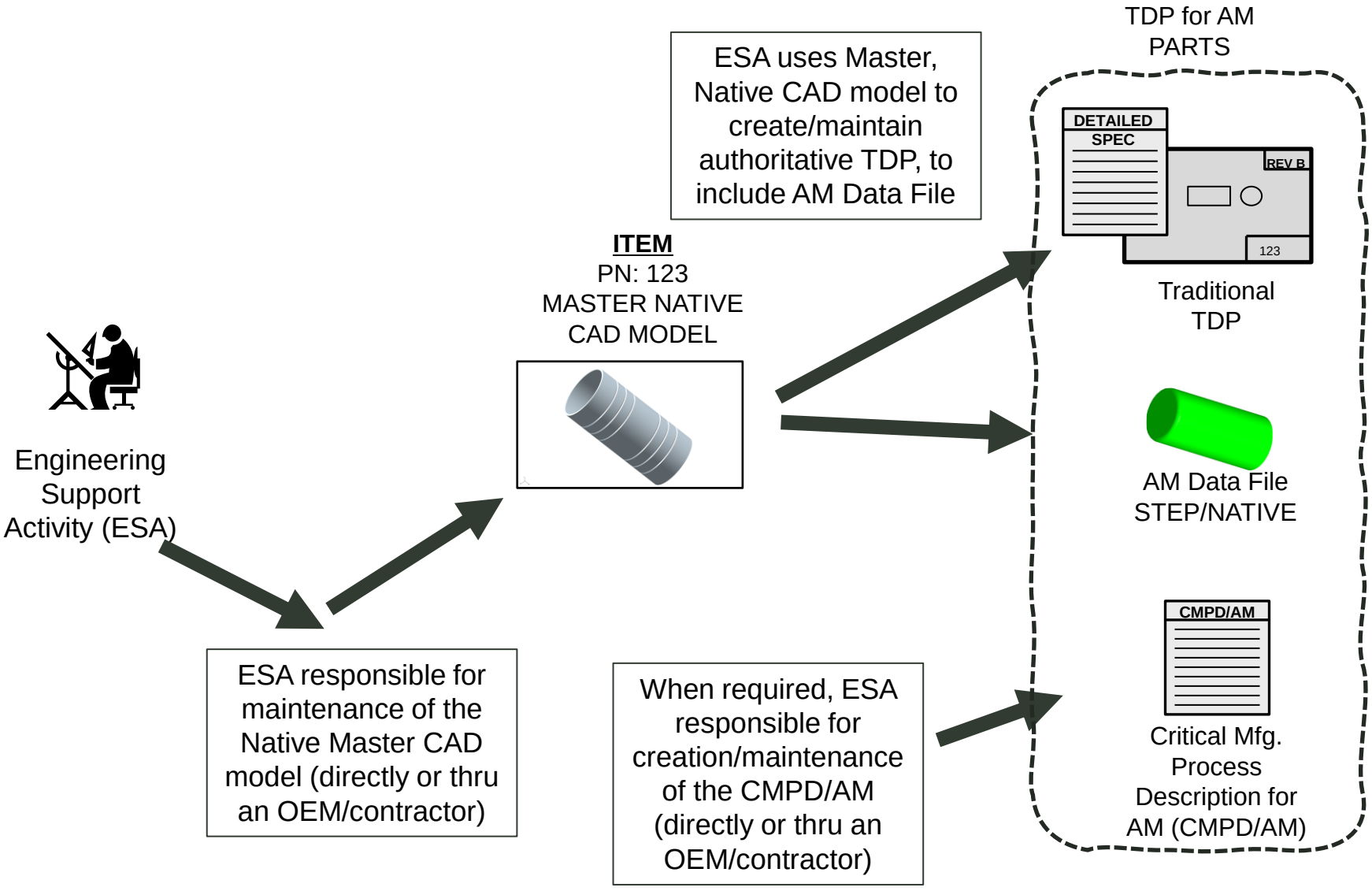
TDP BACKGROUND

DOD receives TDPs from developmental contractors and pass TDPs to production contractors (end item and spare part production).

AM Data Flow – Engineering



RELATED ISSUES

- Working to get the TDP Option Selection Worksheet released as a DD Form (DD 2554).

- NAVSEA has developed a training module on MIL-STD-31000. It is an introduction course to the TDP and -31000:

  Navy e-Learning: https://learning.nel.navy.mil/ELIAASv2p/.

Prefix	Course Number	Course Title
NAVSEA	MIL-STD-31000B-1.0	MIL-STD-31000B Technical Data Package (TDP) Overview for Product Support Managers

- Standard reformatted to meet MIL-STD-962 requirements.

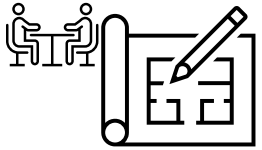
AM Data Flow – Development

1
Govt Acquiring Activity contracts for development of new capability

2
Contract
SOW & CDRL
(Including TDP Option Selection Worksheet)

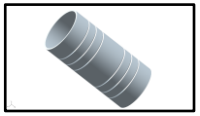
Requires TDP & Native CAD Deliverables

3
Contractor creates new design to include creating Native CAD and TDP

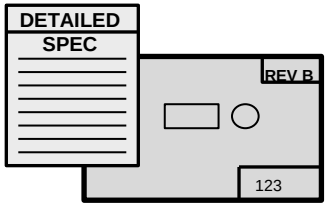


4
Contractor w/Govt oversight decides which components are AM items & which of those need CMPD/AM

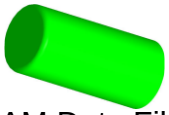
PN: 123



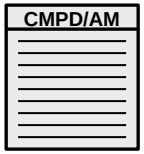
5 TDP for AM PARTS



Traditional TDP



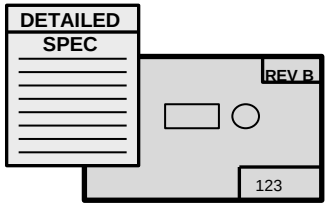
AM Data File STEP/NATIVE



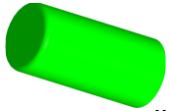
CMPD/AM

AM Data Flow – Logistics/Procurement/Manufacturing

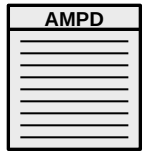
TDP for AM PARTS



Traditional TDP



AM Data File STEP/NATIVE

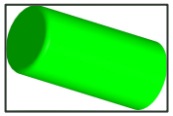


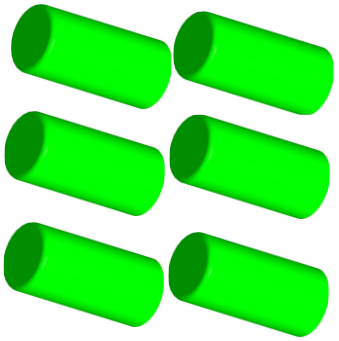
Critical Mfg. Process Description for AM (CMPD/AM)

Industrial Base AM

Organic AM

Creates STL file





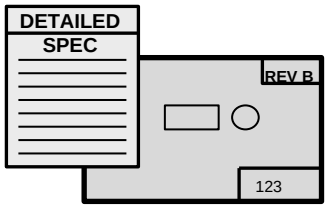
Creates other work process instructions

- Builds parts

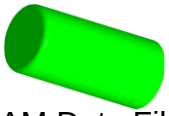
- Verify parts to TDP

AM Data Flow – Field Produced Parts

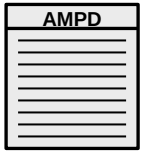
TDP for AM PARTS



Traditional TDP



AM Data File STEP/NATIVE

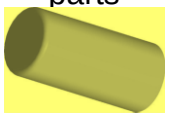


Critical Mfg. Process Description (CMPD/AM)

?

Field Produced AM

Temporary Replacement parts



Permanent Replacement parts