Supporting Army readiness through a robust digital additive manufacturing supply chain

AMNOW

AMNOW Experience with Data Acquisition & Analysis

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AMNOW Program

Demonstrating a robust and capable additive manufacturing supply chain supporting Army readiness

Elevating the capabilities of the additive manufacturing supply chain

- Technology, materials, service
- Supporting processes & technologies
- “Low barrier of entry”

Elevating the additive manufacturing process as a robust, reliable technology

- Complex parts
- Difficult-to-source parts & components
- “Sharpest tool”

Visualizing the additive manufacturing process & supply chain back to US Army

- Regional focus with national scale
- Easy access to this capable technology & the supply chain
- “Source with confidence”

Part Definition (ATDP) & Data Requirements

Initial Contents

- As-Installed Part Model
- Drawing Notes
- Order of Operations

Later Contents

- Table of Order of Operations and Data Requirements

Order	Operation	Data Requirements
1	Load feedstock into machine	AMNOW-913
2	Part Build	AMNOW-931 (LIMS)
3	Remove from machine and de-powder	n.a.
4	Stress Relief	AMNOW-978
5	Build Plate and Support Removal (may perform after HIP or T7)	n.a.
6	HIP	AMNOW-978
7	T7 Heat Treatment	AMNOW-978
8	Tensile coupons may be sent off to machine and test	AMNOW-990
9	Radiography	AMNOW-979
10	Surface Treatment (if performed)	AMNOW-973
11	Interface Machining	AMNOW-975
12	Penetrant Inspection	AMNOW-976
13	Corrosion Protection & Paint	AMNOW-974
14	Dimensional Inspection & Roughness Check/Estimate	ANSI/DMSC QIF AMNOW-990
15	Part Marking	AMNOW-906
16	Packing and Shipping	AMNOW-906

Contents Occasionally Used

- As-Printed Part Model – When Control Needed (Waveguides with Excess Stock for Smoothing)
- Semantic GD&T to Integrate with CMM Machine

What Didn't Work Well

- Incorporating Drawing Notes in 3D-PDF – Attached 2D-PDF at End
- Embedding Dimensional Inspection Requirements – Attached PowerPoint at End
- Simulated Part Qualification Destruct and Testing Requirements – Attached PowerPoint at End

Non-Print Data and Use - Overview

Use of Excel File, Naming Convention, and Common Header Worked

1) 913 – Feedstock Certification
2) 973 – Surface Smoothing
3) 974 – Chemical Finishing
4) 975 – Machining and Grinding
5) 976 – Penetrant Inspection
6) 978 – Thermal Processing
7) 979 – Radiographic Inspection
8) 990 – Coupon Testing

Data Item	Units	Value	Result
AMNOW Document Number	string	**913**	
Part Builder Name	String		na
Part Builder Short Name	String		na
Build Indentification	String		na
Build Start Date and Time	String		na
Build ASOW #	number		na
Group #	number		na
Build #	number		na
AMNOW Part #	number		na

Other Data Files for NDT/Inspection/Test

- DICONDE for Raw Digital Radiographs
- Jpgs for Radiographic & Penetrant Indications, Metallography

All Files Metallurgist-Readable, Machine Readability a Challenge

Print and Coupon Testing Data

Print Data

- Origin of print data is diagnostics printer OEMs developed to develop and improve printers
- Data recorded varies from printer OEM to printer OEM, and within model and OS, including sampling rate
- Significant effort required by LECS Energy to write translators and maintain them

Coupon Testing Data

- While ASTM specifications contain data reporting requirements, no standard for digital data reporting
- AMNOW program developed Excel templates for recording data that is machine and human readable
- Common header as non-print data for traceability
- AMNOW program contracted with 3 labs to write macros to convert test data to Excel format
- Quotient wrote software to automatically ingest coupon test data into database when labs uploaded it
- Significant reductions in time needed to search and analyze data

Recommendation

Stand up Inter-SDO Working Group to Develop Standards for:

- Feedstock
- Printing
- Post-Processing
- NDT & Inspection
- Coupon Testing

Standards Would Include:

- Minimum Types, Precision, and Sampling to be Compliant
- Headers and Naming Conventions for Organization
- Format Requirements for Machine Readability