DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVE SE
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY REFER TO
9070
Ser 05Z/520
18 Oct 24

From: Commander, Naval Sea Systems Command (SEA 05Z)

Subj: GUIDANCE ON ADDITIVE MANUFACTURING OF POLYMERIC MATERIALS FOR SHIPBOARD AND SUBMARINE APPLICATIONS

Ref: (a) NAVSEA ltr 4870 Ser 05T/2018-024 of 17 Aug 18
(b) NAVSEA 0948-LP-045-7010, Revision 3 of Apr 05
(c) MIL-STD-777F of 13 Feb 18
(d) COMUSFLTFORCOMINST 4790.3D, Joint Fleet Maintenance Manual, Ch 4 of 24 Sep 24
(e) NAVSEAINST 4790.8C
(f) S9510-AB-ATM-010 Revision 7 of 1 Oct 20
(g) NMCFHPC ltr 6260 Ser IH/0297 of 1 Dec 23
(h) BUMED ltr 6260 Ser N35/23UN35104 of 5 Dec 23
(i) NMCFHPC ltr 6260 Ser IH/0224 of 23 Sep 24
(j) BUMED ltr 6260 Ser N10F/24UN105083 of 4 Oct 24
(k) NSWCCD-61-TR-2024/2 of Mar 24
(l) NAVSEAINST 5400.95G (Series)

Encl: (1) Polymeric Materials for Surface Shipboard Use
(2) Polymeric Materials for Submarine Forward Compartment / Ancillary Rooms Not Adjacent to Missile Tubes in Missile Compartments
(3) Polymeric Materials for Submarine Engine Compartment

1. Purpose. This correspondence provides guidance for the Additive Manufacturing (AM) of polymeric materials for shipboard and submarine applications. This guidance supersedes reference (a) with respect to polymeric material allowances for manufacture and shipboard installation.

2. Background. Resins used in polymer AM feedstock are typically thermoplastic (i.e., have the ability to readily melt and flow at relatively low temperatures). Thermoplastic materials can have a relatively low energy required for ignition, which pose a shipboard fire safety concern. In a fire, these materials may contribute to fire growth via (1) ease of ignition, (2) increased combustible load, and (3) fire spread due to the potential for flaming droplets of melted polymer. Polymer feedstock with reinforcing particles/fibers, which add additional strength and stiffness to the polymer are available and can assist with mitigation of the flaming droplet concern. Reinforced feedstocks are typically those listed in enclosures (1) through (3) with the highest polymer weight allowances.

3. Applicability

a. This document applies to NAVSEA cognizant systems.

b. This document does not apply to Naval Nuclear Propulsion plant systems, equipment, and facilities under the cognizance of the Deputy Commander, Nuclear Propulsion Directorate (SEA 08). In addition, this document does not supersede or modify existing agreements between SEA 08 and SEA 05 regarding changes to non-reactor plant items in nuclear powered vessels which require SEA 08 concurrence.

c. This document does not apply to Strategic Weapons Systems and Attack Weapon Systems and associated spares and repair parts under the cognizance of Strategic Systems Programs (SSP).

4. NAVSEA Discussion. NAVSEA installation activities and Ship's Commanding Officers are delegated approval authority for the use/installation of polymer AM material but are required to comply with the following exclusions and guidance.

a. Exclusions. The following attributes and systems are excluded from this guidance. For instances where polymer AM is a consideration for these exclusions, contact the cognizant NAVSEA system owner for necessary approvals:

(1) SUBSAFE.

(2) Level I Applications per reference (b).

(3) Fly By Wire.

(4) Deep Submergence System, Scope of Certification.

(5) SEA 08 Cognizant Systems.

(6) Steam Systems.

(7) Strategic Systems Programs.

(8) Combustible Fluid Systems.

(9) Fire Protection Systems.

(10) Components with fire-hardened fitting requirements per reference (c).

(11) Turbine, gear, and blower applications.

(12) Component that would exceed an operating temperature greater than 122 degrees Fahrenheit for enclosures (2) or (3) applications (i.e., submarines) or feedstock manufacturer's specified maximum operating temperature for enclosure (1) applications (i.e., surface ships).

(13) Wetted surfaces (e.g., gaskets) or part of the pressure boundary of fluid systems.

(14) Damage control and firefighting equipment expected to be exposed to elevated temperatures when responding to a fire casualty.

b. Guidance. All polymer AM material to be installed shipboard per this guidance letter must utilize the materials listed in enclosures (1) through (3) and comply with the applicable limitations; the weight limitations in enclosures (1) through (3) do not apply to polymer AM material (e.g., feedstock) properly stowed in noncombustible containers. This letter authorizes the installation and manufacture of polymer AM parts onboard underway submarines, ships, and carriers, per the guidance herein and enclosures (2) and (3).

(1) Polymer AM materials in enclosures (1) through (3) are approved for permanent use without requiring Departure From Specification (DFS) in the following applications. Applicable activities shall

follow the OPNAV 4790/2K process per reference (d) Table 1 of section V-I-5 and reference (e) for all permanent installations.

(a) Replacing a legacy nonmetallic material where the polymer AM material provides the same form, fit, and function, and complies with applicable environmental qualification requirements.

(b) Replacing a legacy material that is below the lowest replaceable unit, where the polymer AM material provides the same form, fit, and function, and complies with applicable environmental qualification requirements.

(2) Polymer AM materials in enclosures (1) through (3) are approved in temporary or transient applications where the polymer AM material provides the same form, fit, and function, and complies with applicable environmental qualification requirements. No DFS is required for all temporary installations and transient material that are removed and/or replaced with a legacy part from supply at the next available opportunity. Applicable activities shall follow the OPNAV 4790/2K process per reference (d) Table 1 of section V-I-5 and reference (e) for temporary installations. For transient applications, to include test builds, applicable activities shall log on the NAVSEA AM Ship Part Log Intake Form provided with the AM printer.

(3) A DFS is required for all polymer AM materials that are replacing a metallic component, if paragraphs 4.b.(1) or 4.b.(2) do not apply.

(4) Local Technical Authority can evaluate the application for permanent installation.

(5) Cumulative weights in enclosures (1) through (3) do not apply when replacing a similar nonmetallic material (e.g. plastic, polymer, composite) with polymer AM material (i.e., permanent or temporary) and only apply to permanent installations (either new AM polymer component or replacing metallic component with AM polymer component).

(6) Enclosures (2) and (3) materials and quantities are assigned to the “Permitted” use category of the reference (f) Submarine Atmospheric Control Manual for the purposes of installation on submarines. For the enclosure (2) and (3) materials, this designation was recommended by the reference (g) Navy and Marine Corps Force Health Protection Command (NMCFHPC) letter and concurred to in the reference (h) Bureau of Medicine and Surgery (BUMED) letter. For the enclosures (2) and (3) materials, if the operating temperature of the installation application is expected to exceed 122 degrees Fahrenheit, the product application should be submitted for material certification per the requirements of 7-2.2 of reference (f).

(7) Nylon 6/CF blend, Onyx CF, TPU95 Black, and Onyx Flame Retardant (FR) are assigned to the “Limited” use category of reference (f) for the purposes of manufacture onboard underway submarines using the Markforged X7 printer only. For these polymer AM feedstocks, this designation was recommended by the reference (i) NMCFHPC letter and concurred to in the reference (j) BUMED letter. The manufacture of these polymer AM materials onboard underway submarines must comply with the applicable limitations in enclosures (2) and (3). The manufacture of polymer AM materials onboard submarines must not occur within the torpedo room or missile compartment.

(8) The fire, smoke, and toxicity (FST) performance of the materials listed in enclosures (1) through (3) are documented in reference (k). When selecting feedstock for AM production (especially permanent applications), users should select the best performing material from an FST perspective

available to them, which are typically those in enclosures (1) through (3) with the highest polymer weight allowances.

c. AM Part Installation Tracking

(1) For polymer parts, applicable activities shall follow the guidance provided in reference (d) Table 1 of section V-I-5 for the submission of an OPNAV 4790/2K required by reference (e).

(2) For applications where a DFS is determined to be required, NAVSEA installation activities and Ship's Commanding Officers shall submit a (temporary or permanent) DFS, per reference (d) or (l), and select "Additive Manufacture" as the DFS Basis.

(3) Activities providing private contractor oversight shall retain any approval authority as invoked by contract. Design/Planning/Executing Agents are requested to provide the authorizing document tracking number, ship class, and hull number for all polymer AM parts installed per the guidance of this letter to NAVSEA_AM@us.navy.mil, within two weeks of authorization.

5. NAVSEA Action

a. NAVSEA approves the installation of polymeric AM materials per paragraph 4 and enclosures (1) through (3) of this letter.

b. NAVSEA supersedes reference (a), enclosure (2), paragraphs 2.b., 5, 9, 11d, Figure E-1, and enclosure (4) Table E-2 per paragraph 4 of this letter.

c. NAVSEA delegates approval authority to NAVSEA installation activities and Ship's Commanding Officers to use, install, and monitor weight allowances of polymer AM components where the guidance of this letter is followed.

6. The NAVSEA point of contact for this letter is Dr. Justin Rettaliata, AM Technical Warrant Holder, 202-781-5312, justin.m.rettaliata.civ@us.navy.mil.

7. The requirements of this letter do not authorize any change in the terms, conditions, delivery schedule or price or amount of the subject contract or any other Government contract. In the event that you consider that these requirements represent a change for which you are entitled to an equitable adjustment, you are to comply with the requirements of the "Notification of Changes" clause of the contract.

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Material	Vendor [6]	AM Process Type	Notes	Polymer Weight Allowance per Compartment Square Footage (ft²) [1]										Mark [2]
				Under 500 ft²		500-1000 ft²		1000-3000 ft²		3000-6000 ft²		Over 6000 ft²		
				[Lb]	[kg]	[lb]	[kg]	[lb]	[kg]	[lb]	[kg]	[lb]	[kg]	
ULTEM 9085	Any	ME	[4][8]	57	25.9	59	26.8	73	33.2	99	45	115	52.3	8
ULTEM 1010	Any	ME	[4][8]	42	19.1	43	19.5	45	20.5	49	22.3	51	23.2	7
PEKK	Any	ME	[4][8]	17	7.7	17	7.7	18	8.2	20	9.1	21	9.5	24
Duraform GF	3D Systems	PBF	[3][5]	8	3.6	11	5	23	10.5	48	21.8	63	28.6	5
Onyx FR	Markforged	ME	[3][5] [7]	7	3.2	8	3.6	10	4.5	14	6.4	16	7.3	25
FormLabs R10KR	FormLabs	SLA	[3]	7	3.2	7	3.2	11	5	19	8.6	24	10.9	28
Nylon 12	Any	Any	[3][5] [8]	6	2.7	7	3.2	14	6.4	26	11.8	34	15.5	3
Duraform HST	3D Systems	PBF	[3][5]	6	2.7	7	3.2	15	6.8	30	13.6	39	17.7	4
Polycarbonate	Any	ME	[3][5] [8]	6	2.7	6	2.7	7	3.2	8	3.6	10	4.5	6
Duraform EX	3D Systems	PBF	[3]	5	2.3	6	2.7	11	5	21	9.5	27	12.3	10
Duraform FR100	3D Systems	PBF	[3]	5	2.3	5	2.3	6	2.7	10	4.5	11	5	11
Nylon 6/CF Blend	Any	ME	[3][5] [7]	5	2.3	6	2.7	10	4.5	19	8.6	25	11.4	17
Onyx CF (Any Setting)	Markforged	ME	[3][7]	5	2.3	6	2.7	8	3.6	12	5.5	14	6.4	18
Nylon 6	Any	ME	[3][5] [7][8]	5	2.3	6	2.7	10	4.5	19	8.6	25	11.4	22
FormLabs FL8001	FormLabs	SLA	[3]	5	2.3	6	2.7	15	6.8	31	14.1	41	18.6	27
PC ABS	Any	ME	[3][5] [8]	4	1.8	4	1.8	4	1.8	6	2.7	7	3.2	9
ABS ESD 7	Stratasys	ME	[4]	4	1.8	4	1.8	5	2.3	7	3.2	8	3.6	14
MJF PA-12	Hewlett-Packard	BJF	[3][5]	4	1.8	4	1.8	6	2.7	10	4.5	12	5.5	16
Nylon 12/CF	Any	ME	[3][5] [7]	4	1.8	5	2.3	8	3.6	15	6.8	19	8.6	23
FormLabs DUCL02	FormLabs	SLA	[3]	4	1.8	4	1.8	7	3.2	12	5.5	16	7.3	26
PETG	Any	ME	[3][5] [8]	3	1.4	4	1.8	7	3.2	12	5.5	15	6.8	1
ASA	Any	ME	[3][5] [8]	3	1.4	3	1.4	4	1.8	5	2.3	6	2.7	13
ABS CF	Any	ME	[4]	3	1.4	3	1.4	4	1.8	5	2.3	6	2.7	15
TPU	Any	ME	[3][5]	3	1.4	3	1.4	5	2.3	8	3.6	10	4.5	21
ABS	Any	ME	[3][5] [8]	2	0.9	2	0.9	4	1.8	6	2.7	8	3.6	2

[1] When two or more different polymer AM materials are used in the same space, notification and approval from the AM TWH is required if the total amount of combined material exceeds the lesser of the individual polymer weight allowance for each material present.
[2] All AM components shall be marked using indelible ink (black, silver, etc.), or another permanent marking method, that labels the material based on the number above. The number shall be circled.
[3] When material installation is constrained due to the height restriction, the material shall be limited to heights less than or equal to 6ft above the deck, and should not be installed in a location that is considered "overhead" such as above a watch or work station.
[4] For materials that experience no flaming droplets when subjected to flame testing, and are not weight bearing/supporting and weigh less than 2 lbs. (.91 kg), there is no height restriction on bulkheads, and no prohibition on ceiling mounting.
[5] For parts/components that weigh less than 0.5 lb (0.23 kg), there is no height restriction on bulkheads if they are not weight bearing/supporting components.
[6] AM TWH approval is required to substitute an equivalent material from an alternate vendor.
[7] Any addition of Continuous Fiber Filament (CFF) would not change the FST allowable.
[8] The inclusion of glass-filled particles (fiber, bead, etc.) is acceptable and has no change to FST allowance.

Polymeric Materials for Submarine Forward Compartment / Ancillary Rooms Not Adjacent to Missile Tubes in Missile Compartments

Material	Vendor [6]	AM Process Type	Notes	Polymer Weight Allowance (pounds [lb] or kilogram [kg]) per Compartment Square Footage (ft²) [1]						Mark [2]
				Under 350 ft²		350-1000 ft²		Over 1000 ft²		
				[lb]	[kg]	[lb]	[kg]	[lb]	[kg]	
ULTEM 9085	Any	ME	[4][8]	7	3.2	7	3.2	10	4.5	8
PEKK	Any	ME	[4][8]	5	2.3	5	2.3	7	3.2	24
Onyx FR	Markforged	ME	[3][5]	4	1.8	7	3.2	7	3.2	25
Duraform FR100	3D Systems	PBF	[3]	3	1.4	6	2.7	7	3.2	11
Nylon 12	Any	Any	[3][5] [8]	2	0.9	5	2.3	7	3.2	3
Duraform HST	3D Systems	PBF	[3][5]	2	0.9	5	2.3	6	2.7	4
Duraform GF	3D Systems	PBF	[3][5]	2	0.9	6	2.7	7	3.2	5
ULTEM 1010	Any	ME	[4][8]	2	0.9	2	0.9	6	2.7	7
PC ABS	Any	ME	[3][5] [8]	2	0.9	3	1.4	4	1.8	9
MJF PA-12	Hewlett-Packard	BJF	[3][5]	2	0.9	4	1.8	5	2.3	16
FormLabs R10KR	FormLabs	SLA	[3]	2	0.9	7	3.2	9	4.1	28
PETG	Any	ME	[3][5] [8]	1	0.5	5	2.3	7	3.2	1
ABS	Any	ME	[3][5] [8]	1	0.5	3	1.4	3	1.4	2
Polycarbonate	Any	ME	[3][5] [8]	1	0.5	3	1.4	3	1.4	6
Duraform EX	3D Systems	PBF	[3]	1	0.5	1	0.5	1	0.5	10
ASA	Any	ME	[3][5] [8]	1	0.5	3	1.4	4	1.8	13
ABS ESD 7	Stratasys	ME	[4]	1	0.5	3	1.4	5	2.3	14
ABS CF	Any	ME	[4]	1	0.5	2	0.9	3	1.4	15
Nylon 6/CF Blend	Any	ME	[3][5] [7][8]	1	0.5	1	0.5	1	0.5	17
Onyx CF (Any Setting)	Markforged	ME	[3][7]	1	0.5	3	1.4	3	1.4	18
TPU	Any	ME	[3][5]	1	0.5	4	1.8	4	1.8	21
Nylon 6	Any	ME	[3][5] [7][8]	1	0.5	4	1.8	4	1.8	22
Nylon 12/CF	Any	ME	[3][5]	1	0.5	5	2.3	7	3.2	23
FormLabs DUCL02	FormLabs	SLA	[3]	1	0.5	3	1.4	4	1.8	26
FormLabs FL8001	FormLabs	SLA	[3]	1	0.5	2	0.9	3	1.4	27

[1] When two or more different polymer AM materials are used in the same space, notification and approval from the AM TWH is required if the total amount of combined material exceeds the lesser of the individual polymer weight allowance for each material present.
[2] All AM components shall be marked using indelible ink (black, silver, etc.), or another permanent marking method, that labels the material based on the number above. The number shall be circled.
[3] When material installation is constrained due to the height restriction, the material shall be limited to heights less than or equal to 6ft above the deck, and should not be installed in a location that is considered “overhead” such as above a watch or work station.
[4] For materials that experience no flaming droplets when subjected to flame testing, and are not weight bearing/supporting and weigh less than 2 lbs. (.91 kg), there is no height restriction on bulkheads, and no prohibition on ceiling mounting.
[5] For parts/components that weigh less than 0.5 lb (0.23 kg), there is no height restriction on bulkheads if they are not weight bearing/supporting components.
[6] AM TWH approval is required to substitute an equivalent material from an alternate vendor.
[7] Any addition of Continuous Fiber Filament (CFF) would not change the FST allowable.
[8] The inclusion of glass-filled particles (fiber, bead, etc.) is acceptable and has no change to FST allowance.

Material	Vendor [6]	AM Process Type	Notes	Polymer Weight Allowance (pounds [lb] or kilogram [kg]) per Compartment Square Footage (ft²) [1]								Mark [2]
				Under 2000 ft²		2000-4000 ft²		4000-6000 ft²		Over 6000 ft²		
				[lb]	[kg]	[lb]	[kg]	[lb]	[kg]	[lb]	[kg]	
ULTEM 1010	Any	ME	[4][8]	85	38.6	95	43.2	95	43.2	95	43.2	7
ULTEM 9085	Any	ME	[4][8]	69	31.4	90	40.9	124	56.4	133	60.5	8
PEKK	Any	ME	[4][8]	31	14.1	39	17.7	66	30	74	33.6	24
Nylon 12/CF	Any	ME	[3][5]	8	3.6	12	5.5	14	6.4	15	6.8	23
Duraform FR100	3D Systems	PBF	[3]	6	2.7	8	3.6	11	5	13	5.9	11
Onyx FR	Markforged	ME	[3][5]	6	2.7	8	3.6	11	5	13	5.9	25
FormLabs R10KR	FormLabs	SLA	[3]	6	2.7	8	3.6	13	5.9	18	8.2	28
Duraform HST	3D Systems	PBF	[3][5]	5	2.3	8	3.6	13	5.9	15	6.8	4
Duraform GF	3D Systems	PBF	[3][5]	5	2.3	7	3.2	11	5	13	5.9	5
TPU	Any	ME	[3][5]	5	2.3	8	3.6	13	5.9	17	7.7	21
Nylon 12	Any	Any	[3][5][8]	4	1.8	7	3.2	8	3.6	8	3.6	3
Polycarbonate	Any	ME	[3][5][8]	4	1.8	7	3.2	9	4.1	10	4.5	6
Duraform EX	3D Systems	PBF	[3]	4	1.8	6	2.7	7	3.2	8	3.6	10
Nylon 6/CF Blend	Any	ME	[3][5]	4	1.8	6	2.7	10	4.5	12	5.5	17
Onyx CF (Any Setting)	Markforged	ME	[3][7]	4	1.8	7	3.2	12	5.5	15	6.8	18
Nylon 6	Any	ME	[3][5][7][8]	4	1.8	6	2.7	7	3.2	7	3.2	22
PETG	Any	ME	[3][5][8]	3	1.4	5	2.3	8	3.6	11	5	1
PC ABS	Any	ME	[3][5][8]	3	1.4	4	1.8	5	2.3	6	2.7	9
FormLabs DUCL02	FormLabs	SLA	[3]	3	1.4	4	1.8	6	2.7	7	3.2	26
ASA	Any	ME	[3][5][8]	2	0.9	3	1.4	4	1.8	5	2.3	13
ABS ESD 7	Stratasys	ME	[4]	2	0.9	4	1.8	5	2.3	6	2.7	14
ABS CF	Any	ME	[4]	2	0.9	4	1.8	5	2.3	6	2.7	15
MJF PA-12	Hewlett-Packard	BJF	[3][5]	2	0.9	4	1.8	6	2.7	10	4.5	16
FormLabs FL8001	FormLabs	SLA	[3]	2	0.9	3	1.4	5	2.3	6	2.7	27
ABS	Any	ME	[3][5][8]	1	0.5	2	0.9	3	1.4	4	1.8	2

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[4] For materials that experience no flaming droplets when subjected to flame testing, and are not weight bearing/supporting and weigh less than 2 lbs. (.91 kg), there is no height restriction on bulkheads, and no prohibition on ceiling mounting.
[5] For parts/components that weigh less than 0.5 lb (0.23 kg), there is no height restriction on bulkheads if they are not weight bearing/supporting components.
[6] AM TWH approval is required to substitute an equivalent material from an alternate vendor.
[7] Any addition of Continuous Fiber Filament (CFF) would not change the FST allowable.
[8] The inclusion of glass-filled particles (fiber, bead, etc.) is acceptable and has no change to FST allowance.