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NAVAL SURFACE WARFARE CENTER
CARDEROCK DIVISION

NAVAL SHIP SYSTEMS
ENGINEERING STATION
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IN REPLY REFER TO

9551

Ser 926/051

22 May 2006

From: Commander, Carderock Division, Naval Surface Warfare Center,
Philadelphia, PA 19112-1403

To: Program Executive Officer, Ships (PMS 400D)

Subj: SELECTIVE APPROVAL OF MONEL ¼" TO 1" SWAGELOK MECHANICALLY
ATTACHED FITTINGS (MAF) IN COMPRESSED AIR SYSTEMS ON SURFACE
SHIPS

Ref: (a) Swagelok Company ltr of 25 January 2005, Re: Alloy 400/405 ¼" through 1"
Swagelok Tube Fittings and ASTM F 1387-99
(b) Swagelok Company, Test Report, Alloy 400/405 Swagelok Tube Fitting Testing per
ASTM F 1387-99 with 70/30 Copper-Nickel Tubing per MIL-T-16420K, 21 Jan 2005
(c) ASTM F 1387-99, Standard Specification for Performance of Piping and Tubing
Mechanically Attached Fittings
(d) MIL-T-16420K, Military Specification, Tube, Copper-Nickel Alloy, Seamless and
Welded, 14 April 1978
(e) MIL-STD-777E, Military Standard, Schedule of Piping, Valves, Fittings, and
Associated Components for Naval Surface Ships, 7 Feb 1986
(f) Naval Ship's Technical Manual (NSTM), S9086-RK-STM-010/CH-505, Piping
Systems, Revision 2 dated 1 Dec 2001

Encl: (1) Rationale for Selective Approval of Swagelok Tube Fittings for Shipboard Use,
NSWCCD-SSES Code 926, May 2006
(2) Cross Reference of Categories and Groups for Compressed Air Systems

1. As requested by Program Executive Office Ships, PMS 400D, Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station (NSWCCD-SSES) Code 926 has reviewed reference (a), a request for approval of Swagelok Company's Alloy 400/405 (Monel) ¼" through 1" OD Mechanically Attached Fittings.

2. Reference (a) forwarded reference (b), a report of testing conducted by Swagelok in accordance with reference (c). All testing was conducted on 70/30 Copper-Nickel (CuNi) tubing in accordance with reference (d), and rationale for extension of test results to apply to 90/10 CuNi tubing in accordance with reference (d) was provided by Swagelok.

3. Reference (e) specifies the Service Categories and Groups of non-nuclear piping systems on surface ships. The categories applicable to compressed air systems are J-1 through J-9. References (e) and (f) address fire hardened fittings and their applications.

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4. The Alloy 400/405 (Monel) Swagelok Tube Fittings were determined to be in compliance with reference (c), Type IV (Grip-Type), Grade C, Class 8 (Class 10 for ¼” OD) and are approved for limited use on CuNi tubing in compressed air systems applications as outlined below. The use of 70/30 versus 90/10 CuNi tubing shall be as specified in reference (e) for each Compressed Air System category. Note that this approval is not applicable to Submarines, Nuclear Systems, or Nuclear Surface Ship Machinery Spaces.

a. The Monel ¼” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-4, J-7, and J-8 throughout the ship, including Fire Hazardous Spaces.

b. The Monel ¼” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-2 and J-3 in Non-Fire Hazardous Spaces only. These fittings are not approved for use in Fire Hazardous Spaces, or in any Category J-1 High Pressure Air application.

c. The Monel 3/8” through 1” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-2, J-3, J-4, J-7, and J-8 in Non-Fire Hazardous Spaces only. These fittings are not approved for use in Fire Hazardous Spaces, or in any Category J-1 High Pressure Air application.

7. Technical rationale for approval of the Swagelok Tube Fittings and details of the applications within the various compressed air system categories is provided in enclosure (1).

8. Care must be taken during construction and maintenance of piping systems to ensure that the different material fittings, including their components (i.e. nuts and ferrules), are only used on the proper tubing. Also, care must be taken not to mix components from different manufacturers of tubing fittings.

9. Note that there may be differences between the categories and groups delineated in reference (e) and a Project Peculiar Document (PPD) being used for new construction. Enclosure (2) is a cross reference table between reference (e) and PPD 802-5959353AT.

10. NSWCCD-SSES point of contact is Keith Grimes, Code 926, Commercial (215) 897-7248, DSN 443-7248 or e-mail: keith.grimes@navy.mil.



T. A. PEROTTI
By direction

Copy to:
NAVSEA Washington, DC (Codes 05Z9, 05P4)

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ATTACHED FITTINGS (MAF) IN COMPRESSED AIR SYSTEMS ON SURFACE
SHIPS

(cont'd)

Swagelok Company
29500 Solon Road
Solon, OH 44139
Attn: John Karkosiak

Rationale for Selective Approval of Swagelok Tube Fittings for Shipboard Use
NSWCCD-SSES Code 926
May 2006

References:

- (a) ASTM F 1387-99, Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings
- (b) Swagelok Company ltr of 25 January 2005, Re: Alloy 400/405 ¼” through 1” Swagelok Tube Fittings and ASTM F 1387-99
- (c) Swagelok Company, Test Report, Alloy 400/405 Swagelok Tube Fitting Testing per ASTM F 1387-99 with 70/30 Copper-Nickel Tubing per MIL-T-16420K, 21 Jan 2005
- (d) MIL-T-16420K, Military Specification, Tube, Copper-Nickel Alloy, Seamless and Welded, 14 April 1978
- (e) Swagelok Company ltr of 7 April 2006, Re: Approval of Swagelok, ¼” to 1” OD, 3750 PSIG and 6000 PSIG, Monel, Mechanically Attached Fittings (MAF), Non-Fire Hardened Applications, Surface Ships Only
- (f) Swagelok Company email of 7 April 2006, Re: Supplemental Information on Monel Tube Fittings
- (g) MIL-STD-777E, Military Standard, Schedule of Piping, Valves, Fittings, and Associated Components for Naval Surface Ships, 7 Feb 1986
- (h) NSWCCD-SSES ltr 9165 Ser 9234/056 dated 29 Nov 2005
- (i) Naval Ship’s Technical Manual (NSTM), S9086-RK-STM-010/CH-505, Piping Systems, Revision 2 dated 1 Dec 2001

Background:

Reference (a) provides specifications for material selection and testing of piping and tubing Mechanically Attached Fittings (MAFs). Type IV MAFs are described in reference (a) as Grip-Type (Separable). Material Grade C refers to Nickel-Copper (Monel) fittings. The Class of a MAF refers to its maximum operating pressure. Class 8 is 3,750 psi maximum; Class 10 is 6,000 psi maximum.

Swagelok Company has interest in obtaining approval for shipboard use of their Alloy 400/405 (Monel) Tube Fittings, which were designed to be in compliance with reference (a), Type IV, Grade C, Class 8 (Class 10 for ¼” OD). To that end, Swagelok Company performed testing meeting the requirements of reference (a). Reference (b) forwarded a test report, reference (c), for review and approval. Testing was accomplished using Monel fittings on 70/30 Copper-Nickel (CuNi) tubing in accordance with reference (d). Extension of test results for approval for using Monel fittings on 90/10 CuNi tubing, in accordance reference (d), was also requested. References (e) and (f) provided engineering rationale to support extension of the test results.

Discussion:

Paragraph 5 of reference (g) specifies the Service Categories and Groups of non-nuclear piping systems on surface ships. The categories applicable to compressed air systems are provided in Table 1.

Table 1 – Service Categories and Groups for Compressed Air Systems

Category/ Group	Medium/Service	Max. Pressure	Max. Temperature
J-1	Air, Nitrogen and Helium	6000 psig	150°F
J-2	Air, Nitrogen and Helium	3300 psig	150°F
J-3	Air and Nitrogen	600 psig	150°F
J-4	Air and Nitrogen	200 psig	150°F
J-5	Air, Aircraft, Starting and Cooling, Bleed-off and 20.2 psi Absolute System	150 psig	550°F
J-6	Air, Aircraft, Starting and Cooling, Main System	150 psig	450°F
J-7	Air, Prairie-Masker, Gas Turbine Starting, Sewage Aerating	100 psig	600°F
J-8	Air, Deballast	50 psig	400°F
J-9	Gas Turbine Bleed Air System	250 psig	950°F

Reference (b) requested General Approval for the use of the Monel fittings in numerous fluid systems utilizing 70/30 and 90/10 CuNi tubing. Via reference (h), Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station (NSWCCD-SSES) Code 9234 approved the fittings for use in seawater systems (Categories D-1, D-2, and D-3).

Reference (b) further requests Selective Approval for the use of the Monel fittings in numerous other fluid systems, including Compressed Air Systems (Categories J-1, J-2, J-3, J-4, J-7 and J-8).

Fire hardened fitting requirements and applications are addressed in reference (g) paragraph 4.14.1 and reference (i) paragraph 505-7.9. Fire hardened fittings are required in Fire Hazardous Spaces for Category J-2, J-3, J-4, J-7, and J-8 Air Systems with Copper and CuNi Piping. Fire hardened fittings are required throughout the ship in all J-1 Air Systems, and J-2 through J-7 and J-9 Air Systems with Steel and CRES piping.

Findings:

NSWCCD-SSES Code 9214 has reviewed the information provided in references (b) and (c) and found the testing methods to be satisfactory and in compliance with reference (a). For the 3/8” to 1” OD tube fittings, testing was accomplished to qualify for operating pressures up to 3750 psig (Class 8). For the 1/4” OD tube fitting, testing was accomplished to qualify for operating pressures up to 6000 psig (Class 10).

The Alloy 400/405 (Monel) 1/4” OD Swagelok Tube Fittings were determined to be in compliance with reference (a) Type IV, Grade C, up to Class 10 when used on 70/30 CuNi and 90/10 CuNi tubing. The 1/4” OD fitting also passed the supplemental Fire Test

in accordance with reference (a) up to 500 psig, qualifying the use of the Monel ¼” OD Swagelok Tube Fittings for use in systems that have operating pressures below 500 psig, use CuNi tubing, and require fire hardened fittings as defined by references (g) and (i). The ¼” OD fittings are not qualified for use in applications that have operating pressures above 500 psig and require fire hardened fittings as defined by references (g) and (i).

The Alloy 400/405 (Monel) 3/8” through 1” OD Swagelok Tube Fittings were determined to be in compliance with reference (a) Type IV, Grade C, up to Class 8 when used on 70/30 and 90/10 CuNi tubing. These sizes of fittings did not pass the supplemental Fire Test in accordance with reference (a). Therefore the Monel 3/8” through 1” OD Swagelok Tube Fittings are not qualified for use in systems with CuNi tubing that require fire hardened fittings as defined by references (g) and (i).

Table 2 provides a summary of piping materials allowed in the various categories of Compressed Air Systems per reference (g). It also summarizes the applicability of Swagelok Type IV MAFs to these piping systems. According to reference (i) Table 505-6-5, similar stainless steel Swagelok Type IV, Class 8, Grade B MAFs have previously been granted selective approval for use on stainless steel piping. Their applicability to Compressed Air Systems is shown in the top section of Table 2. All other sections of Table 2 are referring to the Monel Swagelok Tube Fittings under review.

Conclusions/Recommendations:

The Alloy 400/405 (Monel) ¼” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-4, J-7, and J-8 throughout the ship, including Fire Hazardous Spaces.

The Alloy 400/405 (Monel) ¼” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-2 and J-3 in Non-Fire Hazardous Spaces only. These fittings are not approved for use in Fire Hazardous Spaces, or in any Category J-1 High Pressure Air application.

The Alloy 400/405 (Monel) 3/8” through 1” OD Swagelok Tube Fittings are approved for use in Compressed Air Systems categories J-2, J-3, J-4, J-7, and J-8 in Non-Fire Hazardous Spaces only. These fittings are not approved for use in Fire Hazardous Spaces, or in any Category J-1 High Pressure Air application.

It is important to note that these approvals, and the approvals previously granted for stainless steel Swagelok Tube Fittings, are specific to the tubing material they are to be used on. The stainless steel Swagelok Tube Fittings are only approved for use on stainless steel tubing as delineated in reference (i). Furthermore, the Monel Swagelok Tube Fittings are only approved for use on reference (d) 70/30 and 90/10 CuNi tubing.

Care must be taken during construction and maintenance of piping systems to ensure that the different material fittings, including their components (i.e. nuts and ferrules), are only used on the proper tubing. Also, care must be taken not to mix components from different manufacturers of tubing fittings.

NSWCCD-SSSES Code 926 POC is Keith Grimes, 215-897-7248.

Table 2 - Type IV MAFs in Compressed Air Systems

		COMPRESSED AIR SYSTEM CATEGORY AND GROUP									
		J-1	J-2	J-3	J-4	J-5	J-6	J-7	J-8	J-9	
PIPING MATERIAL	CRES	1/4" OD	Not Approved ¹	Not Approved ¹	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹
		3/8" OD	Not Approved ¹	Not Approved ¹	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹
		1/2" OD	Not Approved ¹	Not Approved ¹	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹	Not Approved ¹	N/A ³	Not Approved ¹
		5/8" OD	Approved ²	Approved ²	Approved ²	Approved ²	N/A ³	Approved ²	Approved ²	N/A ³	Approved ²
		3/4" OD	Approved ²	Approved ²	Approved ²	Approved ²	N/A ³	Approved ²	Approved ²	N/A ³	Approved ²
		1" OD	Approved ²	Approved ²	Approved ²	Approved ²	N/A ³	Approved ²	Approved ²	N/A ³	Approved ²
	70/30 CuNi	1/4" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Approved ⁷	N/A ³	N/A ³	Approved ⁷	N/A ³	N/A ³
		3/8" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Partial Approval ⁶	N/A ³	N/A ³	Partial Approval ⁶	N/A ³	N/A ³
		1/2" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Partial Approval ⁶	N/A ³	N/A ³	Partial Approval ⁶	N/A ³	N/A ³
		5/8" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Partial Approval ⁶	N/A ³	N/A ³	Partial Approval ⁶	N/A ³	N/A ³
		3/4" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Partial Approval ⁶	N/A ³	N/A ³	Partial Approval ⁶	N/A ³	N/A ³
		1" OD	Not Approved ⁴	Partial Approval ⁶	Partial Approval ⁶	Partial Approval ⁶	N/A ³	N/A ³	Partial Approval ⁶	N/A ³	N/A ³
	90/10 CuNi	1/4" OD	N/A ³	N/A ³	N/A ³	Approved ^{7,9}	N/A ³	N/A ³	Approved ^{7,9}	Approved ^{7,9}	N/A ³
		3/8" OD	N/A ³	N/A ³	N/A ³	Partial Approval ^{8,9}	N/A ³	N/A ³	Partial Approval ^{8,9}	Partial Approval ^{8,9}	N/A ³
		1/2" OD	N/A ³	N/A ³	N/A ³	Partial Approval ^{8,9}	N/A ³	N/A ³	Partial Approval ^{8,9}	Partial Approval ^{8,9}	N/A ³
		5/8" OD	N/A ³	N/A ³	N/A ³	Partial Approval ^{8,9}	N/A ³	N/A ³	Partial Approval ^{8,9}	Partial Approval ^{8,9}	N/A ³
		3/4" OD	N/A ³	N/A ³	N/A ³	Partial Approval ^{8,9}	N/A ³	N/A ³	Partial Approval ^{8,9}	Partial Approval ^{8,9}	N/A ³
		1" OD	N/A ³	N/A ³	N/A ³	Partial Approval ^{8,9}	N/A ³	N/A ³	Partial Approval ^{8,9}	Partial Approval ^{8,9}	N/A ³
	Copper	1/4" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
		3/8" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
		1/2" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
		5/8" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
		3/4" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
		1" OD	N/A ³	Not Tested ¹⁰	Not Tested ¹⁰	Not Tested ¹⁰	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³
Glass Reinforced Plastic (GRP)	1/4" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
	3/8" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
	1/2" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
	5/8" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
	3/4" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
	1" OD	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	
Carbon Steel	1/4" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	
	3/8" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	
	1/2" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	
	5/8" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	
	3/4" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	
	1" OD	N/A ³	N/A ³	N/A ³	N/A ³	Not Tested ¹⁰	N/A ³	N/A ³	N/A ³	N/A ³	

- Note 1: MIL-STD-777E Requires Fire Hardened Fittings in this System throughout the entire ship when using CRES Piping. CRES fittings of this size were previously reviewed and are not approved for fire hardened fitting applications per NSTM Chap 505.
- Note 2: MIL-STD-777E Requires Fire Hardened Fittings in this System throughout the entire ship when using CRES Piping. CRES fittings of this size were previously approved for fire hardened fitting applications per NSTM Chap 505.
- Note 3: MIL-STD-777E does not allow this material of piping to be used in this category of System.
- Note 4: MIL-STD-777E Requires Fire Hardened Fittings in this System throughout the entire ship. This size Monel fitting did not pass the Fire Test per ASTM F1387 for pressures over 500 psig. This size Monel fitting is not approved for use in Category J-1 Systems.
- Note 5: MIL-STD-777E Requires Fire Hardened Fittings in this System throughout the entire ship. This size Monel fitting did not pass the Fire Test per ASTM F1387. This size Monel fitting is not approved for use in Category J-1 Systems.
- Note 6: MIL-STD-777E Requires Fire Hardened Fittings in this System in Fire Hazardous Spaces only. This size Monel fitting did not pass the Fire Test per ASTM F1387 for pressures over 500 psig. This size Monel fitting is approved for use in this category System on this material of tubing in Non-Fire Hazardous Spaces only.
- Note 7: Swagelok conducted testing per ASTM F1387 for qualification of their Alloy 400/R-405 (Monel) Fittings for use on CuNi Tubing. Testing conducted meets the all requirements of NSTM Chap 505 and MIL-STD-777E for this category System. The 1/4" OD Monel fittings are approved for use in this category System on this material of tubing throughout the entire ship.
- Note 8: MIL-STD-777E Requires Fire Hardened Fittings in this System in Fire Hazardous Spaces only. This size Monel fitting did not pass the Fire Test per ASTM F1387. This size Monel fitting is approved for use in this category System on this material of tubing in Non-Fire Hazardous Spaces only.
- Note 9: All testing was accomplished using Monel fittings on 70/30 CuNi tubing. Approval was requested for use of the Monel fittings on 90/10 CuNi tubing as well, and technical rationale was provided to support the extension of the test results.
- Note 10: All testing was accomplished using Monel fittings on 70/30 CuNi tubing. Approval was not requested for use of Monel fittings on this material of piping, therefore no approval is granted.

Cross Reference of Categories and Groups for Compressed Air Systems

MIL-STD-777		Max. Pressure	Max. Temperature	PPD 802-5959353AT	
Category/ Group	Medium/Service			Medium/Service	Category/ Group
J-1	Air, Nitrogen and Helium	6000 psig	150°F	Air (for DDG 82 & Follow)	J-1
J-2	Air, Nitrogen and Helium	3300 psig	150°F	Air and Nitrogen	J-2
J-3	Air and Nitrogen	600 psig	150°F	Air and Nitrogen	J-4
N/A	N/A	150 psig	150°F	Air and Nitrogen (for DDG 51 Only)	J-5
J-4	Air and Nitrogen	200 psig	150°F	Air and Nitrogen (for DDG 52 & Follow)	J-5
J-5	Air, Aircraft, Starting and Cooling, Bleed-off and 20.2 psi Absolute System	150 psig	550°F	N/A	N/A
J-6	Air, Aircraft, Starting and Cooling, Main System	150 psig	450°F	N/A	N/A
J-7	Air, Prairie-Masker, Gas Turbine Starting, Sewage Aerating	100 psig	600°F	Air: Prairie, Gas Turbine Starting	J-8
J-8	Air, Deballast	50 psig	400°F	N/A	N/A
J-9	Gas Turbine Bleed Air System	250 psig	950°F	Air: Gas Turbine Bleed, Anti-icing (for DDG 51 & 52 & Follow, follow yard hulls only)	J-10
				Air: Prairie, Gas Turbine Starting (for DDG 53 & Follow, lead yard hulls only)	J-10
N/A	N/A	ATM	150°F	Air: Air Compressor Intake	J-11