

Lokring™ Fitting Specification

Brass Fittings (FS-BR)

Scope: Lokring™ mechanically attached brass fittings use patented elastic strain preload® (ESP®) technology to create a permanent, metal-to-metal seal on as-drawn copper tubing in accordance with ASTM B819 and ASTM B88. This specification includes the pressure-temperature ratings of qualified fittings and matching tubing sizes. See the appropriate Lokring product catalog for additional technical data. See *Lokring Fitting Installation Instructions (LP-110)* for complete installation instructions.

Material Specification: The coupling bodies and all drivers are manufactured from type 360 brass in accordance with ASTM B16. Physical and mechanical properties of the material conform to ASTM B16. Lokring shapes, such as elbows and tees, are manufactured from type 377 brass in accordance with ASTM B283.

Fitting Applications: Fittings are qualified for:

- Use in medical gas applications as an axially swaged, elastic strain preload fitting providing a metal-to-metal seal according to NFPA 99.
- Use on copper tubing in the as-drawn condition made according to the following ASTM specifications:
 - ASTM B819—*Standard Specification for Seamless Copper Tube for Medical Gas Systems*, wall thicknesses of types K and L and in the as-drawn condition.
 - ASTM B88— *Standard Specification for Seamless Copper Water Tube* for wall thicknesses of types K, L, and M in the as-drawn conditions.
- Use on copper tube sizes 3/8 to 2 inch nominal for types K, L, and M tubing wall thicknesses.
- Design temperature range: -452 to 400 °F (-268 to 204 °C).

Caution: Do not install Lokring brass fittings on copper tubing that is in the annealed condition or on copper tubing that has been softened. The joint seal integrity may be compromised if a Lokring fitting is installed on annealed or soft copper tubing. However, Lokring fittings may be used in systems where brazing is performed as long as the Lokring fitting is installed a minimum distance of 6 inches (15 centimeters) away from a brazed joint. See *Lokring Fitting Installation Instructions (LP-110)* for complete installation instructions. If tube hardness measurements are able to be acquired then the following guideline can be used:

According to ASTM	Temper Designation		Rockwell Hardness		Acceptable for Use with Lokring Fittings
	Standard	Condition	Scale	Value	
B88	O60	Annealed	F	50 max	No
B88	O50	Annealed	F	55 max	No
B819	H58	Drawn	30 T	30 min	Yes

Table 1- Lokring Brass Tube Fitting—Qualified Tube Sizes and Wall Thicknesses

Tube OD nominal, in.	Tube O.D. actual, in.	Lokring Size Designation	Wall Thickness, in.		
			K	L	M
3/8	0.500	T06	0.049	0.035	0.025
1/2	0.625	T08	0.049	0.040	0.028
5/8	0.750	T10	0.049	0.042	N/A
3/4	0.875	T12	0.065	0.045	0.032
1	1.125	T16	0.065	0.050	0.035
1 1/4	1.375	T20	0.065	0.055	0.042
1 1/2	1.625	T24	0.072	0.060	0.049
2	2.125	T32	0.083	0.070	0.058

Notes:

- Dimensions are in accordance with ASTM B819 and ASTM B88.
- Type M tube not applicable for medical gas systems.
- Medical gas systems (tube type K and L) require tubing to be in the as-drawn condition.

Table 2- Lokring Brass Tube Fitting- Pressure Ratings

Tube OD nominal, in.	Tube OD actual, in.	Lokring Size Designation	Pressure Rating, psig (bar)		
			K	L	M
3/8	0.500	T06	1946 (134)	1341(92)	982 (67)
1/2	0.625	T08	1534 (105)	1242 (85)	850 (58)
5/8	0.750	T10	1266 (87)	1086 (74)	n/a
3/4	0.875	T12	1466 (101)	1002 (69)	701 (48)
1	1.125	T16	1126 (77)	850 (58)	580 (39)
1 1/4	1.375	T20	914 (63)	755 (52)	582 (40)
1 1/2	1.625	T24	850 (58)	702 (48)	569 (39)
2	2.125	T32	747 (51)	625 (43)	514 (35)

Notes:

- No allowance is made from corrosion, erosion, or bending moments.
- Pressure ratings are limited to the allowable working pressures according to ASTM B88 for copper tube (drawn condition) and not on the capability of the Lokring fitting.
- If annealed tubing or brazing is used in any part of the system the actual system pressure rating may be less.
- Pressure ratings are applicable for system operating temperatures from -452 to 250 °F (-268 to 121 °C). For temperatures above 250 °F (121 °C), use the derating factor to calculate the pressure rating (See Table 3). Interpolating between derating factors is permitted.

Table 3: Temperature Derating Factors in Accordance with ASME B31

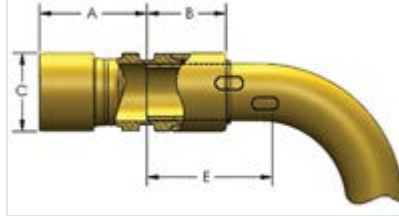
Temperature		Factors
°F	°C	
-452 to 250	-268 to 121	1.00
300	148	0.96
350	176	0.94
400	204	0.91

Thermal Expansion, Flexural Fatigue

The fitting design has been qualified to the flexural fatigue requirements outlined in B31 and ASTM F-1387. Test specimen consisting of a Lokring coupling and two equal length tube tangents on either side of the coupling were tested where a uniform bending moment was applied to the assembly, inducing a bending stress in the assembly equal to or greater than the tube material's yield strength of 13 500 psi (930 bar). One complete bending cycle consists of bending the assembly to one side of the neutral axis to the specified value and then back again through the neutral axis to the specified value on the opposite side and then back to the neutral axis. All assemblies exceeded 80 000 complete bending cycles without leakage, and many greatly exceeded this value. Contact your authorized Lokring representative for more information.

Consider applicable industry codes and practices when using the information in this document.

GENERAL INFORMATION



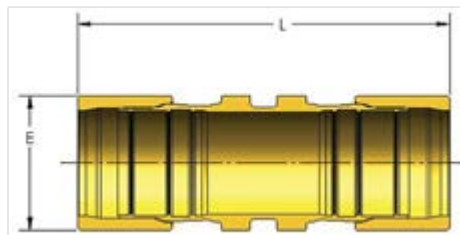
Nominal Fitting Size (TXX)	Tube O.D.	Qualified Wall Thickness K / L / M	Insertion Depth Pre-Install, A	Insertion Depth Post-Install, B	Outside Diameter, C	Minimum Straight Run Before Obstruction, E
3/8" (T06)	0.500	.049 / .035 / .025	1.23	0.89	0.91	1.68
1/2" (T08)	0.625	.049 / .040 / .028	1.23	0.89	0.91	1.68
5/8" (T10)	0.750	.049 / .042 / --	1.41	1.02	1.02	1.95
3/4" (T12)	0.875	.065 / .045 / .032	1.55	1.12	1.19	2.04
1" (T16)	1.125	.065 / .050 / .035	2.04	1.46	1.53	2.63
1 1/4" (T20)	1.375	.065 / .055 / .042	2.31	1.66	1.86	2.82
1 1/2" (T24)	1.625	.072 / .060 / .049	2.64	1.90	2.21	3.20
2" (T32)	2.125	.083 / .070 / .058	3.44	2.47	2.88	4.01

1. All dimensions are in inches.
2. Dimensions A, B, C & E are applicable to all fittings of the same size within this catalog.
3. For use on copper tube per ASTM B819, type K and L wall, and drawn for copper tube per ASTM B88 type K and L wall.
4. For tooling dimensions refer to proper catalog or www.lokring.com
5. Coupling 'thru-bore' design permits tube to pass completely through.
6. Fitting material 360 Brass as per ASTM B16. Fittings are cleaned to CGA G-4.1 standard. (OC = Oxygen Clean)
7. Fittings are approved by NFPA 99-2005 and meet or exceed the design requirements of brazed fittings.
8. CAD files in .DWG file format are available for most configurations.
9. All dimensions are reference only and subject to change.
10. Due to variation in heat affected zones (HAZ), Lokring fittings should be installed at least 6" from a brazed joint.
11. Fittings individually bagged after cleaning

Nominal Fitting Size (TXX)	Tube OD	Qualified Wall Thickness K		Qualified Wall Thickness L		Qualified Wall Thickness M	
		Wall	Pressure Rating (PSI)	Wall	Pressure Rating (PSI)	Wall	Pressure Rating (PSI)
3/8" (T06)	0.500	0.049	1946	0.035	1341	0.025	982
1/2" (T08)	0.625	0.049	1534	0.040	1242	0.028	850
5/8" (T10)	0.750	0.049	1266	0.042	1086	-	-
3/4" (T12)	0.875	0.065	1466	0.045	1002	0.032	701
1" (T16)	1.125	0.065	1126	0.050	850	0.035	580
1 1/4" (T20)	1.375	0.065	914	0.055	755	0.042	582
1 1/2" (T24)	1.625	0.072	850	0.060	702	0.049	569
2" (T32)	2.125	0.083	747	0.070	625	0.058	514

PRESSURE RATING SHOULD BE DERATED AT ELEVATED TEMPERATURE. FITTINGS MEET 1000°F INTEGRITY TEST. TEMPERATURE RATING -425°F TO 400°F

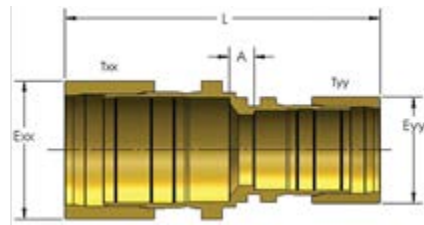
COUPLINGS



	Tubing Size TXX	Ordering Information			Dimensions			LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length (Uninstalled) L	E	Take-Out, A	Installation Tool Kit	
<input type="checkbox"/>	3/8	BR	- CPL -	T06	2.47	0.91	N/A	IT20	
<input type="checkbox"/>	1/2	BR	- CPL -	T08	2.47	0.91	N/A	IT20	
<input type="checkbox"/>	5/8	BR	- CPL -	T10	2.82	1.02	N/A	IT20	
<input type="checkbox"/>	3/4	BR	- CPL -	T12	3.11	1.19	N/A	IT20	
<input type="checkbox"/>	1	BR	- CPL -	T16	4.07	1.53	N/A	IT50	
<input type="checkbox"/>	1 - 1/4	BR	- CPL -	T20	4.62	1.86	N/A	IT50	
<input type="checkbox"/>	1 - 1/2	BR	- CPL -	T24	5.28	2.21	N/A	IT50	
<input type="checkbox"/>	2	BR	- CPL -	T32	6.88	2.88	N/A	IT50	

Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and are subject to change.

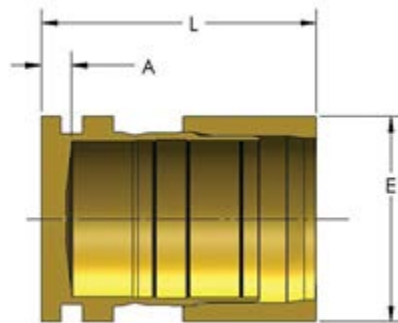
REDUCERS



	Tubing Size TXX	Ordering Information			Dimensions				LOK-TOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX-TYY	Part Length (Uninstalled) L	Take-Out, A	Exx	Eyy	Installation Tool Kit	
<input type="checkbox"/>	1/2 - 3/8	BR	- RED -	T08 - T06	2.47	0.42	0.91	0.91	IT20	
<input type="checkbox"/>	5/8 - 1/2	BR	- RED -	T10 - T08	2.84	0.19	1.02	0.91	IT20	
<input type="checkbox"/>	3/4 - 3/8	BR	- RED -	T12 - T06	3.11	0.53	1.19	0.91	IT20	
<input type="checkbox"/>	3/4 - 1/2	BR	- RED -	T12 - T08	3.17	0.38	1.19	0.91	IT20	
<input type="checkbox"/>	3/4 - 5/8	BR	- RED -	T12 - T10	3.15	0.19	1.19	1.02	IT20	
<input type="checkbox"/>	1 - 1/2	BR	- RED -	T16 - T08	2.47	0.42	0.91	0.91	IT20	
<input type="checkbox"/>	1 - 3/4	BR	- RED -	T16 - T12	3.95	0.36	1.53	1.19	IT50	
<input type="checkbox"/>	1-1/4 - 1	BR	- RED -	T20 - T16	4.61	0.27	1.86	1.53	IT50	
<input type="checkbox"/>	1-1/2 - 1-1/4	BR	- RED -	T24 - T20	5.27	0.32	2.21	1.86	IT50	
<input type="checkbox"/>	2 - 1-1/2	BR	- RED -	T32 - T24	6.58	0.51	2.88	2.21	IT50	

Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and subject to change.

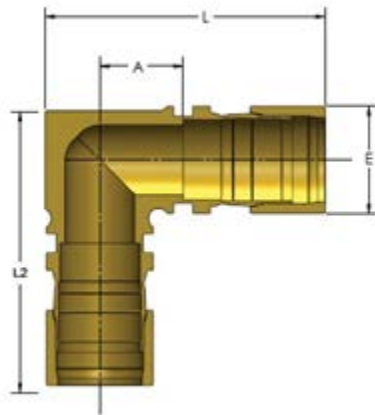
CAPS



	Tubing Size TXX	Ordering Information			Dimensions			LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length (Uninstalled) L	E	Take-Out, A	Installation Tool Kit	
<input type="checkbox"/>	3/8	BR	- CAP -	T06	1.47	0.91	0.24	IT20	
<input type="checkbox"/>	1/2	BR	- CAP -	T08	1.47	0.91	0.24	IT20	
<input type="checkbox"/>	5/8	BR	- CAP -	T10	1.65	1.02	0.24	IT20	
<input type="checkbox"/>	3/4	BR	- CAP -	T12	1.76	1.19	0.21	IT20	
<input type="checkbox"/>	1	BR	- CAP -	T16	2.33	1.53	0.29	IT50	
<input type="checkbox"/>	1-1/4	BR	- CAP -	T20	2.62	1.86	0.31	IT50	
<input type="checkbox"/>	1 - 1/2	BR	- CAP -	T24	2.98	2.21	0.34	IT50	
<input type="checkbox"/>	2	BR	- CAP -	T32	3.86	2.88	0.42	IT50	

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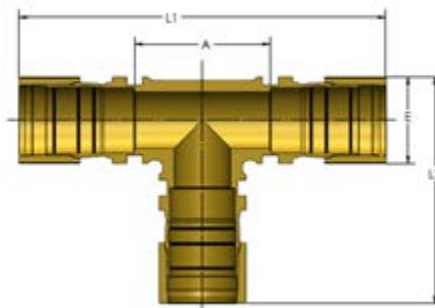
ELBOWS



	Tubing Size TXX	Ordering Information			Dimensions				LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length (Uninstalled) L1	Part Length (Uninstalled) L2	E	Take-Out, A	Installation Tool Kit	
<input type="checkbox"/>	1/2	BR	- EL 90 -	T08	2.79	2.73	0.91	1.05	IT20	
<input type="checkbox"/>	5/8	BR	- EL 90 -	T10	4.09	4.28	1.02	2.17	IT20	
<input type="checkbox"/>	3/4	BR	- EL 90 -	T12	3.53	3.41	1.19	1.16	IT20	
<input type="checkbox"/>	1	BR	- EL 90 -	T16	4.01	3.99	1.53	1.19	IT50	

Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and subject to change.

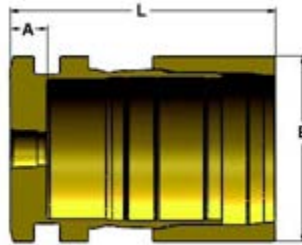
TEES



	Tubing Size TXX	Ordering Information			Dimensions				LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length L1	Part Length L2	E	Take-Out, A	Installation Tool Kit	
<input type="checkbox"/>	1/2	BR	-TEE-FRG-	T08	4.57	2.99	0.91	1.05	IT20	
<input type="checkbox"/>	5/8	BR	-TEE-FRG-	T10	7.16	4.28	1.02	2.17	IT20	
<input type="checkbox"/>	3/4	BR	-TEE-FRG-	T12	2.79	2.73	0.71	1.05	IT20	
<input type="checkbox"/>	1	BR	-TEE-FRG-	T16	6.46	3.99	1.53	2.39	IT50	

Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and subject to change.

GAGE PORT CAPS

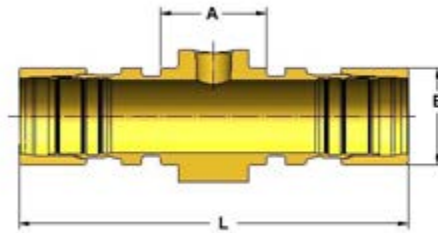


	Tubing Size TXX	Ordering Information			Dimensions			LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length (Uninstalled) L	E	Take-Out A	Installation Tool Kit	
<input type="checkbox"/>	3/8	BR	- GCAP -	T06	1.64	0.91	0.43	IT20	
<input type="checkbox"/>	1/2	BR	- GCAP -	T08	1.64	0.91	0.41	IT20	
<input type="checkbox"/>	5/8	BR	- GCAP -	T10	1.81	1.02	0.40	IT20	
<input type="checkbox"/>	3/4	BR	- GCAP -	T12	1.96	1.19	0.41	IT20	
<input type="checkbox"/>	1	BR	- GCAP -	T16	2.40	1.53	0.36	IT50	
<input type="checkbox"/>	1 - 1/4	BR	- GCAP -	T20	2.68	1.86	0.37	IT50	
<input type="checkbox"/>	1 - 1/2	BR	- GCAP -	T24	3.00	2.21	0.37	IT50	
<input type="checkbox"/>	2	BR	- GCAP -	T32	3.81	2.88	0.37	IT50	

Thread size is 1/8"-27-FPT

Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and subject to change.

GAGE PORT COUPLINGS



	Tubing Size TXX	Ordering Information			Dimensions			LOKTOOL™	Acceptance
		Fitting Material	Shape	Fitting Size TXX	Part Length (Uninstalled) L	E	Take-Out A	Installation Tool Kit	
<input type="checkbox"/>	1/2	BR	- GCPL -	T08	3.78	0.91	0.75	IT20	
<input type="checkbox"/>	5/8	BR	- GCPL -	T10	5.45	1.02	0.70	IT20	
<input type="checkbox"/>	3/4	BR	- GCPL -	T12	4.15	1.19	0.75	IT20	
<input type="checkbox"/>	1	BR	- GCPL -	T16	4.41	1.53	0.60	IT50	
<input type="checkbox"/>	1 - 1/4	BR	- GCPL -	T20	6.20	1.86	0.68	IT50	
<input type="checkbox"/>	1 - 1/2	BR	- GCPL -	T24	7.07	2.21	0.60	IT50	
<input type="checkbox"/>	2	BR	- GCPL -	T32	7.09	2.88	0.75	IT50	

Thread size is 1/8"-27-FPT
 Consult your authorized Lokring distributor for details and other available options. All dimensions are for reference only and subject to change.

Tool Selection for Brass Tube Fitting Sizes								
Tool	3/8	1/2	5/8	3/4	1	1 - 1/4	1 - 1/2	2
IT20								
IT50								

The shaded cells show which size tool can install which size fitting.

**MEDICAL GAS TRAINING CLASSES AND CERTIFICATION ARE
 required TO INSTALL LOKRING FITTINGS.
 TRAINING IS AVAILABLE
 THROUGH YOUR LOCAL
 LOKRING® DISTRIBUTOR**

NOTE: Tool rentals may be available through your local Lokring Distributor

LOKRING TECHNOLOGY STANDARD PRODUCT WARRANTY

Lokring warrants that goods delivered hereunder shall be free from defects in material and workmanship under normal use and service for a period of one (1) year from shipment. If during such one (1) year period,

1. Lokring is notified promptly upon discovery of any defect in the goods, including a detailed description of such defect.
2. Lokring is afforded the opportunity to inspect such goods at the installation site prior to any attempt to repair or retrofit.
3. If requested by Lokring, Customer returns such goods to Lokring for further examination (FOB destination); and upon examination of such, Lokring determines that such goods were defective and such defects were not caused by accident, abuse, misuse, neglect, alteration, improper installation, repair or alteration (other than at the specific direction of Lokring), improper testing or use contrary to instruction of Lokring, then within a reasonable time. Lokring shall at its sole option credit the customer for such goods.

Any goods replaced under this warranty shall be returned to the customer, transportation charges prepaid, and Lokring will reimburse the customer for any transportation charges incurred under section (2) above. The performance of this warranty does not extend the warranty period of any goods beyond the period applicable to the goods originally delivered.

In no event shall Lokring be liable for claims for any other damages whatsoever (whether direct, immediate, foreseeable, consequential or special) suffered by Buyer or anyone else arising out of any breach by Lokring. This express warranty is in lieu of and excludes all other warranties, guarantees, and/or representations, expressed or implied.

System design and system safety are the ultimate responsibilities of the end-user. Consideration to system function, compatibility, product ratings, as well as other factors, must be given to ensure proper product selection and function. All information in this catalog has been compiled with regard to accuracy; however, the most up to date information should be

verified before use of the product. Lokring reserves the right to change product dimensions, ratings, or other information.

Test Report

Distribute to: Al McKay,

Test Number: 04-044A

Test Title: Fire Test of BR-CPL-TXX fittings for NFPA 99

Project Title: Product Development for Oxygen Clean Copper Tube Fitting

References:

Performed by: Al McKay, S. Pereira

Date Performed: February 24, 2005

Written by: Al McKay

Date Written: May 2, 2005

Total Pages: 7

Test Purpose

BR-CPL-TXX fittings are being developed for use on medical gas systems in addition to other applications. NFPA 99 governs the use of piping systems used in this particular application and further stipulates that any fitting must “.. provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint” (5.1.10.5.8.2) and also “Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538 Deg. C (1000 Deg. F) to retain the integrity of the piping system in the event of fire exposure (5.1.10.5.1.1)

The purpose of this plan is to establish a test program which will verify the suitability of Lokring Brass fittings when exposed to a temperature of 1000 Deg. F.

Using the concept of book end testing samples from each size extreme will be subjected to the testing protocol. (1/2” OD and 2” OD)

Test Description

Place a test assembly consisting of two tube sections of the same size joined in the middle by a BR-CPL-TXX fitting. One end of the test assembly shall be capped, the other end shall have a threaded end to receive a 1/4 NPT connection for pressurization and monitoring.

The fitting shall be placed into an electric furnace preheated to the desired temperature of 1000 Deg. F, be brought up to the target temperature as quickly as possible and be maintained at that temperature for a period of 30 minutes. During this process the assembly shall be pressurized with nitrogen at a value that will not overstress the material at temperature, but at the same time will provide a reference point to monitor any leakage that might occur during the test period. The ends of the test specimen will be accessible outside the furnace such that pressure and temperature monitoring connections can be made.

When the allotted time has elapsed the pressure shall be released, specimen shall be removed from the furnace and allowed to cool to room temperature. The specimen shall subsequently, once returned to room temperature, be again tested for pressure integrity with nitrogen at 100 psi. No leakage permissible.

Pressurization temperatures during the fire test shall be based on the formula $P_{temp} = (t_{min} * S_{temp} / t_{min}) / OD$ (ASTM F-1387, S7.4.3.1) where P_{temp} is Pressure at temperature, t_{min} is min wall thickness and t_{min} is temperature adjusted yield strength at 1700 Deg. F, which for copper is 150 psi.

For T08 specimen (on L grade tube) $P_{temp} = (0.040 * 150) / 0.625 = 9.6$ psi or 10 psi

For T32 specimen (on L grade tube) $P_{temp} = (0.070 * 150) / 2.125 = 4.9$ psi or 5 psi

Results

Specimens were assembled from Type K copper in sizes ½” (Actual 0.625”) nominal OD and 2” nominal OD (actual 2.125”). Installation data was collected for each, the specimens were leak tested at assembly and found to be leak tight.

The specimens were then individually heated to 1000 Deg. F and held at temperature for a minimum of 30 minutes. The pressure and temperature for the test was monitored and recorded.



Figure 1 Specimen 04-044-5-2 under test



Figure 2 Specimen 04-044-5-2, close up

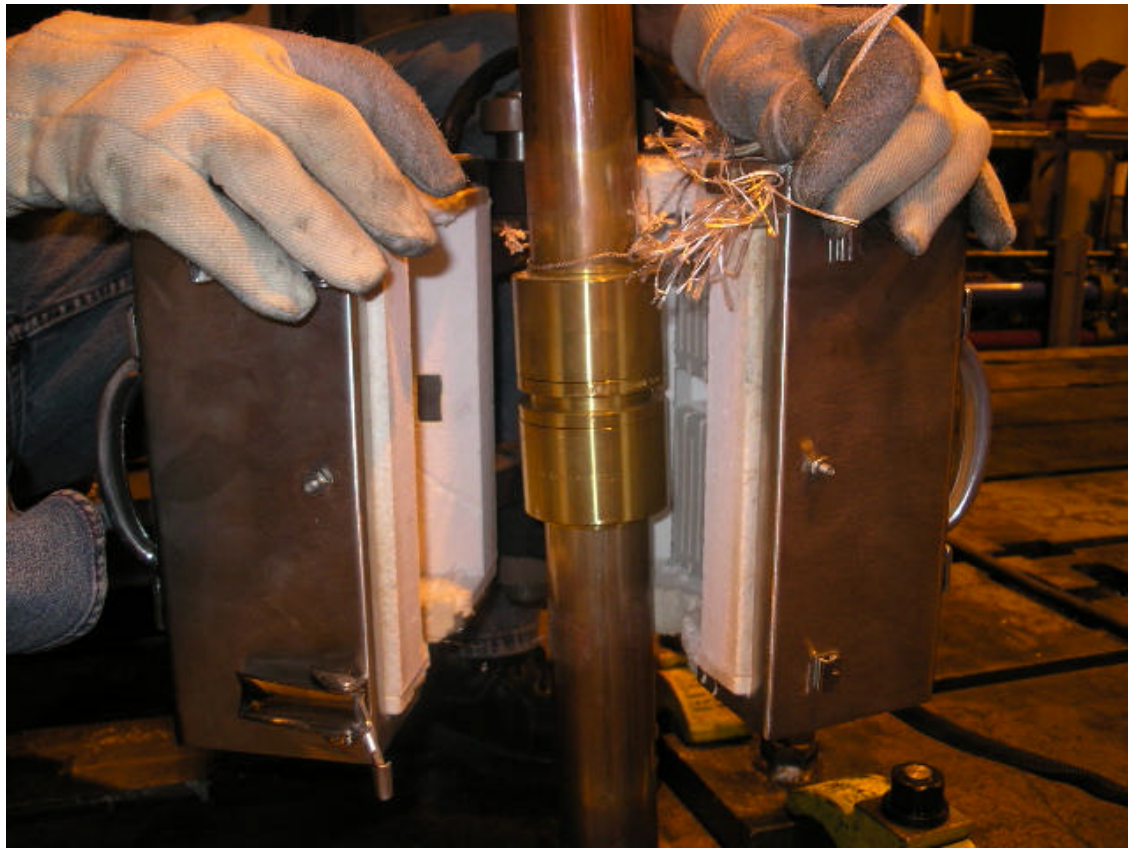


Figure 3 Specimen 04-044-5-2, coming out of furnace

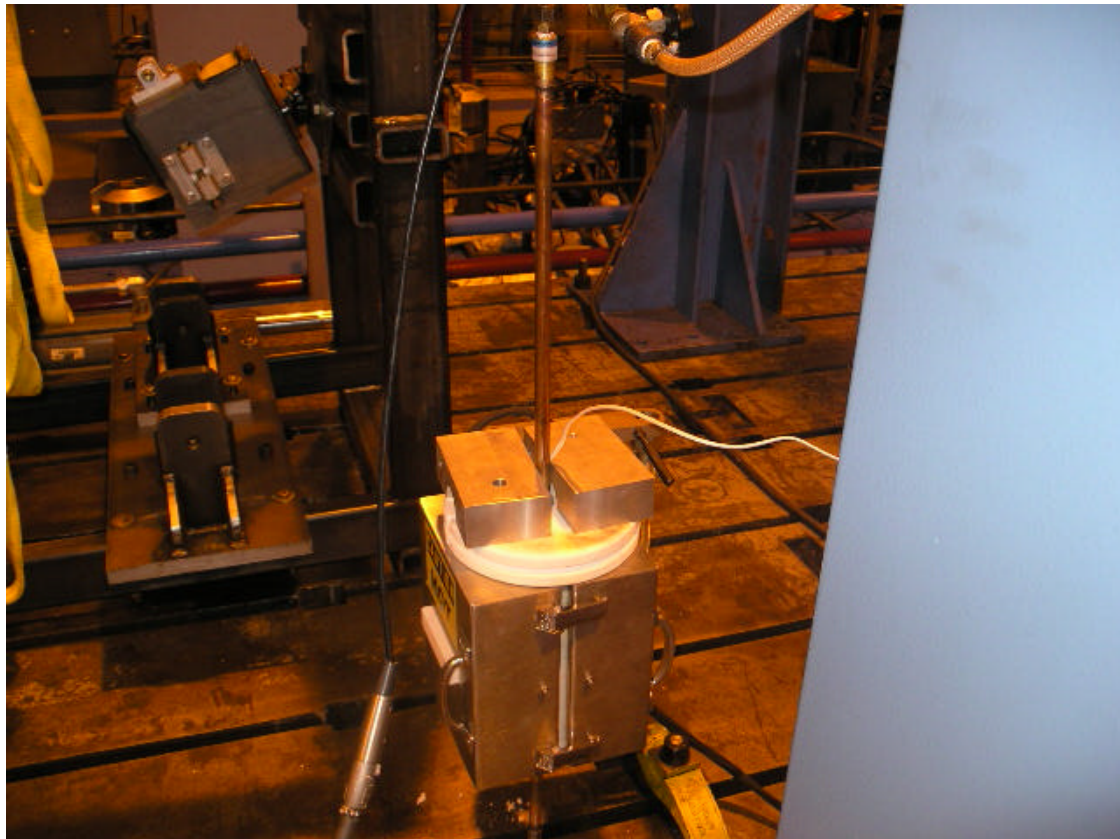


Figure 4 Specimen 04-044-5-1, close up

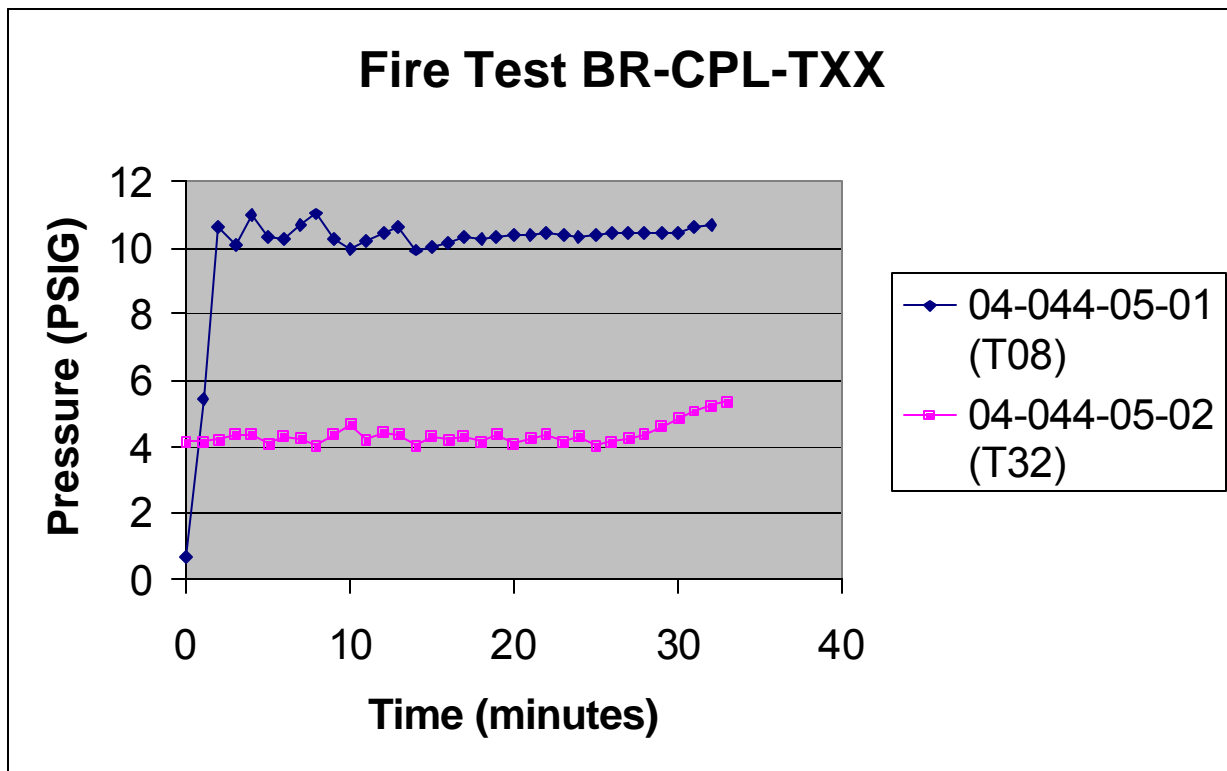


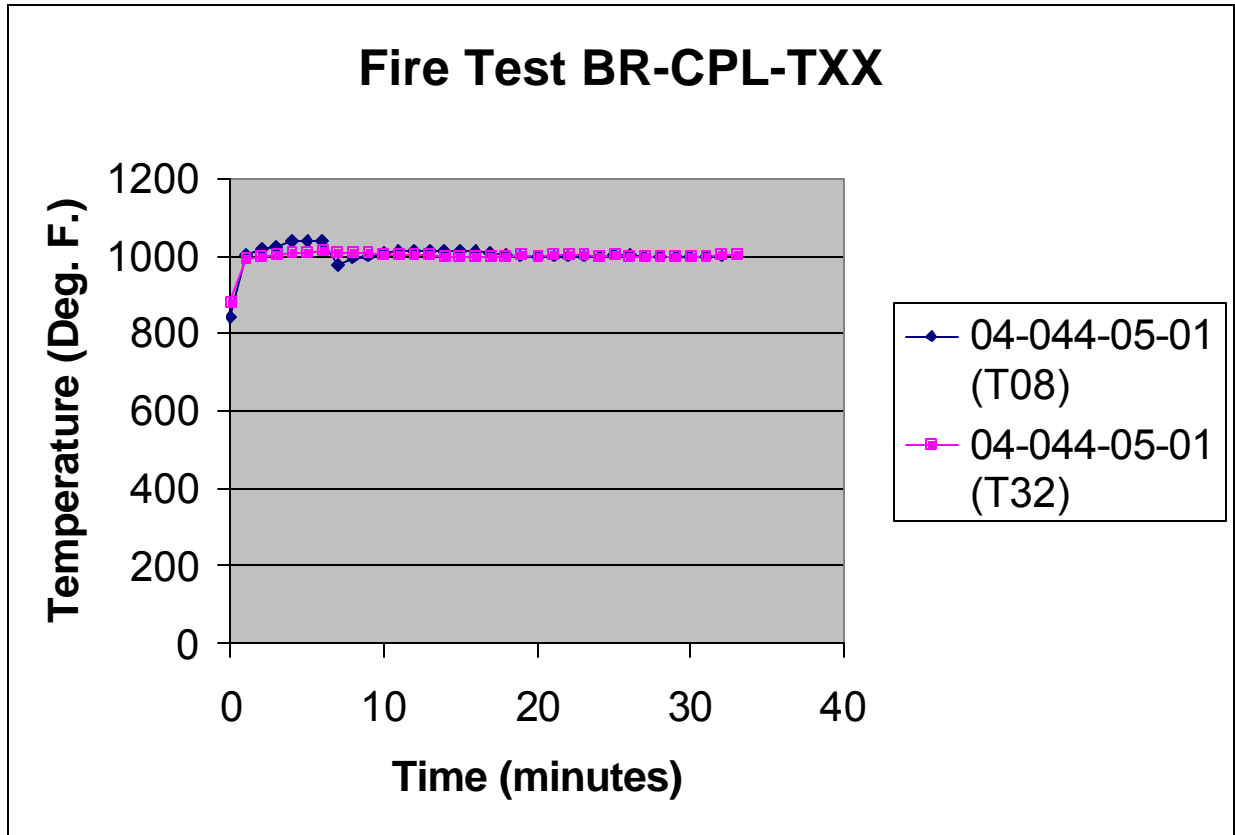
Figure 5 Specimen 04-044-5-1, submerged in water bath, post fire exposure

Recorded data:

Time	04-044-05-01 - T08			04-044-05-02 - T32		
	Temp	Press.	Voltage	Temp	Press.	Voltage
0	843	0.7	0.03	880	4.2	0.187
1	1004	5.4	0.244	993	4.2	0.188
2	1017	10.6	0.477	997	4.2	0.189
3	1024	10.1	0.455	1001	4.4	0.197
4	1040	11.0	0.494	1009	4.4	0.198
5	1039	10.4	0.466	1008	4.1	0.185
6	1040	10.2	0.461	1013	4.3	0.195
7	976	10.7	0.48	1009	4.3	0.192
8	993	11.0	0.495	1009	4.0	0.182
9	1000	10.3	0.463	1007	4.4	0.197
10	1009	10.0	0.45	1005	4.7	0.21
11	1012	10.2	0.46	1005	4.2	0.189
12	1013	10.4	0.469	1003	4.5	0.201
13	1013	10.6	0.477	1001	4.4	0.197
14	1013	9.9	0.447	999	4.1	0.183
15	1015	10.1	0.453	999	4.3	0.194
16	1012	10.2	0.457	999	4.2	0.189
17	1007	10.3	0.464	996	4.4	0.196
18	1003	10.3	0.463	999	4.2	0.188
19	1000	10.4	0.466	1002	4.4	0.197

20	1000	10.4	0.467	1000	4.1	0.184
21	999	10.4	0.467	1001	4.3	0.192
22	998	10.4	0.469	1002	4.4	0.198
23	997	10.4	0.467	1001	4.2	0.188
24	998	10.4	0.466	1000	4.3	0.195
25	1003	10.4	0.468	1001	4.0	0.182
26	1004	10.4	0.469	999	4.2	0.188
27	1000	10.4	0.469	997	4.3	0.192
28	998	10.5	0.471	999	4.4	0.197
29	999	10.4	0.47	999	4.6	0.207
30	998	10.5	0.471	999	4.9	0.219
31	998	10.6	0.477	999	5.1	0.228
32	1000	10.7	0.48	1002	5.3	0.237
33				1004	5.4	0.242





After the fire exposure the specimens were immersed in a water bath and pressurized to 100 PSI air. Submerged assembly was monitored for 10 minutes, no bubbles were observed.

Specimen	Tube Size		Fire temp range (DEG. F)	Duration	Leakage during fire	Post fire leakage
	Nominal	Actual				
04-044-05-01	1/2	0.625"	993-1040	32 min	No	No
04-044-05-02	2	2.125"	976-1040	30 min	No	No

Discussion

Testing has confirmed that the BR fitting installed on Copper tube (ASTM B88/ASTM B819) will withstand a fire exposure at 1000 Deg. F thus being as good as the brazed equivalent for fire.

Test Summary Sheet

Distribute to: Al McKay,

Test Number: 04-044B

Test Title: Tensile Test on BR-CPL-TXX

Project Title: Qualification of Brass fittings

References:

Performed by: Al McKay

Date Performed: Feb. 28, 2005

Written by: Al McKay

Date Written: April 29, 2005

Total Pages: 2

Test Purpose

Testing program to complete tests for BR-CPL-TXX fitting series. Flex, burst, fire (simulated) and torsion tests are covered under separate plans

Test Description

Tensile tests to be conducted based on ASTM F-1387, A7. The tensile strength of the fitting to pipe test specimen shall be greater than the pipe minimum yield strength when calculated as follows:

$$\text{Calculated Tensile Load} = K_t \times A_p \times S_y$$

Where:

K_t = Tensile constant of 1.0

A_p = **Actual cross-sectional area of pipe (in²) based on wall thickness.**

S_y = Minimum specified yield strength of pipe material at test temperature.

Values for required pipe tensile strength are calculated using actual pipe dimensions obtained prior to fitting installation. Typical values based on nominal pipe dimensions and the minimum yield strength of 13,500 psi (per table A6.1 of ASTM-F1387 for drawn copper).

Specimen #	Tube Dia and wall	Nominal Dia	Nominal Wall Thick	Nominal Area	Nominal Tensile Load
04-044-04-01	1/2, K	0.625	0.049	0.0887	1190
04-044-04-02	1/2, M	0.625	0.028	0.0525	708
04-044-04-03	2, K	2.125	0.083	0.5325	7180
04-044-04-04	2, M	2.125	0.058	0.3766	5080

Results

Specimens were installed in the Lokring Engineering lab, tested for leakage pneumatically (100 psig air, no leaks found) and then taken to Bodycote Material Testing Labs in Burlington Ontario for tensile testing. Tensile testing was halted on each specimen when the load reached exceeded the required minimum. Each tube was marked at the junction to the fitting so that any movement could easily be noticed. No movement was noticed in any of the specimens. In addition each load vs displacement graph shows a smooth curve without sudden unloading as would be evident had the coupling shifted on the tube

Specimen #	Tube Dia and wall	Actual OD	Actual Wall	Actual Area	Minimum Tensile Load	Tensile Load reached
04-044-04-01	1/2, K	0.623	0.048	0.0867	1170.56	1395
04-044-04-02	1/2, M	0.623	0.027	0.0506	682.49	873
04-044-04-03	2, K	2.125	0.082	0.5263	7105.02	7924
04-044-04-04	2, M	2.125	0.057	0.3703	4999.29	5688

Discussion

Tensile testing was conducted on the extreme size and wall thickness for this product series. The smallest size was represented by 1/2" nominal O.D. (actual O.D. 0.625") at the thinnest wall, Type M and thickest wall, Type K. The largest size was also tested at K and M wall thicknesses.

Conclusions

The assembly withstood the tensile load demanded by the test plan (based on ASTM F-1387 parameters) and is considered to have passed this portion of the test program.

Test Summary Sheet

Distribute to: Al McKay,

Test Number: 04-044E

Test Title: Install and Flex for BR-CPL-TXX

Project Title: Product Development for Oxygen Clean Copper Tube fitting

References:

Performed by: Al McKay, S. Pereira

Date Performed: November 2004 – February 2005

Written by: Al McKay

Date Written: July 11, 2006

Total Pages: 4

Test Purpose

Testing program to complete tests for BR-CPL-TXX fitting series. This test plan will focus on Flexural Fatigue Testing.

Test Description

The specimens are permanently marked using a vibrating marker to ensure identification throughout the testing program. The tests shall be conducted at ambient temperature (70° F).

ASTM B819, Standard Specification for Seamless Copper Tube for Medical Gas Systems is available in wall thicknesses of K and L, while ASTM B88, Standard Specification for Seamless Copper Water Tube, from whence ASTM B819 was derived also has a third and thinner wall thickness designated M. Where available the heaviest wall thickness K and the lightest wall thickness M will be tested in flexural fatigue in an effort to qualify the BR-CPL-TXX fittings on not only ASTM B819 but also on ASTM B88 tube.

FLEXURAL FATIGUE TEST

The apparatus layout is as found in Figure 1.

Testing Procedure

1. Prior to flexural fatigue testing the fitting assembly shall be pneumatically tested at 100 psig (6.9 Bar)
2. The specimen shall be deflected by adjusting the stroke of the piston in increments of 0.1" up to 1.0" and increments of 0.25" thereafter until a bending moment equal to the minimum yield stress (13,500 psi) of the tube is reached. For each increment of deflection the following are measured:

Load cell force
 Pipe end deflection
 Piston Position

3. Test specimen shall be filled with water and pressurised to 300 psig.
4. The specimen is then flexed in the plane of the deflection at a rate of 20 to 60 cycles per minute (CPM). Flexure is completed in both directions around the neutral axis to simulate 100% reversed bending. The cycling rate for each specimen is recorded.
5. The flexure fixture is instrumented so that any loss in pressure will cause a shutdown of the flexure equipment.
6. The specimen shall experience a minimum of 80,000 cycles.
7. Note the results on the Flexural Fatigue Test Data Sheet.

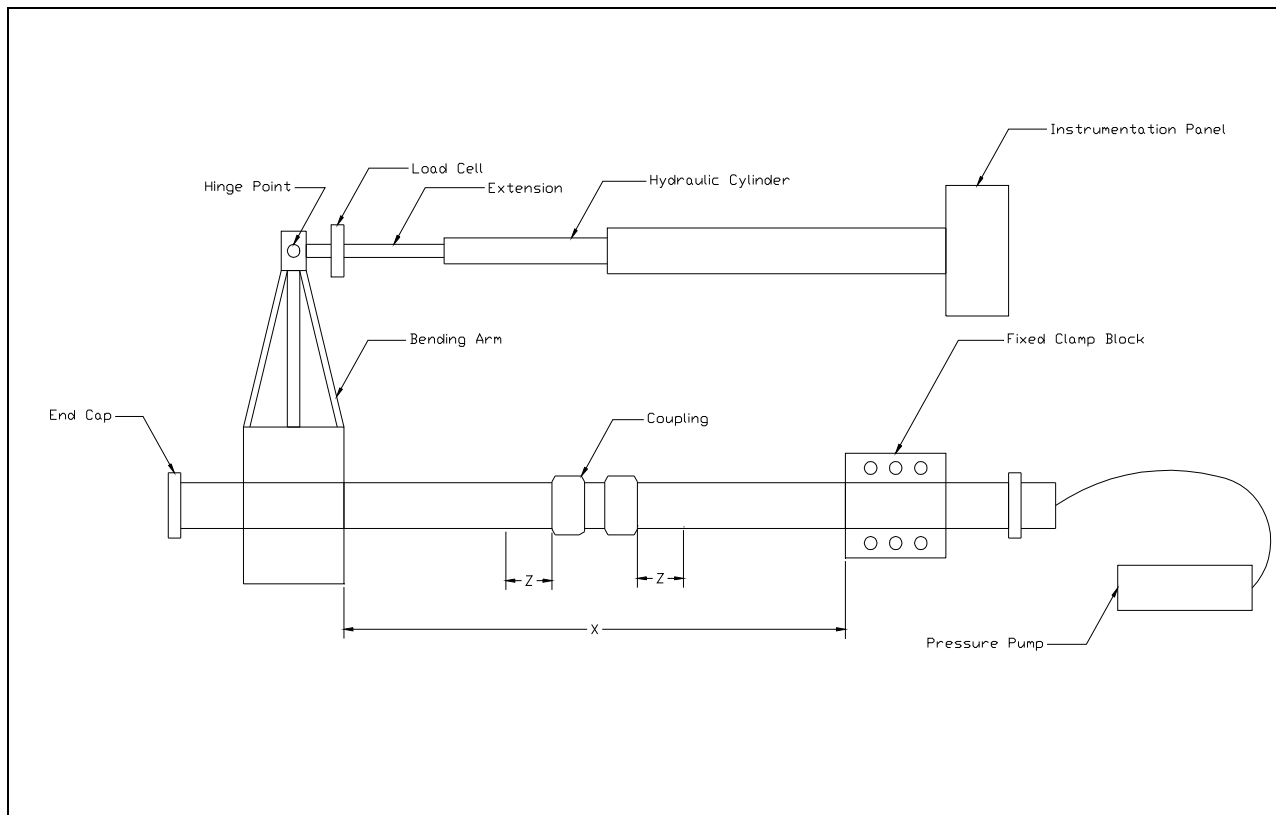


FIGURE 1 Apparatus Layout

Results

Flex Testing Results						
Size		Specimen#	Tube Wall	Peak Stress (PSI)	Number of Cycles	Reason for Termination
T08	0.625"	04-044-01-14	K	13,500	268,247	A
T08	0.625"	04-044-01-23	K	13,500	262,469	A
T08	0.625"	04-044-01-22	M	13,500	126,242	A
T08	0.625"	04-044-01-24	M	13,500	132,729	A
T10	0.750"	04-044-01-10	K	13,500	172,174	A
T10	0.750"	04-044-01-26	K	13,500	169,066	A
T10	0.750"	04-044-01-09	L	13,500	179,554	A
T10	0.750"	04-044-01-27	L	13,500	285,865	A
T12	0.875"	04-044-01-01	K	13,500	309,476	A
T12	0.875"	04-044-01-02	K	13,500	407,257	A
T12	0.875"	04-044-01-29	K	13,500	161,400	A
T12	0.875"	04-044-01-13	M	13,500	173,736	A
T12	0.875"	04-044-01-28	M	13,500	124,351	A
T16	1.125"	04-044-01-03	K	13,500	321,801	A
T16	1.125"	04-044-01-08	M	13,500	282,530	A
T16	1.125"	04-044-01-20	M	13,500	253,192	A
T20	1.375"	04-044-01-11	K	13,500	245,155	A
T20	1.375"	04-044-01-30	K	13,500	316,953	A
T20	1.375"	04-044-01-12	M	13,500	168,781	A
T20	1.375"	04-044-01-21	M	13,500	128,364	A
T24	1.625"	04-044-01-06	K	13,500	81,006	A
T24	1.625"	04-044-01-31	K	13,500	123,692	A
T24	1.625"	04-044-01-07	M	13,500	169,145	A
T24	1.625"	04-044-01-16	M	13,500	107,385	A
T32	2.125"	04-044-01-04	K	13,500	88,000	A
T32	2.125"	04-044-01-05	M	13,500	82,043	A
T32	2.125"	04-044-01-15	M	13,500	165,149	A

A = Test terminated due to time constraints, No Leakage

Discussion

Using ASTM F-1387 as a benchmark, the requirements for flexural fatigue would be a minimum of 80,000 cycles at the test stress of 13,500 psi. In every test that number was exceeded and in some cases by a margin of 4 to 1.

Conclusions

The assemblies withstood the demands of Flexural Fatigue demanded by this test plan and are considered to have passed this portion of the test program.

Test Summary Sheet

Distribute to: Al McKay,

Test Number: 04-044F

Test Title: Install and Burst for BR-CPL-TXX

Project Title: Product Development for Oxygen Clean Copper Tube fitting

References:

Performed by: Al M^cKay, S. Pereira

Date Performed: March – April 2005

Written by: Al M^cKay

Date Written: July 27, 2006

Total Pages: 4

Test Purpose

Testing program to complete tests for BR-CPL-TXX fitting series. This test plan will focus on Burst Testing.

Test Description

The specimens are permanently marked using a vibrating marker to ensure identification throughout the testing program. The tests shall be conducted at ambient temperature (70° F).

ASTM B819, Standard Specification for Seamless Copper Tube for Medical Gas Systems is available in wall thicknesses of K and L, while ASTM B88, Standard Specification for Seamless Copper Water Tube, from whence ASTM B819 was derived also has a third and thinner wall thickness designated M. Where available the heaviest wall thickness K and the lightest wall thickness M will be tested in Burst in an effort to qualify the BR-CPL-TXX fittings on not only ASTM B819 but also on ASTM B88 tube.

Testing Procedure

1. Test specimen to be checked for leakage with air pressure at 100 psig (6.9 Bar) and leak detectant surfactant
2. Fill assembly with water and place in burst chamber
3. Pressurize assembly to failure. Increase pressure in increments of 100 psig and hold at each increment for a minimum of 2 minutes prior to increasing to the next increment, for the final 25 % of the expected burst pressure. Burst pressure recorded to be last value held for full 2 minute interval.
4. Record all results.

Based on ASME B31 criteria the assembly would be suitable for a pressure rating of:

$$\begin{aligned}
 \text{Pressure rating} &= \frac{\text{actual burst (S}_{\text{ACT}}) \times \text{allowable fitting body stress}}{\text{Test factor} \times \text{Actual tensile strength of fitting body (S}_{\text{TFA}})} \\
 &= \frac{6600 \times 20,000}{1.10 \times 79,000} \\
 &= 6400 \text{ psig (372 Bar)}
 \end{aligned}$$

*Testing factor of 1.10 was used as only one specimen was tested.

Size	Specimen	Tube	Body LOK	S _{TFA}	S _{TFM}	Failure Mode*	Actual Burst	S _{ACT}	31.1
T08	04-044-03-01	M	050284	51800	50000	TR	6600	37296	1593
T12	04-044-03-07	M	050284	51800	50000	TR	5450	37296	1315
T16	04-044-03-08	M	050288	55000	50000	TR	4450	39600	1011
T20	04-044-03-10	M	050288	55000	50000	TR	3850	39600	875
T24	04-044-03-13	M	050289	53300	45000	TR	4150	42640	876
T32	04-044-03-15	M	050280	51300	45000	TR	3575	41040	784
T10	04-044-03-05	L	50284	51800	50000	TR	8200	37296	1979
T08	04-044-03-03	K	050284	51800	50000	Ejection	10300	37296	2485
T10	04-044-03-04	K	050284	51800	50000	TR	9400	37296	2268
T12	04-044-03-06	K	050284	51800	50000	Body	9000	37296	2172
T16	04-044-03-09	K	050288	55000	50000	TR	8150	39600	1852
T20	04-044-03-11	K	050288	55000	50000	TR	6250	39600	1420
T24	04-044-03-12	K	050289	53300	45000	TR	5500	42640	1161
T32	04-044-03-14	K	050280	51300	45000	TR	4900	41040	1075

* TR – Tube Rupture

Ejection – tube ejection from fitting

Body – Fitting body failure

Discussion

While the pressure rating of the fitting, based on the sustained burst pressures warrant the values tabulated above, generally accepted pressure rating for the tube is substantially lower than this. Using generally accepted pressure rating values for the copper tube, the values as specified in FS-

BR will be used. FS-BR is attached as an appendix.

Conclusions

The BR-CPL-TXX series of fittings have passed the Burst test portion of the test program as recorded in this report.

FS-BR

Size Designation	Tube O.D. nominal (in.)	Tube O.D. actual (in.)	Wall Thickness (inch)		
			K	L	M
T08	1/2	0.625	0.049	0.040	0.028
T10	5/8	0.75	0.049	0.042	N/A
T12	3/4	0.875	0.065	0.045	0.032
T16	1	1.125	0.065	0.050	0.035
T20	1 1/4	1.375	0.065	0.055	0.042
T24	1 1/2	1.625	0.072	0.060	0.049
T32	2	2.125	0.083	0.070	0.058

Size Designation	Tube O.D. nominal (in.)	Tube O.D. actual (in.)	Pressure rating (PSI)		
			K	L	M
T08	1/2	0.625	1500	1200	800
T10	5/8	0.75	1200	1000	N/A
T12	3/4	0.875	1400	1000	500
T16	1	1.125	1100	800	500
T20	1 1/4	1.375	900	700	500
T24	1 1/2	1.625	800	700	500
T32	2	2.125	700	600	500

Pressure rating is good up to 250 Deg. F, above this the De-rating factor must be used, to a maximum pressure of 400 Deg. F.

Temperature	De-rating Factor
100 Deg. F	1.00
150 Deg. F	1.00
200 Deg. F	1.00
250 Deg. F	1.00
300 Deg. F	0.96
350 Deg. F	0.94
400 Deg. F	0.91

For temperatures above 100 Deg. F, the maximum design pressure given in table 1 shall be multiplied by the temperature de-rating factor listed in table 2. Interpolating between de-rating factors is permitted.

Pressure rating based on the use of Lokring fittings and drawn tube. If annealed tubing is used or system components are brazed or soldered the actual system pressure rating may be less. Lokring Brass fittings BR-XX-TXX may be used down to cryogenic temperatures with no pressure derating applied.