Report No. 4-RD-65

STANDARDIZATION TASK REPORT
TASK NO. 3

with copy of Contractors ltr of 27 Oct 1965

ESTABLISHMENT OF STANDARDIZATION DATA FOR MONEL AND K-MONEL FASTENERS

Conducted for:
Department of the Navy
Bureau of Ships

Contract No. NObs-90493

21 April 1965

VALUE ENGINEERING COMPANY
2316 Jefferson Davis Highway - Alexandria, Va. - 548-8300

VALUE
ENGINEERING COMPANY 2316 JEFFERSON DAVIS HIGHWAY
ALEXANDRIA 1, VIRGINIA — KIng 8-8300

October 27, 1965

Chief, Bureau of Ships
Department of the Navy
Washington, D. C. 20360

Attention: Code 634

Reference: Contract No. NObs-90493

Gentlemen:

This letter report is a supplement to Standardization Task Report Task No. 3, (dated 21 April 1965 and titled Establishment of Standardization Data for Monel and K-Monel Fasteners). This letter report is to confirm a telephone discussion held with Mr. Forrest Nagley, Code 634B, on 8 October 1965. This report covers the effect of thread rolling on the equivalent tensile stress diameter.

As a result of tests performed in Task No. 3, the following limits for equivalent tensile stress diameter, D_{esa}, for monel and K-monel studs were derived.

$$D_{esa}max = E_s min - 0.01 \qquad (1)$$

$$D_{esa}min = E_s min - 4/5\,(E_s min - K_s) \qquad (2)$$

where $E_s min$ = Minimum pitch diameter of external thread, in.

K_s = Minimum diameter of external thread, in.

(The value "4/5" in Equation 2 had been reported previously as "3/5". However, further checking indicated that 4/5 is the correct value.)

Chief, Bureau of Ships — October 27, 1965

The D_{esa} limits for UNC Class 2A threads calculated from Equations 1 and 2 are as follows:

Size	D_{esa} min. (in.)	D_{esa} max. (in.)
1/2	0.4199	0.4335
7/8	0.7484	0.7846

The data reported in Standardization Task Report, Task No. 3 were for UNC Class 2A, cut threads in accordance with Handbook H28, Screw-Thread Standards for Federal Services. No data were obtained for rolled threads.

At the request of Mr. Nagley, several monel and K-monel studs, having UNC Class 2A, rolled threads were tested to determine the effect of thread rolling on the equivalent tensile stress diameter. Test results are shown in Table I.

Table I. Equivalent Tensile Stress Diameter

Stud Material	Stud Size (in.)	Stud No.	Minor Diameter (in.)	Pitch Diameter (in.)	Major Diameter (in.)	Ultimate Load (lbs)	Equivalent Tensile Stress Area (in^2)	Equivalent Tensile Stress Diameter (in.)
Monel	1/2	542	0.4012	0.4449	0.4924	14,750	0.1598	0.4510
		544	0.4012	0.4453	0.4925	14,725	0.1595	0.4507
		548	0.4014	0.4451	0.4925	14,750	0.1598	0.4510
		550	0.4012	0.4449	0.4926	14,800	0.1603	0.4517
	7/8	750	0.7345	0.7994	0.8679	47,900	0.4979	0.7962
		747	0.7342	0.7994	0.8676	47,850	0.4974	0.7958
		746	0.7349	0.7996	0.8675	47,950	0.4984	0.7966
K-monel	1/2	1243	0.3988	0.4442	0.4916	20,500	0.1401	0.4222
		1244	0.3991	0.4441	0.4916	20,350	0.1391	0.4209
		1254	0.3988	0.4440	0.4916	20,600	0.1408	0.4235
		1255	0.3989	0.4442	0.4917	20,500	0.1401	0.4222
		1256	0.3957	0.4442	0.4916	20,300	0.1388	0.4205

Chief, Bureau of Ships October 27, 1965

The tensile strengths of the materials from which these studs were manufactured are shown in Table II.

Table II. Tensile Strength of Stud Material

Material	Stud Size (in.)	Tensile Strength (psi)
Monel	1/2 7/8	92,300 96,200
K-monel	1/2	146,300

The equivalent tensile stress area was obtained by dividing the ultimate load by the tensile strength of the material.

The test results shown in Table I indicate that the equivalent tensile stress diameter for K-monel studs with rolled threads lies within the limits derived from results obtained for cut threads (Equations 1 and 2). This would seem to be consistant with microhardness data shown in Table XII of the supplementary letter report dated August 23, 1965. The data shown in that report indicate that, for the K-monel studs investigated, thread rolling produced no increase in hardness in the thread area.

The equivalent tensile stress diameter for monel studs with rolled threads was found to be higher than the maximum, D_{esa} max, found for cut threads (see Table I of this report). This is also consistant with microhardness data shown in Table XII of the supplementary report dated August 23, 1965. These hardness values indicate that the rolling increased the hardness in the thread area and would require, therefore, a greater load to cause failure. This would result in a higher equivalent tensile stress area.

Based on the results shown in Table I, the following equation can be derived for the minimum and maximum equivalent tensile stress diameter for rolled monel studs.

Chief, Bureau of Ships October 27, 1965

$$D_{esa}max = E_s max + 1/8\ (D_s max - E_s max) \quad (3)$$

$$D_{esa}min = E_s min - 1/20\ (E_s min - K_s) \quad (4)$$

where D_s = Major diameter of external thread, in.

The equations presented in this report are based on the test data generated during the performance of this program and the maximum and minimum D_{esa} values are valid for the monel and K-monel studs used in this program. They do not give the maximum and minimum equivalent tensile stress diameters for all studs throughout the tensile strength range allowed by the specifications. In order to obtain equations that would be valid for all studs, it would be necessary to test studs having the maximum and studs having the minimum allowable tensile strength.

Very truly yours,

VALUE ENGINEERING COMPANY

Elliot Goodman

Elliot Goodman
Project Engineer

EG:bl

Report No 4-RD-65

STANDARDIZATION TASK REPORT
TASK NO. 3

ESTABLISHMENT OF STANDARDIZATION DATA FOR MONEL AND K-MONEL FASTENERS

Conducted for:
Department of the Navy
Bureau of Ships

Contract No. NObs-90493

21 April 1965

Conducted by: E. Goodman
T. Hogland
J. Miller

Approved by: H. P. Weinberg
H. P. Weinberg, Director
Research and Development

VALUE ENGINEERING COMPANY
2316 Jefferson Davis Highway
Alexandria, Virginia

I PURPOSE

The object of this study is to set dimensional requirements for monel and K-monel studs which will have uniform energy absorption along their entire length. The testing in this task, therefore, must generate data which will give the equivalent tensile stress area of the unengaged threaded portion of the stud.

II MATERIALS TESTED

A. Requirements:-

1. K-Monel Studs- K-Monel studs used in the performance of this task must conform to Military Standard MS18116 and the applicable requirements of specifications QQ-N-286 and MIL-8-857.

2. Monel Studs- Monel studs used in the performance of this task must conform to the applicable requirements of QQ-N-281 and MIL-B-857, except that the studs must have the following mechanical properties:

Tensile strength - 80,000 psi, minimum

Yield strength - 40,000 psi, minimum (0.2 percent offset)

Elongation in 2 inches - 20 percent, minimum

B. Actual Chemical and Mechanical Properties:-

Tables I and II are a compilation of the required and actual chemical composition and mechanical properties, respectively, of the monel and K-monel studs used for the tests performed in this task.

Table I Chemical Composition

Material	Size (inches)	C	Si	Mn	Ni	Cu	Fe	S	Al	Ti
Monel Studs	Required	0.3 max	.5 max	2.0 max	63-67	Bal.	2.5 max	.024 max	.5 max	-
	1/2	.14	.10	.93	64.21	33.03	1.56	.010	-	-
	7/8	.15	.19	.90	64.80	33.14	.79	.005	-	-
	1-1/8	.15	.10	1.13	64.12	33.84	.63	.005	-	-
K-Monel	Required	.25 max	1.0 max	1.5 max	63-70	Bal.	2.0 max	.010 max	2.0-4.0	.25-1.00
	1/2	.16	.10	.55	64.80	30.46	.60	.005	2.79	.51
	7/8	.16	.10	.55	64.80	30.46	.60	.005	2.79	.51
	1-1/8	.23	.11	.53	65.75	29.66	.56	.005	2.70	.43

Table II Mechanical Properties

Material	Size (inches)	Tensile Strength (psi)	Yield Strength (psi)	Elongation in 2" (%)
Monel Studs	Required	80,000 min.	40,000 min.	20.0 min.
	1/2	106,500	102,000	23.0
	7/8	95,500	83,000	30.0
	1-1/8	90,500	77,000	31.0
K-Monel Studs	Required	130,000 min.	90,000 min.	20.0 min.
	1/2	178,700	148,200	20.3
	7/8	163,000	119,100	23.4
	1-1/2	151,500	107,200	24.2

III THREAD GAGING

The thread major diameter, minor diameter, pitch diameter, included angle and thread lead of each stud used in this task were measured at three points along the thread. The thread dimensions reported are an average of the three results. The major diameter was measured on a Pratt & Whitney Super Micrometer. Tri-roll gages were used to measure the pitch diameter to an accuracy of 0.0001 inch.

The included angle, minor diameter and lead were measured on a J & L Comparator to an accuracy of 0.0001 inch.

All threads were cut, UNC class 2A in accordance with Handbook H28, Screw-Thread Standards for Federal Services.

IV TEST PROCEDURE

An axial load was applied to continuously threaded monel and K-monel studs to their breaking point and the ultimate load determined. The equivalent tensile stress area was obtained by dividing the ultimate load by the tensile strength of the material (see Table II).

V TEST RESULTS

Test results are tabulated in Table III. These data indicate that the equivalent tensile diameter lies between the minor and pitch diameters.

Table III Equivalent Tensile Stress Area

Stud Material	Stud No.	Stud Size (inches)	Minor Diameter (inches)	Pitch Diameter (inches)	Major Diameter (inches)	Ultimate Load (lbs)	Equivalent Tensile Stress Area (in^2)	Equivalent Tensile Diameter (in)
Monel	1159	1/2	0.3951	0.4461	0.4945	15,750	0.1479	0.4340
	1160	1/2	0.3939	0.4425	0.4914	15,350	0.1441	0.4283
	1161	1/2	0.3942	0.4457	0.4941	15,640	0.1468	0.4323
	1162	1/2	0.3952	0.4456	0.4936	15,750	0.1479	0.4340
	1298	7/8	0.7235	0.7956	0.8628	46,000	0.4817	0.7831
	1299	7/8	0.7238	0.7977	0.8645	46,650	0.4884	0.7886
	1300	7/8	0.7237	0.7974	0.8643	46,400	0.4858	0.7863
	1301	7/8	0.7238	0.7974	0.8640	46,550	0.4874	0.7877
	1302	7/8	0.7240	0.7974	0.8645	46,050	0.4821	0.7835
	189	1-1/8	0.9326	1.0212	1.1168	72,500	0.8011	1.0100
	190	1-1/8	0.9328	1.0248	1.1166	69,500	0.7680	0.9889
	191	1-1/8	0.9326	1.0239	1.1175	70,000	0.7735	0.9924
	192	1-1/8	0.9322	1.0241	1.1153	70,000	0.7735	0.9924
	193	1-1/8	0.9329	1.0251	1.1162	69,900	0.7724	0.9917
	194	1-1/8	0.9320	1.0238	1.1127	69,700	0.7702	0.9903
	195	1-1/8	0.9327	1.0238	1.1144	69,500	0.7680	0.9889
K-Monel	1303	1/2	0.3935	0.4455	0.4951	26,000	0.1454	0.4303
	1304	1/2	0.3930	0.4452	0.4950	25,925	0.1451	0.4299
	1305	1/2	0.3929	0.4447	0.4946	26,150	0.1463	0.4316
	1306	1/2	0.3936	0.4455	0.4943	26,400	0.1477	0.4337
	1307	1/2	0.3931	0.4463	0.4944	25,725	0.1439	0.4280
	1309	1/2	0.3938	0.4450	0.4946	25,775	0.1442	0.4285
	381	7/8	0.7244	0.7956	0.8681	73,700	0.4521	0.7587
	382	7/8	0.7223	0.7952	0.8678	73,600	0.4515	0.7582
	383	7/8	0.7237	0.7949	0.8676	72,600	0.4454	0.7531
	384	7/8	0.7233	0.7955	0.8673	74,300	0.4558	0.7618
	385	7/8	0.7240	0.7948	0.8681	72,500	0.4448	0.7526
	386	7/8	0.7238	0.7951	0.8677	72,600	0.4454	0.7531
	275	1-1/8	0.9313	1.0233	1.1171	112,500	0.7426	0.9724
	276	1-1/8	0.9320	1.0225	1.1177	114,500	0.7558	0.9810
	277	1-1/8	0.9298	1.0219	1.1145	111,600	0.7366	0.9684
	278	1-1/8	0.9317	1.0220	1.1155	113,300	0.7479	0.9758