PH 13-8 Mo (H1000) Kic Discussion

SOUTHWEST RESEARCH INSTITUTE®

U.S. AIR FORCE

Kaylon Anderson

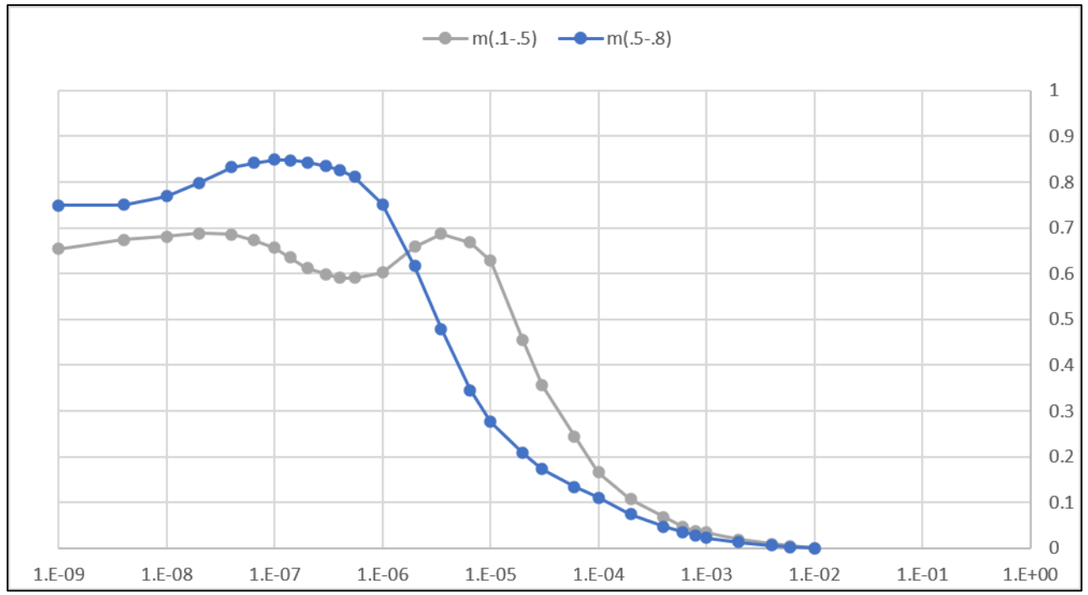
2026 AFGROW Users Workshop

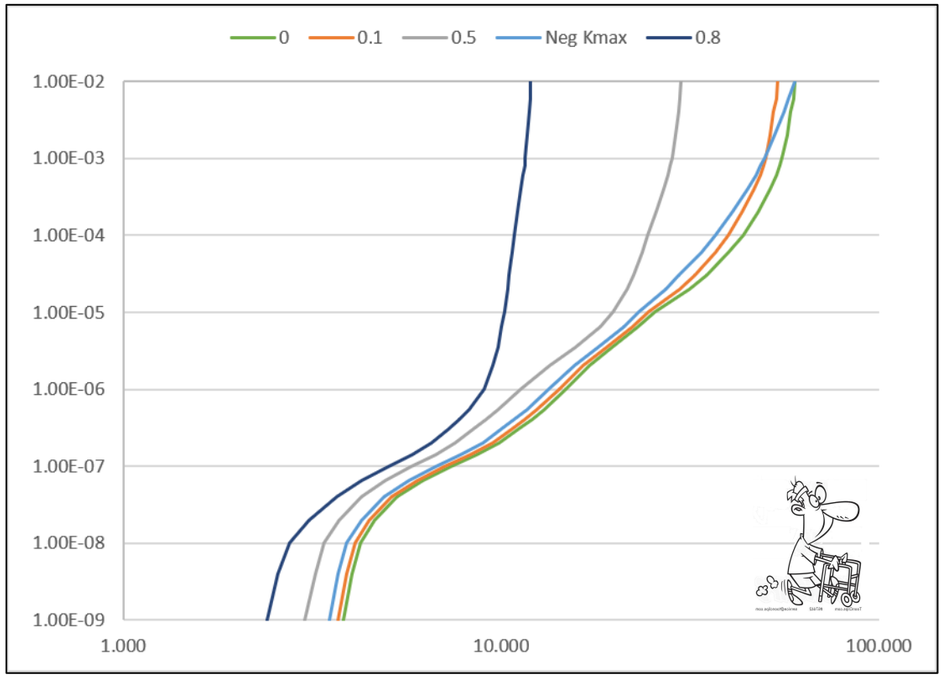
Approved for public release: distribution unlimited. PA#: USAFA-DF-2026-0945

"The views expressed in this article, book, or presentation are those of the author and do not necessarily reflect the official policy or position of the United States Air Force Academy, the Air Force, the Department of Defense, or the U.S. Government."

©SOUTHWEST RESEARCH INSTITUTE

Background





So, here I am just working to fit some curves.

Data from SwRI-22-26284-05, "T-38 Fatigue Crack Growth and Shut Off Overload Ratio (SOLR) Testing Results"

Alloy	13-8PH		Freq	
Cond / HT	H1000 (AMS 5629)		Lab Enviroment	lab air (72F. ~50%RH)
Form	Round Bar (2" dia)		Yield Strength	UTS of 205 ksi
Specimen Type	C(T)		Specimen thk	0.34
Orientation	L-R		Specimen width	1.25
Stress Ratio	0.1		Specimen ID	See Below
Reference	SwRI-22-26284-05		Method	See Below

Round Bar

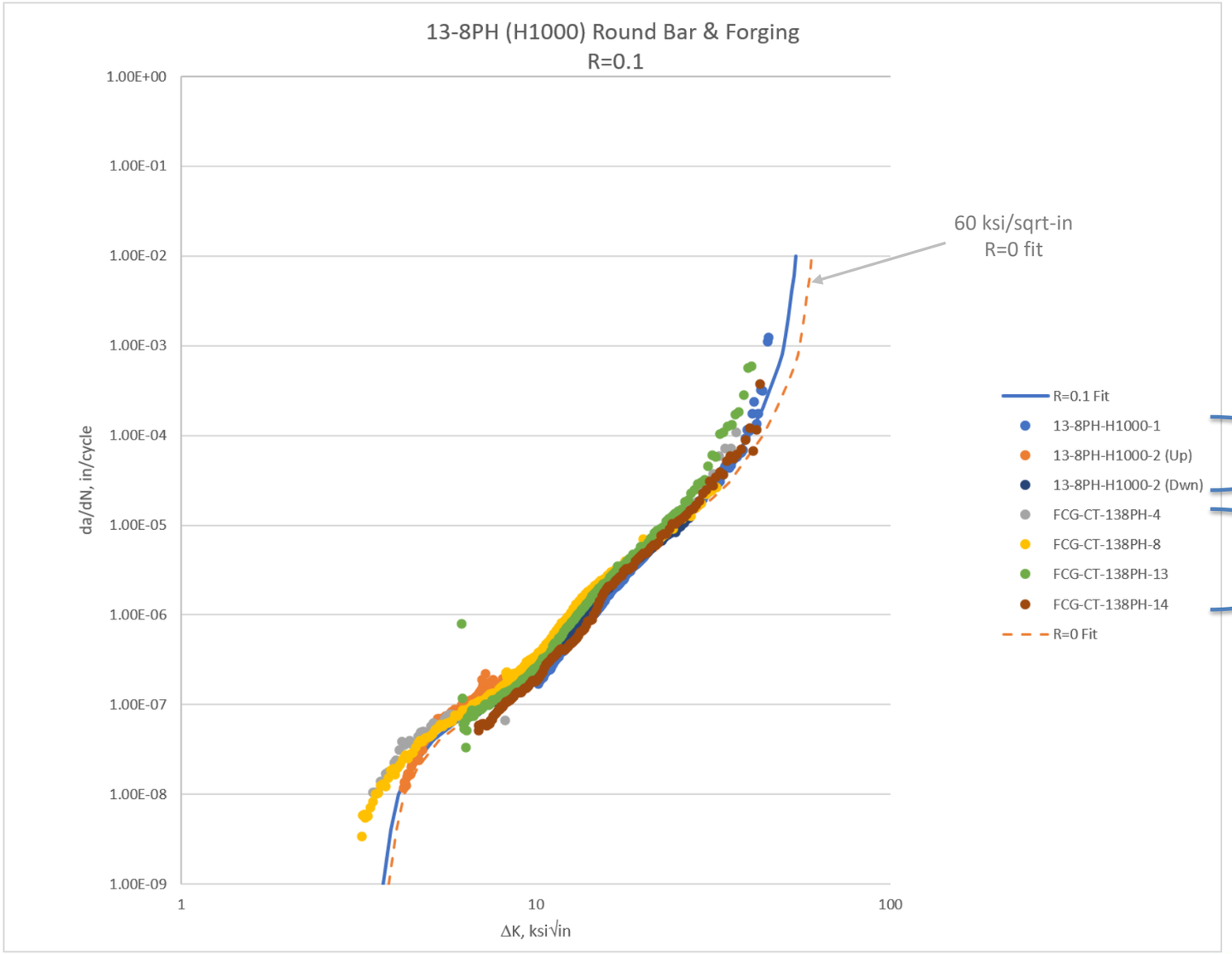
Data from SwRI-16-20411-15, "T-38 FSIS of Non-Modified Aircraft"

Alloy	13-8PH		Freq	
Cond / HT	H1000 (AMS 5629)		Lab Enviroment	lab air
Form	Forging (2" thick)		Yield Strength	UTS of 215 ksi (SwRI-16-20411-15)
Specimen Type	C(T)		Specimen thk	0.12
Orientation	L-T		Specimen width	2
Stress Ratio	0.1		Specimen ID	See Below
Reference	SwRI-16-20411-15		Method	See Below

Forging

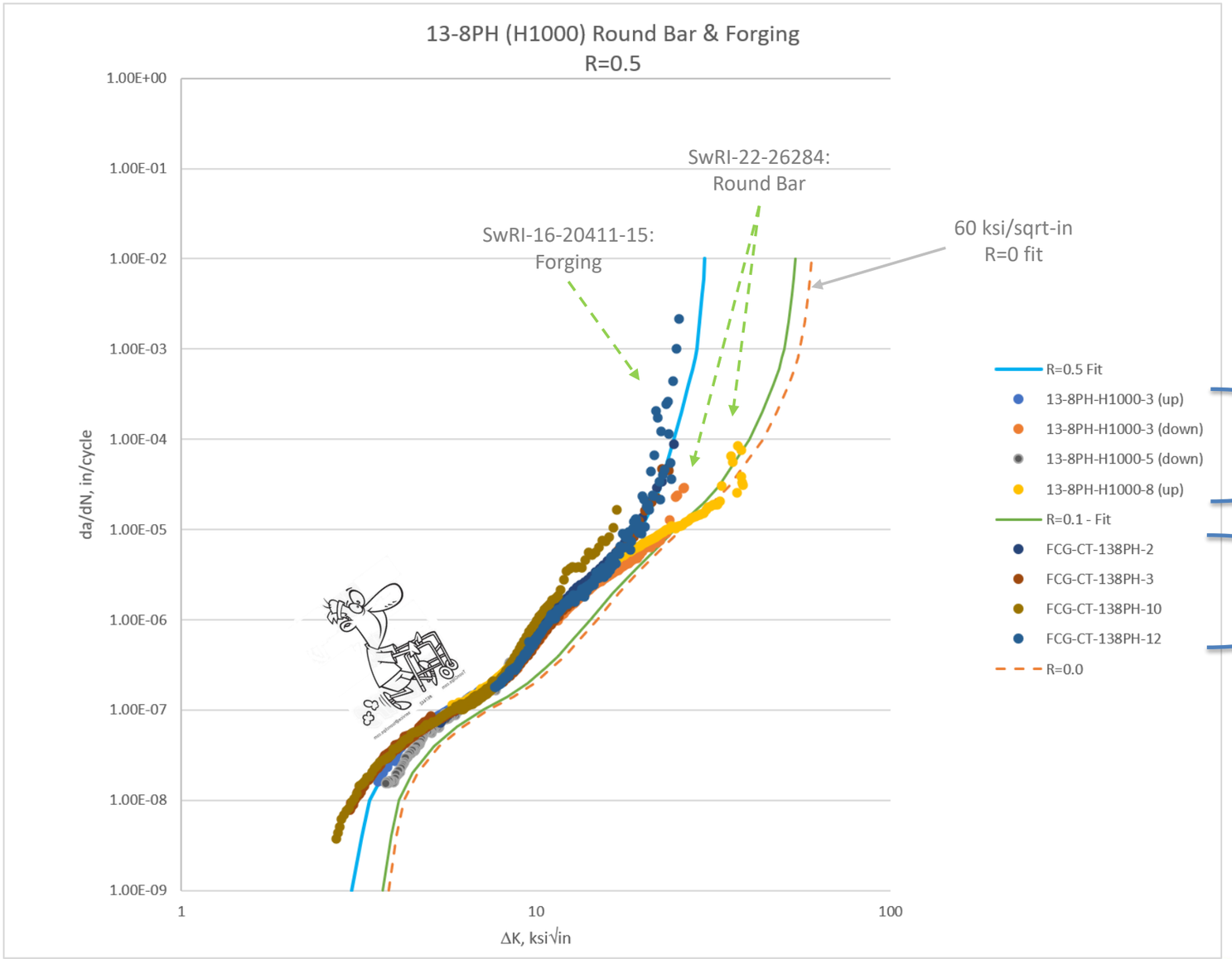
©SOUTHWEST RESEARCH INSTITUTE

R=0.1 Curve Fit



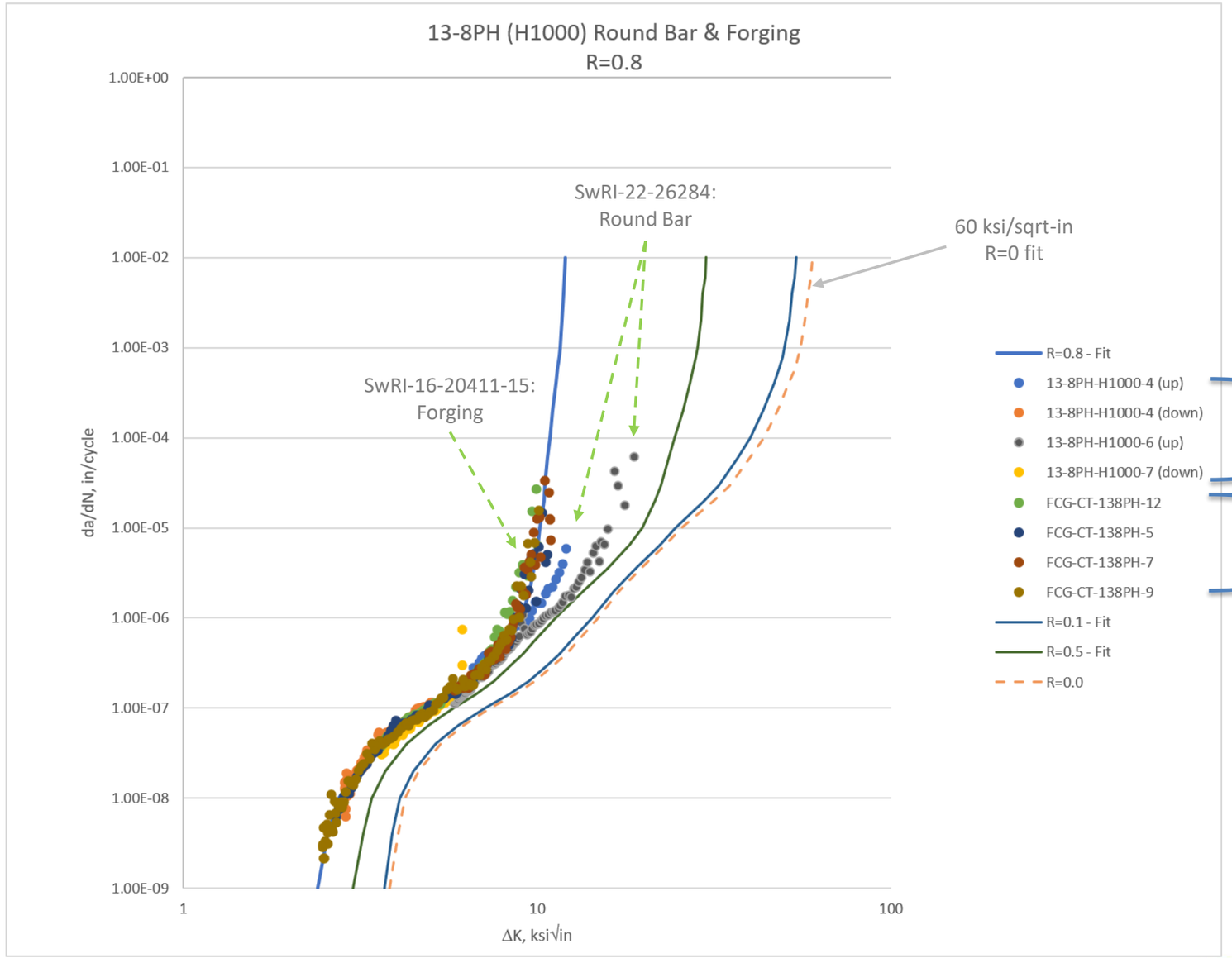
©SOUTHWEST RESEARCH INSTITUTE

R=0.5 Curve Fit



©SOUTHWEST RESEARCH INSTITUTE

R=0.8 Curve Fit



©SOUTHWEST RESEARCH INSTITUTE

Kic Testing

Now I just need some Fracture Toughness Values to Round of the Curve Fit.

Name	Material	Product Form	Orientation	Spec	thickness	Fty	$2.5\left(\frac{K_{IC}}{F_{ty}}\right)^2$	Kic	Kic Ave
A-15a	13-8 PH (200-215 ksi)	Bar Cres	L-T	AMS 5629		191		98	
B-14	13-8 PH (H1000)	Round Bar	L-T	AMS 5629		191		98	
MMPDS Max	13-8 PH (H1000)	Forging	L-T	AMS 5629	4" - 8"	205 - 215	0.61	104	
MMPDS ave	13-8 PH (H1000)	Forging	L-T	AMS 5629	4" - 8"	205 - 215	0.46	90	90
MMPDS Min	13-8 PH (H1000)	Forging	L-T	AMS 5629	4" - 8"	205 - 215	0.14	49	
SwRI-16-20411-15	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.997	215.4	0.10	42.7	
SwRI-16-20411-15	13-8 PH (H1000)	Forging	L-T	AMS 5629	1.001	215.4	0.12	47.4	46.2
SwRI-16-20411-15	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.992	215.4	0.13	48.4	
CT-138-ph-1 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.75	215.4	0.48	94.3	
CT-138-ph-2 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.751	215.4	0.49	95.6	
CT-138-ph-3 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.7505	215.4	0.53	99.0	98.3
CT-138-ph-4 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.403	215.4	0.49	95.1	
CT-138-ph-5 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.403	215.4	0.59	104.3	
CT-138-ph-6 (2019 testing)	13-8 PH (H1000)	Forging	L-T	AMS 5629	0.4025	215.4	0.55	101.3	
*All tests were determined to be valid as discussed in their specific report or in the test data spreadsheets.									
*Fty values were pulled from the reports or test data spreadsheets. This value is what was used to determine validity for the specimens.									

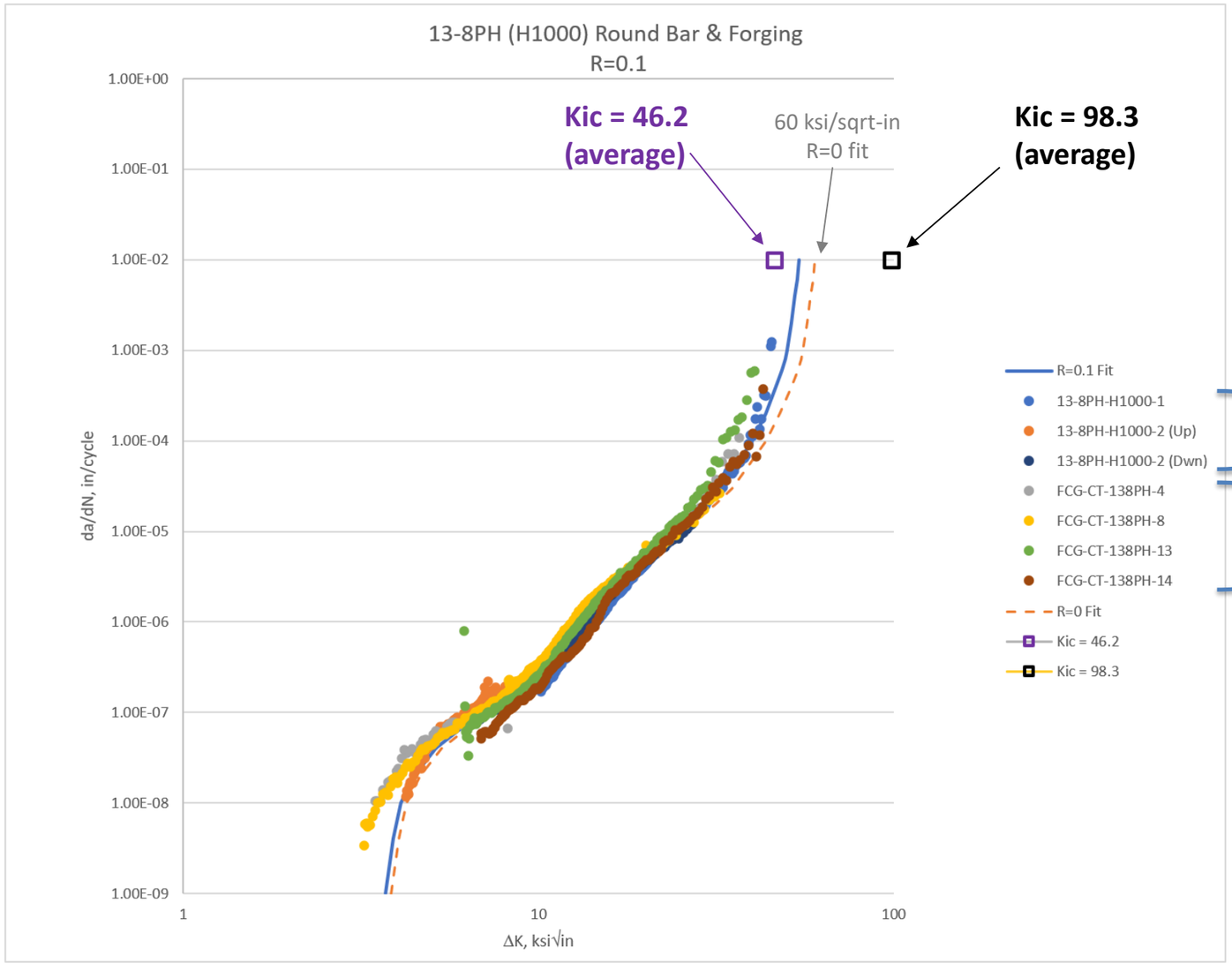
I do not have any testing for Kc. So, I am just assuming, for now

©SOUTHWEST RESEARCH INSTITUTE

The Question!

Wait!

What Kic and Kc should I use?

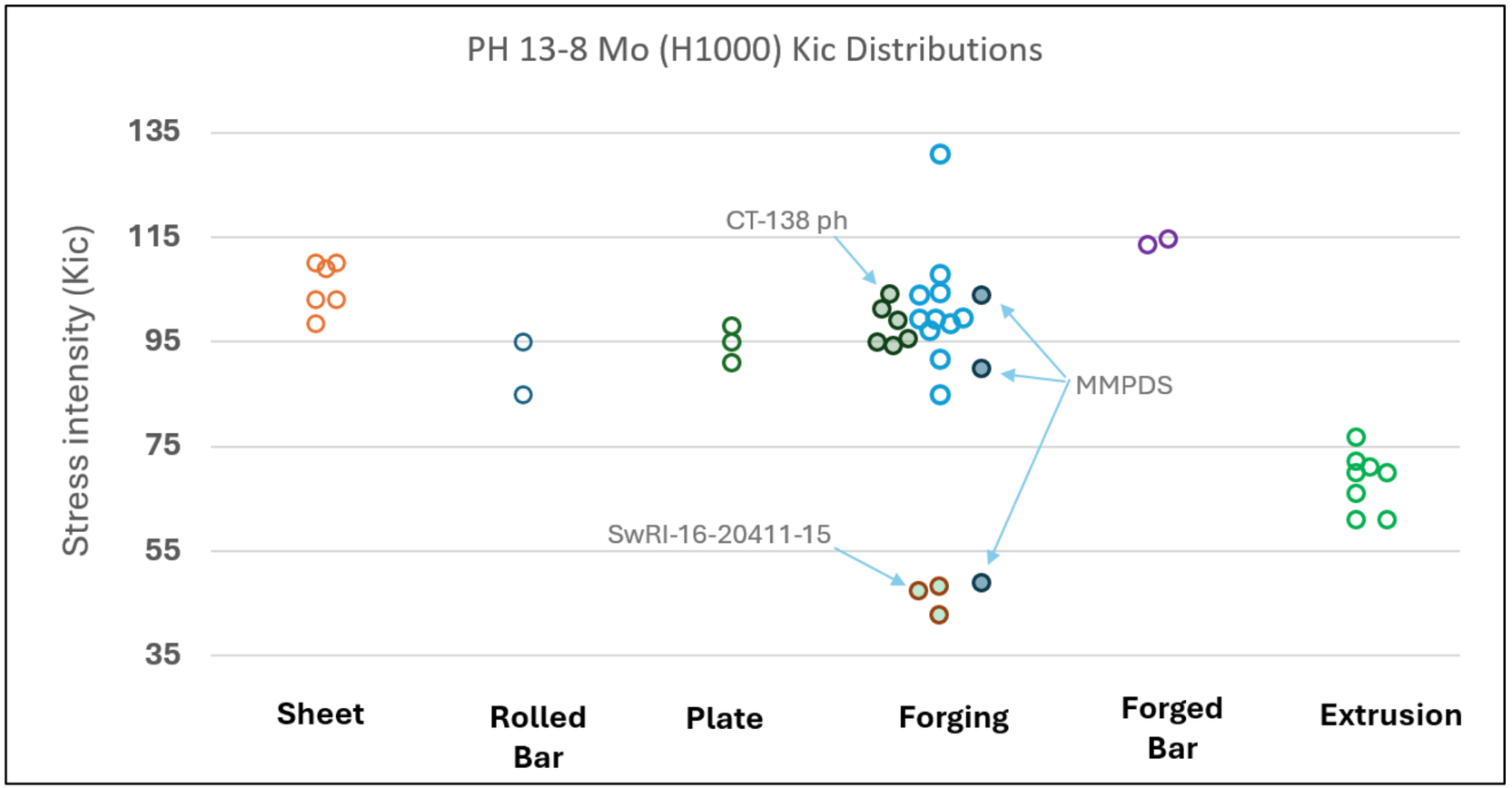


©SOUTHWEST RESEARCH INSTITUTE

Additional PH 13-8 Mo (H1000) Kic Testing

WL-TR-94-4052 (Damage Tolerant Design Handbook)
&
MMPDS -15

Why the Variation?



©SOUTHWEST RESEARCH INSTITUTE

Additional PH 13-8 Mo (H1000) Kic Testing

NASGRO Database

Why the Variation?

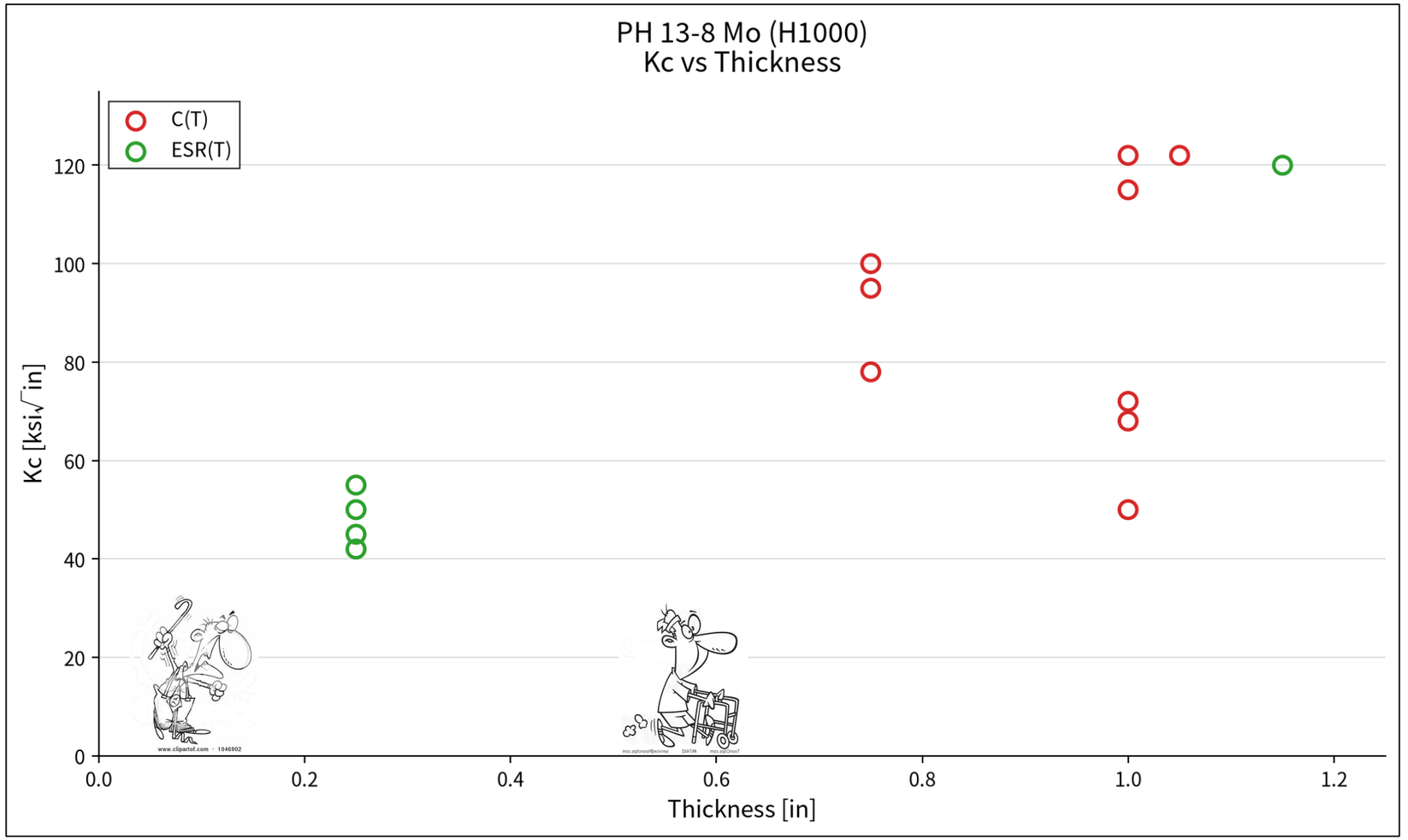


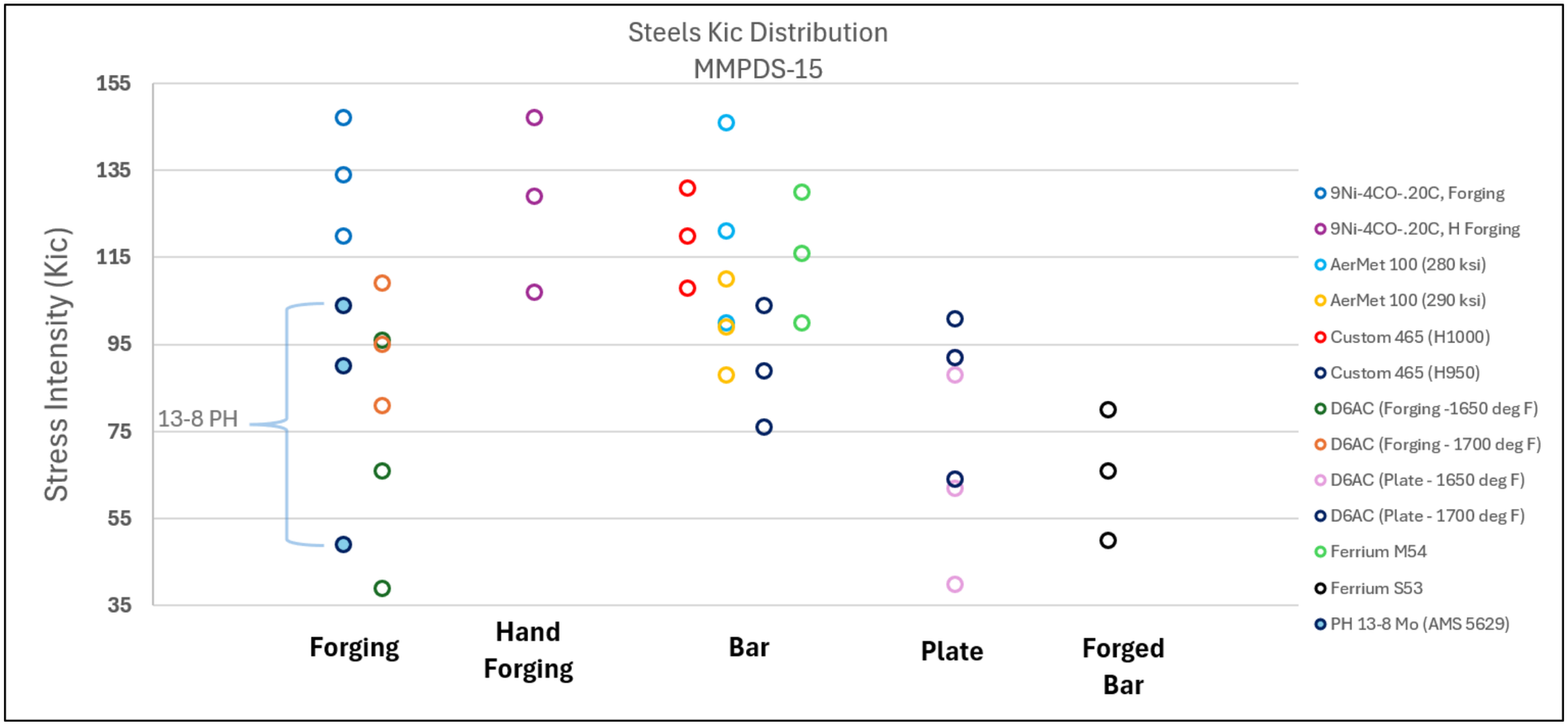
Image formatted by AI

©SOUTHWEST RESEARCH INSTITUTE

Additional Kic Testing

Oh, this is something that happens within the Steel Family.

MMPDS -15
All Steels (L-T, or L-R directions)



©SOUTHWEST RESEARCH INSTITUTE

Additional Kic Testing

Aluminums, for Reference

MMPDS -15
All Aluminums

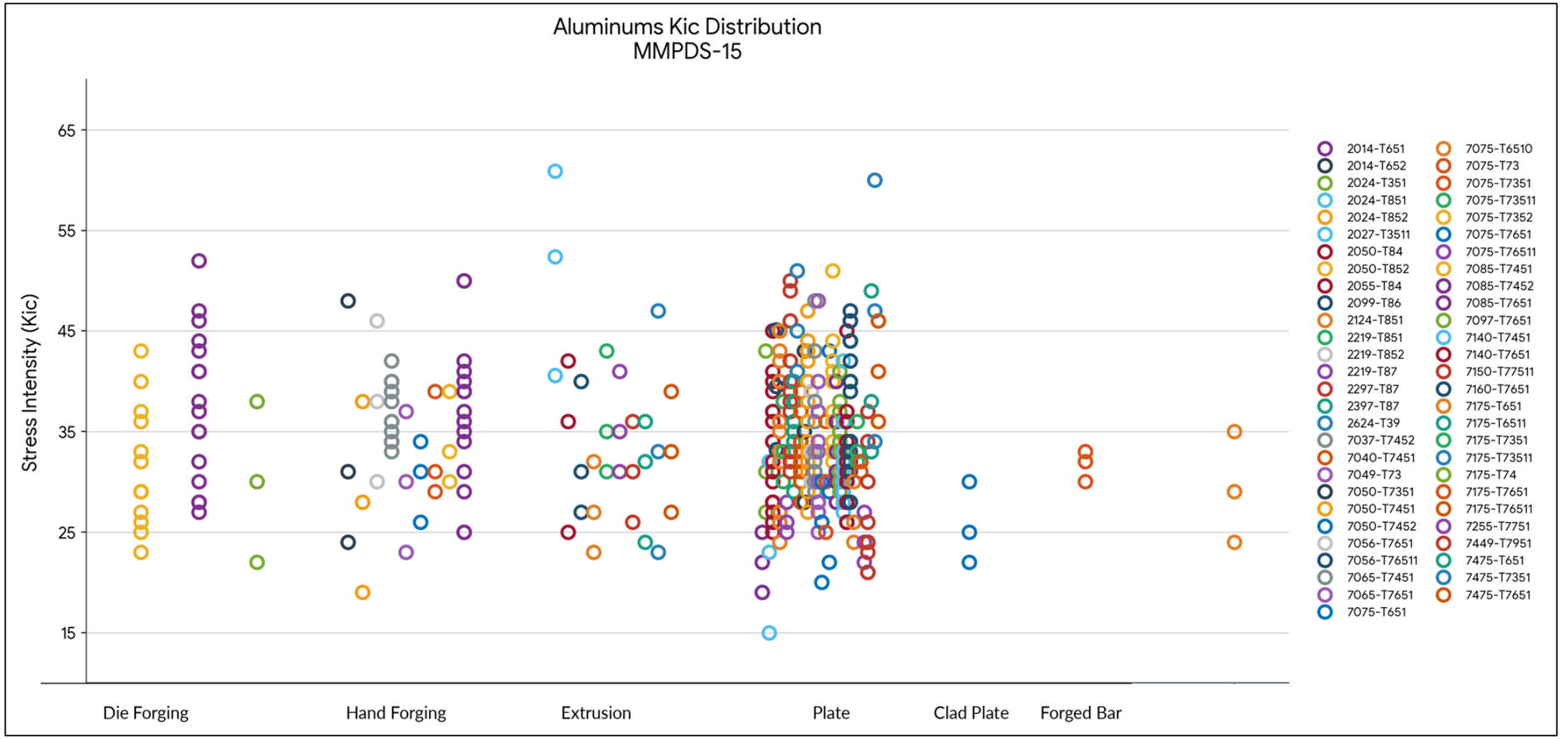


Image formatted by AI

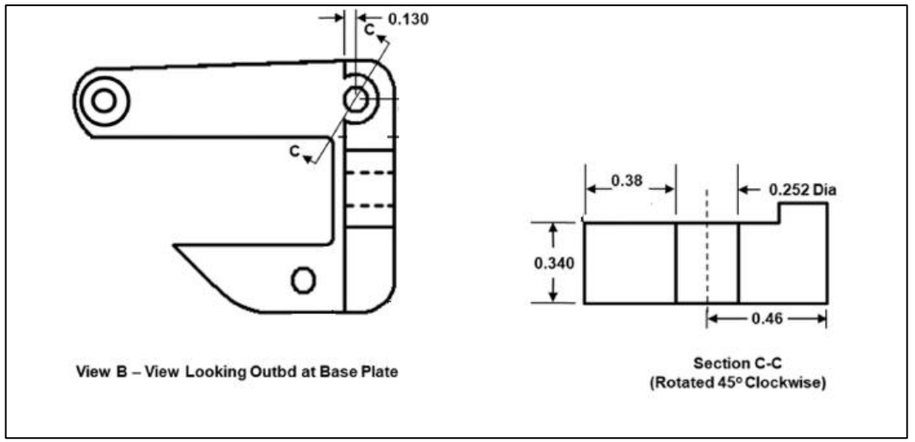
©SOUTHWEST RESEARCH INSTITUTE

What Difference Does it Make?

Where is 13-8PH used?

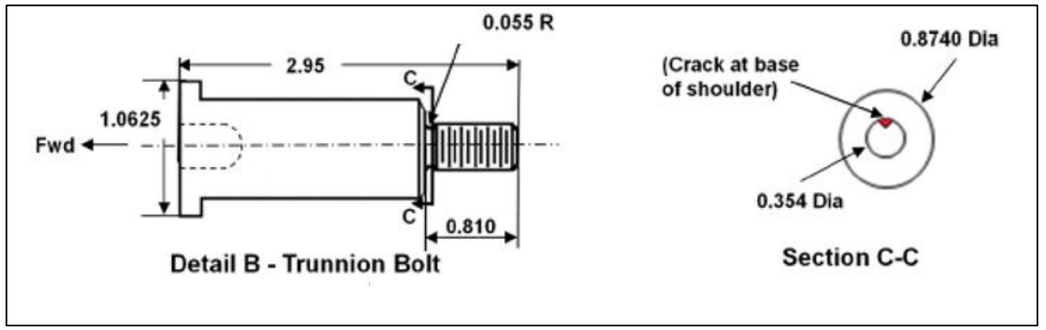
Only two FCL on the Plane that use PH 13-8 Mo (H1000).
Both appear to be bar stock

B-14



Engine Mount Base Plate
13-8PH Cres Bar

A-15a, -29 wing

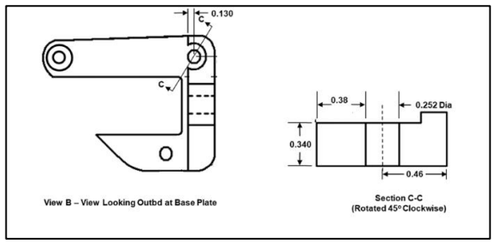


Trunnion Bolt
13-8PH Cres Bar

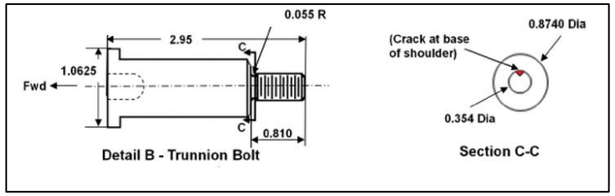
©SOUTHWEST RESEARCH INSTITUTE

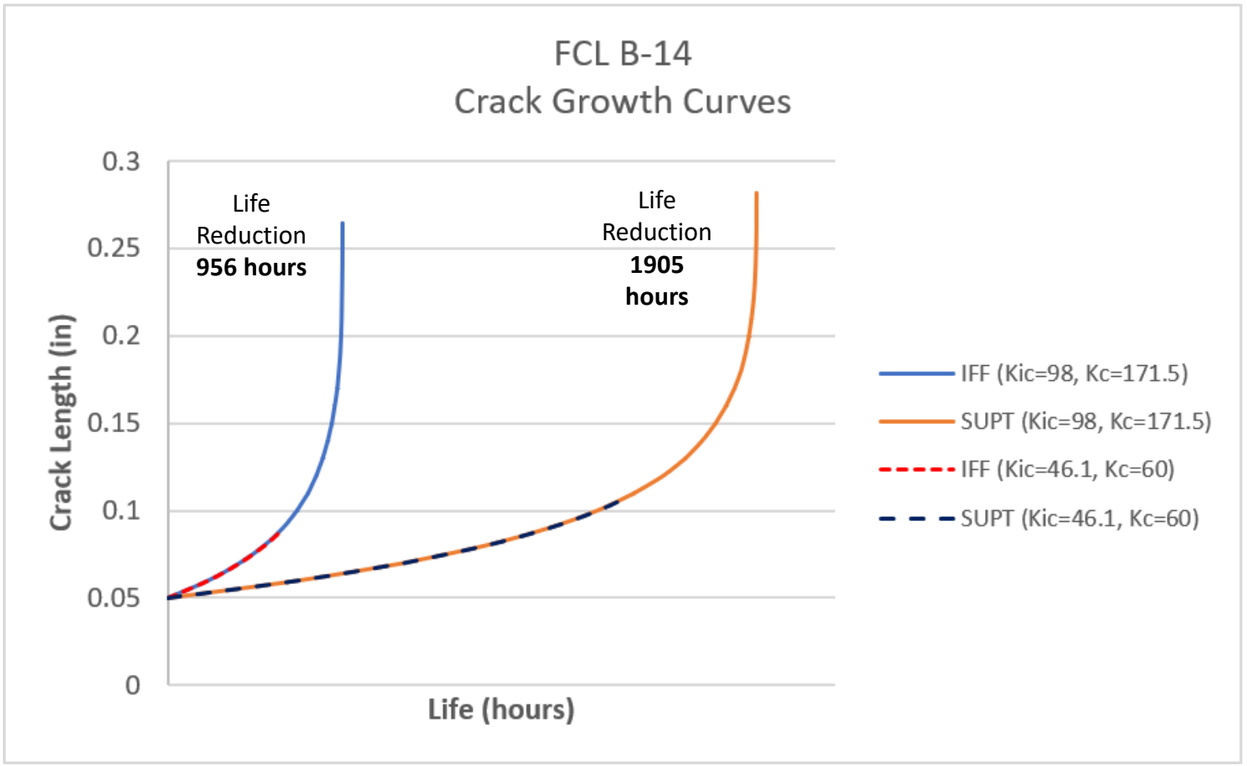
What Difference Does it Make?

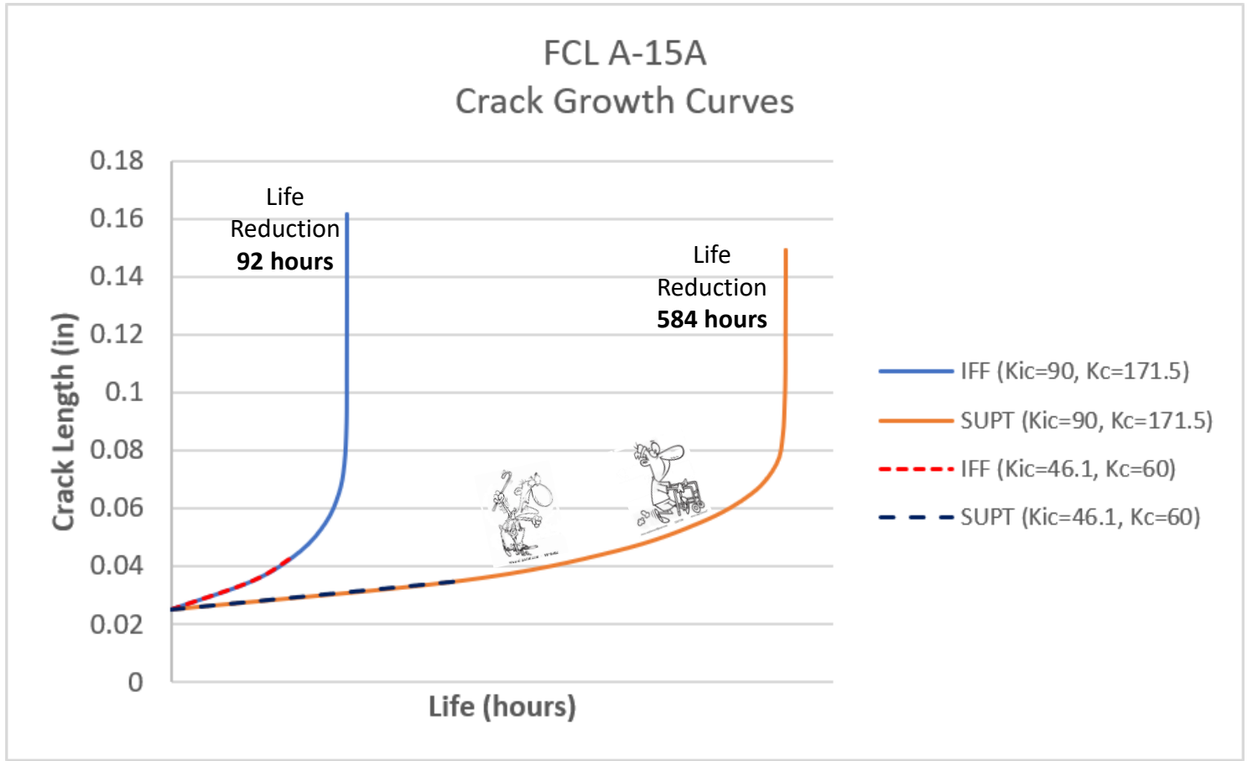
B-14



A-15a, -29 wing



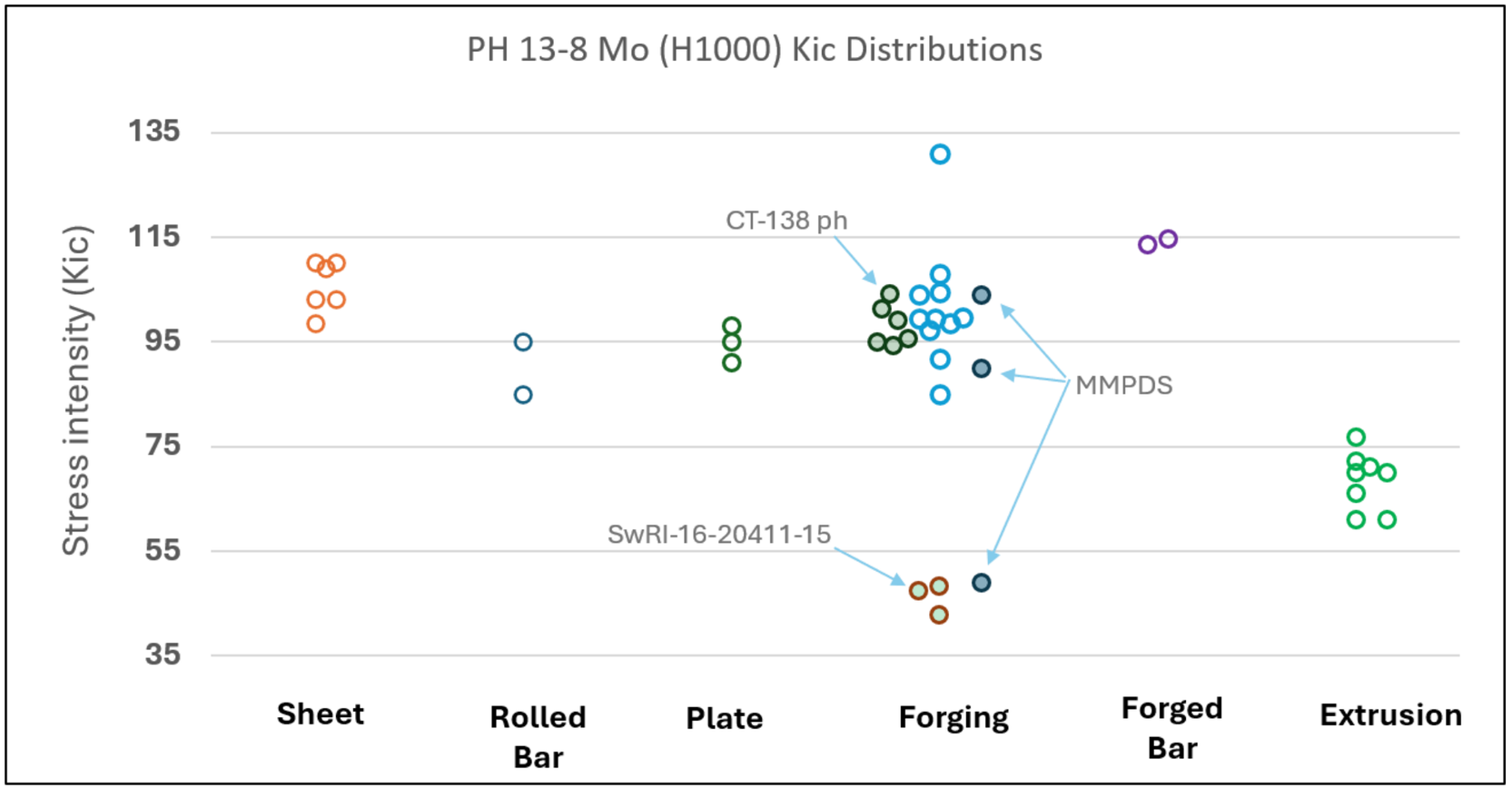




©SOUTHWEST RESEARCH INSTITUTE

Additional PH 13-8 Mo (H1000) Kic Testing

Let's have a Conversation now. If you were in my shoes, what Kic would you use and why?



©SOUTHWEST RESEARCH INSTITUTE

Questions?

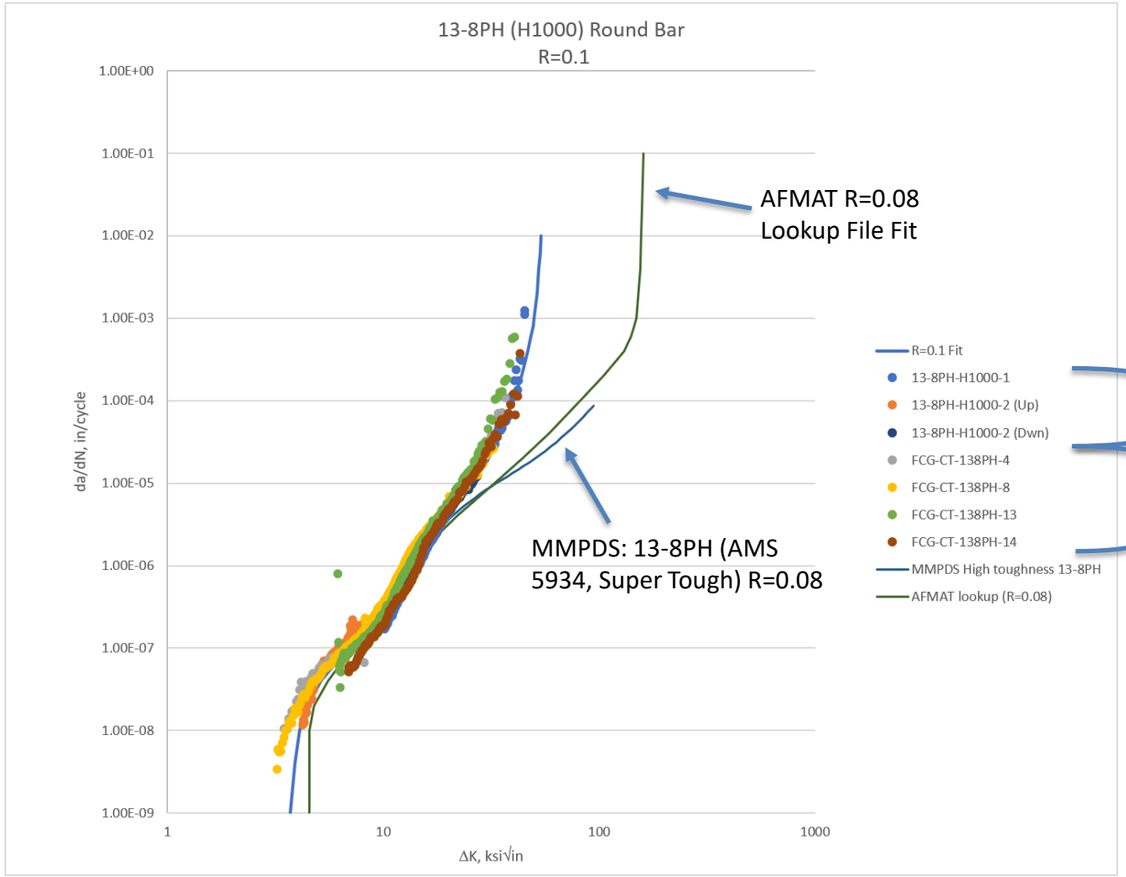
©SOUTHWEST RESEARCH INSTITUTE

Maybe We Might Need to Look at More Slides

©SOUTHWEST RESEARCH INSTITUTE

Reference (Doc)	MMPDS-15	MMPDS-15	MMPDS-15
Reference (Alloy)	PH13-8Mo-H1000	PH13-8Mo-H1000	PH13-8Mo-H1000
Material Title	Forging, flash welded ring, and extrusion	Round, hex, square and flat bar	Round, hex, square and flat bar
Reference Table	Table 2.6.6.0(c)	Table 2.6.6.0(b)	Table 2.6.6.0(b)
Thickness (in)	<= 12	< 8.0	< 8.0
Basis	S	A	B
Orientation	L, T, xx	L, T, xx	L, T, xx
F_tu (ksi)	205, 205, xx	201, 201, xx	208, 208, xx
F_ty (ksi)	190, 190, xx	190 [c], 190 [c], xx	200, 200, xx
F_cy (ksi)	xx, xx, xx	200, 200, xx	211, 211, xx
F_su (ksi)	xx	117	122
F_bru (e/d = 1.5) (ksi)	xx	302	313
F_bru (e/d = 2.0) (ksi)	xx	402	416
F_bry (e/d = 1.5) (ksi)	xx	263	277
F_bry (e/d = 2.0) (ksi)	xx	338	356
e (%) (L, T, ST)	10, 10, xx	10, 10, xx	xx, xx, xx
E (ksi)	28,300	28,300	28,300
E_c (ksi)	29,400	29,400	29,400
G (ksi)	11,000	11,000	11,000
mu	0.28	0.28	0.28
omega (lb/in^3)	0.279	0.279	0.279

©SOUTHWEST RESEARCH INSTITUTE



©SOUTHWEST RESEARCH INSTITUTE

Current Kic & Kc Values in DaDTA Report

Table 10.16-4: 13-8PH Material Data for FCL B-14

Material	13-8PH steel
K_{Ic}	98.0 ksi√in
K_c	171.5 ksi√in
User Defined K_{max}	165.6 ksi√in
F_{ty}	191 ksi
Crack growth model	Tabular Crack Growth Rate Data
Retardation model	None
Retardation parameter	None

Table 6.13-3: Material Data for FCL A-15a

Material	13-8PH Steel
K_{Ic}	98 ksi√in
K_c	171.5 ksi√in
F_{ty}	191 ksi
Crack growth model	Tabular Crack Growth Rate Data
Retardation model	No retardation

©SOUTHWEST RESEARCH INSTITUTE

B-14

Note B-14 has a 17-PH forging drawing also.

QTY REQD	PART OR IDENTIFYING NO.	SEE NOTES	NOMENCLATURE OR DESCRIPTION	MATERIAL OR CODE IDENT NO.	SIZE	SPECIFICATION OR PROCUREMENT DATA	ITI
	-2		PLATE	BAR CRES PH13-8MO	1.25x3.00 x3.3	AMS 5629	
	-1						

PARTS LIST

8 THREAD PER MIL-S-8879

7 HEAT TREAT TO COND H1000 PER PS HT-19

A-15a, -29

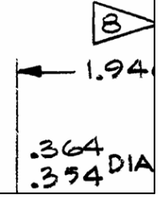
wing

7. HEAT TREAT PER MIL-H-6875 CLASS D, (PH13-8MO) TO TENSILE STRENGTH 200-215 KSI.

8. PLATE SHANK ONLY PER MIL-C-26074, CLASS 2, GRADE A, .0010 TO .0015 THICK, FOR -01 ONLY.

9. THIS PART REPLACES 3-20001, FSCM 76823.

10. CRES 1 1/16 HEX, AMS5629, COLD FINISHED, SOLUTION HEAT TREATED STRAIGHTENED AND DESCALED. ALTERNATE FORM OF STOCK MATERIAL, 1¼ DIA ROUND BAR.



©SOUTHWEST RESEARCH INSTITUTE