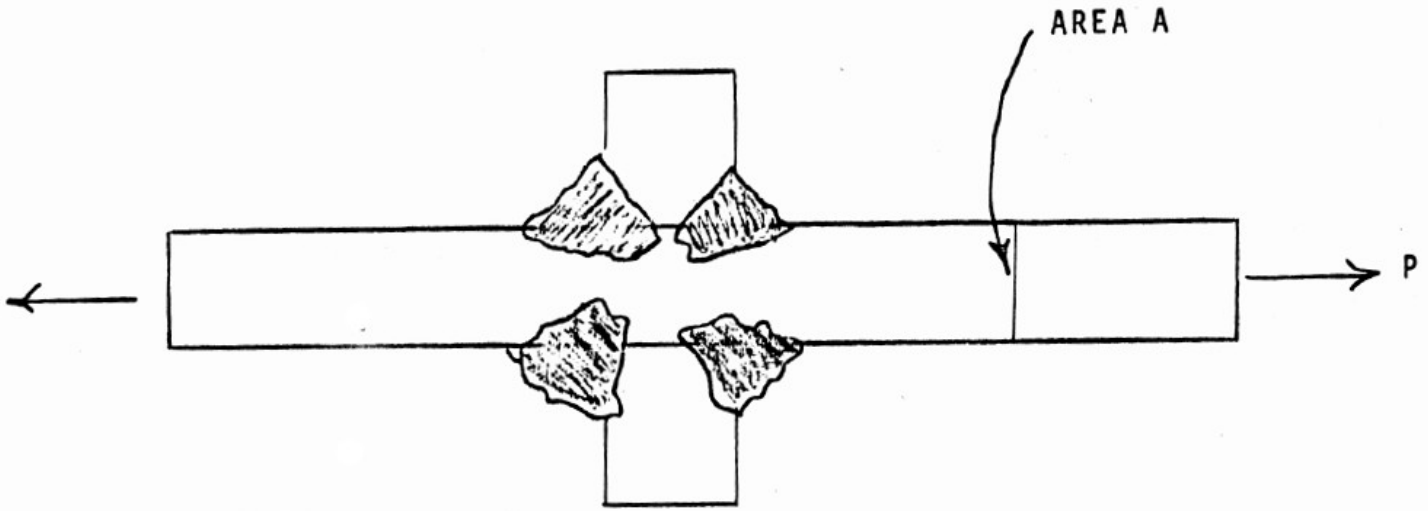
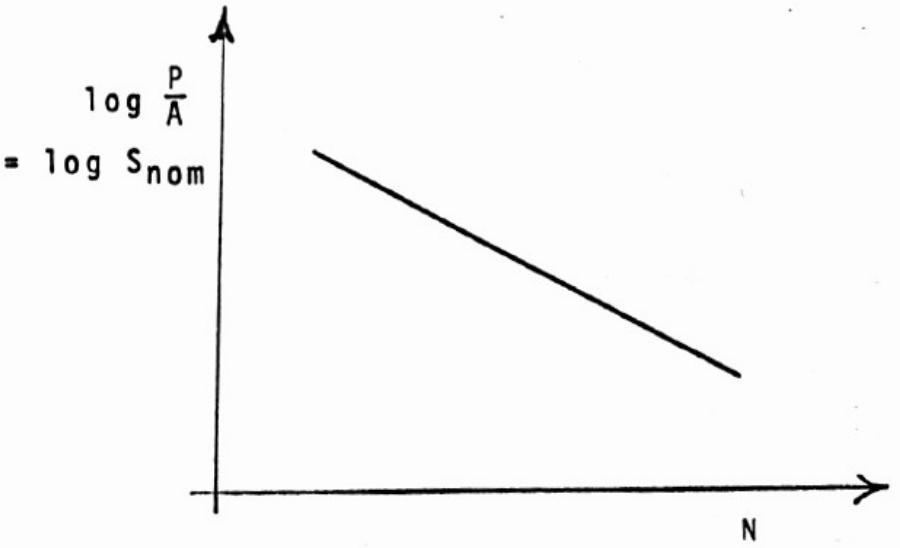
# WELD FATIGUE TEST




FN-238 3-77

GENERAL ELECTRIC

General Electric Company

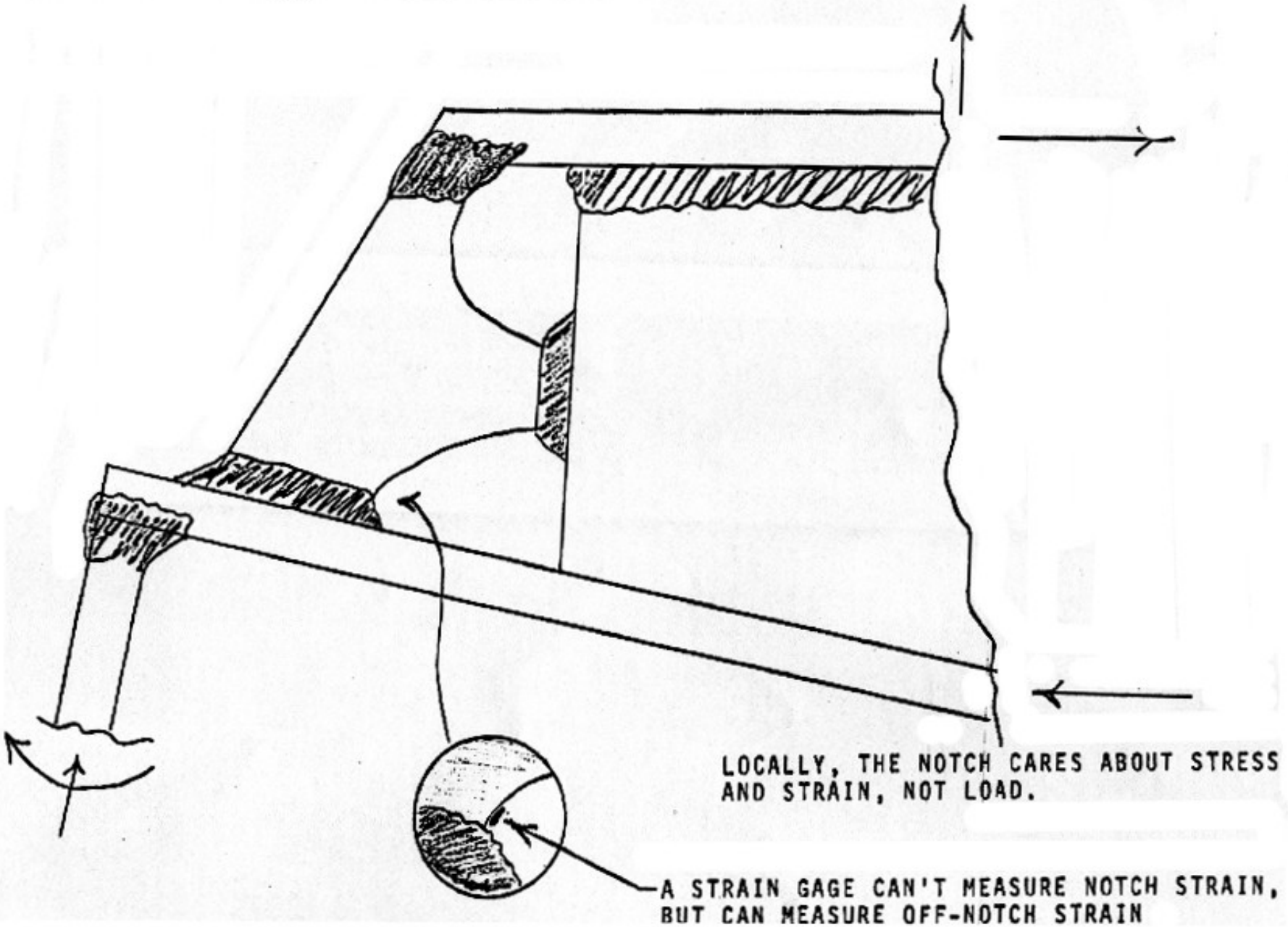
R. C. Leever

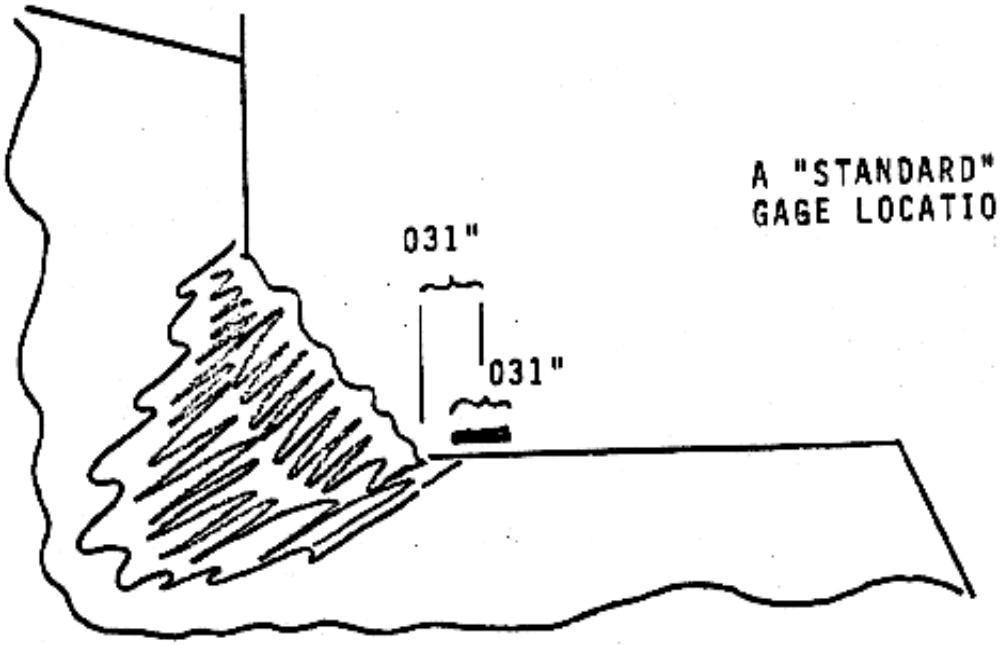
2901 E. Lake Rd. Bldg. 14-1

Erie, PA 16531

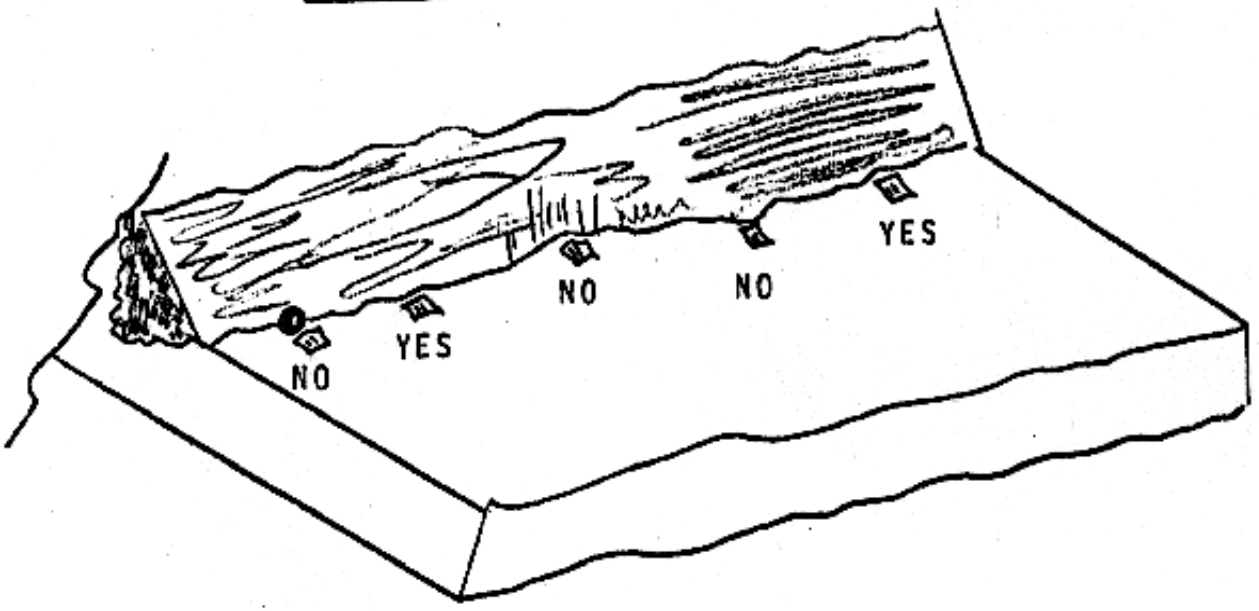
COMPLEX STRUCTURE

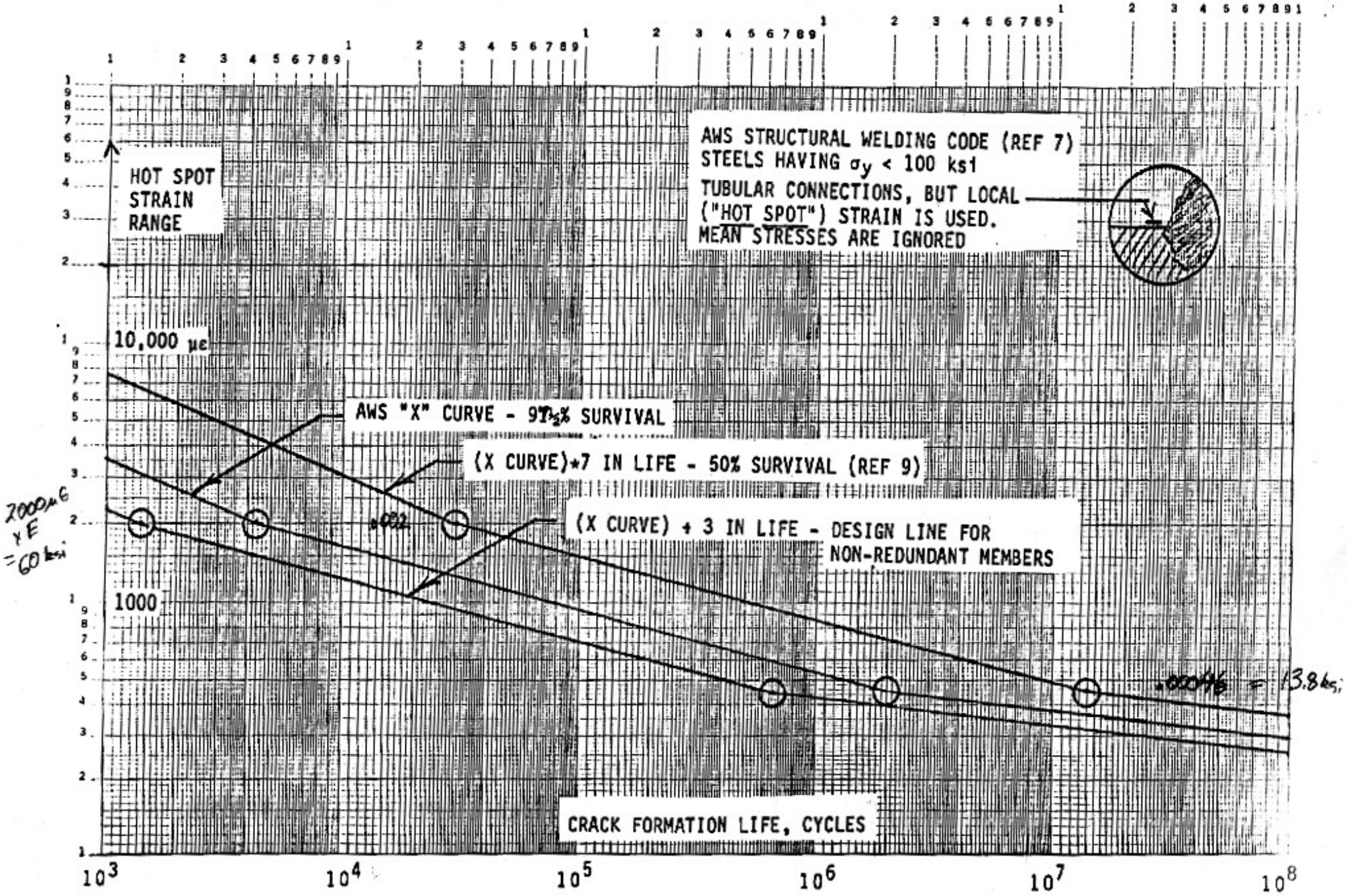
$S_{nom}$ DOESN'T EXIST!

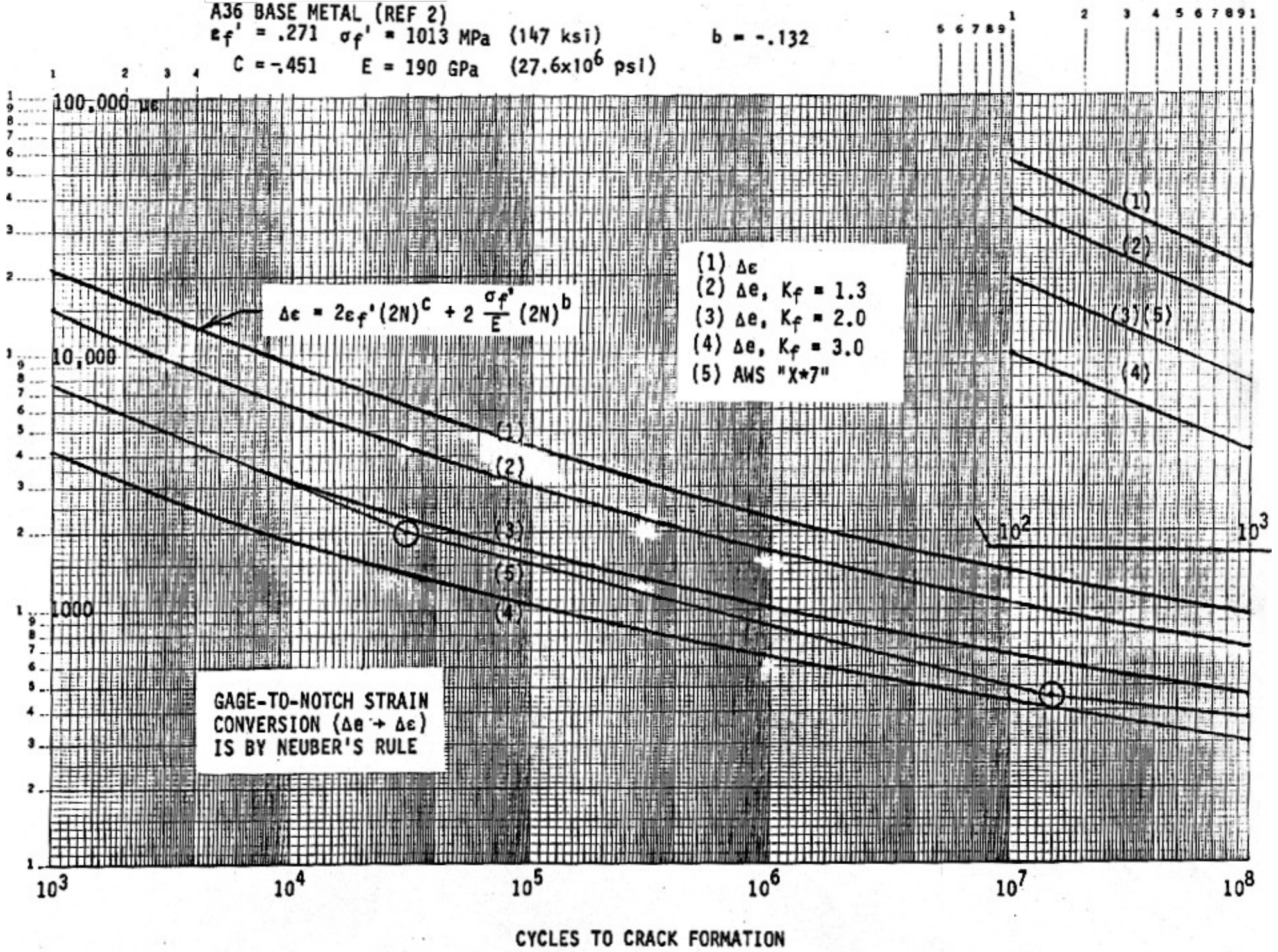





GAGE AT <u>TYPICAL</u> REGION AT FUSION LINE




HOT SPOT STRAIN RANGE
AWS STRUCTURAL WELDING CODE (REF 7)
STEELS HAVING $\sigma_y$ < 100 ksi
TUBULAR CONNECTIONS, BUT LOCAL ("HOT SPOT") STRAIN IS USED.
MEAN STRESSES ARE IGNORED
10,000 με
AWS "X" CURVE - 97½% SURVIVAL
(X CURVE)*7 IN LIFE - 50% SURVIVAL (REF 9)
(X CURVE) ÷ 3 IN LIFE - DESIGN LINE FOR NON-REDUNDANT MEMBERS
1000
CRACK FORMATION LIFE, CYCLES
$10^3$
$10^4$
$10^5$
$10^6$
$10^7$
$10^8$


A36 BASE METAL (REF 2)
$\varepsilon_f'$ = .271 $\sigma_f'$ = 1013 MPa (147 ksi) b = -.132
C = -.451 E = 190 GPa (27.6x10^6 psi)
100,000 με
10,000
1000
$\Delta\varepsilon = 2\varepsilon_f'(2N)^c + 2\frac{\sigma_f'}{E}(2N)^b$
(1) Δε
(2) Δe, $K_f$ = 1.3
(3) Δe, $K_f$ = 2.0
(4) Δe, $K_f$ = 3.0
(5) AWS "X*7"
GAGE-TO-NOTCH STRAIN CONVERSION (Δe → Δε) IS BY NEUBER'S RULE
$10^2$
$10^3$
$10^3$
$10^4$
$10^5$
$10^6$
$10^7$
$10^8$
CYCLES TO CRACK FORMATION

## CONCLUSIONS

(1) "HOT SPOT STRAIN" MEASUREMENTS ARE A VERY USEFUL TECHNIQUE FOR WELD FATIGUE LIFE PREDICTION

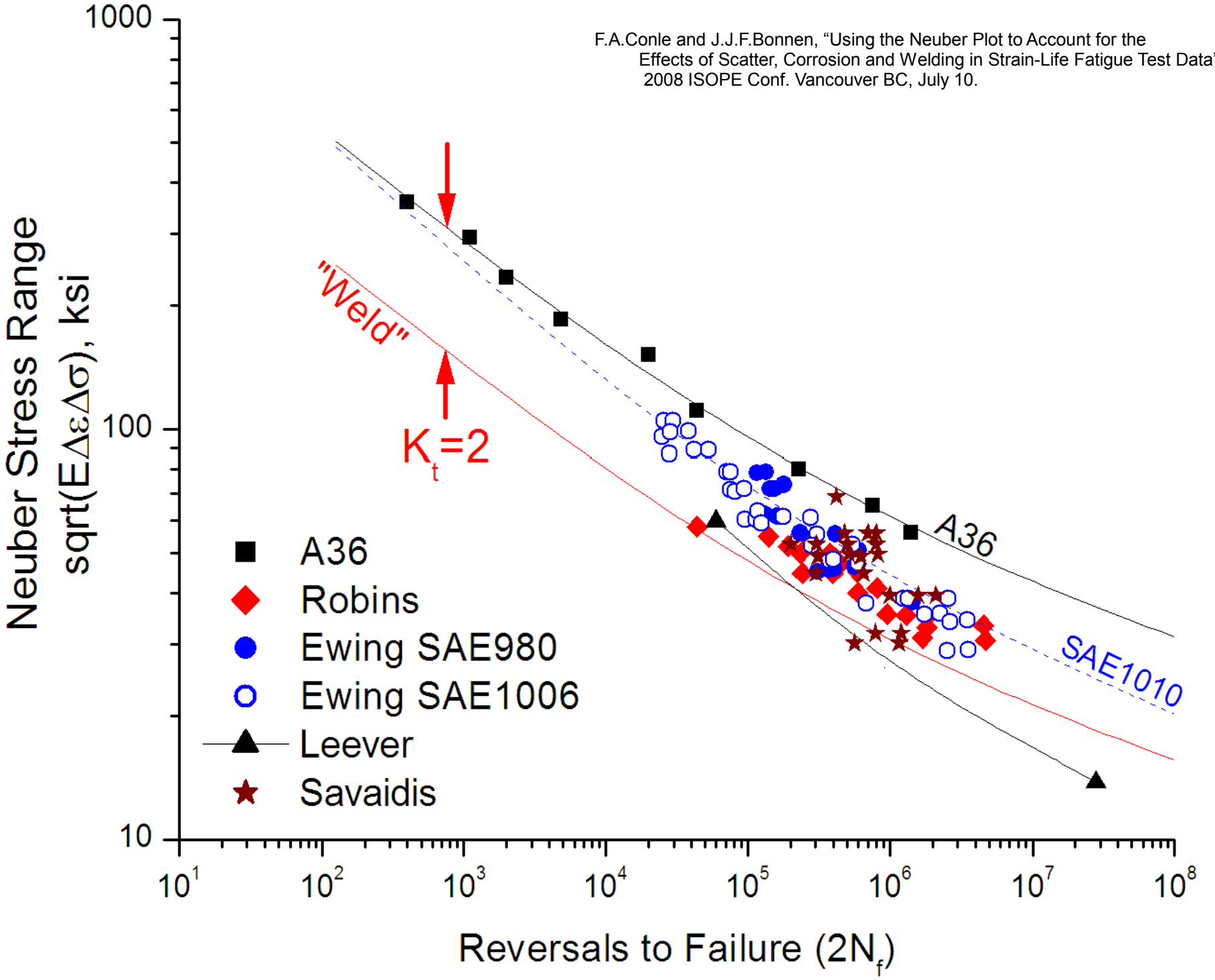
(2) WATCH TECHNOLOGY COMING FROM WORK ON OFF-SHORE DRILLING PLATFORMS

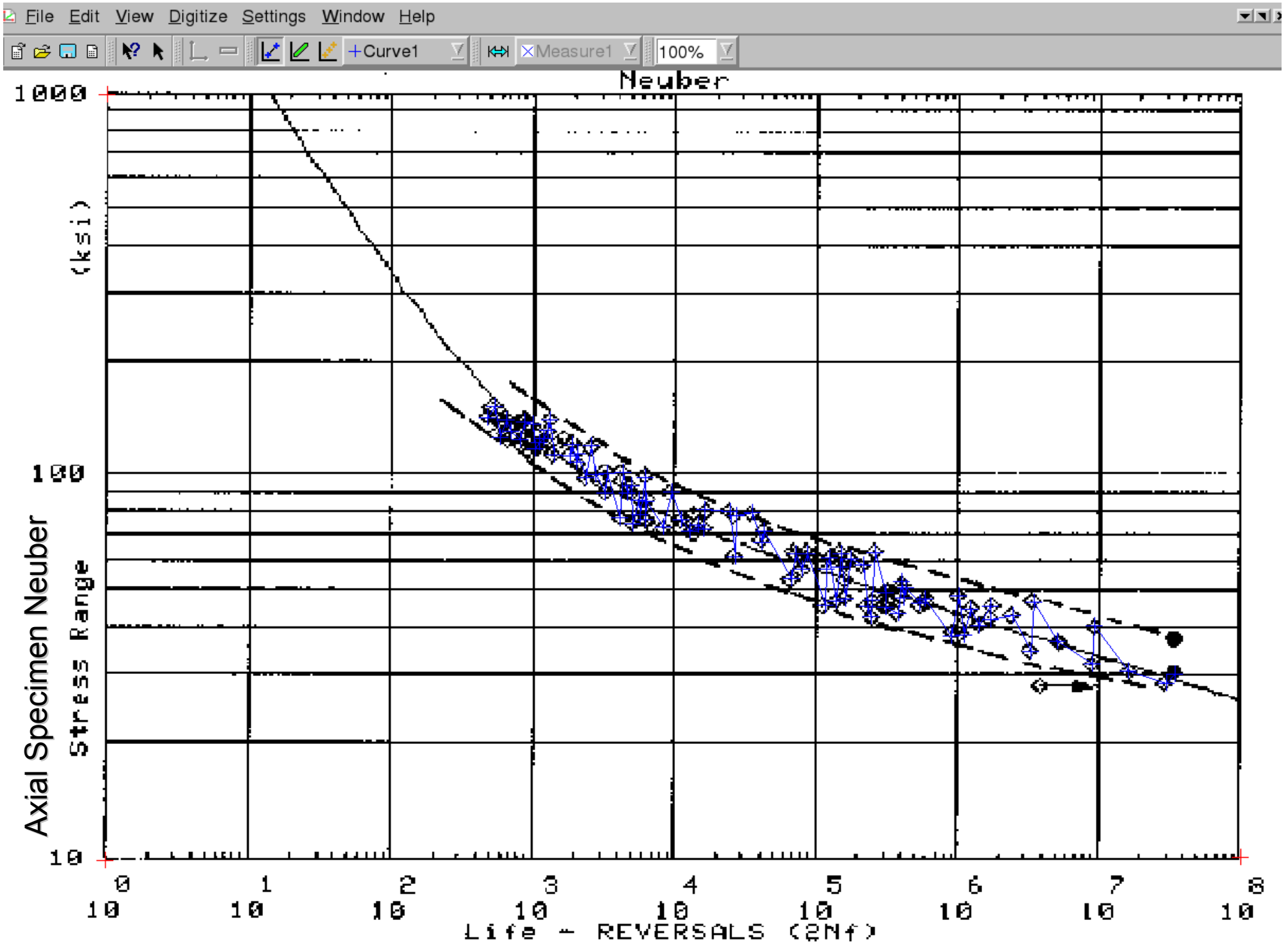
(3) THE AWS "X*7" IS ESSENTIALLY EQUIVALENT TO A NEUBER ANALYSIS WITH:

- o CYCLIC PROPERTIES OF ASTM A-36
- o $K_f = 2.0$
- o MEAN STRESS IGNORED

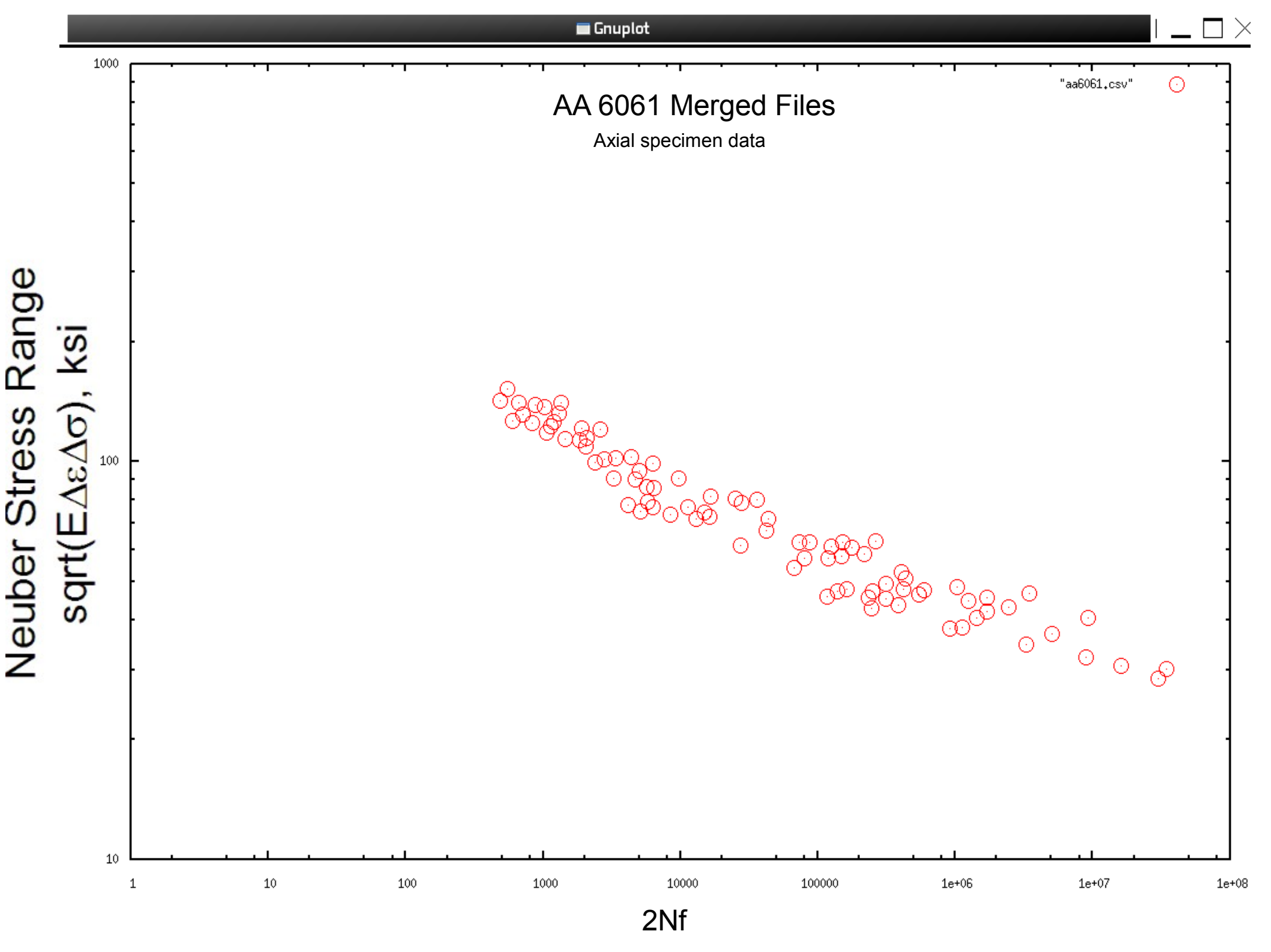
BOTH HAVE CORRELATED WITH GE-ERIE DATA ON STRUCTURES USING 1/4" TO 1/2" NON-CONTOURED FILLET WELDS

(4) DIJKSTRA AND DEBACK EXPERIMENTS SHOW AN IMPORTANT SIZE EFFECT. MY ANALYSIS SUGGESTS THAT VOLUME OF HIGHLY STRESSED WELD IS THE "SERIES SYSTEM" PARAMETER FOR A WEIBULL MODEL


F.A.Conle and J.J.F.Bonnen, "Using the Neuber Plot to Account for the Effects of Scatter, Corrosion and Welding in Strain-Life Fatigue Test Data" 2008 ISOPE Conf. Vancouver BC, July 10.
Neuber Stress Range sqrt(EΔεΔσ), ksi
1000
100
10
"Weld"
$K_t$=2
A36
Robins
Ewing SAE980
Ewing SAE1006
Leever
Savaidis
A36
SAE1010
$10^1$
$10^2$
$10^3$
$10^4$
$10^5$
$10^6$
$10^7$
$10^8$
Reversals to Failure ($2N_f$)




Ref.: F.A. Conle, "Accounting for Scatter in Strain-Life Fatigue Testing," SAE Paper 2002-01-1279


Gnuplot
"aa6061.csv"
AA 6061 Merged Files
Axial specimen data
Neuber Stress Range
sqrt(EΔεΔσ), ksi
2Nf
1000
100
10
1
10
100
1000
10000
100000
1e+06
1e+07
1e+08