SPECIMEN NUMBER REQUIREMENTS FOR T sub(o) ACCURACY

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Trabalho } completo
Texto }

considerar
este título !
(orientação, do autor)

=

TÍTULO FINAL:
"Specimen Number Requirements
for T_0 Accuracy"

considerar 2 autores

Cópia da apresentação oral
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IPEN-DOC- 6755

CONFIDENCE LEVEL IN THE REFERENCE TEMPERATURE (T_o) DETERMINATION

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SCOPE:

Find the Confidence Level for a given number of toughness values to determine T_o (the Master Curve).

RESULTS:

(1) the confidence of the obtained T_o with a given set of experimental results,
(2) the minimum number of experimental results necessary to have a given confidence level in the obtained T_o.

units: **MPa√m** (toughness) and **°C** (temperature)

PREVIOUS WORK - 'Direct' Approach

1. **Two ideal finite sets**, with NTOT = [20, 40] toughness values each fitting perfectly the Weibull Three Parameter Distribution
   Three $(T\text{-}T_o)_u$ or $T_{o,u}$ values were used: [**-50, 0 , +50**] (**°C**)

2. **All subsets were sampled**

   Calculate $(T\text{-}T_o)_s$ or $T_{o,s}$ for each subset. NSET = [**3, 4, 5, 6, 8, 10**]

3. A **distribution of $T_{o,s}$** was defined

4. Find the **probability** of **$| T_{o,u} - T_{o,s} | \leq 10$ °C**

5. Range of $T_{o,s}$ divided in three regions:
   1st region: $T_{o,s} < T_{o,u} - 10°C$
   2nd region: $T_{o,u} - 10°C < T_{o,s} < T_{o,u} + 10°C$ ==> **confidence level**
   3rd region: $T_{o,s} > T_{o,u} + 10°C$

6. **Results** depended too much on NTOT
   ------> approach impractical with NTOT >> 40
   ------> New Approach (from Wallin)

PRESENT WORK - 'Monte Carlo' Approach - Outline

1. $T_{o,u}$ values: **[-100, -75, -50, -25, 0, 25, 50, 75, 100]** (°C)

2. NSET from **[3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]**

3. Let **NTOT** = ∞
Probabilities (P) will be sampled as random numbers, $(0 \leq P \leq 1)$
Toughness values Fitting the Weibull Three Parameter Distribution

4. How many subsets to give good results ?
Tested 10^3, 10^4, 10^5
OK for $\geq$ **10^4 subsets** =====> $3*10^4$ subsets

5. Distribution of $T_{o,s}$ -----> $(T-T_o)_s$

6. Find the **probability of** **$|T_{o,u} - T_{o,s}| \leq 10$ °C** ===> **Confidence Level**

Analyses Performed in 4 Steps

WORK METHODOLOGY 4 Steps

infinite values of probabilities P, $(0 \leq P \leq 1)$, associated with a given $T_{o,u}$ value

Step 1 – $K_{o,u}$ calculation

Obtain $K_{Jc,med}$ ($P = 0.5$)

$$KJc,med = 30 + 70e^{0.019(T-To)} \qquad (1)$$

Obtain $K_{o,u}$ using $K_{Jc,med}$ and $K_{min} = 20$ MPa√m

$$\mathrm{Ko,u} = \left(\frac{KJc,med - K\min}{0.9124}\right) + K\min \qquad (2)$$

Now, at each time, a set with NSET probabilities Pi will be randomly sampled.

Step 2 - Obtain NSET toughness values ($K_{Jc,i}$)

Obtain $K_{Jc,i}$ for each probability P_i, using the previously calculated $K_{o,u}$

$$1 - P_i = \exp\left(-\left[\frac{KJc, i - K_{min}}{K_{o,u} - K_{min}}\right]^m\right), \; K_{min} = 20, \; m = 4 \tag{3}$$

Step 3 - Treating each set with NSET values

Obtain $K_{o,s}$ associated with this set.

$$Ko,s = \left(\frac{\sum_{i=1}^{NSET} (KJc, i - K\min)^m}{NSET - 0.3068}\right)^{1/4} + K\min \tag{4}$$

Obtain $K_{Jc,med}$

$$Ko,s = \left(\frac{KJc, med - K\min}{0.9124}\right) + K\min \tag{2}$$

Obtain $(T\text{-}T_o)_s$ or $(T_{o,s})$

$$KJc, med = 30 + 70e^{0.019(T - To)} \tag{1}$$

***** repeat steps 2 and 3 ($3*10^4$ times) for each NSET value *****

Step 4 – Treating the Results

1. $T_{o,s}$ or $(T-T_o)_s$ **Distributions**

2. Curves "Relative (%) Counting X NSET".

probability of $|T_{o,u} - T_{o,s}| \leq 10\ ^{o}C$ **====> Confidence Level**

3. Curves "Minimum NSET versus $T_{o,u}$**" for each Confidence Level**

for **70%, 80%, 90%, 95% and 98%** of confidence

4. Fitting the curves "Minimum NSET versus $T_{o,u}$ **"**

1st - Exponential Equation

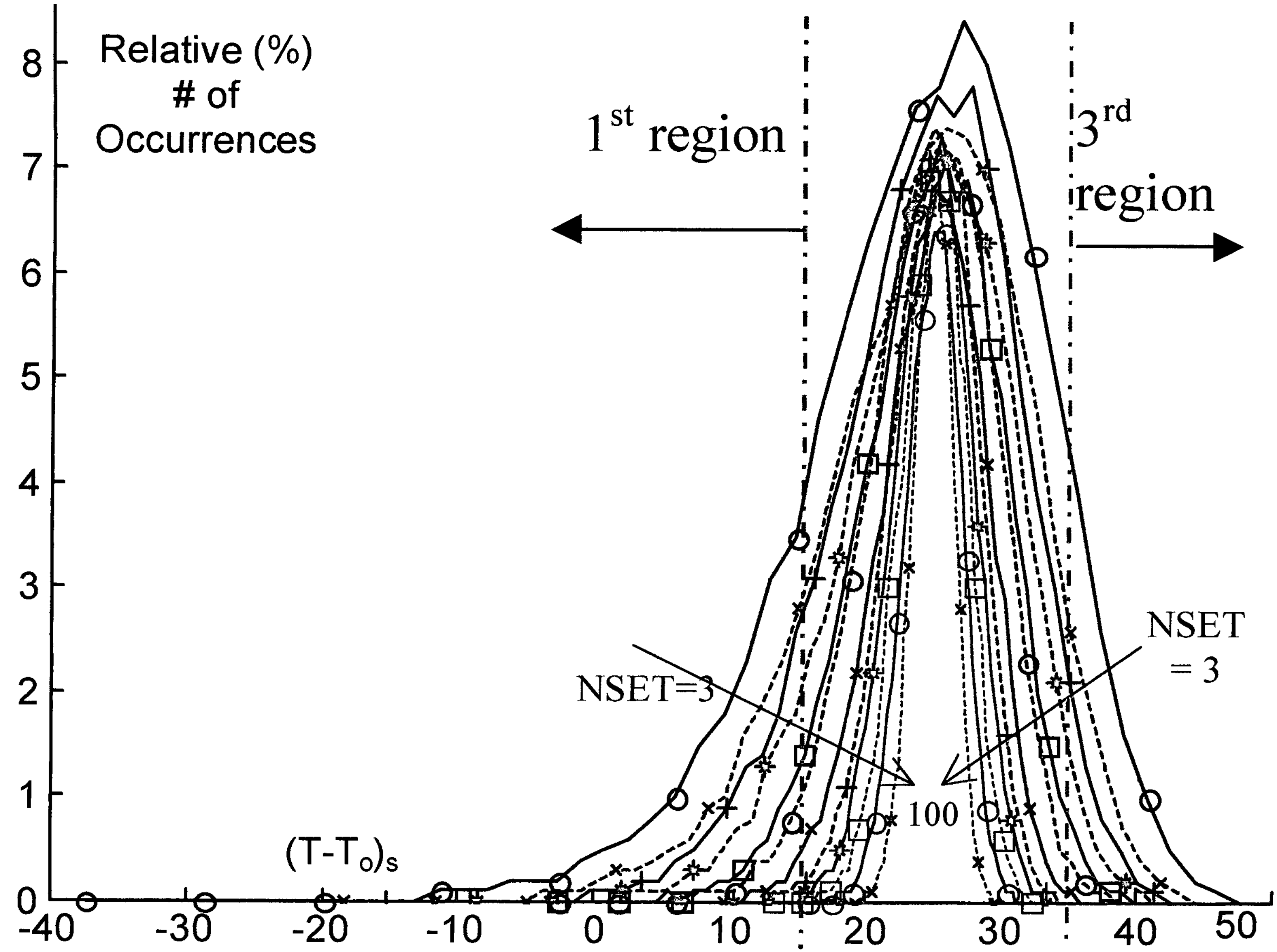
fit the curves "Minimum NSET versus $T_{o,u}$", for each confidence value

2nd - Third Degree Polynomium.

fit the coefficients of the Exponential Equation

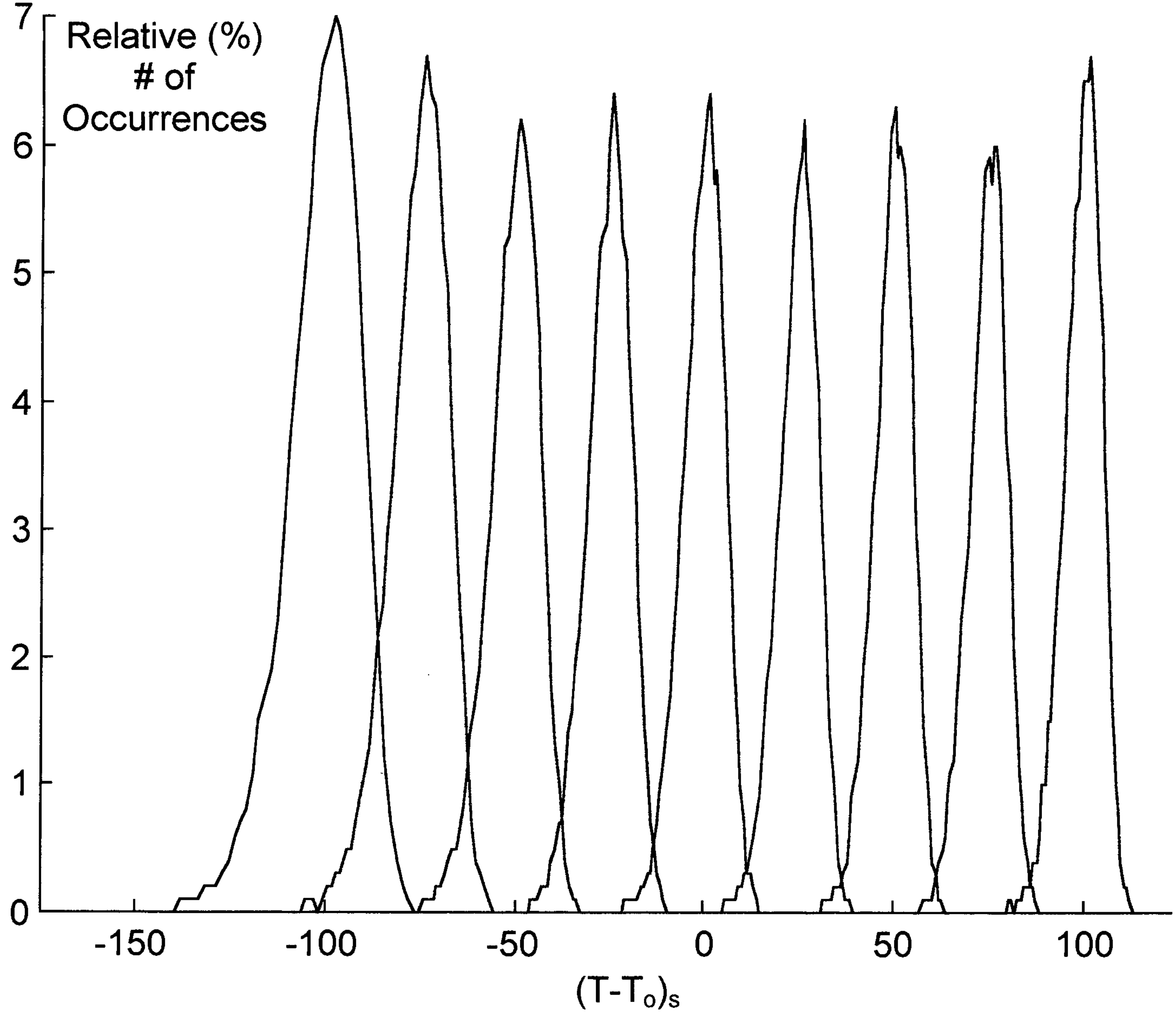
5. Curves "**Confidence Level versus** $T_{o,u}$" **for each NSET**

for NSET = [3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 25, 30]

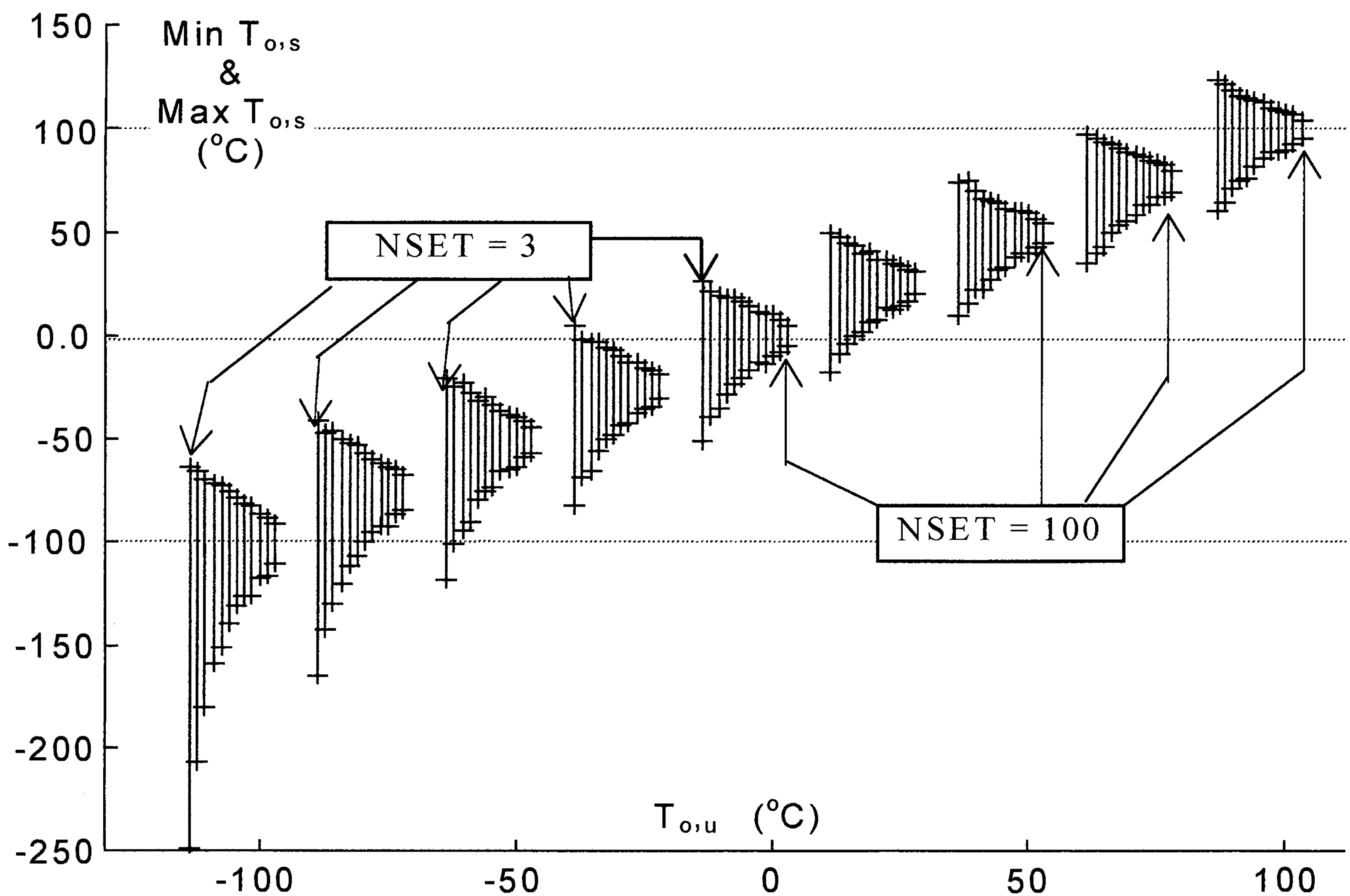


Typical Distribution of $(T\text{-}T_o)_s$ for each NSET - for $T_{o,u} = 25\ ^oC$

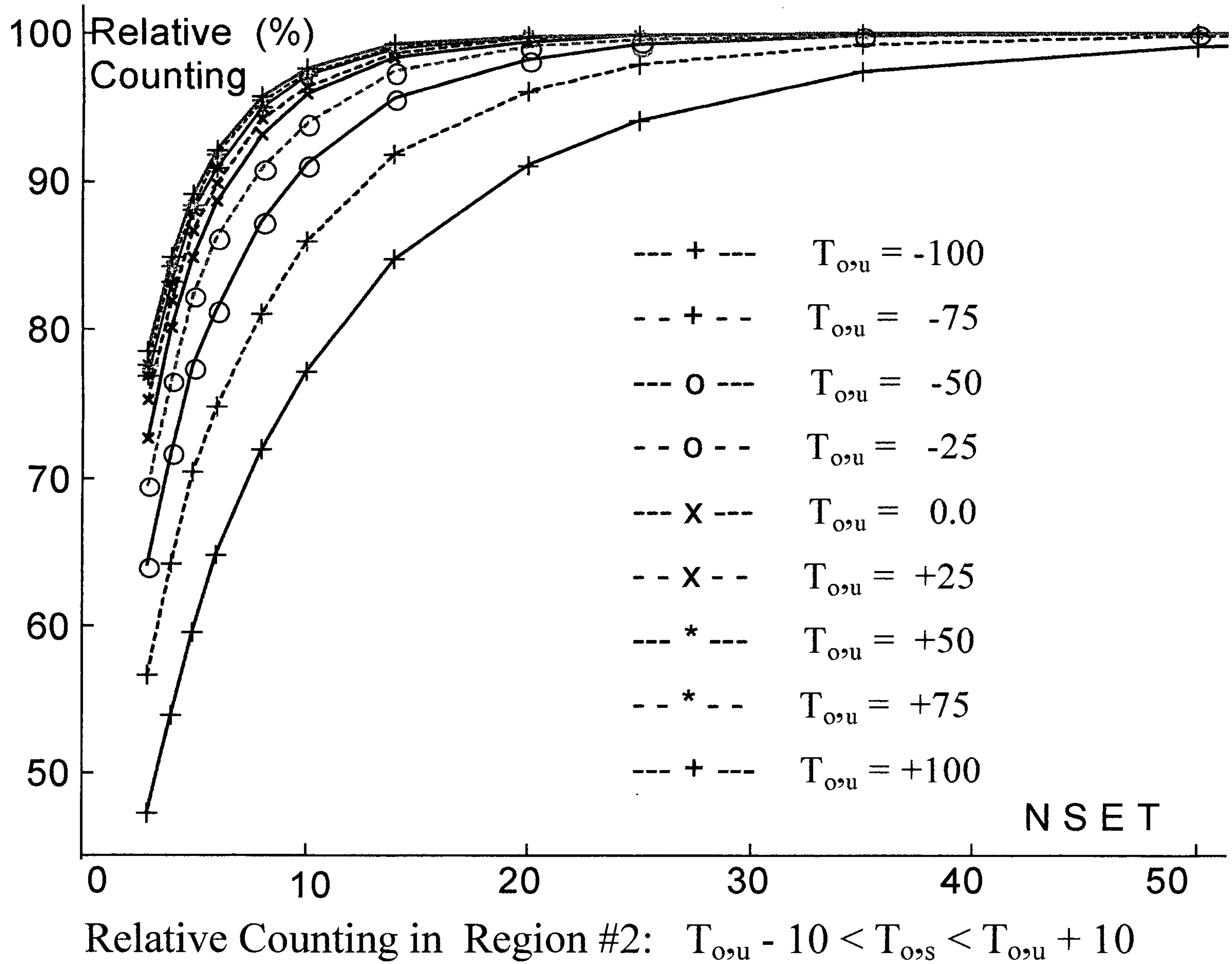
NSET = [3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]



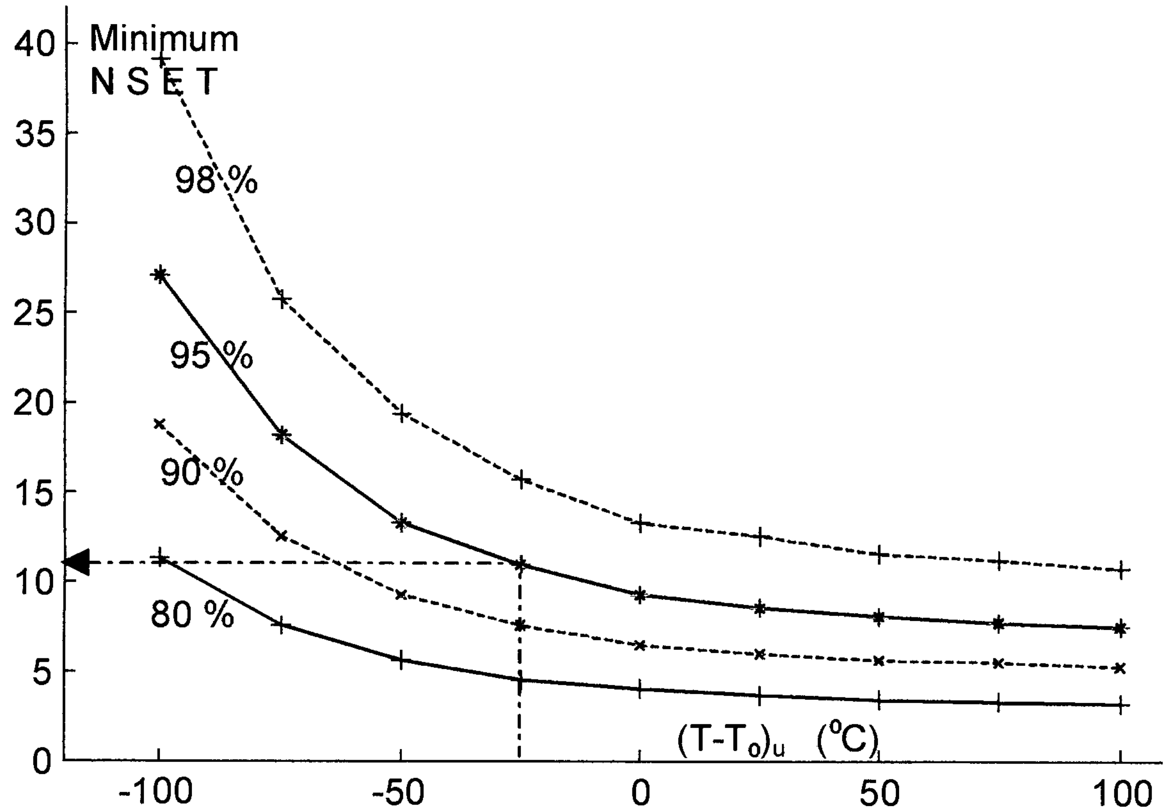
Typical Distribution of $T_{o,s}$ for each $T_{o,u}$ - for NSET = 8



Minimums and Maximums of the $T_{o,s}$ Distributions



Probability of $|T_{o,u} - T_{o,s}| \leq 10\ ^{o}C$



"Minimum NSET versus $T_{o,u}$"

Fitting the Curves "Minimum NSET versus $T_{o,u}$"

$$MinNSET = a_i + b_i e^{\frac{-(T-T_o)}{C_i}} \quad (5)$$

Coefficients to Fit the Curves "Minimum NSET versus $T_{o,u}$"

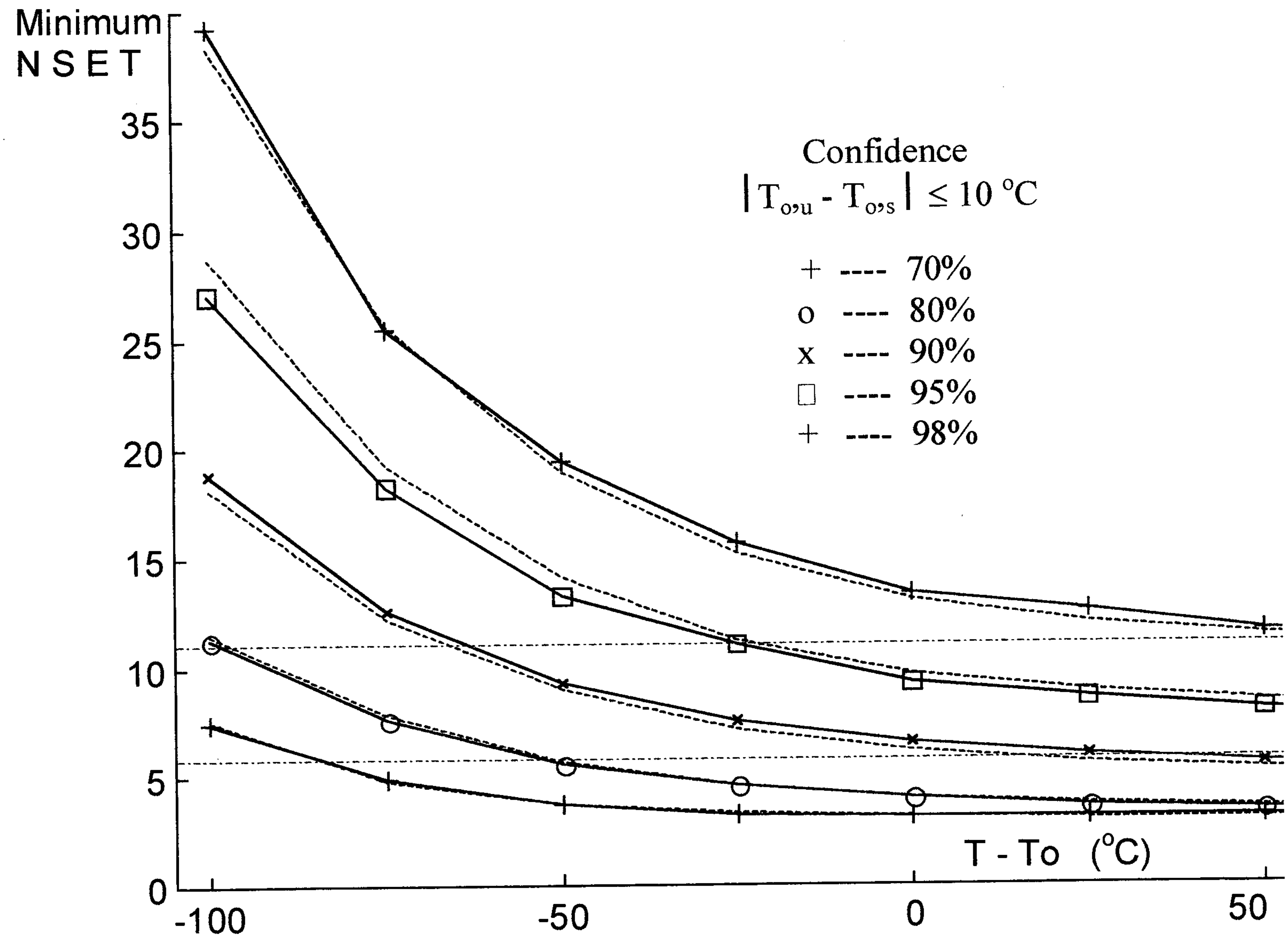
i	Confid. Level	a_i	b_i	c_i
1	(0.70) 70%	3.00	0.12	28.06
2	(0.80) 80%	3.18	0.75	41.99
3	(0.90) 90%	5.24	1.22	41.59
4	(0.95) 95%	7.40	1.88	42.66
5	(0.98) 98%	10.94	2.41	40.76
	x	Coefficients		

Fitting the Coefficients a_i, b_i, c_i

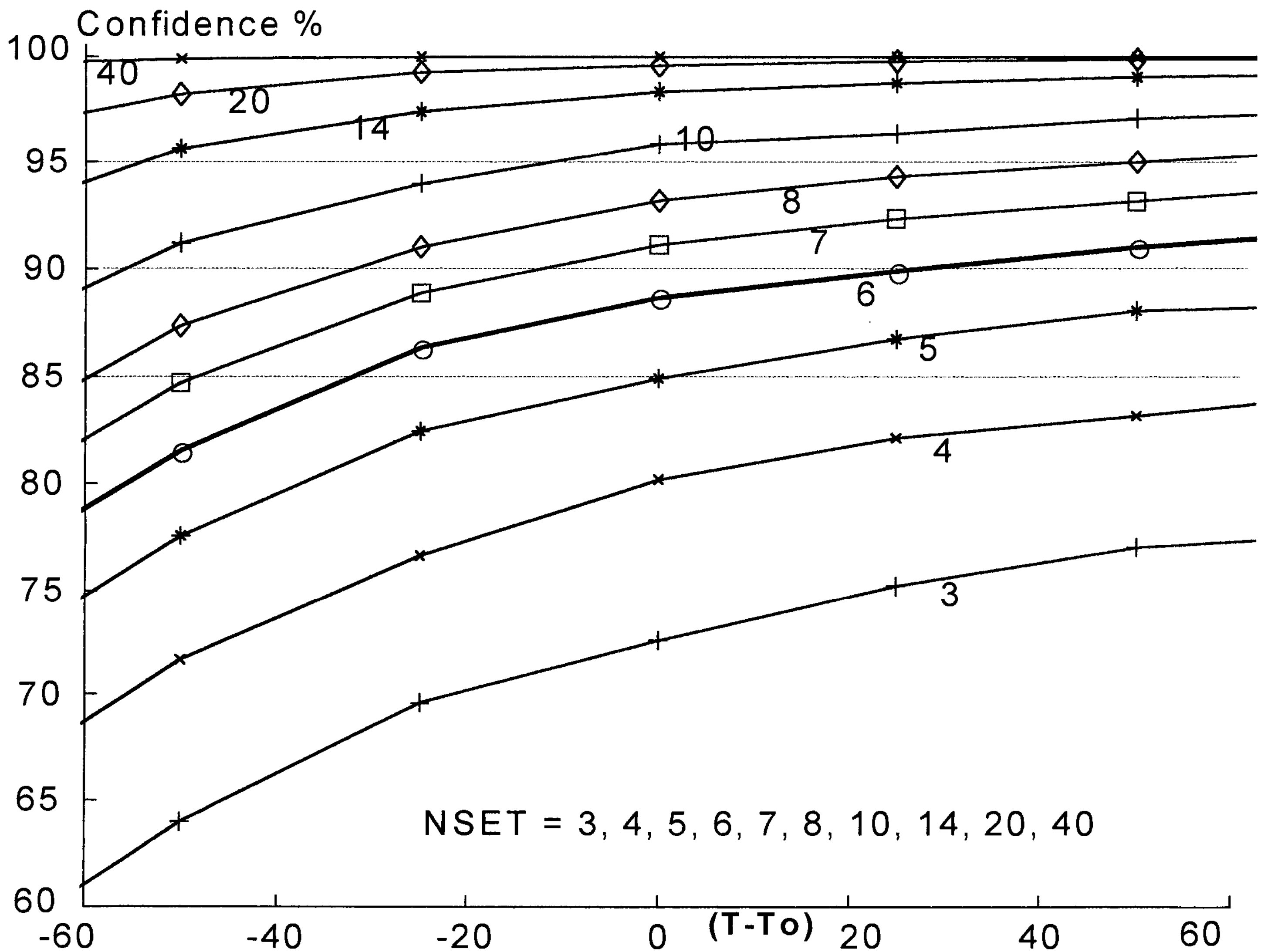
$$\{a_i;\, b_i;\, c_i\} = d_j + e_j\, x + f_j\, x^2 + g_j\, x^3 \qquad (6)$$

Coefficients d_j, e_j, f_j and g_j

		Coefficients			
j		d_j	e_j	f_j	g_j
1	*Coeff. a_i*	-404.75	1581.7	-2042.8	879.0
2	*Coeff. b_i*	-116.65	428.6	-525.6	216.5
3	*Coeff. c_i*	-1389.9	4745.1	-5217.9	1904.1



Original (continuous line) and Fitted (dotted line) curves



Confidence Level for a Given NSET

NSET = [3, 4, 5, 6, 7, 8, 10, 14, 20, 40]

DISCUSSION

1. The distributions of $T_{o,s}$ become narrower as NSET increases.

2. The range of the $T_{o,s}$ values shows a reduction as NSET increases.
For the lower NSETs this reduction is noticeable for the greater $T_{o,u}$

3. The presented results, are directly tied to the assumption that
$| T_{o,u} - T_{o,s} | \leq 10\ ^oC$ is allowed

If this spread value is reduced the number of specimens to be tested to give a certain confidence level will increase.

4. The **3rd region** $(T_{o,u} - T_{o,s}) \geq 10\ ^oC$ could be considered in the Confidence definition.
This would bring some benefit to those sets with, in average, less than 7 values
This option was not adopted to allow some conservatism in the proposed curves

5. No censoring was performed in the sampled sets

CONCLUSION

1. The Confidence Level in the T_0 determination varies with the number of specimens.
   This dependence was obtained numerically and presented graphically.

2. The showed results give the Confidence Level for a set of toughness measurements as a function of the position on the Master Curve.

   Ex.: using 6 specimens the Confidence Level is greater than 90% only when the test is conducted above $(T-T_0) = 25\ ^{o}C$.

3. There is no big benefit in testing at the region at $(T-T_0) > 50\ ^{o}C$.
   Due to the uncertainties no tests should be performed at $(T-T_0) \leq -50\ ^{o}C$

4. The best range for testing is $-25\ ^{o}C \leq (T-T_0) \leq 50\ ^{o}C$

"Minimum NSET versus $(T-T_o)_u$" as function of the Confidence level

$$\mathrm{MinNSET} = a + b\, e^{\frac{-(T-T_o)}{C}}$$

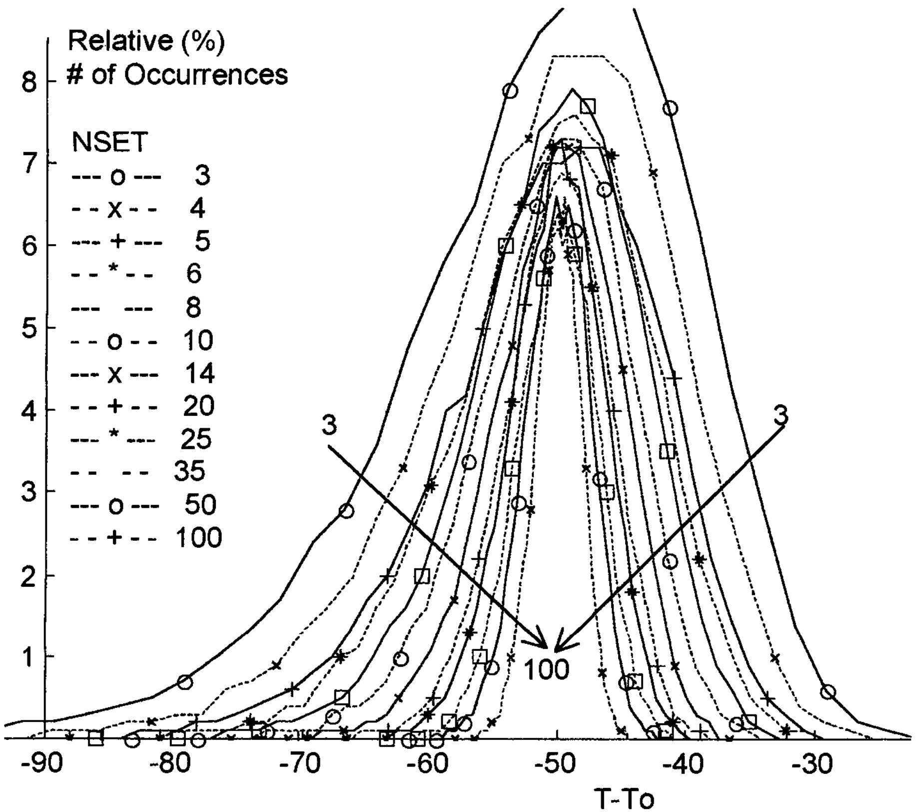
and

$$\{a\ ;\ b\ ;\ c\} = d_j + e_j x + f_j x^2 + g_j x^3$$

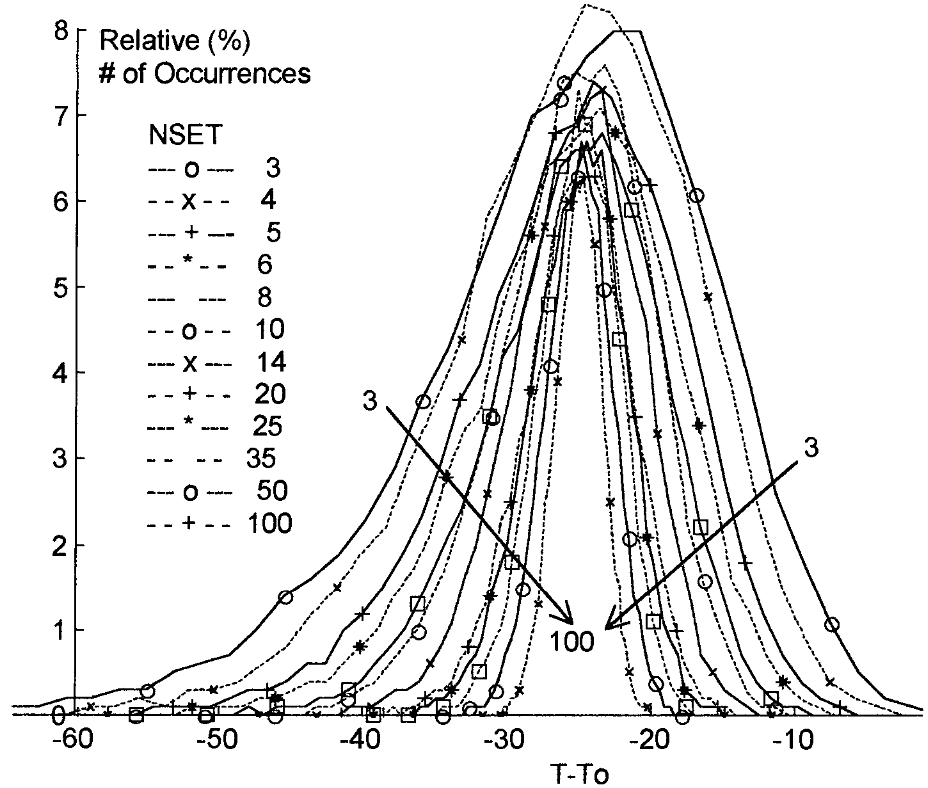
	Coefficients			
j	d_j	e_j	f_j	g_j
1 (Coeff. *a*)	-404.75	1581.7	-2042.8	879.0
2 (Coeff. *b*)	-116.65	428.6	-525.6	216.5
3 (Coeff. *c*)	-1389.9	4745.1	-5217.9	1904.1

***x* = [0.70 - 0.98]** is the desired Confidence Level in the T_o determination

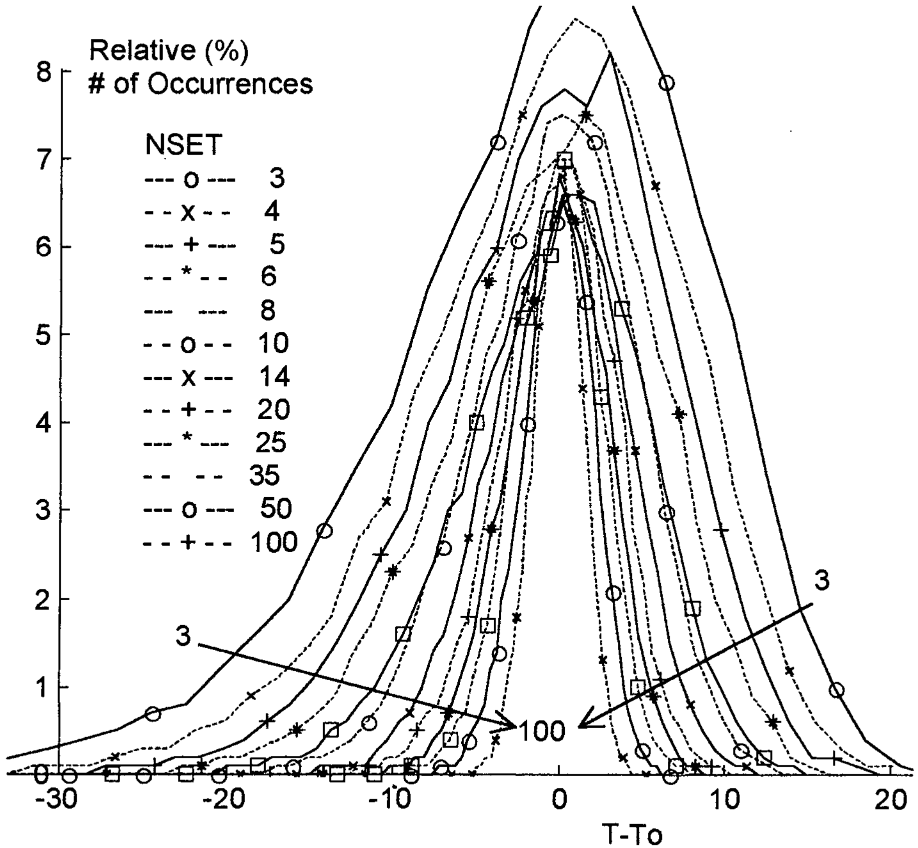
$(T-T_o)$ is the position of the Master Curve



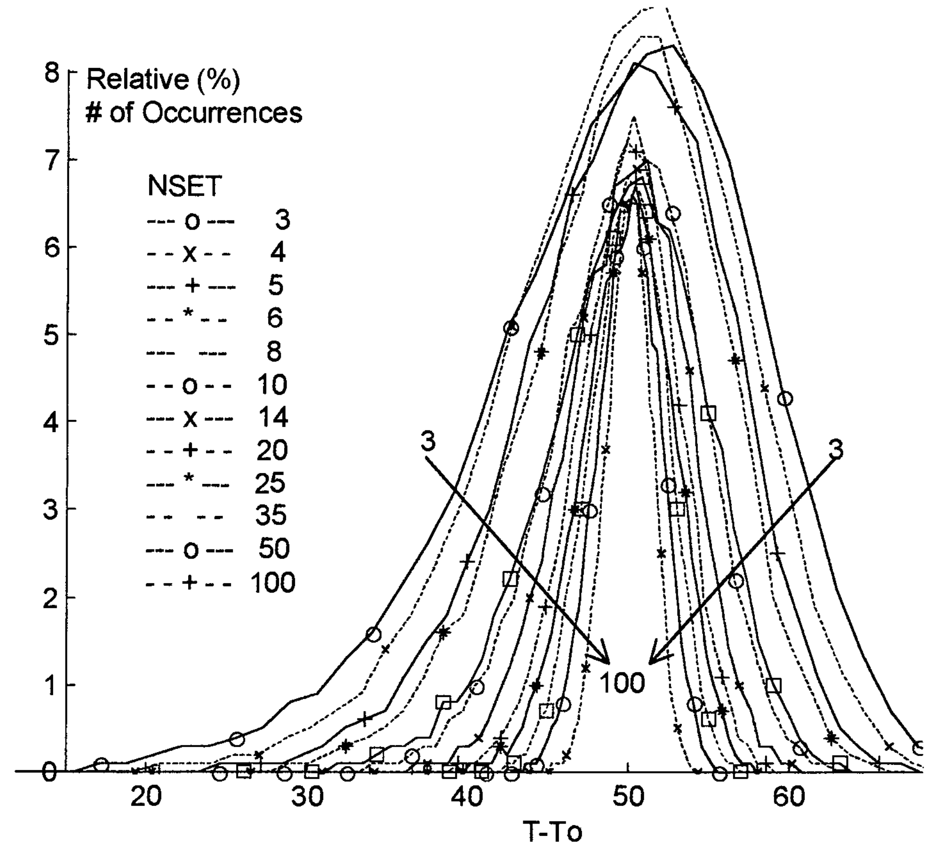
(T-T$_o$)$_s$ Distributions for (T-T$_o$)$_u$ = -50. °C
NSET = [3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]



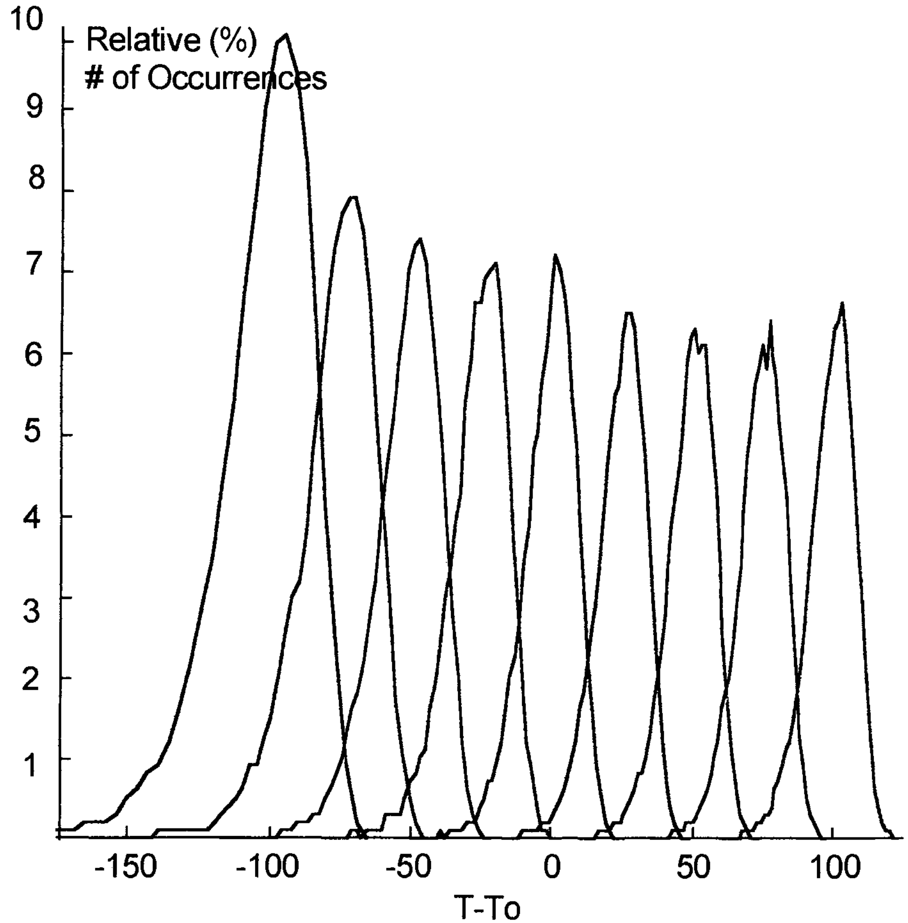
(T-T$_o$)$_s$ Distributions for (T-T$_o$)$_u$ = -25. °C
NSET = [3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]



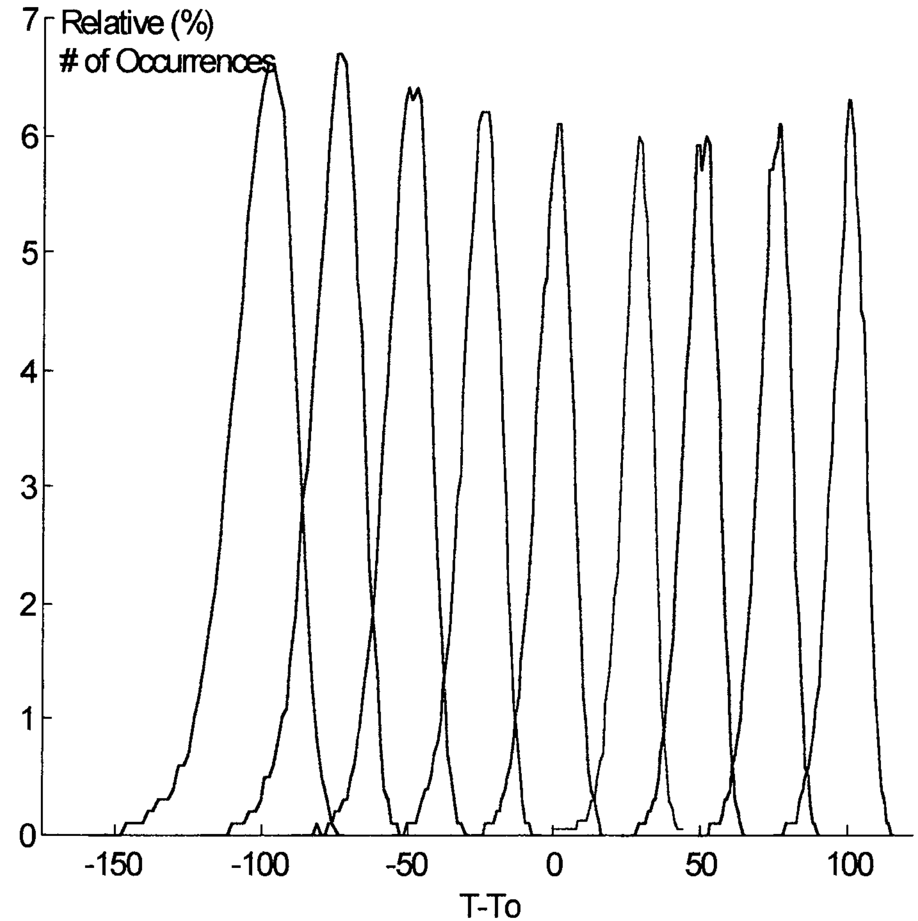
(T-T$_o$)$_s$ Distributions for (T-T$_o$)$_u$ = 0.0 °C
NSET = [3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]



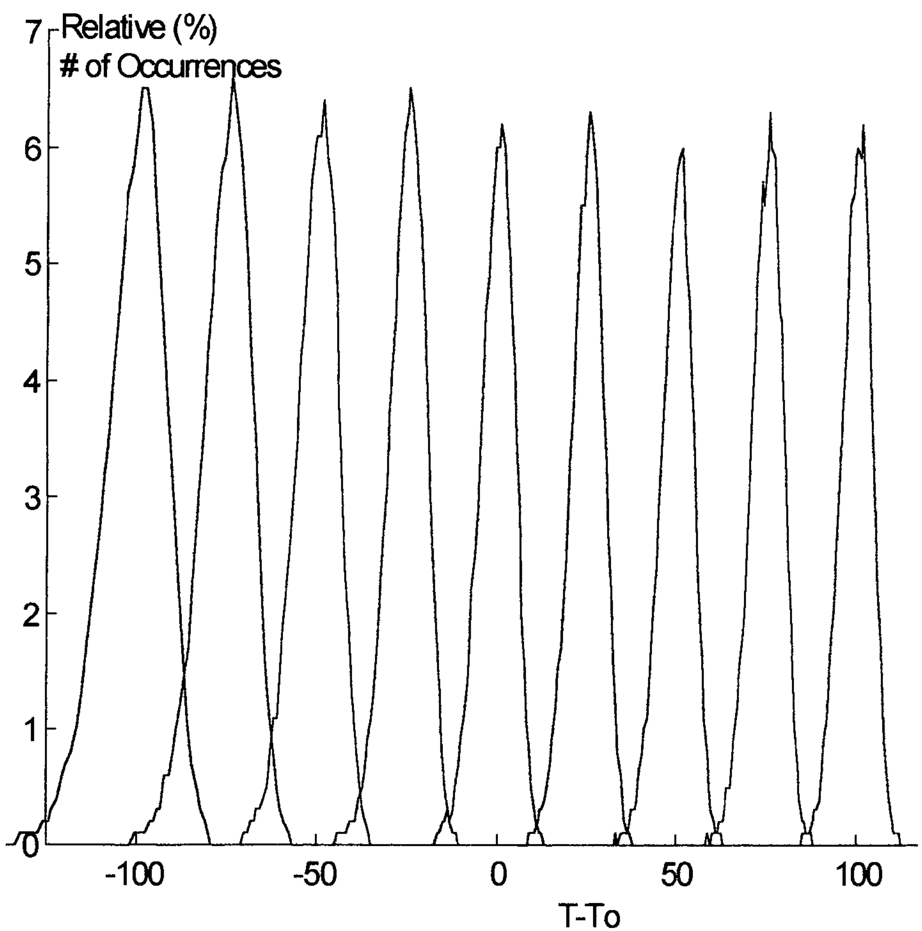
(T-T$_o$)$_s$ Distributions for (T-T$_o$)$_u$ = +50. °C
NSET = [3, 4, 5, 6, 8, 10, 14, 20, 25, 35, 50, 100]



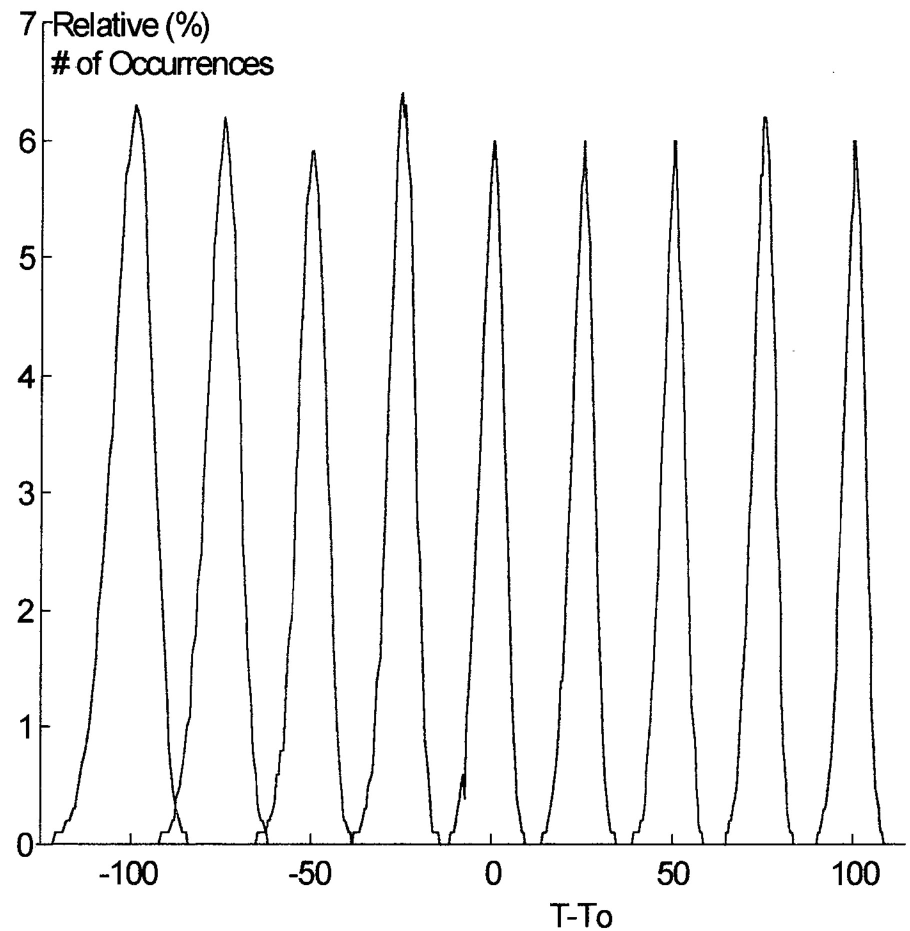
$(T\text{-}T_o)_s$ Distributions for NSET = 3



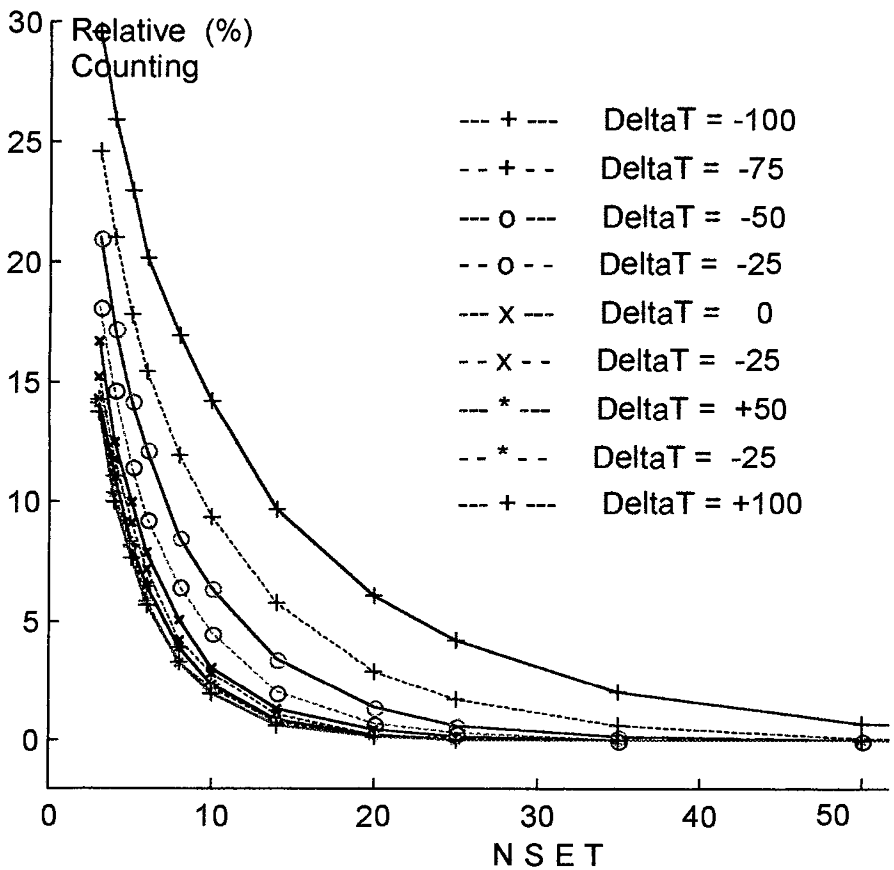
$(T\text{-}T_o)_s$ Distributions for NSET = 6



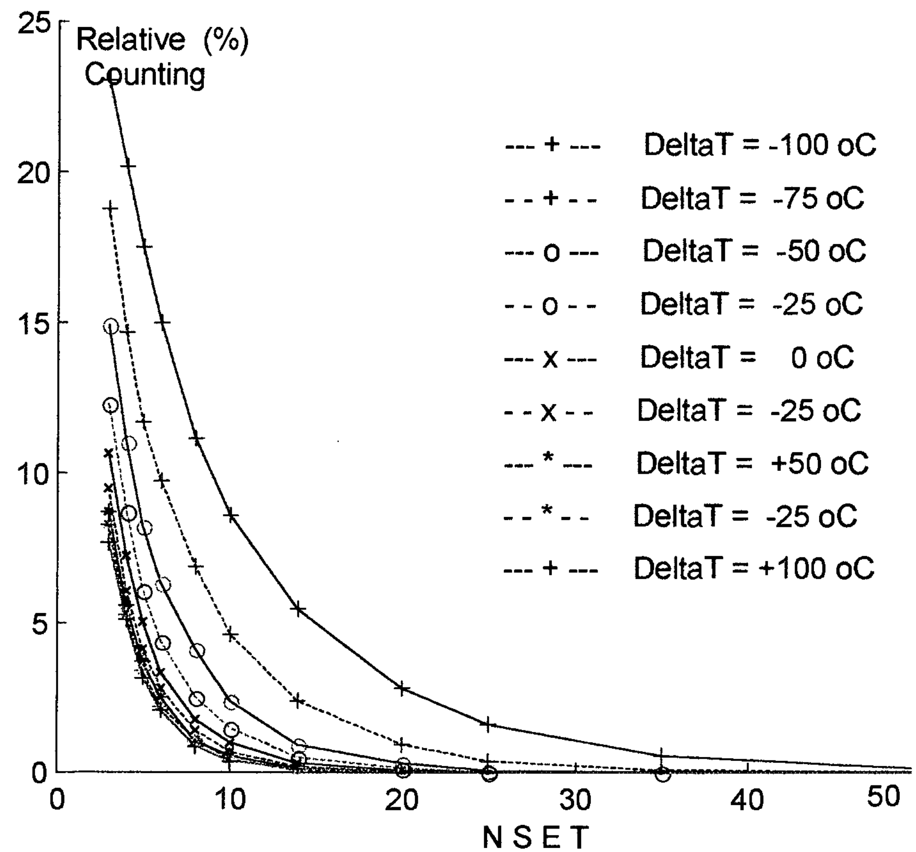
$(T\text{-}T_o)_s$ Distributions for NSET = 10



$(T\text{-}T_o)_s$ Distributions for NSET = 20



Relative Counting in Region #1
$(T - T_o)_s < T_{o,u} - 10.\ ^oC$



Relative Counting in Region #3
$(T - T_o)_s > T_{o,u} + 10.\ ^oC$

Table: Relative (%) Counting in Each Region (Range)
(The Confidence Level is the Counting in the Region #2)

NGROUPs	NCOMB	Seed	Tol
50	30000	3000001	10.

Confidence Results (%)

Range #1: % of the values under DeltaT - Tol
Range #2: % of " " between DeltaT+/-Tol
Range #3: % of " " over DeltaT + Tol

T-To	Range	NSET 03	NSET 04	NSET 05	NSET 06	NSET 08	NSET 10	NSET 14	NSET 20	NSET 25	NSET 35	NSET 50	NSET 100
	#1	29.6	25.9	22.9	20.2	17.0	14.2	9.7	6.1	4.2	2.0	.7	.0
-100.	#2	47.3	53.9	59.5	64.8	71.9	77.2	84.8	91.1	94.2	97.4	99.2	100.0
	#3	23.1	20.2	17.5	15.0	11.2	8.6	5.5	2.8	1.6	.5	.1	.0
	#1	24.6	21.0	17.9	15.5	12.0	9.4	5.8	2.9	1.8	.6	.1	.0
-75.	#2	56.6	64.3	70.4	74.8	81.1	86.0	91.8	96.1	97.9	99.3	99.9	100.0
	#3	18.8	14.7	11.7	9.7	6.9	4.6	2.4	.9	.4	.1	.0	.0
	#1	21.0	17.3	14.2	12.2	8.5	6.4	3.5	1.5	.7	.2	.0	.0
-50.	#2	64.0	71.7	77.5	81.5	87.4	91.2	95.6	98.2	99.3	99.8	100.0	100.0
	#3	15.0	11.0	8.2	6.3	4.1	2.4	.9	.3	.1	.0	.0	.0
	#1	18.1	14.7	11.5	9.3	6.5	4.6	2.1	.7	.4	.1	.0	.0
-25.	#2	69.6	76.6	82.4	86.3	91.0	94.0	97.4	99.2	99.6	99.9	100.0	100.0
	#3	12.3	8.7	6.1	4.4	2.5	1.5	.5	.1	.0	.0	.0	.0
	#1	16.7	12.5	10.0	7.9	5.1	3.1	1.4	.5	.2	.0	.0	.0
0.	#2	72.6	80.2	84.9	88.7	93.2	95.9	98.3	99.5	99.8	100.0	100.0	100.0
	#3	10.7	7.3	5.1	3.4	1.8	1.0	.3	.0	.0	.0	.0	.0
	#1	15.3	11.8	9.2	7.2	4.3	2.9	1.1	.3	.1	.0	.0	.0
25.	#2	75.2	82.1	86.7	89.9	94.3	96.4	98.7	99.7	99.9	100.0	100.0	100.0
	#3	9.5	6.1	4.1	2.8	1.4	.7	.2	.0	.0	.0	.0	.0
	#1	14.3	11.1	8.2	6.5	3.9	2.4	.9	.2	.1	.0	.0	.0
50.	#2	77.0	83.2	88.1	91.0	95.0	97.1	99.0	99.8	99.9	100.0	100.0	100.0
	#3	8.7	5.6	3.7	2.5	1.0	.5	.1	.0	.0	.0	.0	.0
	#1	14.1	10.4	8.2	5.9	3.3	2.2	.8	.2	.1	.0	.0	.0
75.	#2	77.6	84.3	88.4	91.9	95.6	97.4	99.1	99.8	99.9	100.0	100.0	100.0
	#3	8.3	5.3	3.4	2.2	1.1	.4	.1	.0	.0	.0	.0	.0
	#1	13.7	10.0	7.7	5.7	3.3	2.0	.6	.2	.0	.0	.0	.0
100.	#2	78.6	84.8	89.1	92.2	95.8	97.6	99.3	99.8	100.0	100.0	100.0	100.0
	#3	7.7	5.1	3.2	2.1	.9	.4	.1	.0	.0	.0	.0	.0

Table: Minimum and Maximum $(T-T_o)_s$

Max/Min Values of $(T-T_o)_s$ for each NSET and $(T-T_o)_u$ Analyzed

T-To	NSET 03	NSET 04	NSET 05	NSET 06	NSET 08	NSET 10	NSET 14	NSET 20	NSET 25	NSET 30	NSET 35	NSET 100
-100.	-434	-270	-207	-217	-210	-157	-135	-134	-125	-122	-115	-112
	-62	-64	-60	-69	-74	-73	-77	-80	-83	-85	-88	-87
-75.	-310	-203	-147	-130	-136	-115	-113	-99	-96	-91	-89	-84
	-40	-45	-47	-49	-50	-51	-56	-59	-60	-61	-64	-67
-50.	-143	-121	-101	-95	-92	-83	-75	-70	-69	-63	-61	-58
	-17	-24	-26	-25	-29	-31	-32	-35	-38	-39	-40	-43
-25.	-93	-85	-67	-64	-56	-56	-47	-41	-39	-39	-34	-31
	0	0	0	-5	-7	-6	-8	-12	-12	-15	-16	-19
0.	-76	-59	-45	-39	-27	-29	-19	-17	-14	-13	-9	-6
	25	21	22	18	16	14	14	11	10	9	8	6
25.	-38	-18	-15	-9	-3	-3	6	6	10	13	15	17
	48	47	47	44	42	40	38	35	35	34	32	30
50.	-9	-4	7	7	25	24	30	33	37	38	40	43
	75	73	71	68	66	64	63	61	60	58	57	55
75.	19	26	40	44	50	51	54	60	61	62	65	68
	98	95	94	91	90	88	87	86	84	83	81	79
100.	42	58	64	67	74	79	82	81	86	89	91	94
	123	123	117	116	116	113	112	110	109	109	106	105

Table: CONFIDENCE (%) Level as Function of the NSET Value, for each (T-To)u

$(T-T_o)_u$	NSET=3	NSET=4	NSET=5	NSET=6	NSET=7	NSET=8	NSET=9	NSET=10
-100.	47.30	53.90	59.50	64.80	68.57	71.90	74.67	77.20
-75.	56.60	64.30	70.40	74.80	78.12	81.10	83.71	86.00
-50.	64.00	71.70	77.50	81.50	84.71	87.40	89.43	91.20
-25.	69.60	76.60	82.40	86.30	88.86	91.00	92.60	94.00
0.	72.60	80.20	84.90	88.70	91.17	93.20	94.67	95.90
25.	75.20	82.10	86.70	89.90	92.38	94.30	95.42	96.40
50.	77.00	83.20	88.10	91.00	93.23	95.00	96.14	97.10
75.	77.60	84.30	88.40	91.90	93.98	95.60	96.57	97.40
100.	78.60	84.80	89.10	92.20	94.22	95.80	96.77	97.60

$(T-T_o)_u$	NSET=12	NSET=14	NSET=16	NSET=18	NSET=20	NSET=25	NSET=30	NSET=40
-100.	81.34	84.80	87.21	89.31	91.10	94.20	96.00	98.08
-75.	89.19	91.80	93.49	94.92	96.10	97.90	98.70	99.52
-50.	93.66	95.60	96.62	97.48	98.20	99.30	99.58	99.87
-25.	95.92	97.40	98.16	98.76	99.20	99.60	99.77	99.93
0.	97.26	98.30	98.80	99.20	99.50	99.80	99.92	100.00
25.	97.71	98.70	99.12	99.45	99.70	99.90	99.96	100.00
50.	98.18	99.00	99.34	99.61	99.80	99.90	99.96	100.00
75.	98.37	99.10	99.40	99.63	99.80	99.90	99.96	100.00
100.	98.58	99.30	99.49	99.66	99.80	100.00	100.00	100.00

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00-03

COMMITTEE E08 CONTINUED

.07	.03	Surface Cracks [Crystal E]	Monday 9:00A-11:00A
	.05	Dynamics Fracture Toughness [Crystal E]	Monday 11:00A-12:00N
	.07	Welds (Joint with 08.08.07) [Crystal E]	Monday 1:00P-3:00P
.08		Elastic-Plastic Fracture [Ballroom A]	Tuesday 3:30P-5:00P
	.02	Crack Initiation, Growth, Frac. Under Elas.- Plas. Cond. [Ballroom A]	Tuesday 10:30A-12:30P
	.04	Analytical Tech. And Proced. [Ballroom A]	Tuesday 9:30A-10:30A
	.06	CTOD Concepts and Procedures [Ballroom A]	Tuesday 1:30P-3:30P
	.07	Welds (Joint with 08.07.07) [Crystal E]	Monday 1:00P-3:00P
.09		Advanced Materials and Their Composites [Crystal C]	Monday 9:00A-10:30A
.01		Student Paper Workshop [Walton]	Wednesday 9:30A-12:00N
Fatigue Lecture [DeKalb]			Wednesday 5:00P-6:00P
ISO Meeting [Embassy]			Friday 8:00A-5:00P
.05		Workshop on Micro and Nano Scale Structures [DeKalb]	Wednesday 9:30A-5:00P
.07		Workshop on Users Experience w/The Fracture Toughness Master Curve [Walton]	Wednesday 1:00P-5:00P

Symposium on Mixed Mode Crack Behavior [Crystal F/G]	Wednesday 9:30A-5:15P
[Salon E]	Thursday 8:25A-4:50P

Complete program appears in abstract booklet in rear of room

COMMITTEE E20 ON TEMPERATURE MEASUREMENT
(Room names in brackets)

Main Briefing [Salon C]			Monday 8:15A-8:30A
Main Closing [Crystal B]			Wednesday 10:00A-10:30A
.90		Executive [Salon A]	Tuesday 2:00P-4:30P
.91		Editorial and Terminology [Salon C]	Monday 7:00P-9:00P
Colloquium [Salon A]			Tuesday 1:00P-2:00P
.03		Resistance Thermometry [Salon C]	Monday 1:00P-3:00P
	.01	Task Group [Salon C]	Monday 8:30A-11:00A
.04		Thermocouples Briefing [Salon A]	Tuesday 8:00A-8:15A
		Thermocouples Report [Crystal B]	Wednesday 9:30A-10:00A
		ASME [Crystal B]	Tuesday 3:00P-6:00P
		[Council]	Wednesday 1:00P-4:00P
	.01	Thermocouples Testing [Salon A]	Tuesday 10:15A-12:00N
	.02	Thermocouples Materials and Use [Crystal B]	Wednesday 8:00A-9:30A
	.03	Thermocouples Specifications [Salon A]	Tuesday 8:15A-10:00A
.06		New Thermometers and Techniques [Salon C]	Monday 11:00A-12:00N
.07		Fundamentals [Salon C]	Monday 3:00P-6:00P
.08	.05	Infrared Thermometry [Rockdale]	Monday 8:30A-12:00N
		Infrared Thermometry Report [Rockdale]	Monday 1:00P-3:00P

Attendees

Workshop on User's Experience with Fracture Toughness Master Curve

Atlanta, May 6, 1998

T. L. Anderson
President
SRT - Structural Reliability Technology
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3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

+ Kim. WALLIN
+ D. E. McCabe

Workshop on User's Experience with the Fracture Toughness Master Curve

May 6, 1998
Atlanta, GA

Chair: T. Anderson, SRT
Cochair: D. McCabe, ORNL

1. "Overview of the EU Project on Fracture Toughness of Steel in the Ductile to Brittle Transition Regime." **J. Heerens, GKSS, Germany.**

(12)

2. "Master Curve Analysis of Data from the European Round-Robin Testing Program." **K. Wallin, VTT Manufacturing Technology, Finland.**

3. "Constraint Effects on Measured T_0 Values: Results of 3-D Numerical Studies." **R.H. Dodds Jr., University of Illinois.**

4. "Bias and Accuracy of ASTM E 1921 Values for Reactor Pressure Vessel Steels." **M.T. Kirk, Westinghouse.**

5. "Activities of the PVRC Task Group on the Master Curve." **W.A. Vandersluys, Babcock & Wilcox.**

6. "Dynamic Fracture Toughness Tests of Linde 80 Welds Using E 1921." **K. Yoon, Framatone Technology.**

7. "Specimen Number Requirements for T_0 Accuracy." **C. Miranda, University of Tennessee.**

8. Open Discussion.

→ falta o autor
título ≠ do material

+ Dr. Landes
Dr. Christofer wilson.
Dr. Ted Anderson
Dr. McCabe

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July 2, 1998

CARLOS MIRANDA
UNIVERSITY OF TENNESSEE
350 SUTHERLAND AVE,
KNOXVILLE TN 37919

Dear Colleague:

Thank you for your attendance at the Committee E08 on FATIGUE AND FRACTURE standards development meetings which were held MAY 1-9, 1998 in ATLANTA, GA.

You are invited to join ASTM and Committee E08. A membership application is enclosed along with the pamphlet "What is ASTM? If you are already a member of ASTM and Committee E08, please pass the enclosed application on to one of your colleagues.

For $65 annually you may participate as an individual, representing either yourself or the company you are employed by in the increasingly important standards-writing community, or for $350 as the official representative of an organizational membership. Benefits of each class of membership are described on the reverse of the application.

As a member you will receive many tangible benefits, including our monthly magazine, Standardization News; one free volume of the ASTM Book of Standards, to be sent to you upon payment of your administrative fee; affiliation with the technical committees in your area of interest; and reduced prices on ASTM journals and Special Technical Publications (STP's).

There are also significant intangible advantages of membership, including the professional contacts made with others in your field of interest, knowledge gained through committee work, and other participation in the Society's activities--even life and health insurance at attractive group rates.

The next meeting of Committee E08 will be held November 2-4, 1998 in Norfolk, VA.

For additional information on ASTM or the Committee, please call, Bode Buckley, Staff Manager of Committee E08, at 610-832-9740. I look forward to your participation in the Society's activities!

Sincerely,

Anne Richter

Anne Richter
Administrative Assistant
Membership Promotion

Enclosures