DCD-016

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 09 1982

SUBJECT: SUMMARY OF MEETING WITH WESTINGHOUSE OWNERS GROUP (WOG) ON JULY 30, 1982, CONCERNING THE PRESSURIZED THERMAL SHOCK (PTS) ISSUE

Introduction

The meeting was held in Bethesda, Maryland on July 30, 1982, at the request of the NRC staff to discuss the subjects on the tentative agenda (Enclosure 1). The discussions followed the actual agenda (Enclosure 2). The attendees of the meeting are identified in Enclosure 3. Material used by the staff to introduce the discussions concerning the fracture mechanics analysis are included in Enclosure 4.

Discussion

The WOG discussions regarding our concerns include the following highlights in the order covered in the actual agenda, Enclosure 2:

1. SBLOCA Sizes Resulting in Stagnation Flow

The W SBLOCA analysis determined the smallest break size which would result in the maximum pressure with the min. temperature. This would be the same as loss of natural circulation or stagnation flow. W found that for pipe sizes equal to or less than 1 1/2" that natural circulation was maintained. For 4 loop plants a LOCA involving a 3" pipe size appeared to be the area of stagnation flow. For 3 loop and 2 loop plants, 2" pipe breaks are the areas of concern for stagnation flow.

2. Heat Transfer Coefficient

The heat transfer coefficient for the thermal hydraulic transient analysis comes from the code used in the analysis and is relatively low. A higher value was used in the fracture mechanics analysis which is explained in WCAP 10019 and ranges between 100 and 300.

3. Effect of Secondary System

The temperature transient which bounds the case for operator action on the secondary side is the no mixing transient. The operator action on the secondary side has some benefits and some bad effects. The present procedures have steps in the recovery phase to reduce secondary pressure. However, the review of the emergency recovery guidelines recommended that these steps be removed. W indicated that credit cannot be given for operator action because the operator would not take action until after warm prestressing has taken effect which is 30 minutes into the transient.

4. Steam Generator Tube Rupture Event

An evaluation of the steam generator tube rupture event (SGTR) was considered in the WOG May 28, 1982 submittal. The May 28 report addresses the

SGTR event with no mixing which results in a low probability number.

5. Effect of Warming RWST

The effect of warming RWST was covered in WCAP 10019. W has not considered temperature of ECCS water higher than 120°. Effect on fracture mechanics - good. Effect on ECCS - Heat transfer benefit
- Containment Cooling penalty
Overall - more benefits than penalties

6. Crack Arrest Phenomenon

The W found for all SBLOCA cases that the crack always arrested below the upper shelf. The W analysis assumed a finite flaw and considered that the crack growth would not exceed that which it would have been if they would have assumed a continuous flaw. The W analysis does consider warm prestressing. The heat transfer coefficient used was the WCAP 10019 data. It was not 300° continuous through the vessel wall.

The explanation of the method of calculating K follows: W calculated K for an elliptic flaw. Along the flaw length the largest calculated K was used in the fracture mechanics analysis. As the crack propagated the K was calculated and never allowed to be larger than if it were calculated assuming an infinite length flaw. For shallow flaws the W analysis would use the elliptic flaw. For deeper flows they assumed infinite flaw length. The W analysis did not consider clad effects. The major identifiable difference between the staff analysis and the W analysis was in the flaw shape.

7. Frequency of SBLOCA with Stagnation Flow

W determined that the probability of SBLOCA which would result in stagnation flow was $6x10^{-4}$. This figure basically comes from an adjustment of WASH1400 data — 10^{-4} as a medium adjusted to $6x10^{-4}$ as a mean for double ended breaks of 1 1/2" to 6" — The information does not come from operating history (350 reactor years of operation)(WASH1400 considered all industry experience - W adjustment considers nuclear experience only). The loss of 2 RCP seals would result in stagnation flow and would have a probability range of 10^{-5}.

The $6x10^{-4}$ figure is in the May 28 report. All incoming lines to the RCS either have orifices or check valves. Considering all the above W believes that the $6x10^{-4}$ probability could be reduced by an order of magnitude ($6x10^{-5}$) and still be conservative.

8. Other Events Resulting In Stagnation Flow

Other events which result in stagnation flow include SGTR with RCP off. The conditional probability of this event is 10^{-2}. (The probability of losing power to RCP is 10^{-3}). There are other ways for stagnation flow to occur but all are not presently known and their probabilities are not known.

9. Response After Caucus

The probability of other events which result in stagnation flow centers around events resulting in no mixing. Stagnation in a single loop is not synonymous with loss of natural circulation. For SBLOCA greater than

1 1/2" (1 1/2 to 4") W believes $6x10^{-4}$ is the proper probability and it may be too conservative. W believes SBLOCA produced cracks would arrest. They believe only high probability events resulting in stagnant flow effect only one loop.

10. Crack Arrest Concerns

The crack arrest phenomenon for the SBLOCA appears to be the major difference between the staff's view and the W views. W assumed an elliptic flow. The staff assumed an infinite length flow. Therefore, this has caused a major difference in calculating the RT_{NDT}.

Conclusions

The staff was to check their methods of fracture mechanics analysis and WOG was requested to recheck their methods and both the staff and WOG were requested to try to come to an agreement. The WOG was also requested. to look further into the identification and probabilities of events which result in stagnation flow.

Original signed by

Guy S. Vissing, Project Manager
Operating Reactors Branch #4
Division of Licensing

Enclosures:
1. Tentative Agenda
2. Actual Agenda
3. Attendance List
4. NRC Discussion Material

cc w/enclosures:
See next page

OFFICE	ORB#4:DL						
SURNAME	GVissing/cb						
DATE	8/ /82						

ORB#4:DL

MEETING SUMMARY DISTRIBUTION

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Docket File
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L PDR
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JStolz
Project Manager-GVissing
Licensing Assistant-RIngram
OELD
Heltemes, AEOD
IE
SShowe (PWR) or CThayer (BWR), IE
Meeting Summary File-ORB#4
RFraley, ACRS-10
Program Support Branch

ORAB, Rm. 542
BGrimes, DEP
SSchwartz, DEP
SRamos, EPDB
FPagano, EPLB

Meeting Participants Fm. NRC:

NRAnderson
MVagins
GLauben
ARubin
FSchroeder
SHanauer
TMurley
BSheron
RKlecker
RRantala
SIsrael

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The staff was to check their methods of fracture mechanics analysis and WOG was requested to recheck their methods and both the staff and WOG were requested to try to come to an agreement. The WOG was also requested. to look further into the identification and probabilities of events which result in stagnation flow.

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Enclosure 1

TENTATIVE AGENDA

FOR

MEETING WITH WESTINGHOUSE OWNERS GROUP

JULY 30, 1982

1. SBLOCAs (sizes) of concern which result in loss of natural circulation but where continued high pressure can exist to cause a PTS concern.

2. Understanding frequency and basis for frequency of SBLOCAs defined in #1.

3. Calculation details on crack arrest phenomenon for the SBLOCAs of #1.

4. Justification for credit for warm prestressing for the SBLOCAs of #1.

5. Heat transfer coefficient when there is a loss of natural circulation during SBLOCA.

6. Effect of secondary system and what operator does to secondary system on SBLOCA. What would operator be expected to do, with what probability, and does secondary depressurization make PTS more or less severe.

7. Analysis (frequency, transient, and fracture mechanics) of steam generator tube rupture event with pressurizer on the good steam generator ("Ginna" event in other SG).

8. Analysis (frequency, transient and fracture mechanics) of SBLOCA where the break is isolated early in the transient.

9. Effect of warming RWST on the SBLOCA and the fracture mechanics analysis. Include both benefit for PTS, and detriment for ECCS consideration.

Enclosure 2

ACTUAL AGENDA FOR

MEETING WITH WESTINGHOUSE OWNERS GROUP

JULY 30, 1982

1. SBLOCAs (sizes) of concern which result in loss of natural circulation but where continued high pressure can exist to cause a PTS concern.

2. Heat transfer coefficient when there is a loss of natural circulation during SBLOCA.

3. Effect of secondary system and what operator does to secondary system on SBLOCA. What would operator be expected to do, with what probability, and does secondary depressurization make PTS more or less severe.

4. Analysis (frequency, transient, and fracture mechanics) of steam generator tube rupture event with pressurizer on the good steam generator ("Ginna" event in other SG).

5. Effect of warming RWST on the SBLOCA and the fracture mechanics analysis. Include both benefit for PTS, and detriment for ECCS consideration.

6. Calculation details on crack arrest phenomenon and consideration of warm prestressing for the SBLOCAs of #1.

7. Understanding frequency and basis for frequency of SBLOCAs.

8. Other events causing stagnation flow

9. Response After Caucus

10. Crack Arrest Concerns

ATTENDANCE LIST FOR

MEETING WITH WOG CONCERNING PRESSURIZED THERMAL SHOCK
JULY 30, 1982

NRC

G. Vissing
N. R. Anderson
M. Vagins
G. Lauben
A. Rubin
F. Schroeder
S. Hanauer
T. Murley
B. Sheron
R. Klecker
R. Rantala
S. Israel

NUTECH w/FPL

J. Copeland

FP&L

J. Moaba
S. K. Matharan

Va. Elec. & Power Co.

D. W. Lippard

W

R. Sero
W. Bamford
T. Meyer
K. Balkey
B. King
H. Julian
M. J. Hitchler
D. R. Sharp
J. A. Rumancik

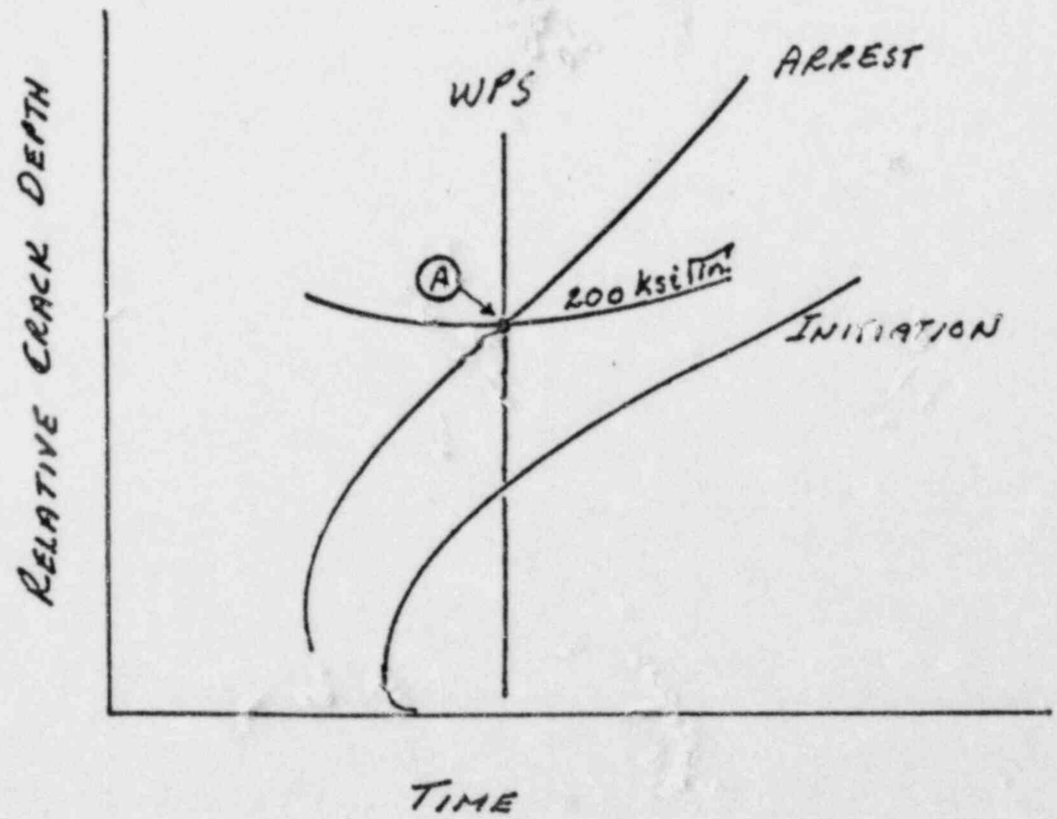
Con. Edison of NY

D. M. Speyer

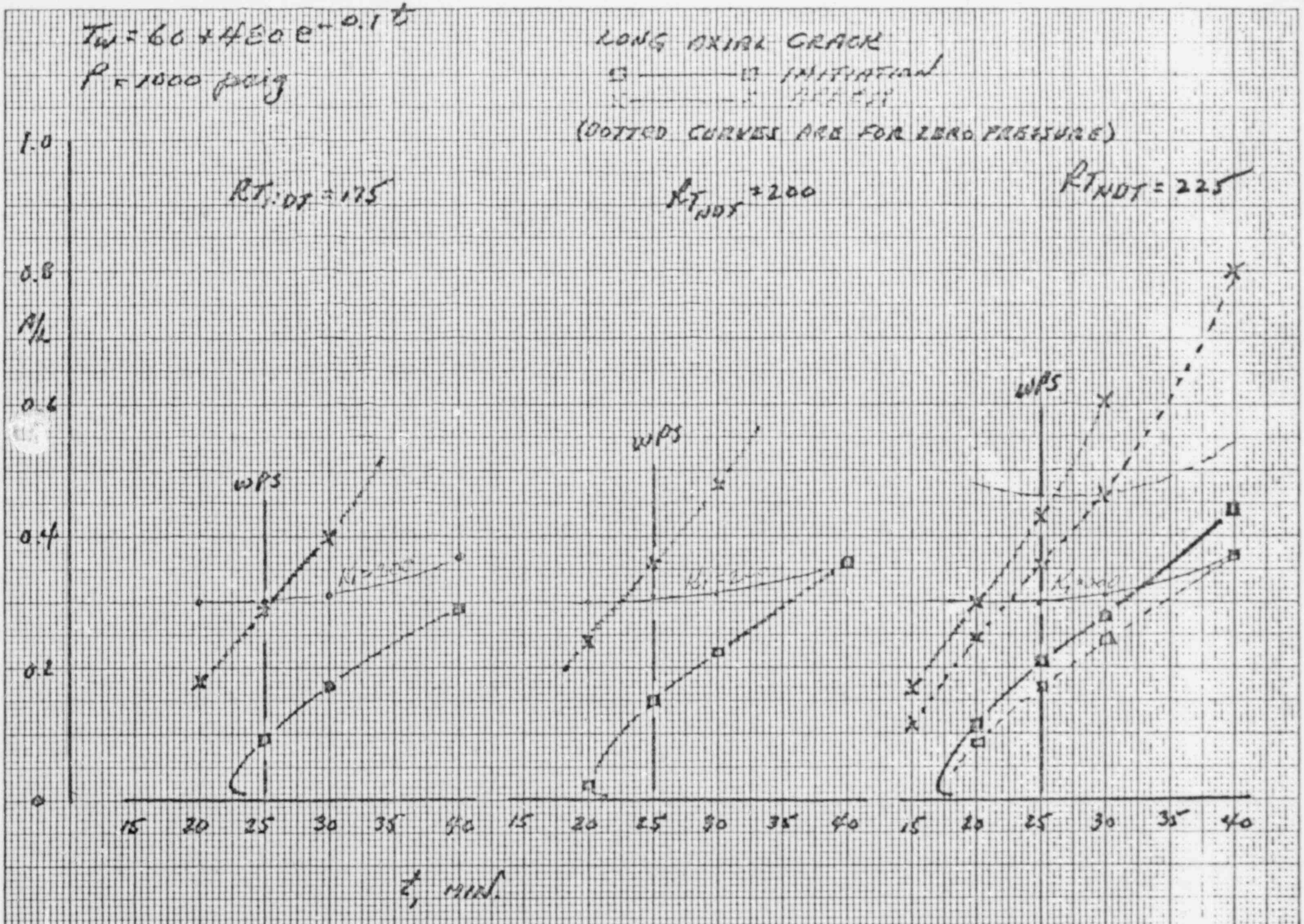
Carolina Power & Light Co.

J. J. Sheppard

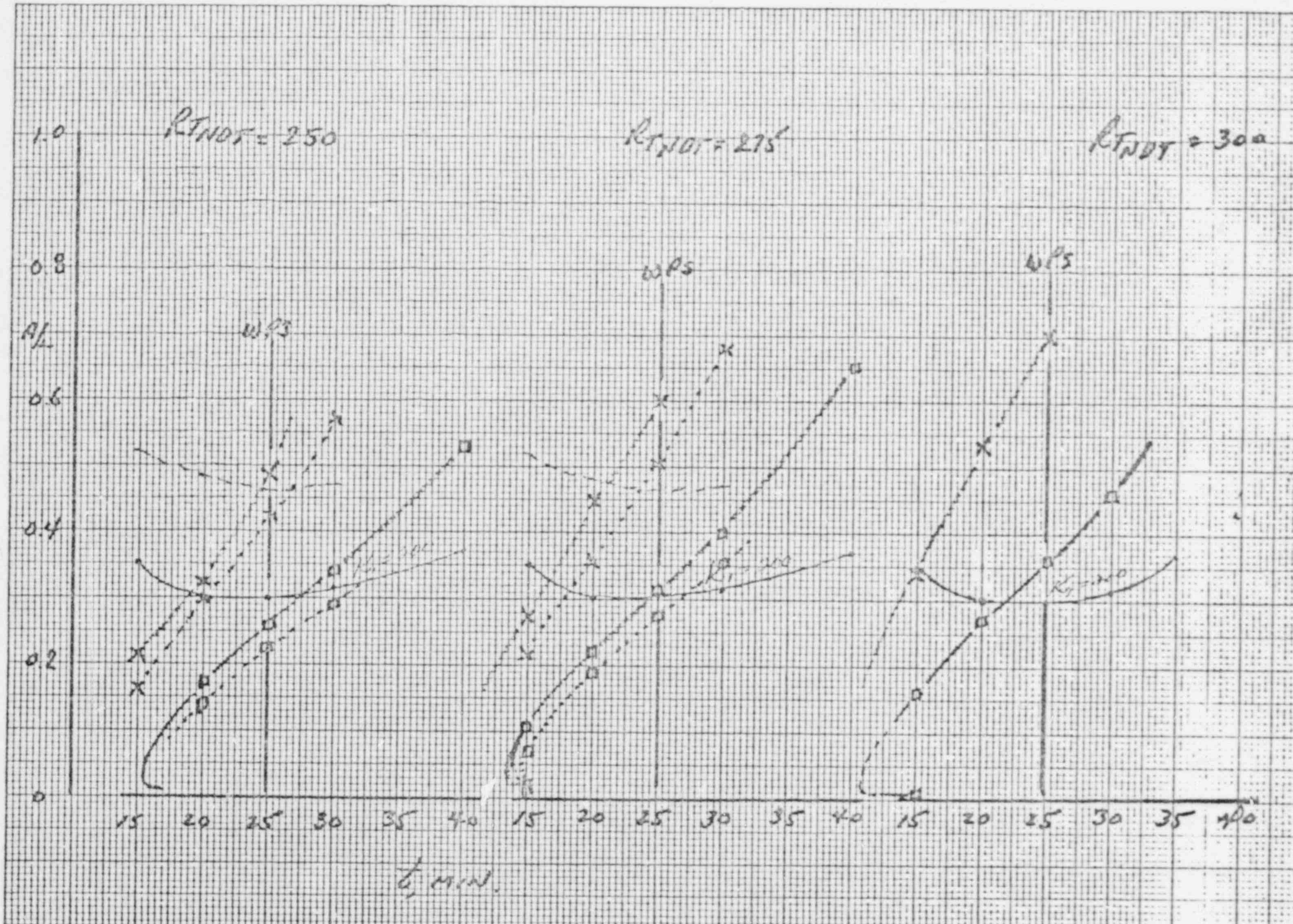
NRC CRACK ARREST MODEL



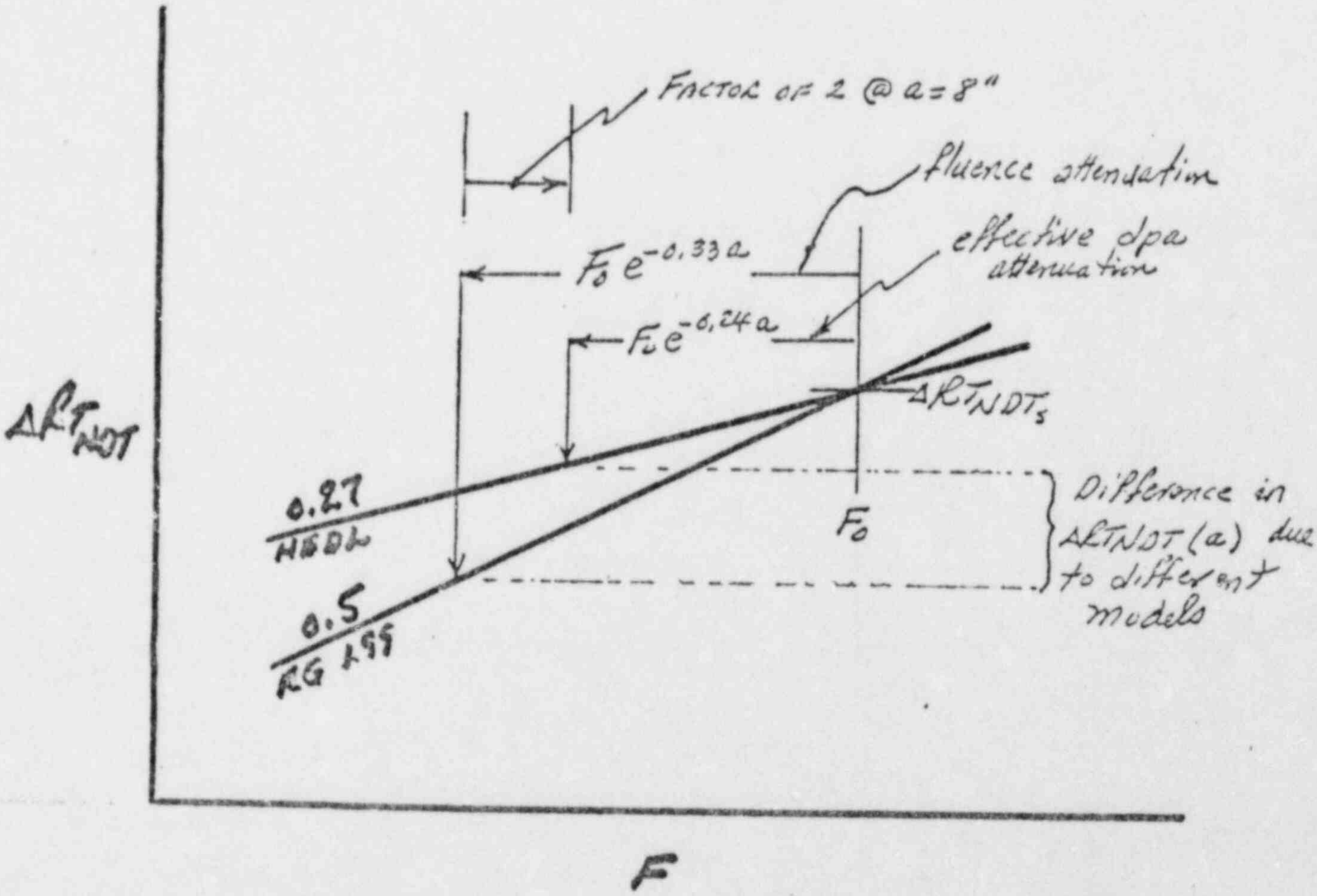
FOR A GIVEN THERMAL TRANSIENT, AND A GIVEN RT_{NDT} AT THE VESSEL INNER RADIUS, MAXIMUM PRESSURE IS DETERMINED WHEN CRACK ARREST OCCURS AT 200 ksi√in. AT THE TIME WARM PRESTRESSING OCCURS (POINT "A" IN THE ABOVE FIGURE)

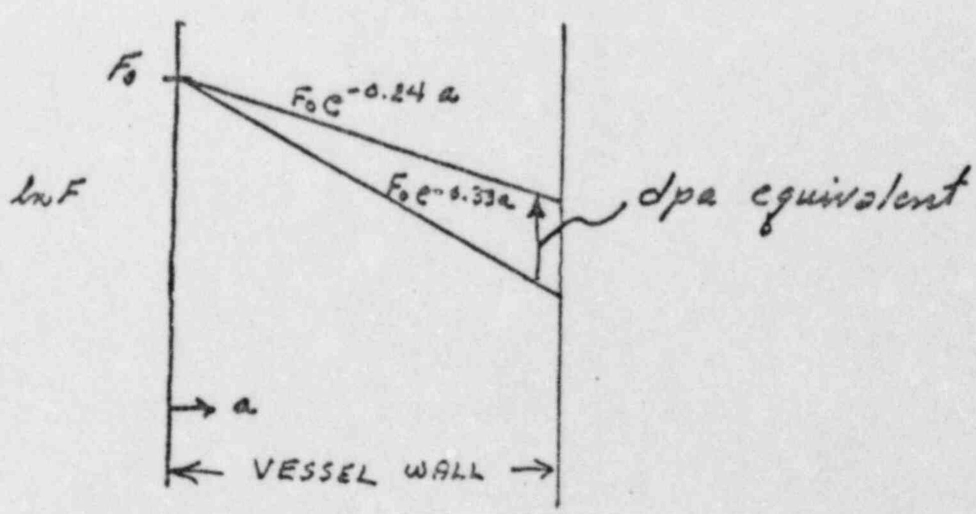


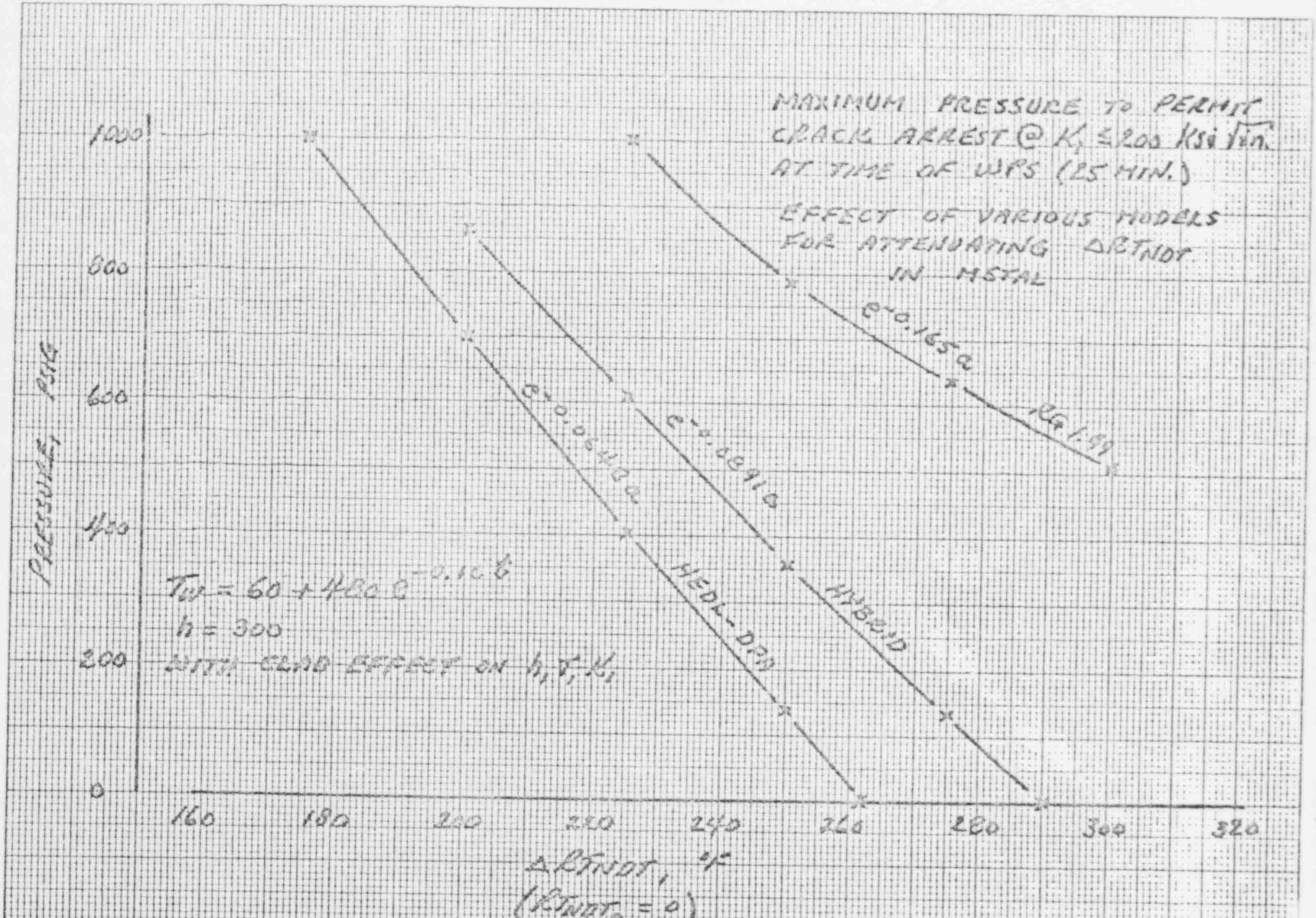
Tw = 60 + 460 e^-0.1 t
P = 1000 psig
LONG AXIAL CRACK
INITIATION
(DOTTED CURVES ARE FOR ZERO PRESSURE)
RTNDT = 175
RTNDT = 200
RTNDT = 225
WPS
WPS
WPS
a/w
1.0
0.8
0.6
0.4
0.2
0
15
20
25
30
35
40
t, min.


RTNDT = 250
RTNDT = 275
RTNDT = 300
WPS
WPS
WPS
a/L
1.0
0.8
0.6
0.4
0.2
0
15 20 25 30 35 40 15 20 25 30 35 40 15 20 25 30 35 40
t, MIN.

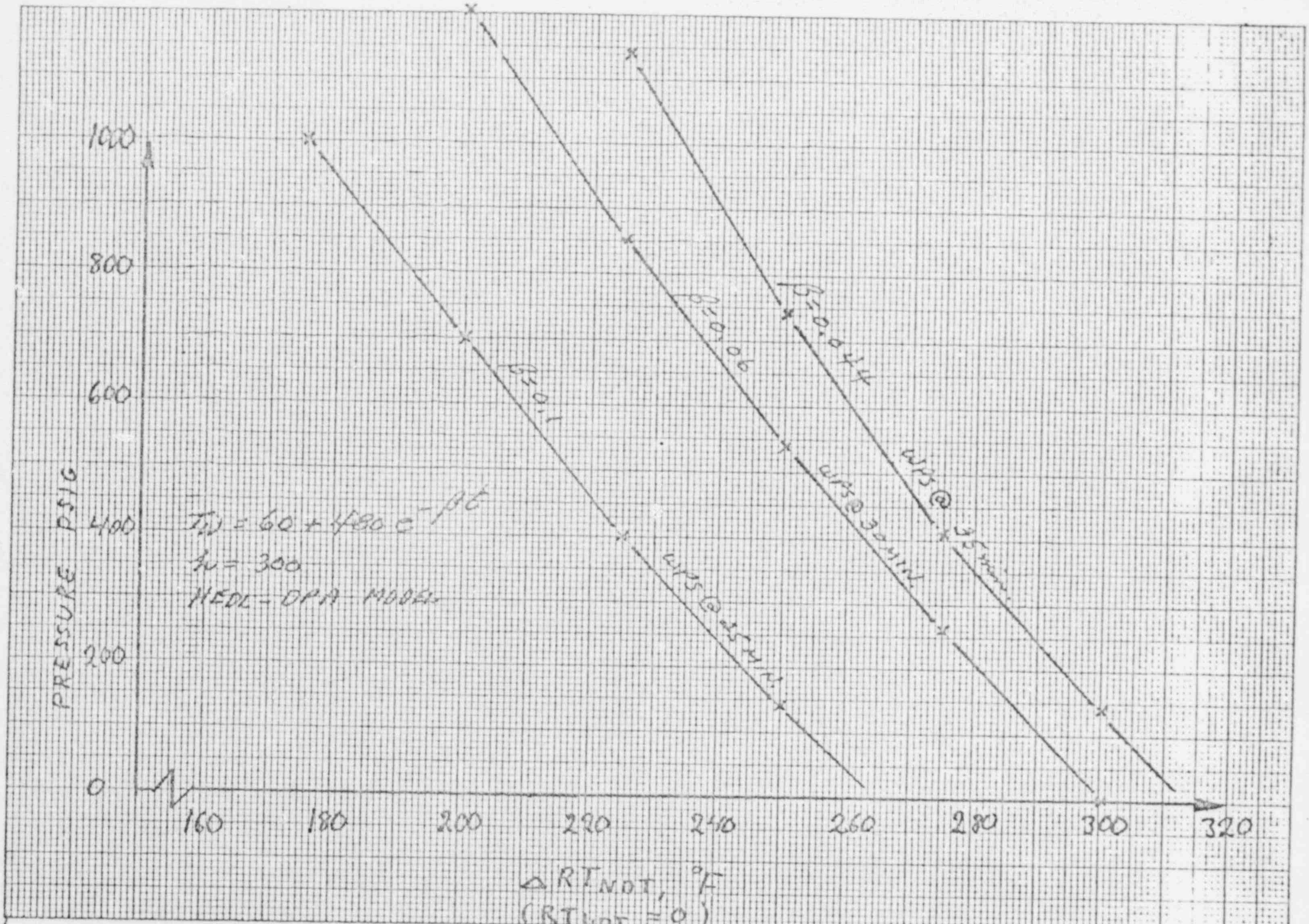
ΔRTNDT ATTENUATION IN VESSEL WALL

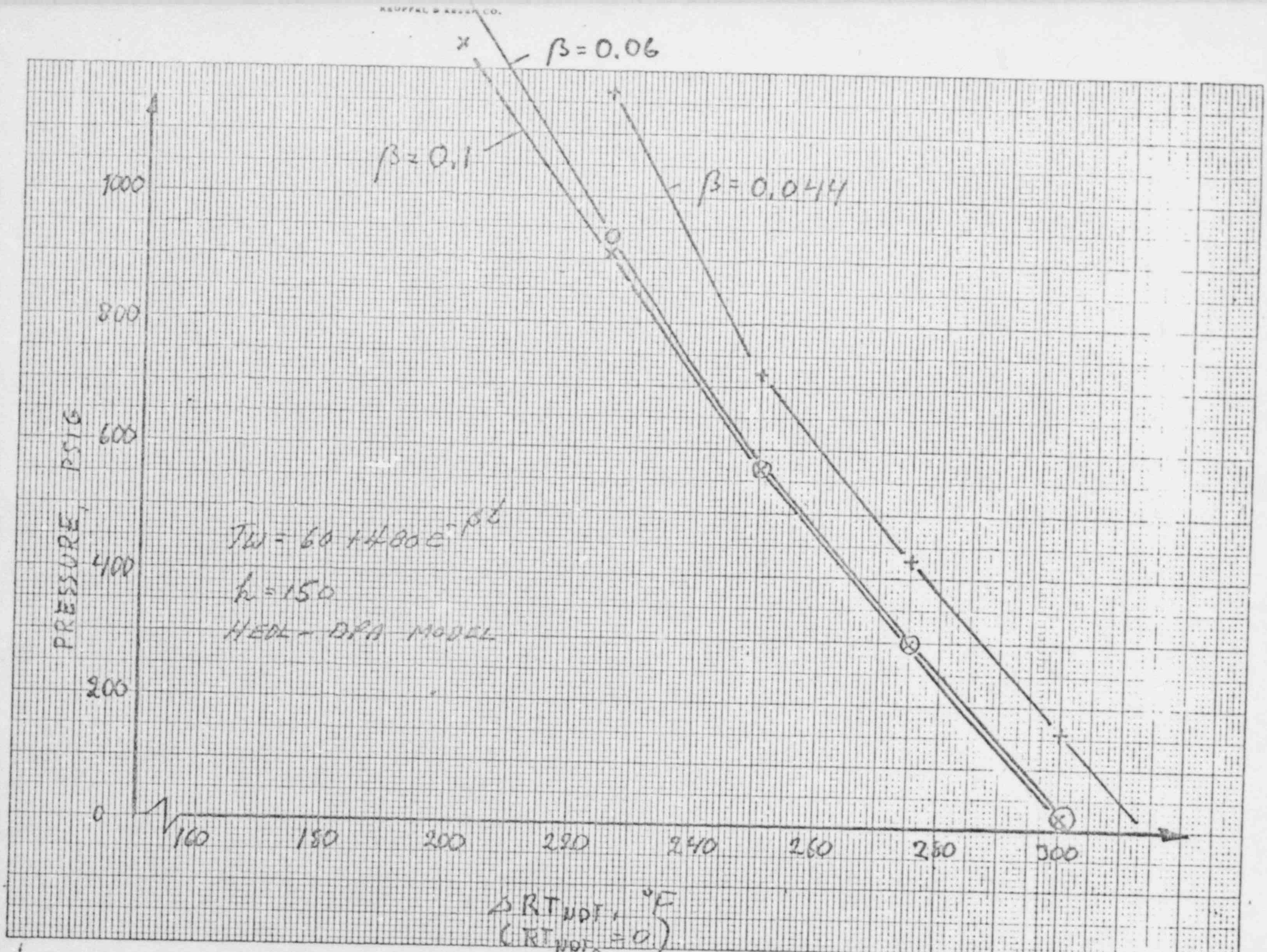




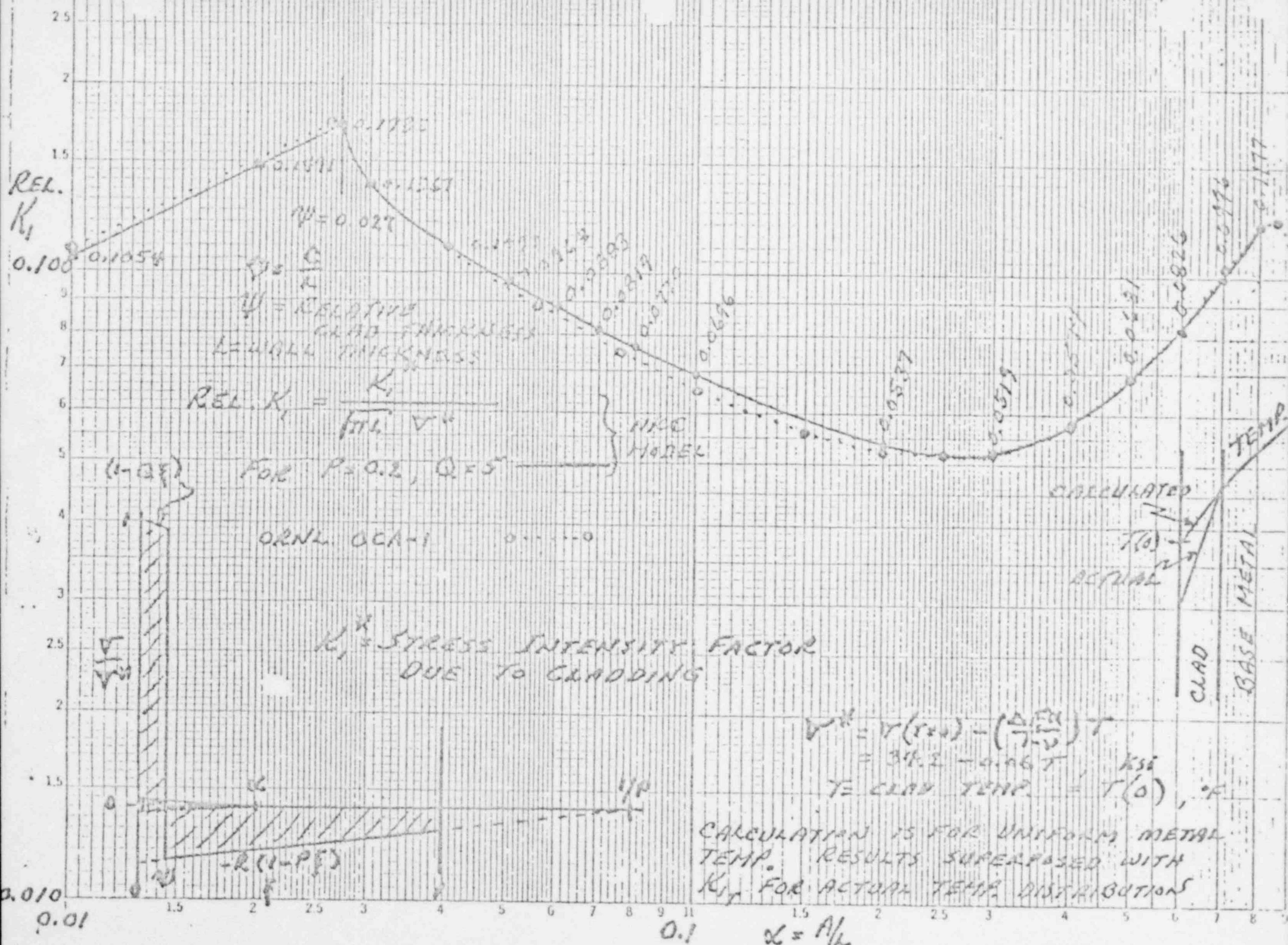


MAXIMUM PRESSURE TO PERMIT
CRACK ARREST @ K1 ≤ 200 KSI √IN.
AT TIME OF WPS (25 MIN.)
EFFECT OF VARIOUS MODELS
FOR ATTENUATING ΔRTNDT
IN METAL
e^-0.165a
RG 1.99
e^-0.0891a
e^-0.0640a
HYBRID
HEDL-DPR
Tw = 60 + 480 e^-0.1ct
h = 300
WITH CLAD EFFECT ON h, σ, K1
PRESSURE, PSIG
0
200
400
600
800
1000
160
180
200
220
240
260
280
300
320
ΔRTNDT, °F
(RTNDT0 = 0)


1000
800
600
400
200
0
PRESSURE PSIG
160
180
200
220
240
260
280
300
320
ΔRTNDT, °F
(RTNDT₀ = 0)
β=0.044
β=0.06
β=0.1
WPS @ 35 min.
WPS @ 30 MIN.
WPS @ 25 MIN.
TW = 60 + 480 e^-βt
hW = 300
HEDL - OPA MODEL



KEUFFEL & ESSER CO.
β = 0.06
β = 0.1
β = 0.044
PRESSURE, PSIG
1000
800
600
400
200
0
Tw = 60 + 480e^-βt
h = 150
HEDL - DPA MODEL
160
180
200
220
240
260
280
300
ΔRT_NDT, °F
(RT_NDT0 = 0)



REL. K1
0.100
0.010
0.01
0.1
α = A/L
0.1054
0.1780
0.1351
ψ = 0.027
ψ = RELATIVE CLAD THICKNESS
L = WALL THICKNESS
0.0893
0.0819
0.0776
0.0696
0.0537
0.0519
0.0826
0.1177
NRC MODEL
ORNL OCA-1
K1* = STRESS INTENSITY FACTOR DUE TO CLADDING
T = CLAD TEMP. = T(0), °F
CALCULATION IS FOR UNIFORM METAL TEMP. RESULTS SUPERPOSED WITH K1T FOR ACTUAL TEMP. DISTRIBUTIONS
CALCULATED
T(0)
ACTUAL
CLAD
BASE METAL
TEMP.
-R(1-Pξ)
1/P