John D. O'Toole
Vice President

Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, NY 10003
Telephone (212) 460-2533

October 10, 1984

Re: Indian Point Unit No. 2
Docket No. 50-247

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Dear Mr. Varga:

During our meeting on Wednesday October 3, 1984 to discuss the results of our evaluations and investigations of the ultrasonic indication recently detected in the Indian Point Unit No. 2 reactor vessel, the staff requested certain confirmatory information in support of our conclusions.

Attachment A to this letter summarizes an Indian Point Unit No. 2 plant-specific fracture mechanics evaluation of a hypothetical flaw considerably larger than the measured indication under conditions indicative of the low temperature overpressurization event which occurred at Turkey Point Unit No. 4 in 1981. An assessment of the probability of occurrence of such an event at Indian Point Unit No. 2 is also provided. This information was presented to the staff during our meeting on October 3, 1984. The results of these evaluations demonstrate that the probability of such an event occurring at Indian Point Unit No. 2 is extremely low. Nevertheless, if such an event were to occur at Indian Point Unit No. 2, the transient loadings imposed would result in stress intensities acceptable under ASME B&PV Code Section XI requirements.

Attachment B contains data in support of our conclusions as to the maximum size of the indication based on the delta techniques. This data supports our September 21, 1984 response to Question 1A of your August 16, 1984 request for additional information. Also addressed are the methods by which we have determined that the location of the reflector is contained within the weld material.

8410160124 841010
PDR ADOCK 05000247
P PDR

A001
1/1

The information contained in the attachments is believed to be completely responsive to the staff's requests and together with the information previously provided is sufficient to enable the staff to conclude that the indication is of no structural significance from an operating or safety standpoint and requires neither repair nor augumented inspection under the applicable code.

Accordingly, we request the staff's prompt completion of its review as preparations for startup are essentially complete and criticality is presently scheduled for this weekend, October 13-14, 1984.

Very truly yours,

John D. O'Toole

John D. O'Toole
Vice President

cc: Resident Inspector
U. S. Nuclear Regulatory Commission
P. O. Box 38
Buchanan, New York 10511

Attachment A

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
October, 1984

Attachment A

At the request of NRC, the likelihood of low temperature overpressure events at Indian Point Unit 2 and the impact of such events on the acceptability of the recently identified reactor vessel indication was investigated. Since the installation of overpressure protection systems industry-wide in the 1980-81 time frame, only one such event has occurred, at Turkey Point Unit 4. No overpressure events have occurred at Indian Point Unit 2 since the overpressure protection system was installed in 1978.

Design and operational differences exist between Indian Point 2 and Turkey Point. First, the Indian Point 2 pressurizer is always maintained with a gas or steam bubble. Thus, the water solid condition which contributed greatly to the rapidity of the Turkey Point LTOP event would not exist. Second, there is no automatic isolation feature associated with the Indian Point 2 RHR letdown path. Thus, even if a pressure surge were assumed to occur upon starting a reactor coolant pump as happened at Turkey Point, the Indian Point 2 plant would not isolate RHR and by design turn the event into a "mass addition" pressure transient. Third, as discussed at the October 3, 1984 meeting with the Staff, the Indian Point 2 overpressure protection system (OPS) design includes two redundant PORVs, each actuated by a Class 1E 2-out-of-3 logic system and provided with N_2 accumulators to supply the valve actuators independent of the instrument air system. Thus, the Indian Point 2 design is more reliable than the standard Westinghouse generic OPS design. Therefore, when one considers the above, plus the multitude of alarms and indicators that would actuate on impending overpressure, the likelihood of Indian Point 2 experiencing the LTOP event as occurred at Turkey Point is so low as to not be credible.

A probabilistic assessment was also carried out by Westinghouse to determine the probability of a significant overpressure event at Indian Point Unit 2. This assessment was based on the generic Westinghouse OPS design which is considered to provide conservative results with respect to the actual Indian Point 2 OPS. The assessment used event tree analysis, and two trees were constructed, as shown in Tables 1 and 2. The details of the event tree analysis are contained in Appendix A. The trees included consideration of the following areas:

- o probability of the pressure exceeding the technical specification limit (OPC)
- o probability that the system temperature is below 250°F (TMP)
- o probability that the overpressure protection system is available (OPS)

- o probability that the pressurizer has a bubble formation (WSO)
- o probability that the high pressure alarm works (ALR)
- o probability that the operator mitigates the event (OPA)

The tree shown in Table 1 was constructed based on best estimate considerations for each of the above probabilities, and resulted in a probability of occurrence of 2.75×10^{-7} per reactor year. If worst case assumptions are made concerning the probabilities above, including the assumption that the alarm system is inoperative, the probability of occurrence of an overpressure event was calculated to be 10^{-5} per reactor year, as shown in Table 2. Either of these probabilities classifies the low temperature overpressure event as a very low likelihood event, which could be classified as a faulted event*. Consideration of the best estimate calculations of probability lead to the conclusion that such an event is so unlikely that its evaluation is not necessary.

Nonetheless, the Turkey Point low temperature overpressure (LTOP) event was evaluated for informational purposes to determine the acceptability of the indication in the core region of the Indian Point Unit 2 vessel even though this is a very low likelihood event for this plant. For a temperature of 110F and pressure of 1100 psi (which characterized the Turkey Point event), the applied stress intensity factor K_I was calculated to be 16.3 ksi$\sqrt{in}$ for a postulated flaw 1.45 inches deep and 2.0 inches long. Recent work has led to the conclusion that it is much smaller. Thus, this represents a conservative bounding analysis. The applied stress intensity factor K_I would be less than 16.3 Ksi$\sqrt{in}$ for a smaller flaw.

The allowable stress intensity factor for this region of the vessel calculated from the fracture toughness and RT_{NDT} of the vessel weld material, using the Guthrie trend curves (as described in WCAP 0657) gives an allowable stress intensity factor shown below:

<u>Weld 3-042A (end-of-life RTNDT=79F)</u>

$$\frac{K_{Ia}}{\sqrt{2}} = \frac{71.7}{\sqrt{2}} = 50.7 \text{ ksi} \sqrt{\text{in}}$$

7. Considering the possibility that the indication could be located in either of the adjacent plates, the allowables are:

<u>Plate B-2003-1</u> (end-of-life RT_{NDT}=148.7F)

$$\frac{K_{Ia}}{\sqrt{2}} = \frac{42.8}{\sqrt{2}} = 30.3 \text{ ksi} \sqrt{\text{in}}$$

<u>Plate B-2003-2</u> (end-of-life RT_{NDT}=96.9F)

---

*Based on ANS "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants" as reproduced in Table 3.

$$\frac{K_{Ia}}{\sqrt{2}} = \frac{60.1}{\sqrt{2}} = 42.5 \text{ ksi}\sqrt{\text{in}}$$

8. Clearly from these calculations it may be seen that the postulated bounding indication is acceptable per the requirements of Section XI, IWB 3600.

APPENDIX A

The following plant specific items are considered in the modeling:

1. There is a nitrogen blanket in the pressurizer during low temperature operation. Thus a bubble is maintained at all times. Any pressure increase thus will take a relatively long time and will enable operator intervention if the LTOP system fails.

2. Although LTOP events are not addressed in present plant technical specifications, the plant is currently operated in accordance with the technical specifications submitted to the NRC for approval on February 14, 1983. Operating procedures pertinent to LTOP events are consistent with the February 14, 1983 submittal. The operators are trained in LTOP events.

3. The LTOP event is of concern if the primary coolant temperature is less than 250 degrees F. The pressure increase is of major concern if the pressure reaches multiples of the technical specification limit.

4. There are two redundant trains of the LTOP system. Each one has 2/3 logic for a PORV activation. The three channels are independent.

5. There have been no LTOP events at IP2 since the implementation of the OPS and associated procedures.

6. There is no automatic RHR isolation; thus automatic blockage of RHR letdown lines is not credible.

The following items were not considered in the model, but add conservatism to the treatment:

1. IP2 OPS is designed not to exceed Appendix G limits for 10 minutes without any operator action.

2. Below 310°F, the IP2 OPS is armed for actuation.

3. When the OPS is not operable, compensatory protection is provided by either opening an equivalent vent path from the primary coolant system to containment or utilizing a very large bubble in the pressurizer.

An event tree with six nodes and 8 event sequences is constructed to model the progression of events following a low temperature overpressurization challenge to the plant. This challenge may be due to inadvertent addition of heat or mass into the primary system, e.g., in the form of startup of a reactor coolant pump or a SI pump or due to blockage of letdown lines.

The event tree nodes are described below:

	TABLE 1	TABLE 2
(OPC) LTOP event challenges the plant safety systems	freq=0.1	0.2
(TMP) Primary coolant temperature during challenge is less than 250 degrees F	q=0.5	1.0
(OPS) Overpressure protection is available		
both trains are available	p=0.99	0.99
only one train is available	q1=0.01	0.01
both trains are unavailable	$q0=5x10^{-4}$	$5x10^{-4}$
(WSO) The pressurizer has bubble formation	$q=1x10^{-4}$	0.001
(ALR) High pressure alarm works	q=0.01	1.0
(OPA) Operator mitigates the event		
Alarm available	q=0.01	N/A
Alarm fails	q=0.01	0.1

Table 1 and 2 contain the best estimate and worst case point estimate calculations, respectively.

In OPS node, the unavailability of one train was estimated to be 5×10^{-3} due to maintenance or mechanical failures of valves. Common cause between two trains is modeled with a beta factor of 0.1. Thus

$$q1=2 \times 5 \times 10^{-3} = 0.01$$

$$q0=(5x10^{-3})^2 \pm 0.1 \times 5.0 \times 10^{-3}=5 \times 10^{-4}$$

$$p=1 - (q1 + q2)=0.99$$

N/A stands for "not applicable"

q refers to failure probability

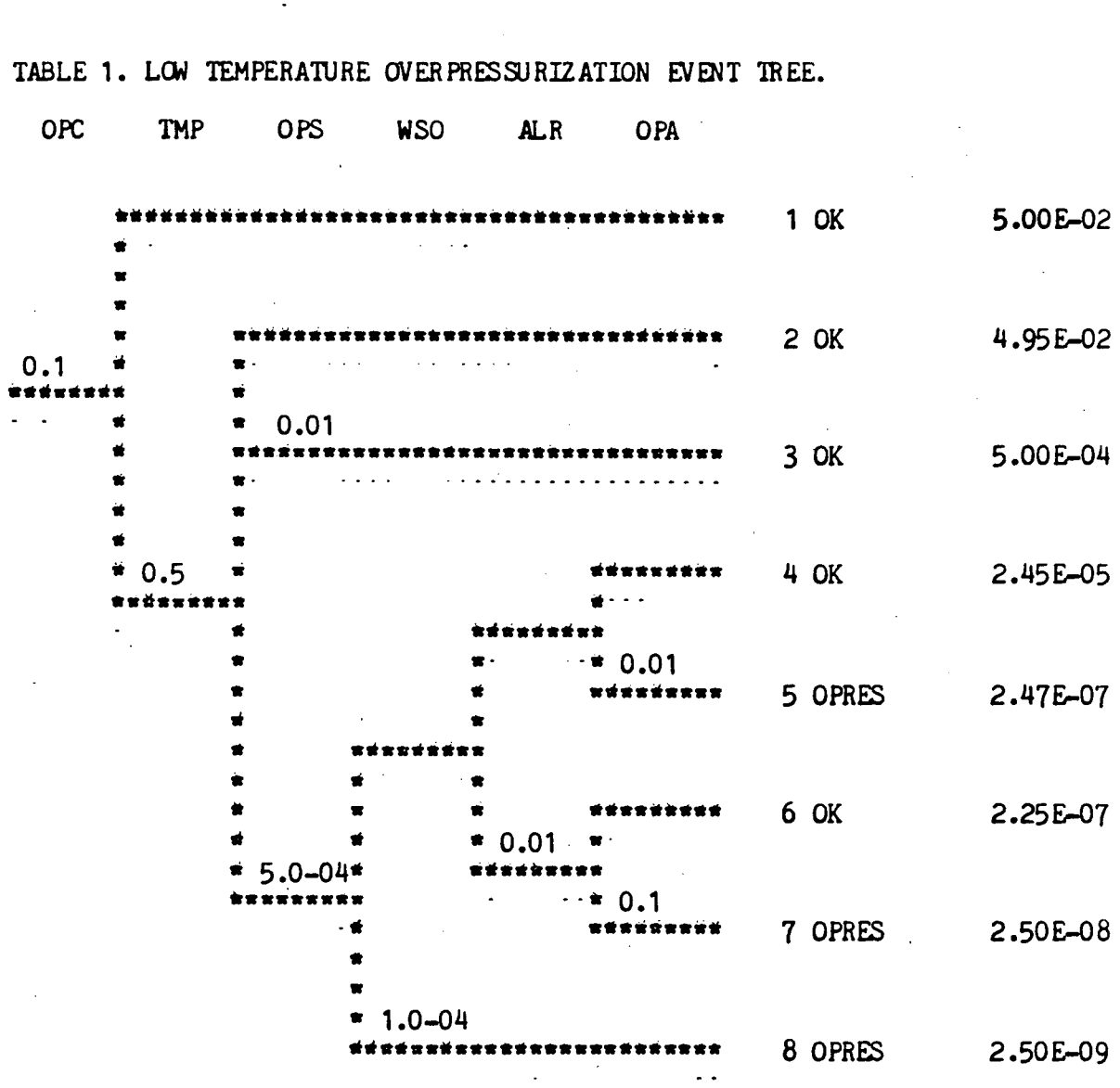
With the above estimates, the frequency of unmitigated overpressurization event is calculated to be 2.75×10^{-7}/year (see Table 1).

A conservative estimate is made by taking the initiating event frequency to be 0.2/year; temperature during event to be always less than 250 degrees (qTMP = 1.0); and the alarm system being unavailable (common cause failure between alarm and the OPS system: qALM= 1.0); water solid operation probability is taken as qWSO=0.001.

The result of this conservative estimate gives (see Table 2):

$$f_2=1.0 \times 10^{-5}/\text{year}$$

TABLE 1. LOW TEMPERATURE OVERPRESSURIZATION EVENT TREE.



CATEGORY	DESCRIPTION
OK	OVERPRESSURE EVENT IS MITIGATED
OPRES	OVERPRESSURE SPIKE OCCURS

SUMMARY OF FREQUENCY TOTALS

FREQ (OVER PRES) = 2.75E-07/YEAR.

TABLE 2. LOW TEMPERATURE OVERPRESSURIZATION EVENT TREE

```
 OPC     TMP     OPS     WSO     ALR     OPA

      ****************************************   1 OK        0.00E-01
      *
      *
      *
      *       ********************************   2 OK        1.98E-01
 0.2  *       *
********       *
      *       *  0.01
      *       ********************************   3 OK        2.00E-03
      *       *
      *       *
      *       *
      * 1.0   *                       *********   4 OK        0.00E-01
      *********                       *
              *               *********
              *               *       *
              *               *       *********   5 OPRES     0.00E-01
              *               *
              *       *********
              *       *       *
              *       *       *       *********   6 OK        8.99E-05
              *       *       * 1.0   *
              * 5.0-04*       *********
              *********               * 0.1
              ...     *               *********   7 OPRES     9.99E-06
                      *
                      *
                      * 0.001
                      ************************   8 OPRES     1.00E-07
```

CATEGORY	DESCRIPTION
OK	OVERPRESSURE EVENT IS MITIGATED
OPRES	OVERPRESSURE SPIKE OCCCURS

SUMMARY OF FREQUENCY TOTALS

FREQ (OVER PRES) = 1.0E-05/YEAR.

EVENT FREQUENCY RANGE (per reactor-year)	PLANT CONDITIONS CATEGORIES	OTHER CATEGORIZATION SCHEMES					
		NRC			ANS		
		10 CFR	RG 1.48 ASME Code*	RG 1.70 Rev. 2	51.1 (N18.2)	52.1 (N212)	53.1 (N213)
Planned Operations	PC-1	Normal	Normal	Normal	Condition I	Normal PPC	Plant Condition A
10^{-1}	PC-2	Anticipated Operational Occurrences	Upset	Moderate Frequency	Condition II	Frequent PPC	Plant Condition B
10^{-2}	PC-3			Infrequent Incidents	Condition III		
10^{-3}	PC-4	Accidents	Emergency	Limiting Faults	Condition IV	Infrequent PPC	Plant Condition C
10^{-4}							
10^{-5}	PC-5		Faulted			Limiting PPC	Plant Condition D
10^{-6}							
	Not Considered						

*This terminology has been eliminated from 1977 version of the ASME Code.

Fig. B-1
Event Categorization

TABLE 3

Attachment B

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
October 1984

Attachment B

Delta Technique Mockup Results

The delta technique was one of the techniques utilized to evaluate the reactor vessel indication. This technique was demonstrated and further evaluated on two reactor vessel mockups. This attachment summarizes the detailed delta technique mockup results and provides additional information on how the vessel indication was located using both a pulse echo and the delta technique. The above information was requested by the NRC in a meeting on October 3, 1984.

Delta results from the IPP-2T mockup are presented in Table 1. Delta results from the IPP-1T block are presented in Table 2 as supporting information, but not considered in the evaluation because the radius of curvature differs from that of the vessel. Measurements were made from both sides of each reflector (where possible) with both delta arrangements. Data from transit time measurements based on total metal path were plotted versus the mathematical model to identify the uncertainty which might be involved. Although a statistical analysis was not performed, the data could be bounded by a $\pm$ 2 microsecond limit. This translates to a measuring tolerance of $\pm$ 0.2 inches over a range of reflector depths from 0.1 to 2.0 inches. See Figure 1.

Data from the delta measurements was also reviewed in terms of the time interval spacing between indications representing the upper and lower extremes of the reflectors. These limits were approximated to be on the order of $\pm$ 1.5 microseconds or a measuring tolerance of 0.15 inches over a range of reflector depths from 0.1 to 1.0 inches. This information is included in the "Difference (b) - (a)" columns of Tables 1 and 2.

The detailed information provided herein for the delta technique supports our previous evaluation regarding the depth of the indication. This information and preceeding information submitted on the pitch catch and pulse echo techniques and length and depth exaggeration studies support the conclusion that the indication is 0.26 inches deep by 0.85 inches long.

Locating the Vessel Indication

In addition to gathering more quantitative information concerning the depth of the reflector, the delta transducer arrangement was utilized to more clearly identify the azimuthal location of the reflector. With the ultrasonic system operating in the pulse-echo mode, the reflector was detected with the 45° transducer oriented in the counter-clockwise direction (TR 22). With the array in that same position, the system was switched to the delta mode, with TR 22 as a transmitter, and a delta signal was observed.

A delta signal was also observed when the system was switched to the delta mode with the opposing 45° transducer (TR 24) used as a transmitter. The reflector location as determined by the delta plate arrangement was 345.12 degrees.

Vessel drawings and associated documentation used to develop the examination program identify the centerlines of the Indian Point Unit 2 lower shell longitudinal weld seams at 345° and 165° vessel axis.

Results of the reflector investigation in the delta mode, therefore, locate the reflector at 0.12° clockwise [or 0.20 inches] off the centerline of the lower shell longitudinal weld at 345° vessel axis.

TABLE 1

DELTA TECHNIQUE
SIZING DATA

Block IPP-2T Reflector	Nominal Depth (1)	Transit Times (2) To First Indication (a)	To Second Indication (b)	Difference (b) - (a)
A	0.1"	(3)	134.7	
			135.4	
			134.3	
			135.0	
			134.4	
			134.8	
			134.8	
			136.3	
			135.3	
			134.3	
			134.7	
			134.6	
			134.0	
			134.1	
			134.3	
B	0.3"	131.8	135.0	3.2
		132.3	135.6	3.3
		131.8	133.3	1.5
		133.8	135.7	1.9
		131.9	134.7	2.8
		133.3	136.3	3.0
		133.1	136.3	3.2
		132.7	136.0	3.3
		131.7	134.8	3.1
		131.7	134.8	3.1
		132.4	134.8	2.4
		131.5	134.8	3.3
		130.6	134.3	3.7
		130.0	134.9	4.9
		131.9	134.4	2.5

TABLE 1 (CONTINUED)

DELTA TECHNIQUE
SIZING DATA

Block IPP-2T Reflector	Nominal Depth (1)	Transit Times (2) To First Indication (a)	To Second Indication (b)	Difference (b) - (a)
C	0.5"	129.9	134.1	4.2
		130.5	135.2	5.2
		130.1	134.0	3.9
		129.8	134.0	4.2
		128.7	134.8	6.1
		130.3	134.8	4.5
		130.0	134.3	4.3
		129.2	133.2	4.0
		128.7	133.6	4.9
		128.5	134.8	6.3
		129.9	134.8	4.9
		128.0	132.7	4.7
		127.9	134.3	6.4
		128.6	134.5	5.9
		129.6	134.2	4.6
D	1.5"	117.1	130.8	13.7
		117.6	--	
		118.0	--	
		116.9	129.7	12.8
		117.0	131.0	14.0
		120.7	--	
		120.4	135.0	14.6
		120.0	129.9	9.9
		120.3	--	
		117.7	134.7	17.0
		118.1	134.2	16.1
		120.0	129.3	9.3
E	1.85"	114.4	133.8	19.8
		115.3	133.8	18.5
		115.8	--	
		114.6	--	

TABLE 1 (CONTINUED)

DELTA TECHNIQUE
SIZING DATA

Block IPP-2T Reflector	Nominal Depth (1)	Transit Times (2) To First Indication (a)	To Second Indication (b)	Difference (b) - (a)
E (Cont'd)		115.0	131.7	16.7
		116.9	135.6	18.7
		117.5	132.4	14.9
		115.8	134.1	18.3
		116.0	134.1	18.1
		115.0	134.3	19.3
		115.7	131.0	16.6
		115.8	128.5	13.5
		116.7	134.6	17.9
	2.00"	113.1 (4)	113.3 (4)	
		114.4	114.2	
		114.3	114.0	
		113.7	114.0	
		114.2	114.4	
		116.9	116.4	
		115.6	115.3	
		114.3	114.7	
		114.4	114.9	
		113.1	113.0	
		114.1	113.8	
		115.6	114.8	
		114.6	114.1	
F	0.18"	133.2	134.9	1.7
		133.4	137.2	3.8
		132.9	137.6	4.7
		133.0	136.6	3.6
		132.9	137.2	4.3
		133.6	138.1	4.5
G	0.18"	133.9	136.3	2.4
		134.5	--	
		132.6	--	
		135.1	--	

TABLE 1 (CONTINUED)

DELTA TECHNIQUE
SIZING DATA

Block IPP-2T Reflector	Nominal Depth (1)	Transit Times (2) To First Indication (a)	To Second Indication (b)	Difference (b) - (a)
H	0.18"	132.8	135.3	2.5
		134.2	--	
		134.4	--	
		135.5	--	
J	0.25"	133.4	135.7	2.3
		134.1	137.8	3.7
		133.6	135.1	1.5
		133.5	137.7	4.2
		134.1	137.4	3.3
		133.7	--	
K	0.87"	124.8	134.5	9.7
		125.4	140.1	14.7
		124.9	134.6	9.7
		124.8	134.0	9.2
		125.7	134.0	8.3
		125.2	137.6	12.4

(1) Depth measured from the OD (unclad surface)

(2) All times stated in micro-seconds

(3) Unable to resolve first indication of this reflector

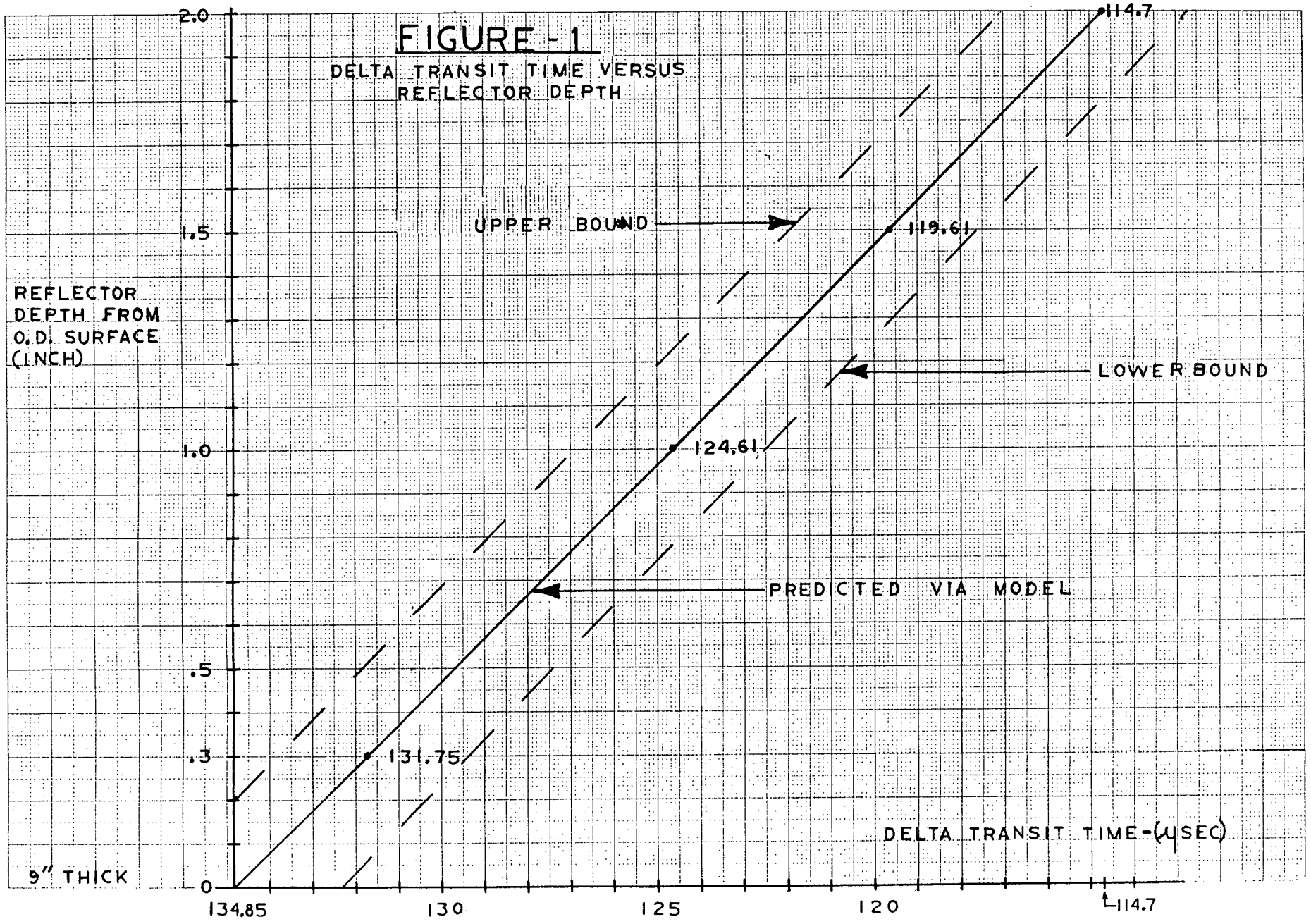
(4) Measured at "Left" and "Right" 2" extremeties of Reflector E

TABLE 2

DELTA TECHNIQUE
SIZING DATA

Block IPP-1T Reflector	Nominal Depth (1)	Transit Times (2) To First Indication (a)	To Second Indication (b)	Difference (b) - (a)
A	.385	132	135.3	3.3
		131.2	134.2	3.0
		130.0	134.2	4.2
		130.5	134.2	3.7
B	.985	123.5	130.1	6.6
		123.3	132.3	9.0
		123.4	130.9	7.5
		123.9	132.5	8.6
C	.997	122.9	131.4	8.5
		123.8	133.7	9.9
		123.7	133.4	9.7
		123.9	132.7	8.8
D	.250	132.3	138.8	6.5
		131.4	134.5	3.1
		133.8	140.2	6.4
		132.9	134.9	2.0
E	.250	130.9	136.8	5.9
		132.8	134.3	1.5
		134.0	138.8	4.8
		131.4	134.1	2.7
F	.249	132.4	135.8	3.4
		132.6	--	--
		131.3	134.8	3.5
		131.0	134.5	3.5
G	.179	134.1	135.8	1.7
		132.9	134.6	1.7
		132.5	134.8	2.3
		132.7	135.3	2.6
H	.248	133.5	137.8	4.3
		130.7	--	--
		133.8	137.9	4.1
		133.3	134.6	1.3

(1) Depth measured from the OD (unclad surface)
(2) All times stated in microseconds



K+E 10 X 10 TO ½ INCH
KEUFFEL & ESSER CO.
47 1320