BALTIMORE
GAS AND
ELECTRIC

CHARLES CENTER • P. O. BOX 1475 • BALTIMORE, MARYLAND 21203

ARTHUR E. LUNDVALL, JR.
VICE PRESIDENT
SUPPLY

April 6, 1982

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

Attention: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing

Subject: Calvert Cliffs Nuclear Power Plant
Units 1 & 2, Dockets Nos. ~~50-318~~ & 50-318
Fire Protection Licensing 50-317

References: (a) Letter from A. E. Lundvall, Jr. to Robert A. Clark dated February 18, 1982.
(b) Telephone conversation of March 19, 1982, P. Katz and R. Hunt (BG&E) and D. Jaffe and R. Eberly (NRC)

Gentlemen:

This letter confirms statements made during a recent telephone conference (reference (b)) concerning details of the acceptablility of usin, water curtains or dedicated sprinklers at certain designated doorways in lieu of standard fire doors at CCNPP.

Reference (a) transmitted the report entitled "Fire Evaluation of Doors and a Water Curtain, " Project No. 01-6763-201 dated February 1982, prepared by Southwest Research Institute. This report documented full scale fire tests of water curtain assembly consisting of two dedicated automatic sprinklers, one installed on each side of the doorway. The procedure required that water flow tc the automatic sprinklers was to be supplied at 100 psi throughout the duration of the test. Water pressure was continuously monitored and adjusted to 100 psi during the test. That pressure was selected as being representative of the actual pressure experienced at Calvert Cliffs Nuclear Power Plant.

The enclosed hydraulic calculation demonstrates that the Calvert Cliffs Power Plant water supplies are adequate to meet the test volumes and specifically the 100 psi water pressure criteria. The calculation was performed to identify the most remote sprinkler system required to supply a dedicated sprinkler head at a protected doorway.

A006
s
1/1

The calculation shows that sufficient pressure is available to certain sprinkler systems with dedicated heads (identified in a listing of those doorways in Unit No. 1 fire barriers which are to be protected by water curtains). This listing was also an enclosure to reference (a).

With reference to the attached hydraulic calculations, we offer the following for clarification and to demonstrate the conservatism of the calculation:

1) Within the time constraint allowed, a simplistic hydraulic calculation was performed which demonstrates the adequacy of the water supply to meet the demand.

2) The water supplies at Calvert Cliffs consist of two full sized standard fire pumps, a jockey pump, a make-up pump and a 15,000 gallon pressurized water tank. Credit was taken for only one fire pump rated 2500 GPM at 125 PSI.

3) No credit was taken for head pressure gain from the fire pump suction tanks.

4) No attempt was made to utilize the plant grid system which provides a multiple loop piping configuration which in turn would substantially reduce pipe friction losses to the various designated systems.

5) The calculations assume that all sprinkler heads, including dedicated heads serving as water curtains, are simultaneously flowing. This is conservative as it contemplates that in some cases more than 30 sprinklers would be flowing. Fire experience shows that most fires are extinguished by less than five sprinklers in industrial occupancies.

The enclosed information substantiates the applicability of the Southwest Research Institute report to Calvert Cliffs Nuclear Power Plant with regard to the use of water curtains. Furthermore, this report documents the acceptability of watertight and bullet proof doors as installed at Calvert Cliffs as alternatives to labeled fire doors. This completes our committment relative to SER Item 3.1.20 and Appendix R separation criteria.

Very truly yours,

A. E. Lundvall, Jr.

cc: J. A. Biddison, Esquire
G. F. Trowbridge, Esquire
Mr. D. H. Jaffee - NRC

bcc: R. P. Hunt
P. E. Katz
C. H. Cruse
G. W. Powell
W. H. Allen
A. R. Thornton
R. C. L. Olson
M. D. Patterson
R. F. Ash/File

Project – CCNPP – FIRE PROTECTION

Est. No.

Eng'r RPH Date 2/31

Elec. Eng.

CALCULATION TO DEMONSTRATE ADEQUACY OF WATER SUPPLY PRESSURE TO MOST REMOTE WATER CONTAINING (ie DEDICATED SPRINKLERS) SPRINKLER SYSTEMS. VERIFY THAT AT LEAST 100 PSI IS AVAILABLE.

ASSUMPTIONS

(1) MOST REMOTE DEDICATED SPRINKLER IS AT DOORWAY TO CHARGING PUMP ROOM 115 FROM CORRIDOR 100 AT ELEVATION (–) 10'-0 OR THE DOORWAY TO ROOM 228 FROM CORRIDOR 200.

(2) WATER SUPPLY CONSISTS OF 1 - 2500 GPM AT 125 PSI RATED HEAD FIRE PUMP LOCATED IN THE PUMP HOUSE AT ELEVATION 45'-0"

(3) TOTAL FLOW IS CONSERVATIVELY ASSUMED TO BE THRU ONLY ONE LOOP FROM PUMP HOUSE TO WEST SIDE OF THE AUXILIARY BUILDING FOR CONSERVATISM.

(4) HAZEN & WILLIAMS FORMULA & C = 120

$$P = \frac{4.52 \times Q^{1.85}}{C^{1.85} \times d^{4.87}}$$

$$K = \frac{4.52}{C^{1.85} \times d^{4.87}}$$

$$P = K \times Q^{1.85}$$

(5) THE DEDICATED SPRINKLER HEAD IS SUPPLIED FROM HYDRAULICALLY DESIGNED SPRINKLER PIPING SYSTEMS. IT IS CONSERVATIVE TO ANTICIPATE ALL SYSTEM SPRINKLER HEADS FLOWING SIMULTANEOUSLY AND ONE DEDICATED SPRINKLER HEAD AT THE MOST REMOTE LOCATION IN THE ROOM OF FIRE ORIGIN. REALISTICALLY, FIVE SPRINKLERS ARE SUFFICIENT TO CONTROL THE MAJORITY OF FIRES.

B. G. & E. Co.

(1268)-9571-X (82-697)

Project – CCNPP – Fire Protection

Est. No.

Eng'r RPA Date 2/21

Elec. Eng.

B. G. & E. Co.

(1268-9371 X - (82-697)

References

(1) NFPA Codes: Std 13 - Sprinklers
Std 14 - Standpipes & Hose

(2) CCNPP Spec: 61-523 & 61-527-E (Underground)
60-347-E ICNS (Aux. Bldg.)

(3) Ascor Containment Spec - F.R.F. 12-261 Sh. 3
and Hydraulic Calc for System No 115 (ie 451.6 GPM at 92.71 PSI) & System No 100 (ie 726.9 GPM at 87.7 PSI) & Sys No 200 (ie 1054 at 119.1)

(4) Bechtel Calc. No 80-12 - Fire Protection System

(5) 26-E Calculations for 79-1069 dated 7/16/81 prepared by D. C. Winston.

(6) Viking Hydraulic Tables, Table 1, Pressure Loss (PSI/FT) or $\Delta P = L \times K \text{ Factor} \times Q^{1.85}$

Pipe Size/Factor

$K_4 = 7.30 \times 10^{-7}$
$K_6 = 9.91 \times 10^{-8}$
$K_8 = 2.46 \times 10^{-8}$
$K_{10} = 3.45 \times 10^{-9}$

(7) CCNPP Fire Pump Performance Curves
Pump No 54783 - Diesel Eng. Driven
Pump No 54782 - Electric Motor Driven

(8) Grinnell Protectospray Nozzle Cut Sheets
a) Data Sheet
b) Discharge Curves
c) Discharge vs Pressure Insulation

(9) Southwest Research Institute Report No 01-6763-

Project – CCNPP – FIRE PROTECTION

Est. No.

Eng'r RPH Date 3/31

Elec. Eng.

B. G. & E. Co.

(1266)-9571-X (82-697)

CALCULATION – ELEVATION (–) 10'-0"

PIPING SUMMARY – SEE REF (4), SHEET 2

LENGTH OF PIPE:

FROM PUMPS TO UNIT 1/2 SPLIT

786' OF 12" CICL
50 OF 8" CICL
420 OF 8" CS

FROM SPLIT TO HS (–) 15'-21 & SPKLR SYSTEM 100 (EAST RISER)

335.5' OF 6" CS
249 OF 4" CS
+ 233 OF 4" CS FROM HS(–) 15'-21 TO # 100

FROM SPLIT TO HS (–) 10-22 & SPKLR SYSTEM 100 (WEST RISER)

53' OF 6" CS
135 OF 4" CS
+ 51 OF 4" CS FROM HS(–) 10-22 TO # 100

FROM REFERENCE (3) Q = 726.9 GPM AT 87.7 PSI FOR ALL HEADS FLOWING IN SYSTEM # 100. ADD TO THAT 55 GPM FOR ONE DEDICATED SPRINKLER – SEE REFERENCE (8). TOTAL FLOW WILL BE 781.9 GPM. THE CORRELATING PRESSURE REQUIREMENT EQUALS $\frac{Q_1}{Q_2}\sqrt{P_2}$

$$\therefore \left[\frac{781.9}{726.9}\sqrt{87.7}\right]^2 = 101.5$$

FROM REFERENCE (7), THE PUMP CURVE SHOWS WITH 781.9 GPM FLOWING, THE PUMPS DISCHARGE PRESSURE IS 146 PSI

LOSSES TO THE RESPECTIVE AUTOMATIC SPRINKLER SYSTEMS ARE CALCULATED USING REFERENCE (6) TO DETERMINE ΔP_{TOTAL} FROM PUMP HOUSE TO SYSTEM.

Project – CCNPP – FIRE PROTECTION

Est. No.

Eng't [illegible] Date 7/31

Elec. Eng.

TO SUPPLY SYSTEM #100 ASSUME FLOW SPLITS BETWEEN EAST & WEST RISERS –

LOSSES FOR EAST RISER - EQUIV. PIPE

2.8 × 335 FT of 6"ϕ = 939 FT of 4"ϕ

+ 482

1421 ∴ 23%

VS LOSSES FOR WEST RISER - EQUIV PIPE

2.8 × 53 FT of 6"ϕ = 148

+ 186

334 ∴ 77%

Q_{TOTAL} = 781.9 or ROUND OFF = 780 GPM

Q_{WEST} = 77% × 780 = 585 GPM – WEST RISER

Q_{EAST} = 23% × 780 = 195 GPM – EAST RISER

$Q^{1.85}_{WEST}$ = 131,600

$Q^{1.85}_{EAST}$ = 17,240

$Q^{1.85}_{TOTAL}$ = 224,050

$\Delta P = L \times K \times Q^{1.85}$

$\Delta P_T = \Delta P_{12} + \Delta P_8 + \Delta P_6 + \Delta P_4$

WEST RISER PRESSURE LOSSES

$\Delta P_{12} = 786\,(3.45 \times 10^{-9})(224050) = 0.61$ PSI

$\Delta P_8 = 470\,(2.46 \times 10^{-8})(224050) = 2.59$ PSI

$\Delta P_6 = 53\,(5.91 \times 10^{-8})(131,600) = 0.69$

$\Delta P_4 = 186\,(7.30 \times 10^{-7})(131,600) = 17.86$

21.75 PSI

EAST RISER PRESSURE LOSSES:

ΔP_{12} = = 0.61 PSI

ΔP_8 = = 2.59

$\Delta P_6 = 335.5\,(5.91 \times 10^{-8})(17240) = 5.73$

$\Delta P_4 = 482\,(7.30 \times 10^{-7})(17240) = 6.06$

14.99

EAST/WEST ΔP = 6.75

B. G. & E. Co.

(8258)-9571-X (82-697)

Project – CCNPP - FIRE PROTECTION

Est. No.

Eng'r [illegible] Date 2/31

Elec. Eng.

REVISE FLOW SPLIT TO REDUCE ΔP

$Q_T = 780$

$Q_{WEST} = 70\% \times 780 = 545$

$Q_{EAST} = 30\% \times 780 = 235$

$Q^{1.85}_{WEST} = 115,440$

$Q^{1.85}_{EAST} = 24,350$

WEST RISER

$\Delta P_{12} = 786(3.45 \times 10^{-9})(224,050) = 0.61$ PSI

$\Delta P_8 = 470(2.46 \times 10^{-8})(224,050) = 2.59$

$\Delta P_L = 53(9.91 \times 10^{-8})(115,440) = 0.61$

$\Delta P_4 = 186(7.30 \times 10^{-7})(115,440) = 15.67$

19.48 PSI

B. G. & E. Co.

EAST RISER

$\Delta P_{12} =$ (ABOVE) $= 0.61$

$\Delta P_8 =$ (ABOVE) $= 2.59$

$\Delta P_L = 335.5(9.91 \times 10^{-8})(24,350) = 8.10$

$\Delta P_4 = 482(7.30 \times 10^{-7})(24,350) = 8.57$

19.87

EAST/WEST $\Delta P = 19.87 - 19.48 = 0.39$ PSI

WHICH IS ACCEPTABLE

NOW VERIFY THAT SYSTEM 100 IS MOST REMOTE HYRAULICALLY VS SYSTEM 115. FROM REFERENCE (3) FLOW TO SYSTEM 115 IS 451.6 AT 92.71 PSI + 55 GPM FOR THE DEDICATED HEAD AT THE DOORWAY GIVES A FLOW REQUIREMENT OF 506.6 GPM AT A CORRECTED PRESSURE EQUAL TO $\frac{Q}{C}\sqrt{P_2}$

(1268-9571-X)

Project – CCNPP - FIRE PROTECTION

Est. No.

Eng'r RPH Date 7/31

Elec. Eng.

$$\therefore \left[\frac{506.6}{451.6}\sqrt{92.71}\right]^2 = P_1 = 116.67_6 \text{ PSI}$$

PIPING SUMMARY - SEE SHEET 3 OF THIS CALCULATION

TO SUPPLY SYSTEM 115 IT IS NECESSARY TO ADD APPROXIMATELY 138' OF 4" Ø CS TO CALCULATION SHOWN ON SHEET 3 OF 4

∴ FOR CALCULATION OF SYSTEM 115:

WEST RISER ΔP_4 = 186 + 138 = 324 FT

EAST RISER ΔP_4 = 482 + 138 = 620 FT

B. G. & E. Co.

$Q_{TOTAL} = 506.6$

$Q_{WEST} = 70\% \times 506.6 = 355$

$Q_{EAST} = 30\% \times 506.6 = 152$

$Q_{WEST}^{1.85} = 52,230$

$Q_{EAST}^{1.85} = 10,874$

$Q_{TOTAL}^{1.85} = 100,220$

$\Delta P = L \times K \times Q^{1.85}$

$\Delta P_T = \Delta P_2 + \Delta P_8 + \Delta P_6 + \Delta P_4$

WEST RISER

$\Delta P_2 = 786(3.45 \times 10^{-9})(100,220) = 0.27$

$\Delta P_8 = 470(2.46 \times 10^{-8})(100,220) = 1.16$

$\Delta P_6 = 53(9.91 \times 10^{-8})(52,230) = 0.27$

$\Delta P_4 = 324(7.3 \times 10^{-7})(52,230) = 12.35$

14.05

(1269-9571-X (82-697)

Project – CCNPP - FIRE PROTECTION

Est. No.

Eng'r RWH Date 8/21

Elec. Eng.

EAST RISER

ΔP_{12} = (ABOVE) = 0.27

ΔP_8 = (ABOVE) = 1.16

$\Delta P_6 = 335.5(9.91 \times 10^{-8})(10,874) = 3.61$

$\Delta P_4 = 620(7.30 \times 10^{-7})(10,874) = 4.92$

9.96

EAST/WEST ΔP = 4.09 PSI.

REVISE FLOW SPLIT TO REDUCE ΔP

TEST: $Q^{1.85}_{EAST}$ 10,874 $\times \frac{12}{10}$ = 13,048 or 168 PSI

$Q_{TOTAL} = 506.6 \therefore Q^{1.85}_{T} = 100,220$

$Q_{WEST} = 336$ $Q^{1.85}_{WEST} = 47177$

$Q_{EAST} = 170$ $Q^{1.85}_{EAST} = 13,370$

WEST RISER

$\Delta P_{12} + \Delta P_8 = 1.43$ PSI.

$\Delta P_6 = 53(9.91 \times 10^{-8})(47,177) = 0.25$

$\Delta P_4 = 324(7.3 \times 10^{-7})(47,177) = 11.16$

12.84

EAST RISER

$\Delta P_{12} + \Delta P_8 = 1.43$ PSI.

$\Delta P_6 = 335.5(9.91 \times 10^{-8})(13,370) = 4.55$

$\Delta P_4 = 620(7.30 \times 10^{-7})(13,370) = 6.05$

12.03

EAST/WEST ΔP = 0.81 PSI.

WHICH IS ACCEPTABLE. NO FURTHER CORRECTION IS REQUIRED.

B. G. & E. Co.

(1268)-9571-X (82-597)

Project – CCNPP - FIRE PROTECTION Est. No.

Eng'r RPH Date 3/81

Elec. Eng.

THE FIRE PUMPS ARE LOCATED AT ELEVATION 45'-0" WHILE SYSTEMS 100 AND 115 ARE LOCATED AT ELEVATION (-) 10'-0". THE DIFFERENCE IN ELEVATION WILL REDUCE (PIPE FRICTION) LOSSES BY 55 FT x 0.433 PSI/FT = 23.81 PSI.

THE NET PRESSURE AVAILABLE AT SYSTEM 100 ALARM CHECK VALVE, WITH ALL SPRINKLER HEADS FLOWING INCLUDING THE DEDICATED HEAD AT THE DOORWAY, EQUALS THE NET DISCHARGE PRESSURE OF THE FIRE PUMP = 146 PSI, PLUS THE NET PRESSURE GAIN FOR DIFFERENCE IN ELEVATION = 23.81 PSI, LESS FRICTION LOSSES IN PIPING FROM THE PUMP DISCHARGE TO SYSTEM 100 = 19.87 PSI

OR 146 + 23.81 − 19.87 = 149.94 PSI

SIMILARLY, THE NET PRESSURE AVAILABLE TO SYSTEM 115 ALARM CHECK VALVE IS:

OR 147 + 23.81 − 12.84 = 157.97

SYSTEM 100 REQUIRES 101.5 PSI VS AVAILABLE HEAD PRESSURE 149.94 PSI

SYSTEM 115 REQUIRES 116.67 VS AVAILABLE HEAD PRESSURE 157.97

∴ AT ELEVATION (-) 10'-0" HEAD PRESSURES EXCEED 100 PSI TO MOST REMOTE SPRINKLER HEADS AT DOORWAY.
(SEE SUBSEQUENT CALCULATIONS FOR ELEVATION 5'-0" SYSTEMS.)

B. G. & E. Co.

(1268-9571-X (82-597)

Project – CCNPP – FIRE PROTECTION Est. No.

CALCULATION – ELEVATION 5'-0" Eng'r RPH Date 2/81

VERIFY THAT SYSTEMS AT ELEVATION 5'-0" ARE NOT MORE HYDRAULICALLY REMOTE THAN ELEV (-)10'-0"

PIPING SUMMARY – COMPILED FROM 60-367-E TAKE-OFFS FOR SYSTEMS 200 & 228.

NORTH HEADER – SUPPLY FROM WEST SIDE OF AUXILIARY BUILDING (IE SINGLE LOOP)

FROM AUX BLDG SPLIT TO SYSTEM 228

338 FT OF 6" ϕ CS

$Q_{228} = 1076$ @ 93 PSI

SOUTH HEADER – SUPPLY FROM WEST SIDE OF AUXILIARY BUILDING ONLY

FROM AUX BLDG SPLIT TO SYSTEM 200

149 FT OF 6" ϕ CS

62 FT OF 4" ϕ CS

$Q_{200} = 1054$ GPM @ 119.1 PSI

FROM REFERENCE (3), SHEET 2, SYSTEM 200 IS MOST REMOTE HYDRAULICALLY:

SYSTEM 200 $Q = 1054$ GPM @ 119.1 PSI WITH ALL HEADS FLOWING. ADD 55 GPM FOR DEDICATED HEADS AT DOORWAY – $Q_{TOTAL} = 1054 + 55 = 1109$ GPM

$$\frac{Q_1}{Q_2} = \frac{\sqrt{P_1}}{\sqrt{P_2}} \quad \therefore P = \left(\frac{1109}{1054}\sqrt{119.1}\right)^2 = 131.85$$

VERIFY ONE SUPPLY LOOP IS ADEQUATE.

$Q = 1109$ GPM $\quad Q^{1.85} = 361{,}400$

$\Delta P_{12} = 786\,(3.45 \times 10^{-7})(361{,}400) = 0.98$

$\Delta P_8 = 470\,(2.46 \times 10^{-8})(361{,}400) = 4.18$

$\Delta P_6 = 149\,(9.91 \times 10^{-8})(361{,}400) = 5.34$

$\Delta P_4 = 62\,(7.3 \times 10^{-4})(361{,}400) = 16.36$

$\Sigma = 26.86$ PSI

DIFFERENCE IN ELEVATION WITH FIRE HOSE AT ELEV 45'-0" VS CORRIDOR #200 AT ELEV 5'-0" REDUCES HEAD LOSS 40 FT × .433 PSI/FT = 17.32

B. G. & E. Co. Elec. Eng. (1268)-9511-X (82-697)

Project – CNPP - FIR - PROTECTION Est. No.

Eng'r RPH Date 2/81

FROM PUMP CURVE REFERENCE (7) SHEET 2, DISCHARGE PRESSURE IS 145 PSI WITH 1105 GPM FLOWING.

145 PSI AT PUMP, ELEV 4'-0
LESS 28.86 PSI FRICTION LOSS IN PIPING
ADD 17.32 PSI HEAD GAIN WITH SYSTEM 200 AT ELEV 5'-0

∴ 133.46 PSI IS AVAILABLE VS 131.85 PSI REQUIRED BY SYSTEM # 200

NOTE: NO CREDIT IS TAKEN FOR SYSTEM GRID. FRICTION LOSSES WOULD BE REDUCED OVER 50% IF MULTIPLE FLOW PATHS ARE CALCULATED.

THE GRINNELL PROTECTOSPRAY NOZZLE UTILIZED AS DEDICATED SPRINKLER HEADS AT DOORWAYS ARE SOLID CONE PATTERN, U/L LISTED WATERSPRAY NOZZLES TYPE EA-1, 95° DISCHARGE PATTERN, 175°F RATED WITH 1/2" ORIFICE. THE VENDOR DESCRIPTION AND DISCHARGE CURVE ARE ATTACHED. FOR "VOLUME VS PRESSURE" RELATIONSHIP USE K FACTOR = 5.56

∴ SYSTEM # 200 APPEARS TO BE THE MOST HYDRAULICALLY DEMANDING SYSTEM SHOWN ON THE WATER CURTAIN LISTING SUBMITTED BY LETTER DATED FEBRUARY 18, 1982 FROM A.E. LUNDVALL, JR to ROBERT A. CLARK

Bechtel Eng.

B. G. & E. Co.

(1268-057)-X (82-097)

Project – CCNPP – FIRE PROTECTION

Est. No.

Eng'r RPH Date 8/3

AS SHOWN BY REFERENCE (9), THROUGHOUT THE DURATION OF THE FIRE TEST OF THE DEDICATED SPRINKLER AT DOORWAY WATER CURTAIN, INLET PRESSURE WAS MAINTAINED AT 100 PSI. THE FIRE ENDURANCE TEST DEMONSTRATED WATER CURTAINS CAN PROVIDE ACCEPTABLE 3 HOUR FIRE RESISTANCE AT DOORWAYS.

CONCLUSIONS

MORE THAN 100 PSI IS AVAILABLE TO SUPPLY THE MOST REMOTE DEDICATED SPRINKLER HEAD AT A DOORWAY WATER CURTAIN.

ATTACHMENTS

1) CCNPP FIRE PUMP PERFORMANCE CURVES (REFERENCE (7))

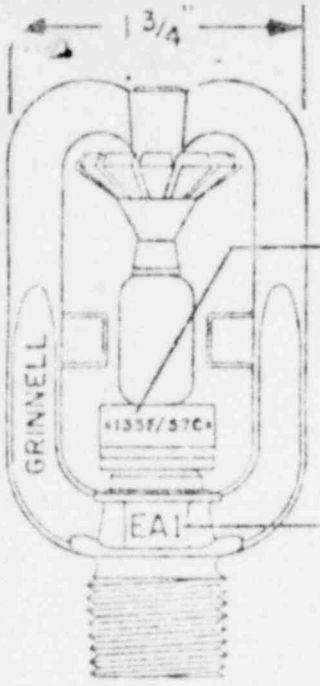
2) GRINNELL PROTECTOSPRAY NOZZLE CUT SHEETS (REFERENCE (8))

Elec. Eng.

B. G. & E. Co.

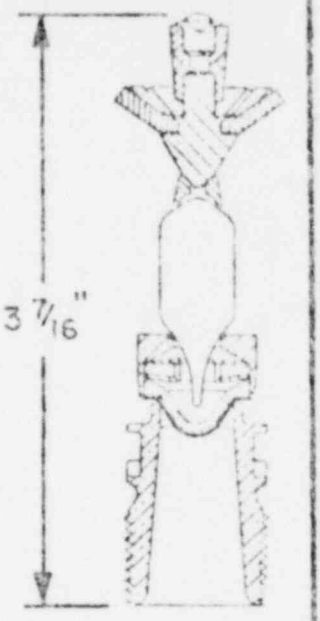
(1268-9571-X (82-697)

ATTACHMENT A



TEMPERATURE RATING.

SIZE STAMPED ON REVERSE SIDE OF 3/8" & 1/4" ORIFICE NOZZLES.



TEMPERATURE RATING & COLOR CODE:

135° - PLAIN	325° - RED
[redacted]	400° - GREEN
250° - BLUE	500° - ORANGE

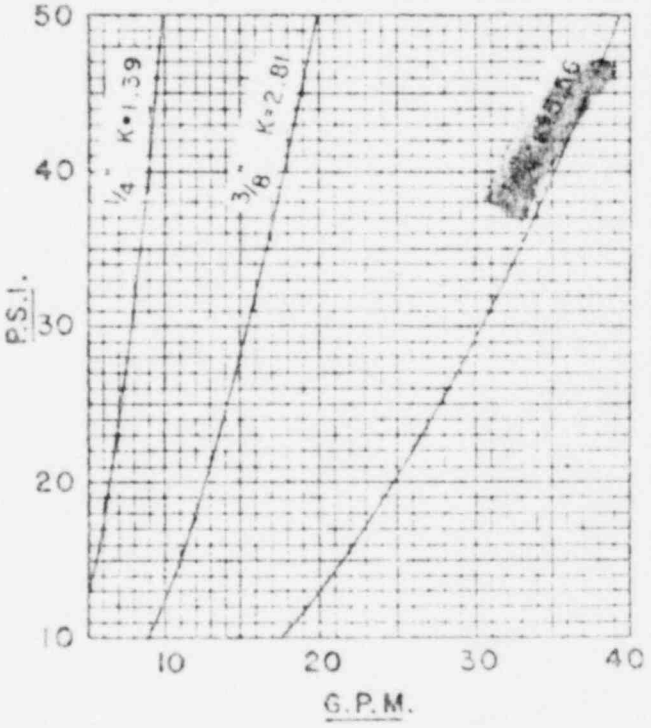
INCLUDED ANGLE OF DISCHARGE PATTERN:

65°	80°	[redacted]	110°
125°	140°	160°	180°

ORIFICE SIZE: [redacted], 3/8" OR 1/4".

PIPE THREAD CONNECTION: 1/2" NPT.

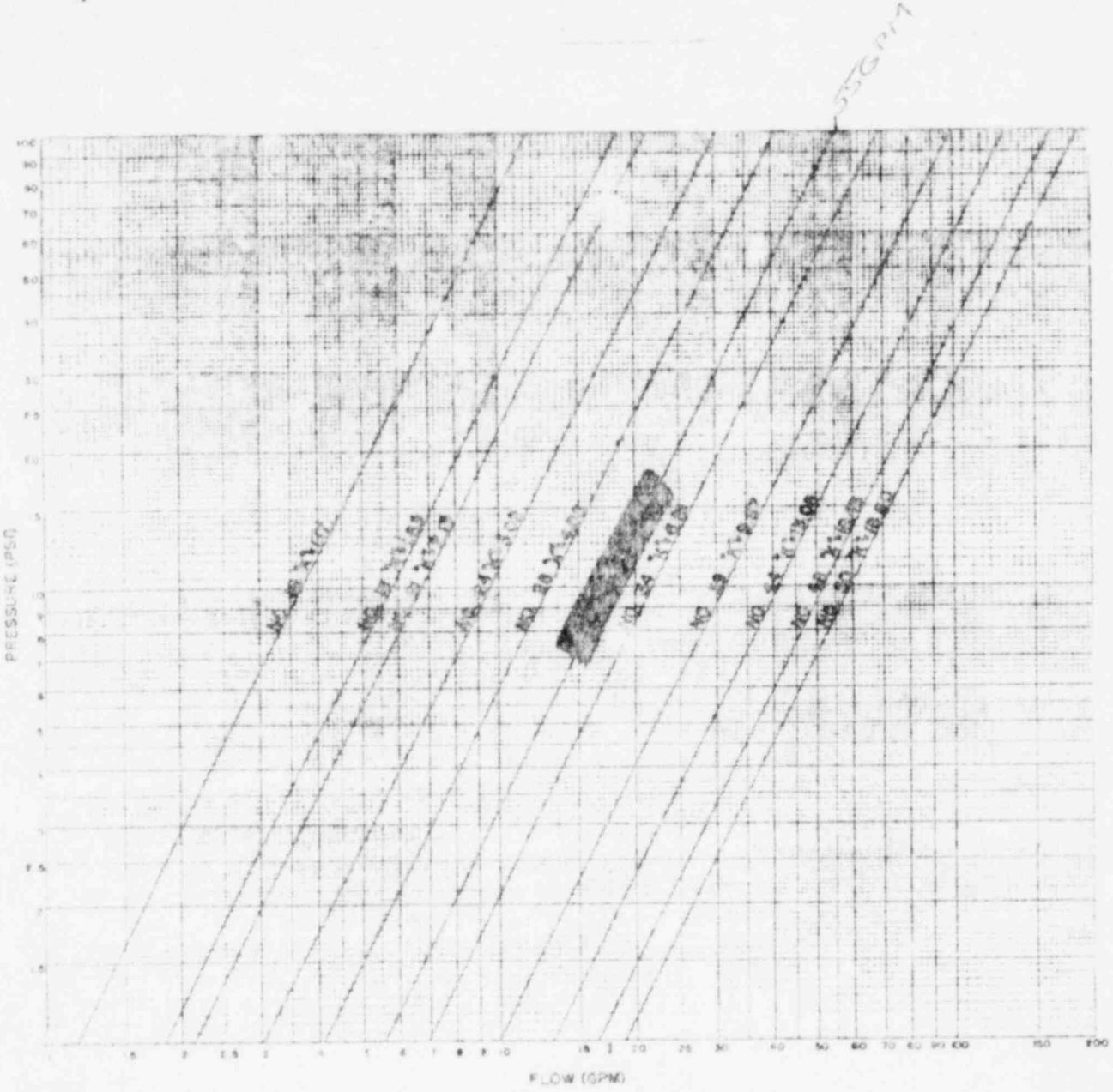
MATERIAL & FINISH: BRASS – PLAIN, LEAD COATED OR CHROME PLATED. FURNISHED WITH PLAIN FINISH UNLESS OTHERWISE SPECIFIED.



DISCHARGE CURVE

TO ORDER SPECIFY:
GRINNELL (ORIFICE SIZE) (TEMPERATURE RATING) (SPECIFY FINISH IF OTHER THAN PLAIN BRASS IS REQUIRED) PROTECTOSPRAY NOZZLE, TYPE EA-1 (ANGLE OF DISCHARGE PATTERN). - (QUANTITY)

GRINNELL
PROTECTOSPRAY NOZZLE
TYPE EA-1



NOTE:
¼", ⅜", & ½" EARLY PROTECTOSPRAY NOZZLES
HAVE THE SAME DISCHARGE AS SPRINKLERS

GRINNELL
PROTECTOSPRAY NOZZLES
DISCHARGE CURVES

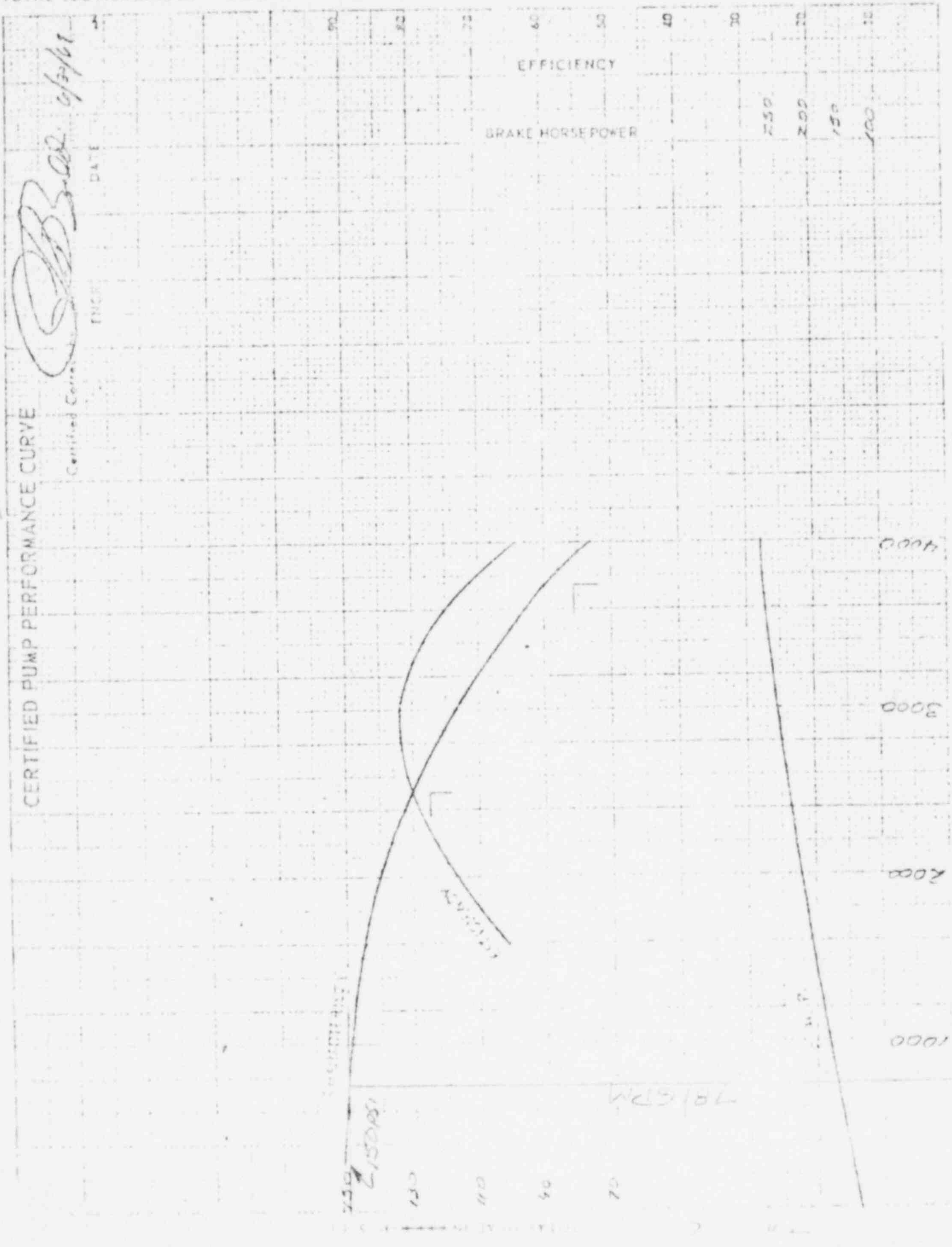
GRINNELL PROTECTOSPRAY NOZZLES

DISCHARGE IN GALLONS PER MINUTE

PSI	No. 16	No. 18	No. 21	No. 24	No. 28	[illegible]	No. 34	No. 39	No. 44	No. 48	No. 50
1	1.2	1.8	2.1	3.0	4.1	5.6	7.0	10.0	13.1	16.4	18.8
2	1.7	2.6	3.0	4.3	5.8	7.9	9.8	14.2	18.5	23.2	26.6
3	2.0	3.2	3.7	5.2	7.1	9.6	12.3	17.3	22.7	28.5	32.6
4	2.3	3.7	4.3	6.0	8.2	11.1	13.8	19.9	26.2	32.9	37.6
5	2.6	4.1	4.8	6.8	9.1	12.4	15.5	22.3	29.3	36.8	42.2
6	2.9	4.5	5.2	7.4	10.0	13.6	16.9	24.4	32.1	40.3	46.1
7	3.1	4.8	5.6	8.0	10.8	14.7	18.3	26.4	34.6	43.6	49.8
8	3.3	5.2	6.0	8.6	11.6	15.7	19.5	28.2	37.1	46.6	53.3
9	3.5	5.5	6.4	9.1	12.3	16.7	20.7	29.9	39.3	49.4	56.5
10	3.7	5.8	6.7	9.6	13.0	17.6	21.8	31.5	41.4	51.1	59.5
11	3.9	6.1	7.1	10.0	13.6	18.4	22.9	33.1	43.4	54.6	62.4
12	4.1	6.3	7.4	10.5	14.2	19.2	23.9	34.6	45.4	57.0	65.2
13	4.2	6.6	7.7	10.9	14.7	20.0	24.9	36.0	47.2	59.3	67.9
14	4.4	6.9	8.0	11.3	15.3	20.8	25.8	37.3	49.0	61.6	70.4
15	4.5	7.1	8.3	11.7	15.8	21.5	26.7	38.6	50.7	63.7	72.9
16	4.6	7.3	8.5	12.1	16.3	22.2	27.6	39.9	52.4	65.8	75.3
17	4.8	7.5	8.8	12.5	16.8	22.9	28.5	41.1	54.0	67.9	77.6
18	5.0	7.8	9.1	12.8	17.3	23.6	29.3	42.3	55.5	69.8	79.8
19	5.1	8.0	9.3	13.2	17.8	24.2	30.1	43.5	57.0	71.7	82.0
20	5.2	8.2	9.5	13.5	18.3	24.8	30.9	44.6	58.5	73.6	84.2
21	5.4	8.4	9.8	13.8	18.7	25.4	31.6	45.7	60.0	75.4	86.3
22	5.5	8.6	10.0	14.2	19.2	26.0	32.4	46.8	61.5	77.2	88.3
23	5.6	8.8	10.2	14.5	19.6	26.6	33.2	47.9	62.8	77.9	90.2
24	5.7	9.0	10.4	14.8	20.0	27.2	33.9	48.9	64.1	80.6	92.2
25	5.9	9.2	10.7	15.1	20.4	27.8	34.6	49.9	65.4	82.3	94.1
26	6.0	9.3	10.9	15.4	20.8	28.4	35.2	50.9	66.7	83.9	95.0
27	6.1	9.5	11.1	15.7	21.2	28.9	35.9	51.9	68.0	85.5	97.8
28	6.2	9.7	11.3	16.0	21.6	29.4	36.6	52.8	69.3	86.0	99.6
29	6.3	9.9	11.5	16.3	22.0	29.9	37.2	53.7	70.5	87.6	101.3
30	6.4	10.0	11.7	16.5	22.4	30.4	37.8	54.6	71.7	90.1	103.0
31	6.5	10.2	11.9	16.8	22.8	30.9	38.5	55.5	72.9	91.6	104.8
32	6.6	10.4	12.0	17.1	23.1	31.4	39.1	56.4	74.0	93.1	106.5
33	6.7	10.5	12.2	17.4	23.5	31.9	39.7	57.3	75.2	94.5	108.1
34	6.8	10.7	12.4	17.6	23.8	32.4	40.3	58.2	76.4	95.0	109.7
35	6.9	10.8	12.6	17.9	24.2	32.9	40.9	59.0	77.5	96.4	111.3
36	7.0	11.0	12.8	18.1	24.5	33.4	41.5	59.9	78.5	98.7	112.8
37	7.1	11.1	13.0	18.4	24.8	33.8	42.0	60.7	79.6	100.0	114.3
38	7.2	11.3	13.1	18.6	25.2	34.3	42.6	61.5	80.7	101.3	115.9
39	7.3	11.4	13.3	18.9	25.5	34.7	43.1	62.3	81.8	102.7	117.5
40	7.4	11.6	13.5	19.1	25.8	35.2	43.7	63.0	82.8	104.0	119.0
41	7.5	11.7	13.6	19.3	26.2	35.6	44.2	63.8	83.9	105.2	120.5
42	7.6	11.9	13.8	19.6	26.5	36.0	44.8	64.6	84.9	106.5	122.0
43	7.7	12.0	14.0	19.8	26.8	36.4	45.3	65.4	85.9	107.8	123.4
44	7.8	12.1	14.1	20.0	27.1	36.9	45.8	66.1	86.9	109.1	124.8
45	7.9	12.3	14.3	20.2	27.4	37.3	46.4	66.9	87.8	110.3	126.1
46	7.9	12.4	14.5	20.5	27.7	37.7	46.9	67.6	88.8	111.5	127.5
47	8.0	12.5	14.7	20.7	28.0	38.1	47.4	68.3	89.8	112.7	129.9
48	8.1	12.7	14.8	21.0	28.3	38.5	47.9	69.0	90.7	113.9	130.3
49	8.2	12.8	14.9	21.2	28.6	38.9	48.4	69.8	91.6	115.1	131.7
50	8.3	12.9	15.1	21.4	28.9	39.3	48.9	70.5	92.6	116.3	133.0
51	8.4	13.1	15.2	21.6	29.2	39.7	49.4	71.2	93.5	117.5	134.3
52	8.4	13.2	15.4	21.8	29.4	40.1	49.9	71.9	94.4	118.6	135.6
53	8.5	13.3	15.5	22.0	29.7	40.5	50.4	72.6	95.3	119.7	136.9
54	8.6	13.4	15.7	22.2	30.0	40.8	50.8	73.3	96.2	120.8	138.2
55	8.7	13.6	15.8	22.4	30.3	41.2	51.2	74.0	97.1	121.9	139.5
56	8.8	13.7	15.9	22.6	30.6	41.6	51.7	74.6	98.0	123.0	140.8
57	8.8	13.8	16.1	22.8	30.8	42.0	52.1	75.3	98.8	124.1	141.9
58	8.9	13.9	16:2	23.0	31.1	42.3	52.6	76.0	99.7	125.2	143.2
59	9.0	14.1	16.4	23.2	31.4	42.7	53.1	76.6	100.6	126.2	144.5
60	9.1	14.2	16.5	23.4	31.6	43.1	53.5	77.2	101.4	127.3	145.8
62	9.2	14.4	16.8	23.8	32.2	43.8	54.4	78.5	103.0	129.4	148.1
64	9.4	14.6	17.0	24.2	32.7	44.5	55.3	79.7	104.6	131.5	150.5
66	9.5	14.9	17.3	24.6	33.2	45.2	56.1	81.0	106.2	133.6	152.9
68	9.7	15.1	17.6	24.9	33.7	45.9	57.0	82.2	107.9	135.7	155.3
70	9.8	15.3	17.8	25.3	34.2	46.5	57.8	83.4	109.5	137.7	157.6
72	9.9	15.5	18.1	25.6	34.6	47.2	58.6	84.6	111.0	139.6	159.8
74	10.1	15.7	18.3	26.0	35.1	47.9	59.4	85.8	112.5	141.5	161.9
76	10.2	15.9	18.5	26.4	35.6	48.5	60.2	86.9	114.0	143.4	164.0
78	10.3	16.2	18.8	26.7	36.1	49.1	61.0	88.0	115.5	145.2	166.1
80	10.5	16.4	19.1	27.0	36.6	49.8	61.8	89.1	117.0	146.0	168.1
82	10.7	16.6	19.3	27.3	37.0	50.4	62.5	90.3	118.5	148.8	170.2
84	10.7	16.8	19.5	27.7	37.4	51.0	63.3	91.4	120.0	150.6	172.3
86	10.9	17.0	19.8	28.0	37.9	51.6	64.1	92.5	121.4	152.4	174.4
88	11.0	17.2	20.0	28.4	38.3	52.2	64.9	94.5	122.8	154.2	176.5
90	11.1	17.4	20.2	28.7	38.7	52.8	65.6	94.5	124.1	156.0	178.5
92	11.3	17.6	20.4	29.0	39.2	53.4	66.3	95.6	125.4	157.7	180.5
94	11.4	17.8	20.7	29.3	39.6	54.0	67.0	96.6	126.8	159.3	182.4
96	11.5	17.9	20.9	29.6	40.0	54.5	67.7	97.6	128.1	161.0	184.3
98	11.6	18.1	21.1	29.9	40.4	55.0	68.4	98.5	129.3	162.5	186.1
100	11.7	18.3	21.3	30.2	40.8	55.5	69.1	99.5	130.8	163.3	188.0

PUMP NO N9P1-C54783 STAGES 1 SIZE FIGURE 8" 5B24E
TESTED MLC RAL 6-27-69 REFERENCE NY IMPELLER D6D1AN
PLOTTED JB 6-30-69 DRIVER T MTR 250 IMP DIA 18.5"
TOTAL SUCTION 6.6 FT MAXIMUM ON TEST R.P.M. 1750

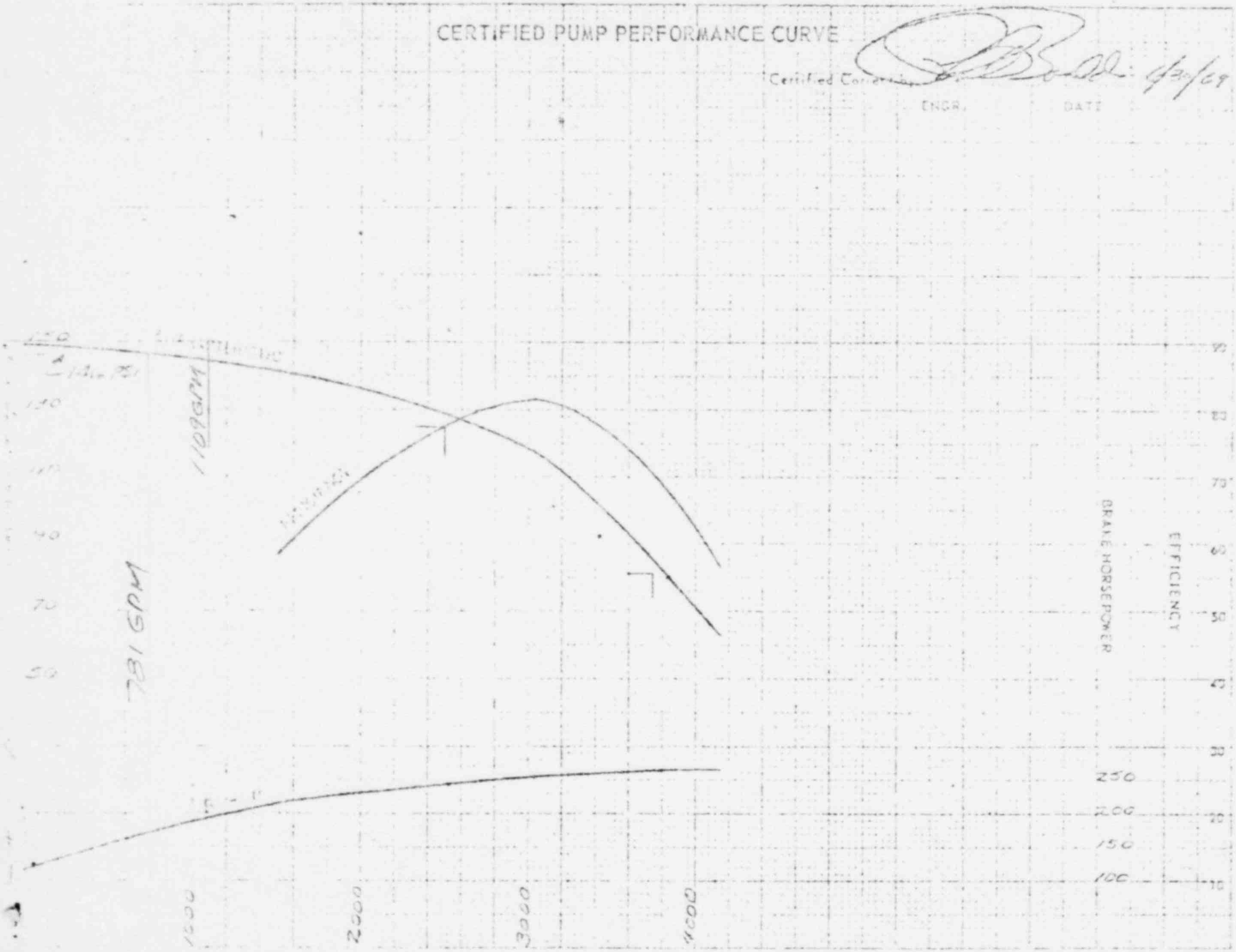
Calvert Cliffs Nuclear Plant
Diesel Fire Pump
6750-dx-53-Rev. 5



Calvert Cliffs Nuclear Plant
Electric Fire Pump

CERTIFIED PUMP PERFORMANCE CURVE

Certified Correct: [signature] ENGR. 4/30/69 DATE



PUMP NO. [illegible] STAGES 1 SIZE FIGURE 8" 5823F?
TESTED [illegible] REFERENCE C1 IMPELLER [illegible]
PLOTTED J.B. 6-20-?? DRIVER [illegible] IMP DIA [illegible]
TOTAL SUCTION 6.5 FT MAXIMUM ON TEST R P M 1770