CAUSTIC FEED DESIGN ANALYSIS
DESIGN CHANGE 77-9
CONTAINMENT SPRAY SYSTEM MODIFICATION
SURRY POWER STATION- UNIT 2

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

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INTRODUCTION

The Containment Spray System of Surry Unit No. 2 has been modified in order to provide assurance of meeting site boundary dose limitations set forth in 10CFR part 100. These modifications involved modifications to the caustic addition system and the installation of a new spray ring header within containment along with other related changes. This report involves itself with analyzing the performance of the modified caustic addition system which with the other containment spray modifications will be capable of meeting parameters of spray pH and sump pH.

Part A demonstrates maximum and minimum spray and sump pH values versus time based on calculated data for twelve (12) scenarios utilizing different combinations of two (2) containment spray and four (4) safety injection pumps. As shown by these curves, the spray pH remains within the bounds of 8.5 to 11.0 set forth in the Standard Review Plan 6.5.2. In addition, the ultimate sump pH value is 8.2 which will enable the Recirculation Spray System to remove atmospheric radioactive iodine and prevent it from leaving the sump solution for long term considerations.

Part B of this analysis deals with the determination of Caustic Fluid Flow Rate History (CFFRH) which is derived from calculated head loss values of the caustic addition piping system and Caustic Addition Tank levels for the twelve scenarios discussed in Part A. Two (2) major considerations used during calculations flow rates were:

1. Is a restrictive flow orifice required; and if so, it must be designed to meet flow requirements which yield caustic for a spray pH range of 8.5 - 11.0 for all pumping scenarios.

2. The Caustic Addition Tank must empty completely during each of the pumping scenarios in order to take credit for the entire tank volume for ultimate sump pH considerations.

As shown by the curves of caustic flow for the twelve scenarios, the flow rate in all cases remains within the bounds of a maximum and minimum rate which would result in a spray pH of 8.5 to 11.0.

In conclusion, the new system for caustic addition will be a reliable means of adding sodium hydroxide solution to the containment spray fluid which will provide iodine removal and consequently keep site boundary dose within the limits of 10CFR part 100.

PART A

PART A

CONTAINMENT SPRAY SYSTEM - SURRY #2

SPRAY AND SUMP pH vs. TIME HISTORIES

Figures 1-12 demonstrate that spray pH is maintained between 8.5 and 11 during each of twelve(12) scenarios utilizing combinations of four pumps for the following considerations following a design basis accident. The values of spray pH shown in these curves were developed from caustic flow histories presented in Part B. The documents from which these curves are taken are filed under Stone & Webster calculation numbers 12846.07-35 and 57 and 12846.07-PE-037-0.

Figures 1-4	Starting parameters in these scenarios will maximize spray pH. (10.75 maximum scenario No. 4)
Figures 5-8	Starting parameters in these scenarios will minimize spray pH. (9.0 minimum, scenario No. 8)
Figures 9-12	Starting parameters are used which will maximize the time required to empty the caustic addition tank. Relating to the minimum time to empty for the RWST. (3860 sec. CAT vs 3975 RWST, scenario No. 11)

Figure 13 shows sump pH vs. time history after LOCA. This curve, developed from scenario 11, postulates the longest emptying time for the CAT relative to the RWST. As shown by this curve, ultimate sump pH will be 8.2.

APPENDIX A

SCENARIO NO.1 1CS PUMP + 1LHSI + 1HHSI WITH MAX SPRAY pH ASSUMPTIONS

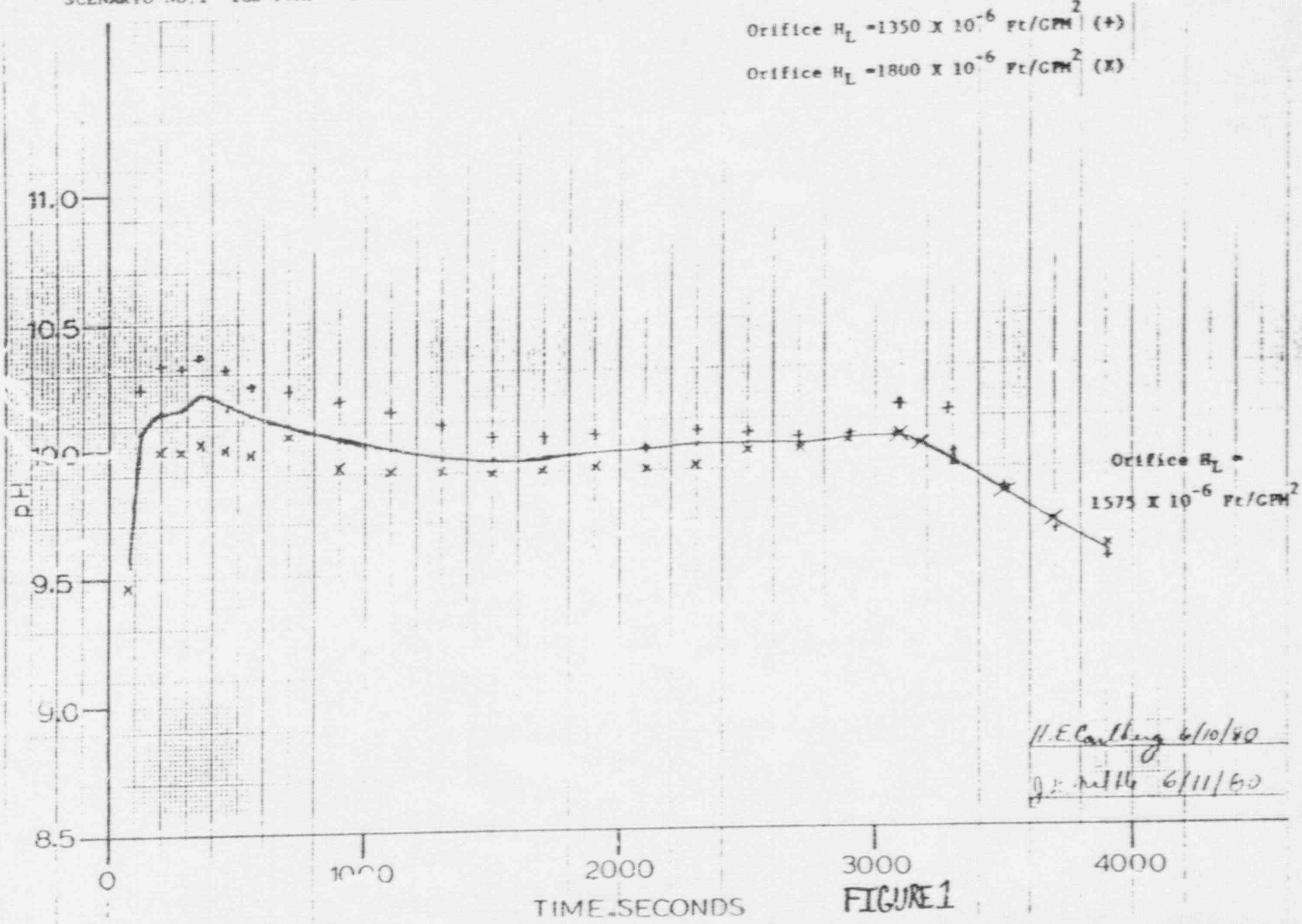
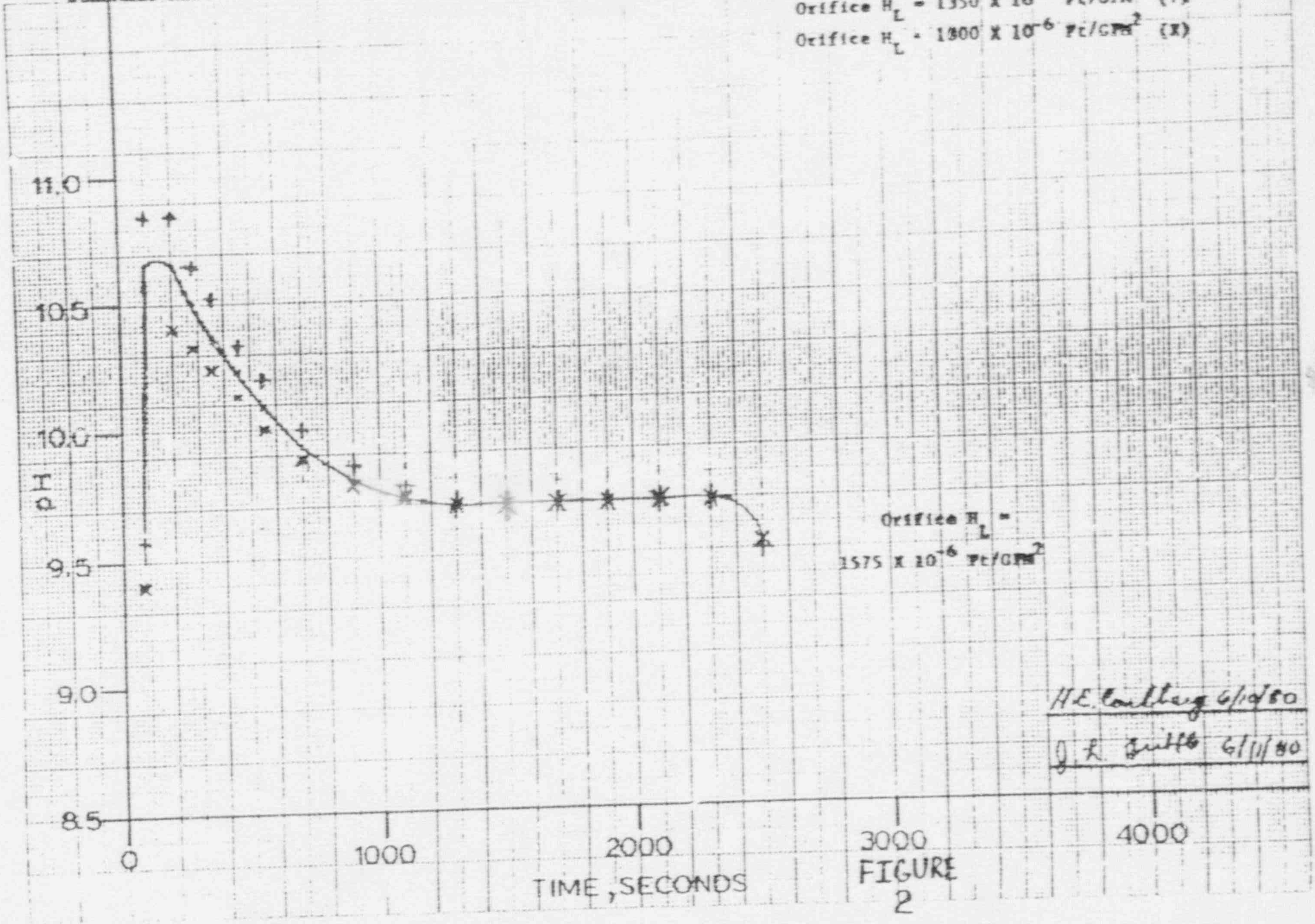


FIGURE 1

H.E.Carlberg 6/10/80

6/11/80

APPENDIX A
SCENARIO NO. 2 2 CS PUMPS + 2 LHSI + 2 HHSI WITH MAX SPRAY pH ASSUMPTIONS



H.E. Carlberg 6/10/80
J. L. Griffo 6/11/80

FIGURE
2

APPENDIX A

SCENARIO NO. 3 1CS PUMP + 2 LHSI + 2 HHSI WITH MAX SPRAY pH ASSUMPTIONS

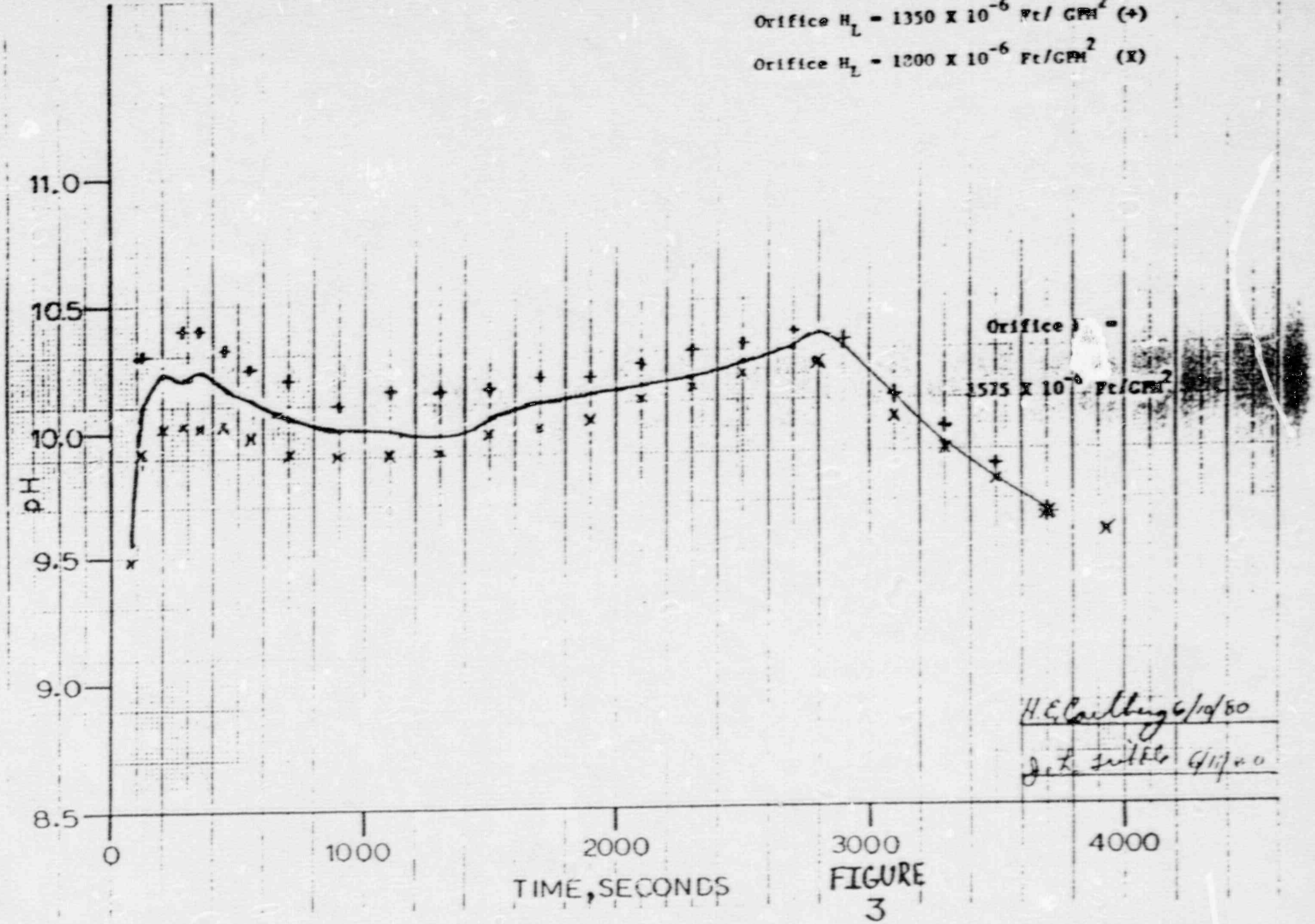


FIGURE 3

H.E. Carlberg 6/19/80

6/17/80

APPENDIX A

SCENARIO NO. 4: 2CS PUMPS + 1 LHSI + 1 HHSI WITH MAX SPRAY pH ASSUMPTIONS

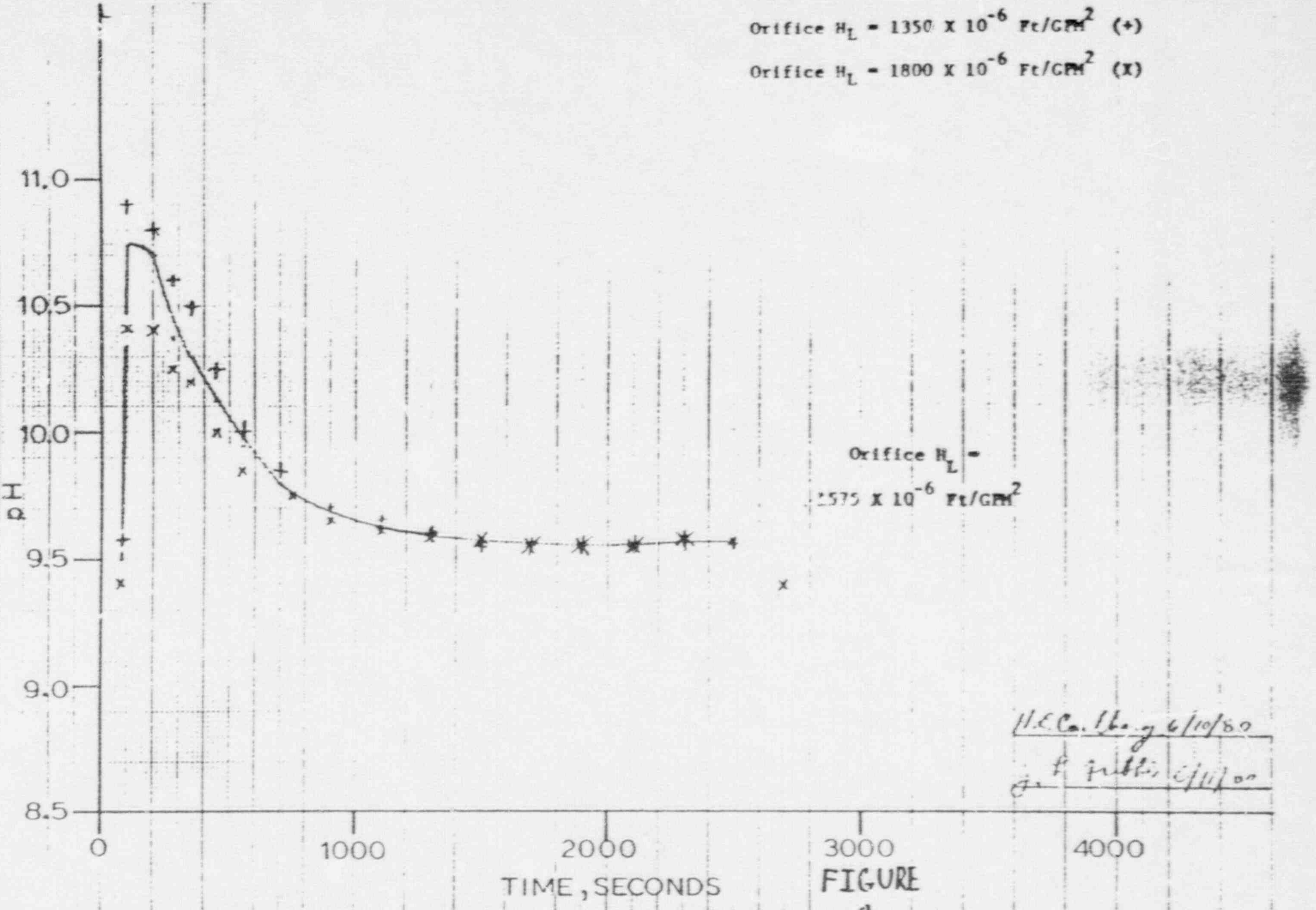


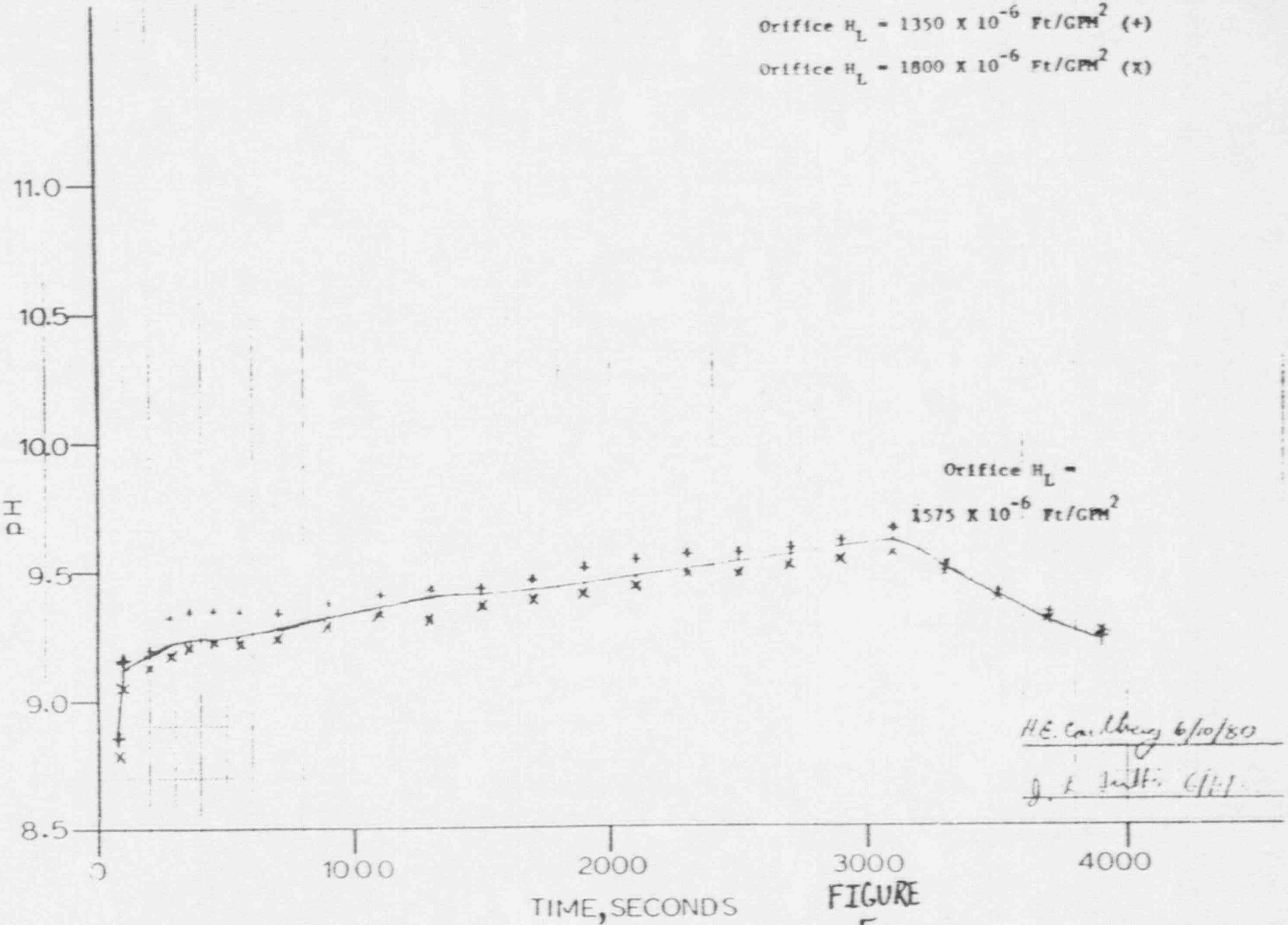
FIGURE 4

H.E.Co. [illegible] 6/10/80

[illegible] 6/11/80

APPENDIX A

SCENARIO NO. 5: 1 CS PUMP + 1 LHSI + 1 HHSI WITH MIN SPRAY pH ASSUMPTIONS



H.E. Carlberg 6/10/80

FIGURE
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APPENDIX A

SCENARIO NO. 6: 2 CS PUMPS + 2 LHSI + 2 HHSI WITH MIN. SPRAY pH ASSUMPTIONS

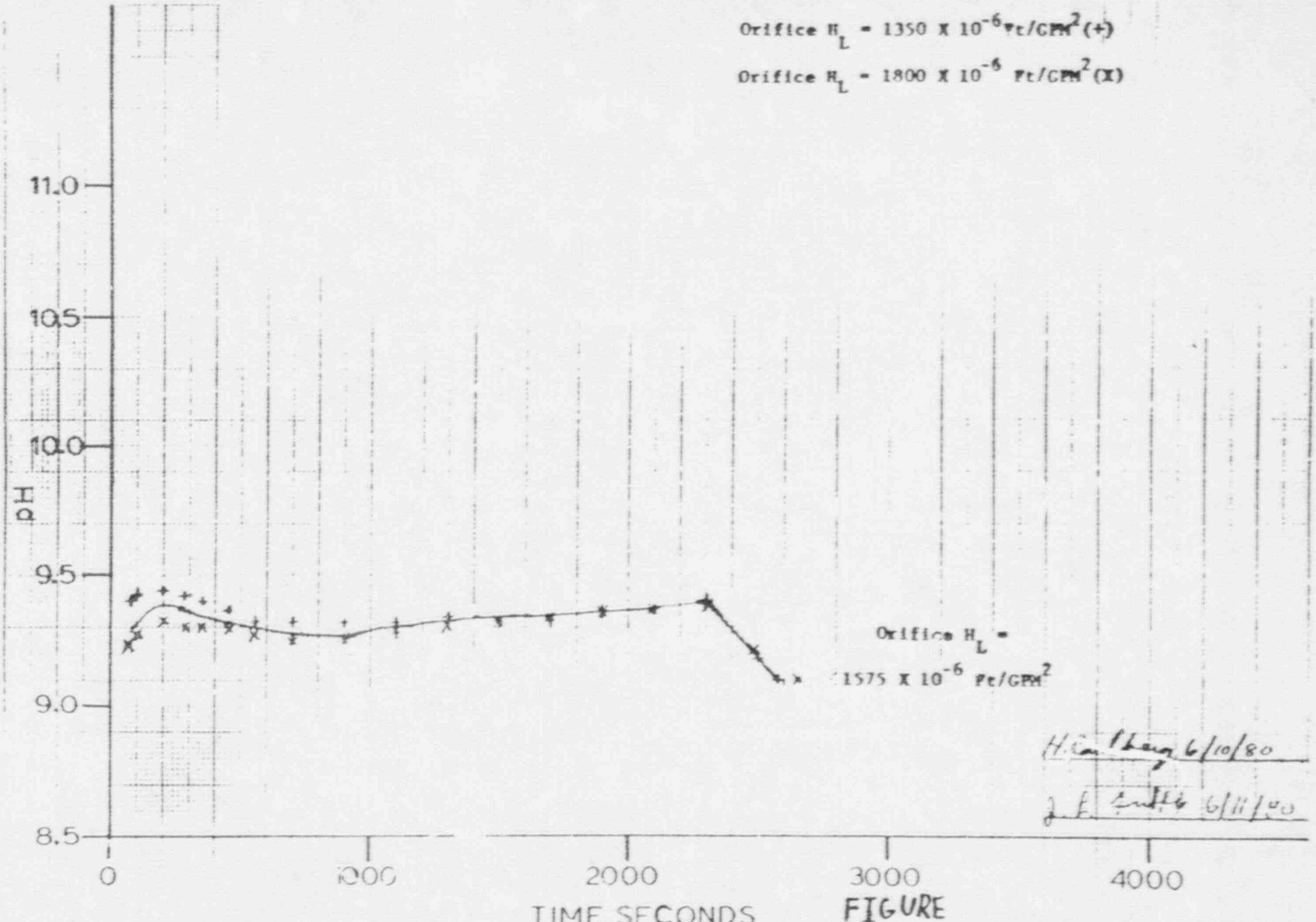

FIGURE 6

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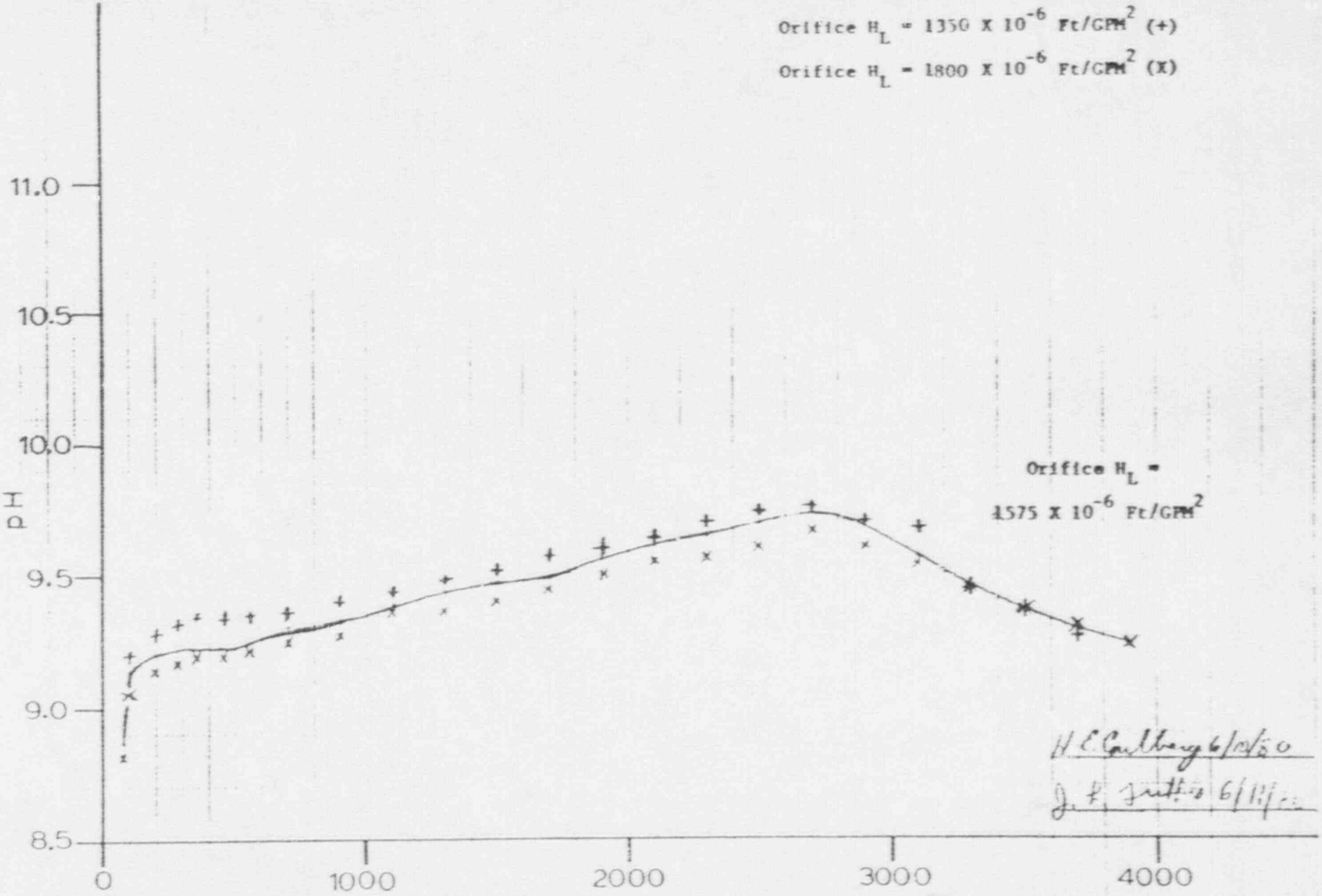
6/11/80

APPENDIX A

SCENARIO NO. 7: 1 CS PUMP + 2 LHSI + 2 HHSI WITH MIN SPRAY pH ASSUMPTIONS



H E Carlberg 6/10/80

J. F. Juttis 6/11/80

FIGURE 7

APPENDIX A

SCENARIO NO. 8: 2 CS PUMPS + 1 LHSI + 1 HHSI WITH MIN SPRAY pH ASSUMPTIONS

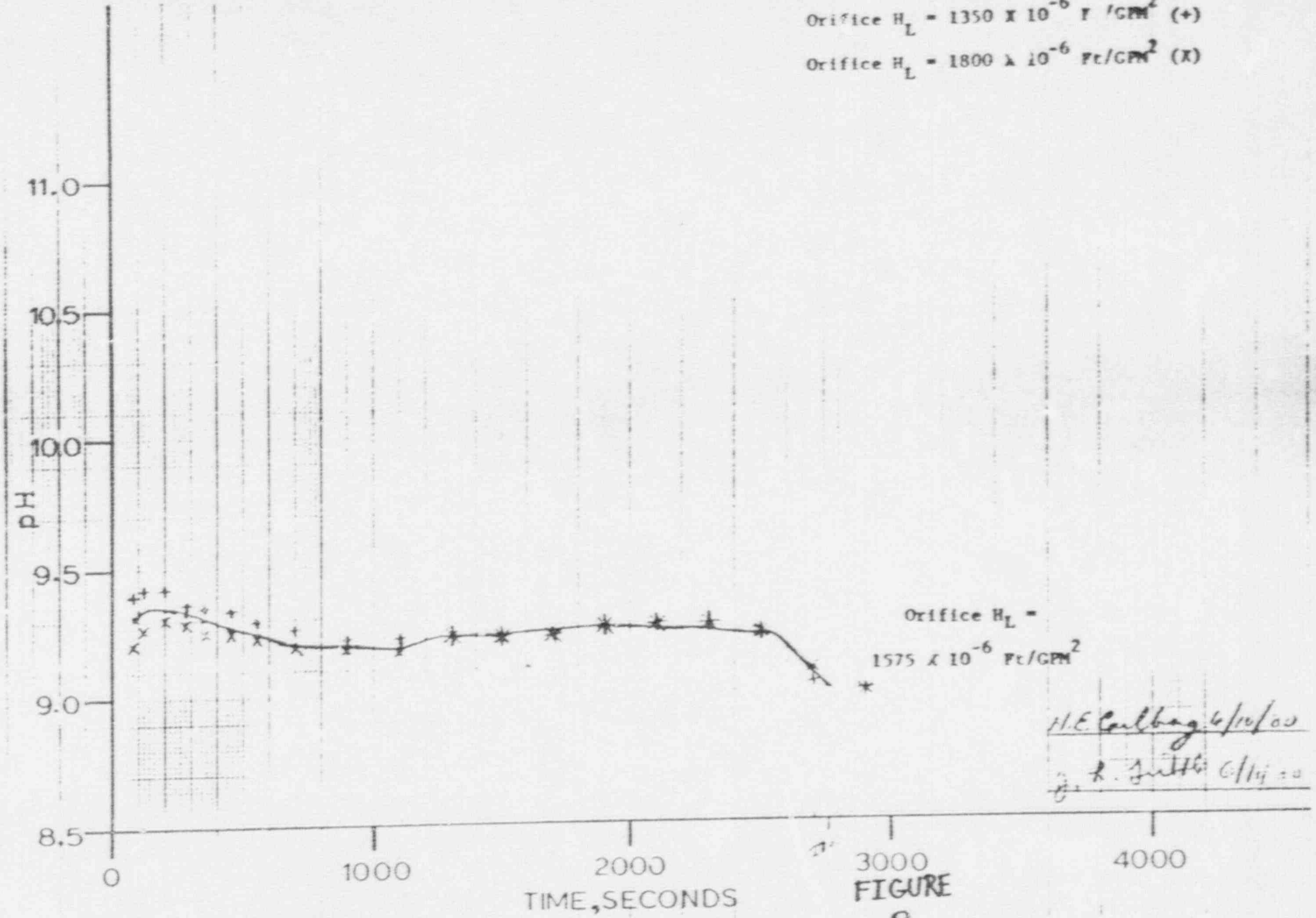


FIGURE 8

H.E. Carlberg 6/10/80

R. [illegible] 6/14/80

APPENDIX A
SCENARIO NO. 9: 1CS PUMP + 1 LHSI + 1 HHSI WITH MIN SUMP pH ASSUMPTIONS

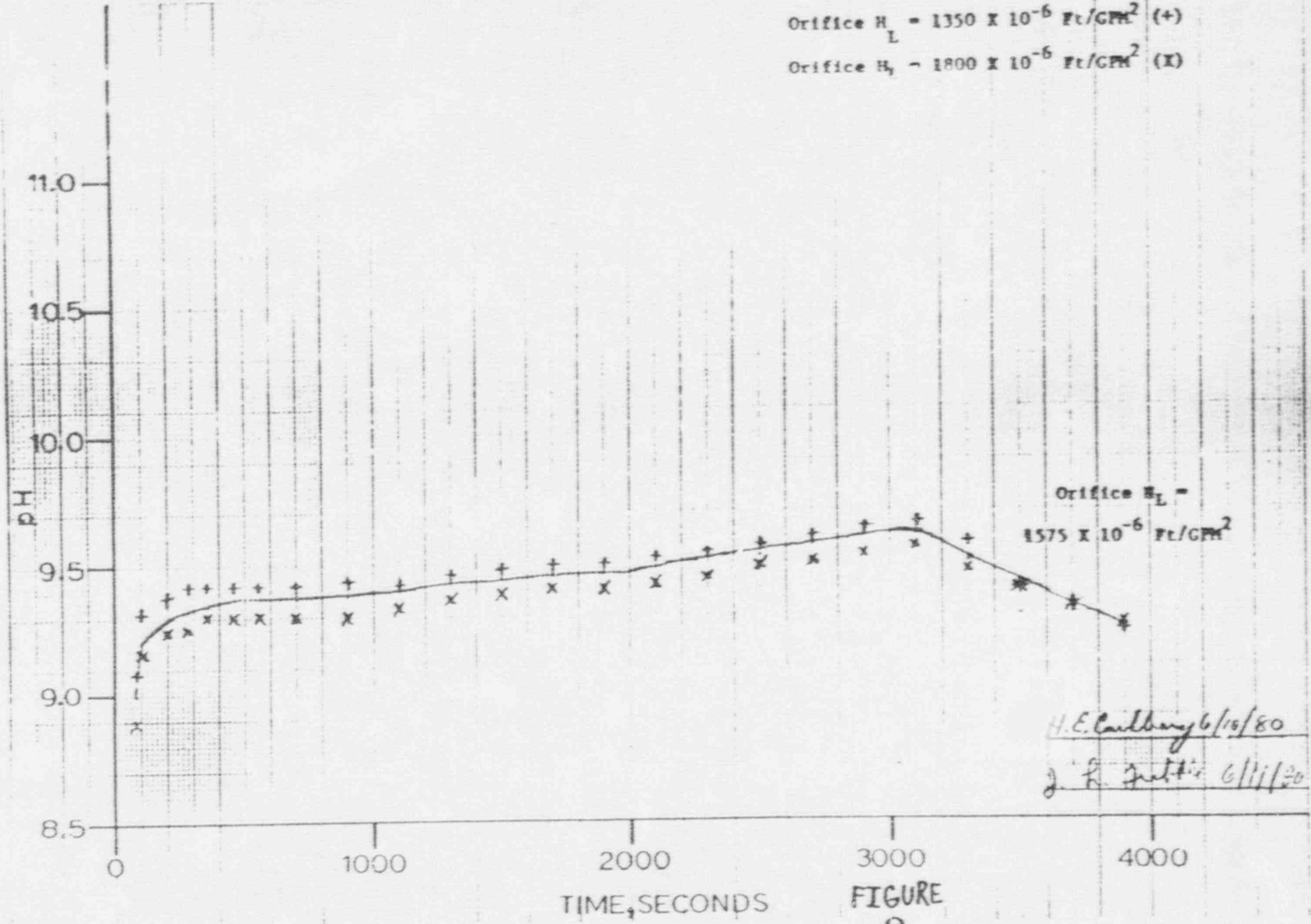
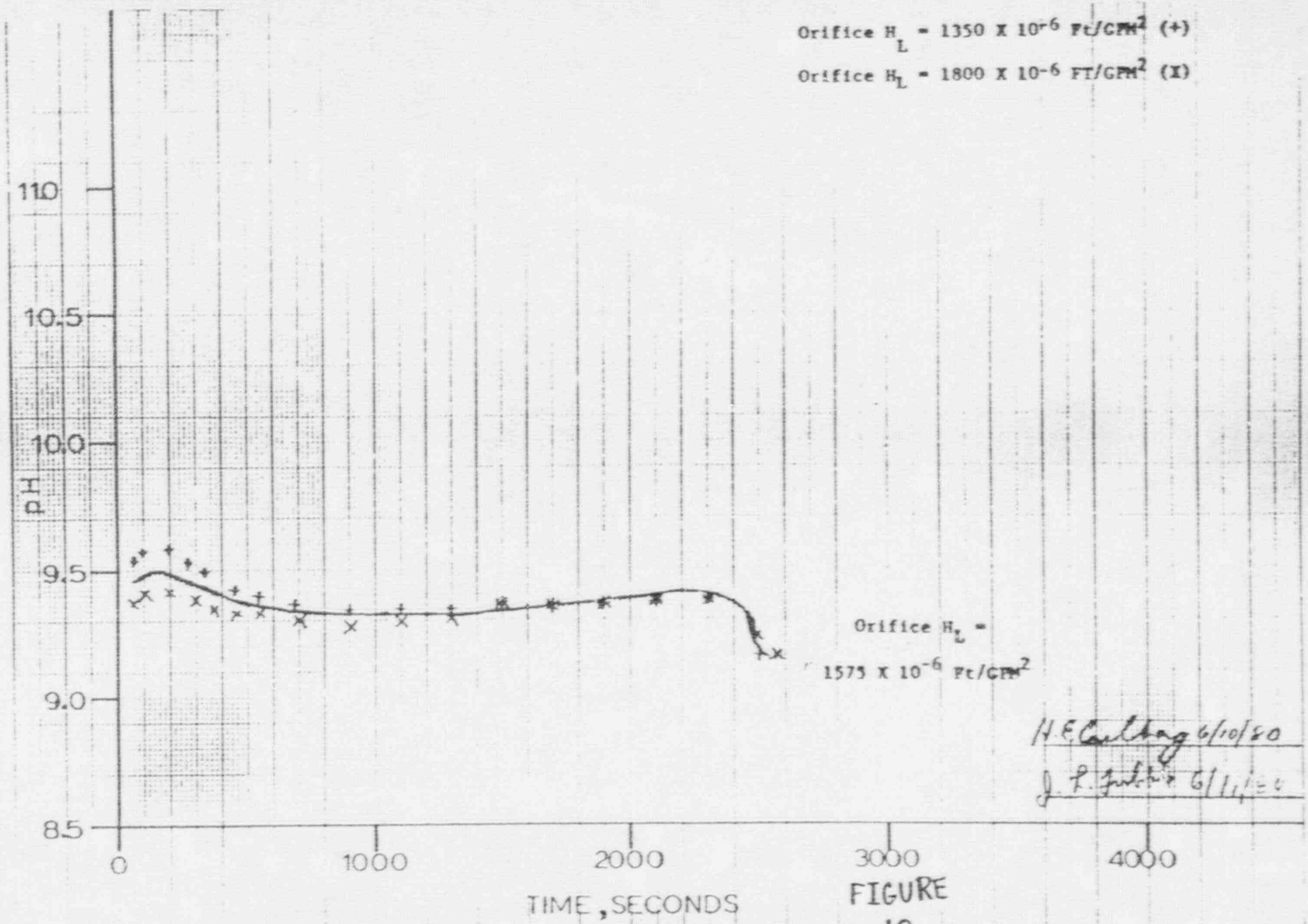


FIGURE 9

H.E. Carlberg 6/18/80

J. L. [illegible] 6/11/80

APPENDIX A
SCENARIO NO. 10: 2 CS PUMPS + 2 LHSI + 2 HHSI WITH MIN SUMP pH ASSUMPTIONS



H.E. Carlberg 6/10/80
J. L. [illegible] 6/11/80

FIGURE
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APPENDIX A

SCENARIO NO. 11: 1 CS PUMP + 2 LHSI + 2 HHSI WITH MIN SUMP pH ASSUMPTIONS

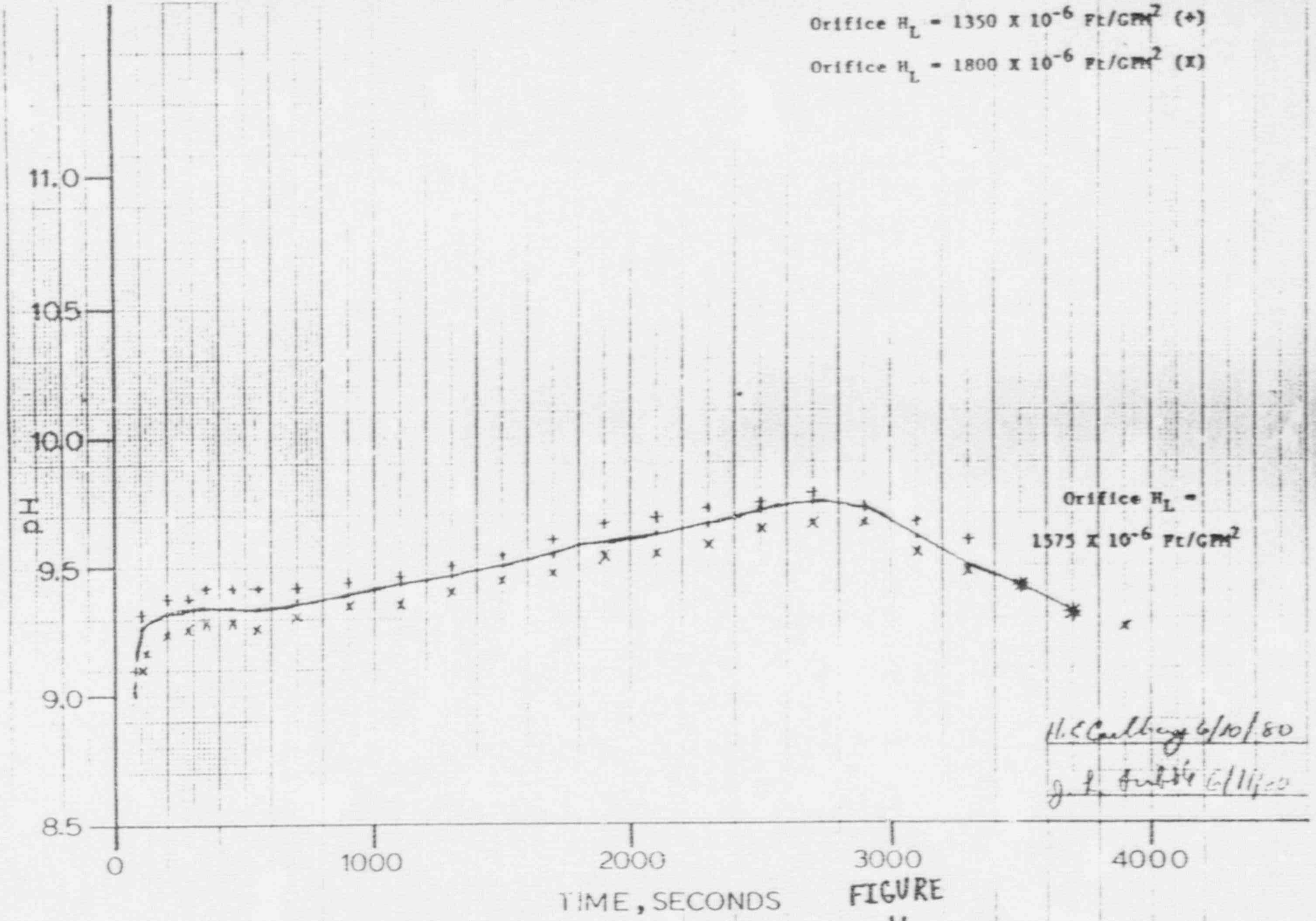
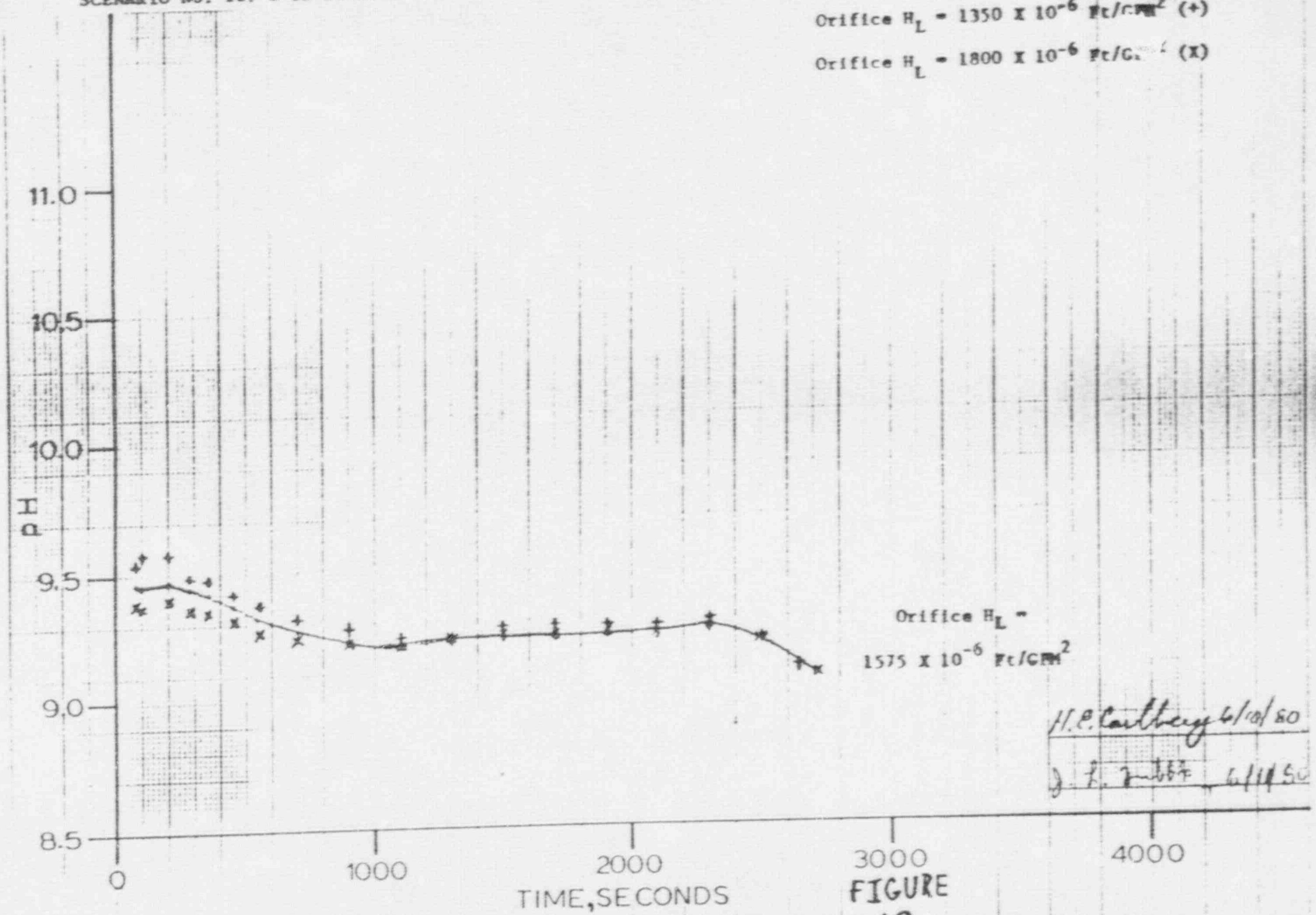


FIGURE 11

H. C. Carlberg 6/10/80

6/11/80

APPENDIX A
SCENARIO NO. 12: 2 CS PUMPS + 1 LHSI + 1 HHSI WITH MIN SUMP pH ASSUMPTIONS



H.E. Caltberg 6/10/80

6/11/80

FIGURE
12

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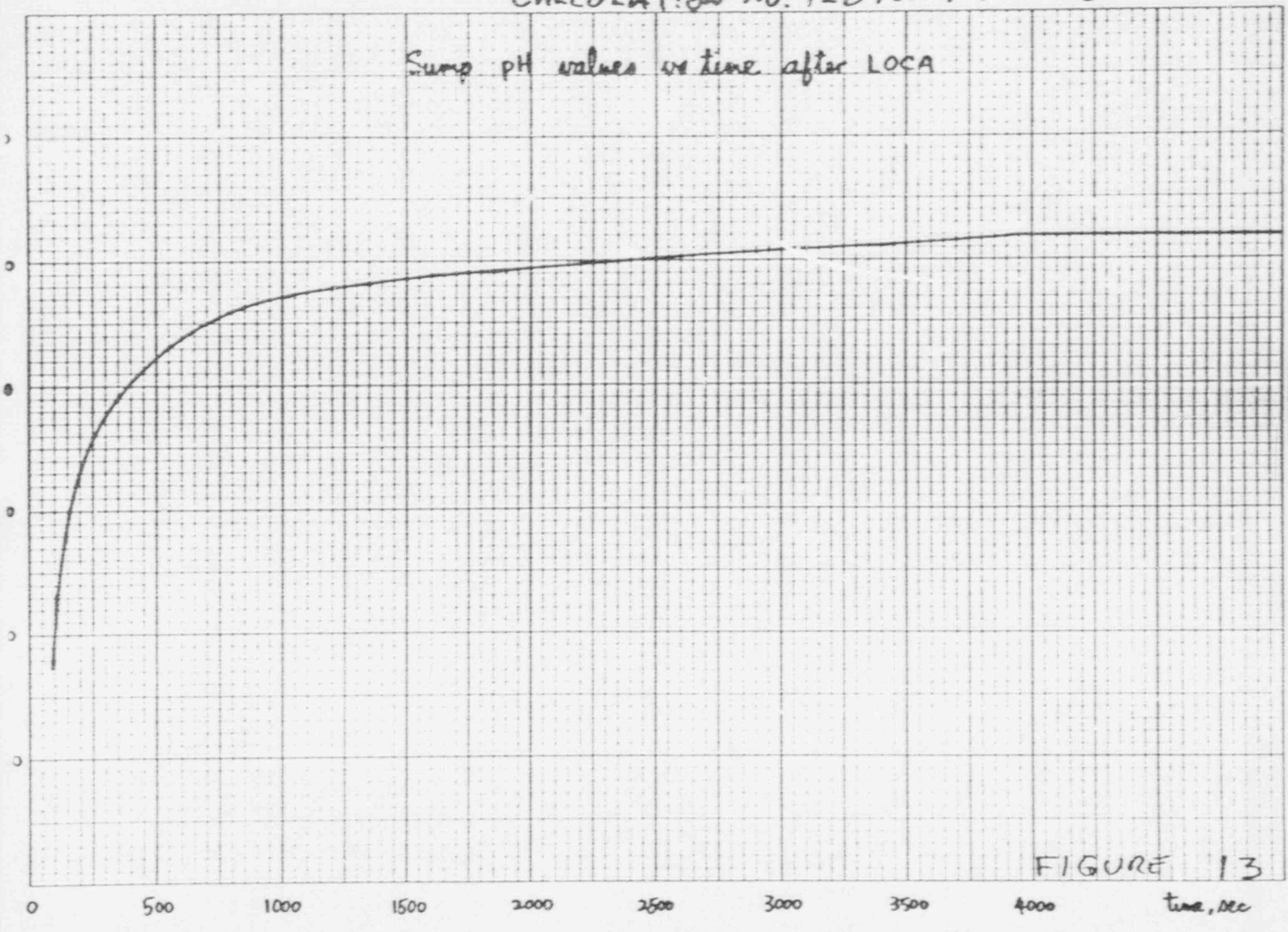
CALCULATION No. 12846.07-PE-037-0



Sump pH values vs time after LOCA

FIGURE 13

PART B

CONTAINMENT SPRAY SYSTEM - SURRY #2 CAUSTIC FLUID FLOW RATE HISTORY (CFFRH) AND CHEMICAL ADDITION TANK (CAT.) DRAWDOWN FOR DESIGN BASIS ACCIDENT SCENARIOS

Part B contains excerpts from Stone & Webster calculation No. 12846.07/35 "Caustic Fluid Flow Rate Histories in the Containment Spray System (Containment Spray pH Analysis"):

CALCULATION SHEET

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J.O./W.O./CALCULATION NO. 12846.07 / 85		REVISION 0	PAGE 4 / 26
PREPARED/DATE Octor Faiher 5/27/80	REVIEWER/CHECKER/DATE P. O'NEIL / 3 JUNE 80	INDEPENDENT REVIEWER/DATE	
SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS I	

Objective of Calculation:

To determine the Caustic Fluid Flow Rate History (CFFRH) in the Containment Spray System for a caustic solution concentration of 17.5% ± 0.5%, under the following modes of operation and assumptions (accident scenarios):

SCENARIO No	PUMPS IN OPERATION			ASSUMPTION		
	CS	LH	HH	MAX SPRAY pH	MIN SPRAY pH	MIN SUMP pH
1	1	1	1	✓		
2	2	2	2	✓		
3	1	2	2	✓		
4	2	1	1	✓		
5	1	1	1		✓	
6	2	2	2		✓	
7	1	2	2		✓	
8	2	1	1		✓	
9	1	1	1			✓
10	2	2	2			✓
11	1	2	2			✓
12	2	1	1			✓

CS = Containment Spray Pump(s)

LH = Low Head Safety Injection Pump(s)

HH = High Head Safety Injection Pump(s)

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4- CFFRH requirements:

a) At any time during caustic injection:

Min Allowable Flow Rate < Predicted Flow Rate < Max. Allowable Flow Rate
(Flow Rate corresp. to pH=8.5) (Flow Rate corresp. to pH=11.0)

b) CAT gets empty before RWST gets empty.

Note: Max and Min Allowable Flow Rates are determined in Attachment No 1.

5 - Determine CFFRH for all accident scenarios specified on page 4, with no restrictive orifices, to demonstrate whether or not direct suction flow from the CAT is feasible and whether or not restrictive orifices are required.

Direct suction flow is not feasible if during caustic injection:

Predicted Flow Rate < Min. Allowable Flow Rate

Restrictive orifices are required if:

Predicted Flow Rate without orifices > Max Allowable Flow Rate

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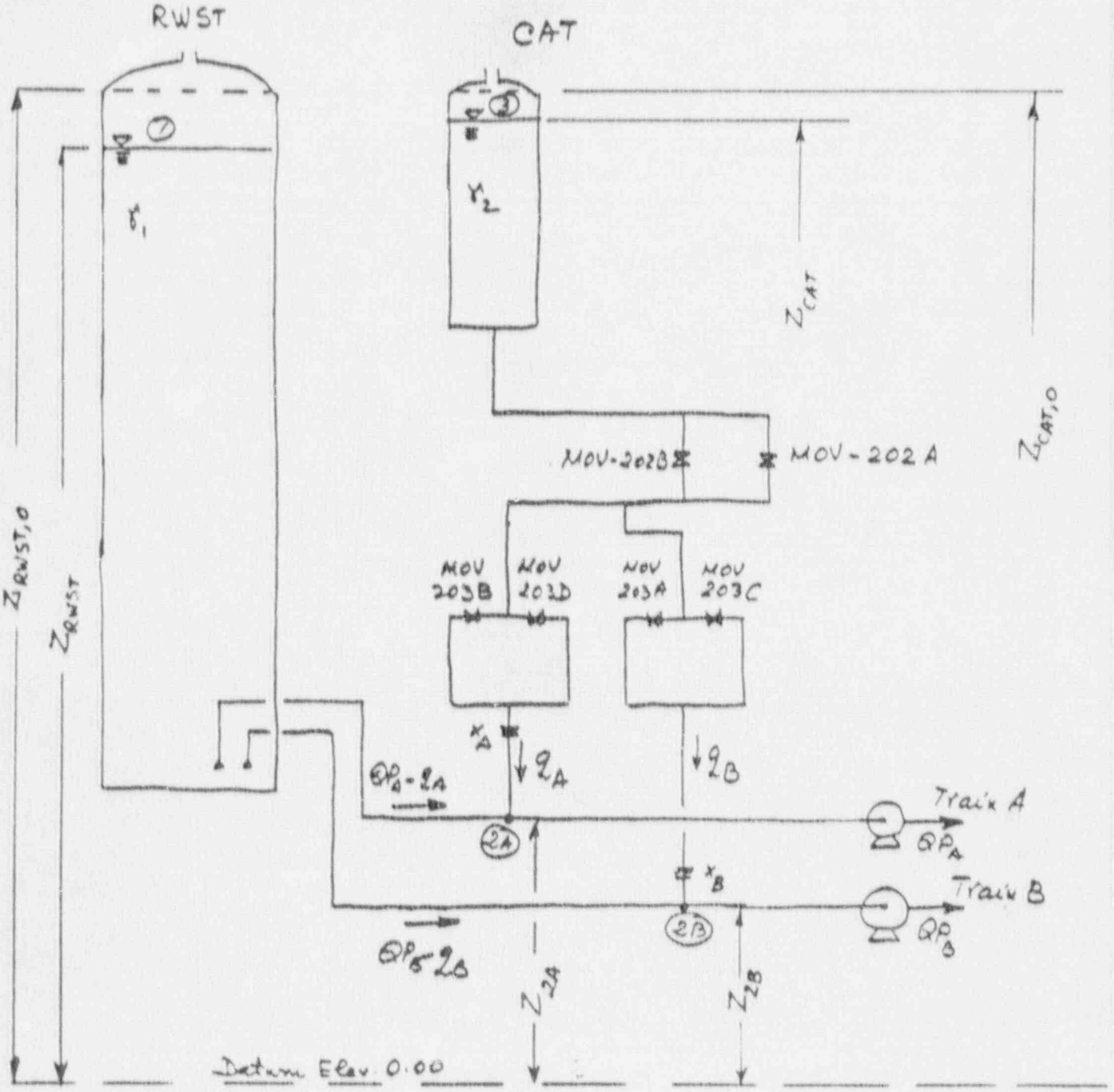
SUBJECT/TITLE CFFR1K in the Containment Spray System.		QA CATEGORY/CODE CLASS I

Direct Suction System Schematic



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SUBJECT/TITLE	QA CATEGORY/CODE CLASS
CFFRH in the Containment Spray System	

The set of equations is:

$$\left\{\begin{aligned}
&Z_{CAT}(0) \rightarrow \text{known} \\
&q_A(i) = \frac{1}{\sqrt{K_{3-2A} + x_A}} \sqrt{Z_{CAT}(i) - Z_{2A} - \frac{S_{RWST}}{S_{CAT}} * E_{2A}(i)} \qquad (1) \\
&q_B(i) = \frac{1}{\sqrt{K_{3-2B} + x_B}} \sqrt{Z_{CAT}(i) - Z_{2B} - \frac{S_{RWST}}{S_{CAT}} * E_{2B}(i)} \qquad (2) \\
&Z_{CAT}(i+1) = Z_{CAT}(i) - 0.0085233 * \left[q_A(i) + q_B(i)\right] * \Delta t_{min} \qquad (3)
\end{aligned}\right.$$

Notes:

- K_{3-2A}, K_{3-2B} are constant parameters (head loss coef between the CAT and the Junction Points 2A, 2B without the restrictive orifices - Ft/GPM^2); the numerical values of K_{3-2A}, K_{3-2B} are specified on pages 6 and 8.
- x_A, x_B are constant parameters, (head loss coef through the restrictive orifices) in Ft/GPM^2; numerical values of x_A, x_B are selected as described on page 11
- Z_{2A}, Z_{2B} constant numerical values (see page 16) in Ft.

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SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS	

- S_{RWST} , S_{CAT} are constant parameters (sp. gr. of the Boric Acid solution and caustic solution); numerical values as specified on pages 6 and 8.

- $Z_{CAT}(0)$ is a constant parameter (initial elevation of the caustic solution in the CAT); numerical values as specified on pages 5 and 7 in Ft

- Δt_{min} is a constant numerical value (integration time), selected arbitrarily 1/3 min; (20 sec)

- $E_{2A}(i)$, $E_{2B}(i)$ are variables (pressure and kinetic energy at the junction points in Ft of Boric Acid solution).
  $E_{2A}(i)$ and $E_{2B}(i)$ are calculated and analytically expressed in Attachment No 1

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SUBJECT/TITLE CFPRH in the Containment Spray System.		QA CATEGORY/CODE CLASS I	

Conclusions:

1- The "direct suction flow" method for chemical addition is feasible since without any control (orifice) the flow rates from the CAT exceed the max. allowable flow rates (See Attachment No 5, $x_A = x_B = 0$ cases)

2- With an orifice $x_A = x_B = 1575 \times 10^{-6}$ Ft/GPM² the flow rates from the CAT can be kept between the min and the max. allowable flow rates, or the pH can be maintained between 8.5 and 11.0 for all accident scenarios analyzed. (See Attach No 5)

3- With an orifice $x_A = x_B = 1575 \times 10^{-6}$ Ft/GPM² the CAT will empty before the RWST, hence, under any of the accident scenarios analyzed the entire volume of caustic solution in the CAT will be pumped by the containment spray pump into the reactor containment.

Considerations regarding the sensitivity of the calculation and input data.

1- Input data: The calculated flow rates and CAT drawdown for each accident scenario represent max or min envelopes rather than the actual flow rates or drawdown which can be expected. All the inputs were analyzed and then selected

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SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS	

in such a way to form two sets of consistent inputs, one to maximize the flow rates (pH), the other one to minimize the flow rates (pH). The inputs considered parametric in the calculation are as follows:

- The RWST initial elevation, including the instrument error
- The CAT initial elevation, including the instrument error
- Caustic solution concentration
- Caustic solution temperature
- Boric Acid solution concentration

The fact that in developing the max or min envelopes, all the parametric values were selected either to minimize or to maximize the results, is a guaranty that sufficient conservatism does exist in the results of the calculation

2- <u>Calculations</u>

There are two parameters, namely the head loss coefficient between the RWST and the Junction Point, and the head loss coefficient between the CAT and the Junction Point which are essential in estimating the CAT flow rates and drawdown. These two coefficients were

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS
CFFRH in the Containment Spray System	I

analytically calculated and then verified by way of a field test (RWST-CAT Drawdown Test 4/30/80 - See Ref. 6). The results of the field test showed that the actual head losses were 2.6% greater than their analytical evaluation. In order to simplify the sensitivity analysis of the head losses, the calculation was performed with head loss coefficients between RWST and Junction Point modified, to include a margin of uncertainty of ± 5%, while the CAT - Junction head loss coefficient was kept at its calculated value. However, a sensitivity analysis of the head loss between the CAT and Junction Point shows that while the design orifice head loss coefficient is 1575×10^{-6} Ft/GPM², the CFFRH requirements are met for any coefficient between 1350×10^{-6} Ft/GPM² and 1800×10^{-6} Ft/GPM². The head loss coefficient of the CAT piping system without the restriction orifice was considered parametric, between a min of 420×10^{-6} Ft/GPM² and a max of 520 Ft/GPM² (See pages 6 and 8). The total head loss coefficients between the CAT and Junction Point for which the CFFRH requirements are met

2

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SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS I

are as follows:

Max: $K = 1800\times10^{-6} + 520\times10^{-6} = 2320\times10^{-6}$ Ft/Gpm²

Design: $K = 1575\times10^{-6} + 470\times10^{-6} = 2045\times10^{-6}$ Ft/Gpm²

Min: $K = 1350\times10^{-6} + 420\times10^{-6} = 1770\times10^{-6}$ Ft/Gpm²

The above coefficients show that the head losses between the CAT and Junction Points could vary ± 13% without affecting the CFFRH requirements.

3 - Predicted CFFRH and CAT Drawdown

The calculated caustic flow rates and CAT drawdown are based on the set of equations shown on page 17. The set of equations models the hydraulics of the RWST and CAT drawdowns as a succession of steady state conditions since certain hydraulic parameters change gradually with time. In order to demonstrate that this analytical approach can rigorously model the CAT drawdown, a field test was performed on 4/30/80. The results of this test (See Ref 6) show that from a practical stand point there are no differences between measured and calculated values and therefore the analytical method can accurately model the CAT draw down. However, the margin of uncertainty 9

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SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS	

of the CAT drawdown measurements was approximately ± 4 inches (Ref 6) and therefore the same margin of uncertainty can be attributed to the calculated drawdown.

Assuming that a difference between calculated and actual CAT drawdown could exist, a legitimate concern could be derived regarding the capability of the drawdown to empty the CAT before CS pump(s) shutdown. In order to analyzed the criticality of this concern, scenario No 11 was selected for testing the sensitivity of the CAT drawdown possible margin of uncertainty. (Scenario No 11 is the most critical case regarding the CAT drawdown). Under design conditions (orifice head loss coef 1575×10^{-6} Ft/GPM^2) the CAT is almost empty at 3860 sec after the start of the accident (CAT Elev. 34.1 Ft), approximately 115 sec before the shutdown of the CS pump which occurs at time 3975 sec. If at 3860 sec the CAT is not empty, there are approximately 2 min available to eventually empty the CAT. The drawdown corresponding to an orifice of 1800×10^{-6} Ft/GPM^2 head loss coefficient shows that at 3860 sec. the CAT elev is 34.9 Ft, or approximately 9.6 inches above CAT elev. of 34.1 Ft and the CAT is empty at

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SUBJECT/TITLE CFF:2H in the Containment Spray System		QA CATEGORY/CODE CLASS I	

approximately 3980 sec.

This demonstrates that even with a margin of uncertainty of 9.6 inches the CAT drawdown will not be critical, the CAT will empty before CS pump shut down, and the spray pH will be between the two 8.5 and 11.0 limits.

11

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Attach. No. I

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SUBJECT/TITLE CFFRH in the Containment Spray System		QA CATEGORY/CODE CLASS I	

Graphical Representation of the Caustic Fluid Flow Rate History (CFFRH) and CAT Drawdown:

1- CFFRH - pages 2 - 13

Legend:

2CAT ———— Max and Min flow rates corresponding to pH of 11.0 and 8.5

—△——△——△— Flow Rate Time History without restrictive orifice

———————— Design Flow Rate History

—●——●——●— } Flow Rate Time History for sensitivity analysis

—⊡——⊡——⊡— } (assuming ±13% head loss variation in the caustic lines and restrictive orifice)

2 - CAT Drawdown - pages 14 - 25

Legend:

———————— Design Drawdown

———

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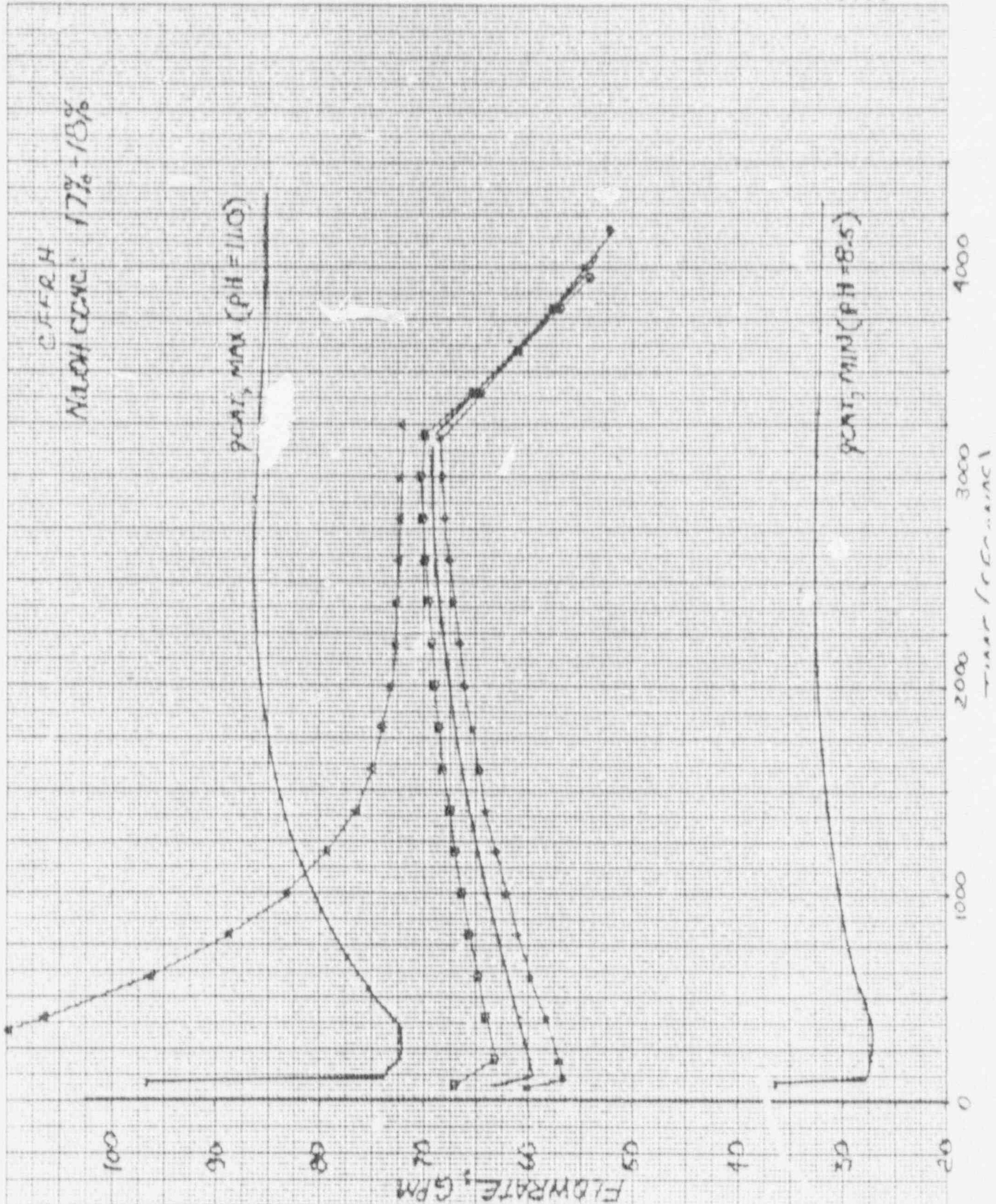
ATTACHMENT NO 5 PG: 2/25
PREP: P. ONEIL 2 JUNE 80
REV: C. [illegible] 6/5/80



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Calc No 12846.07/35

ATTACHMENT NR 5
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REV: C [illegible] 6/5/80

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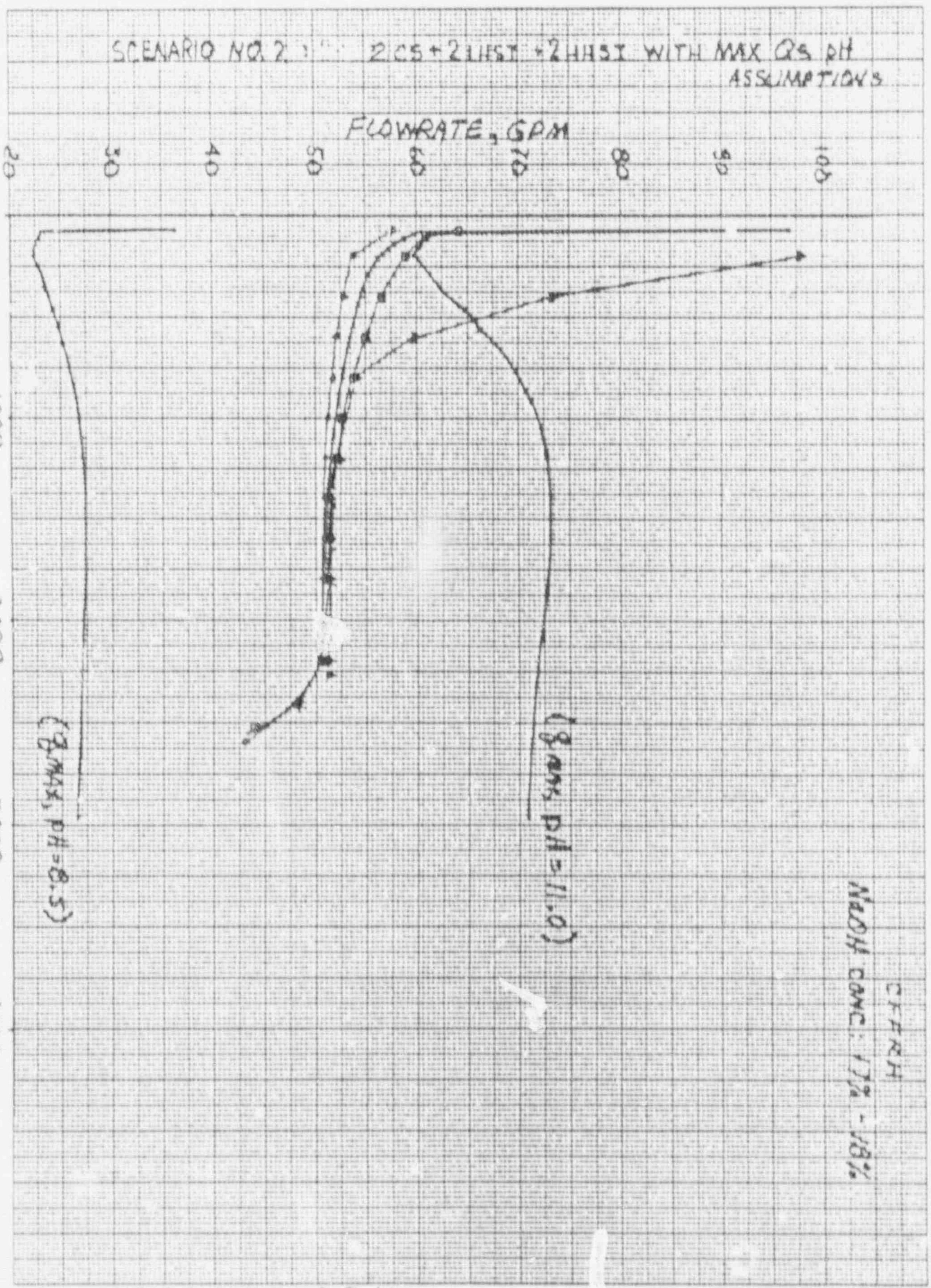

SCENARIO NO. 2 : 2CS + 2LHSI + 2HHSI WITH MAX QS pH ASSUMPTIONS

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Calc. No 12846.07/35 ATTACHMENT No 5 Pg. 4/25
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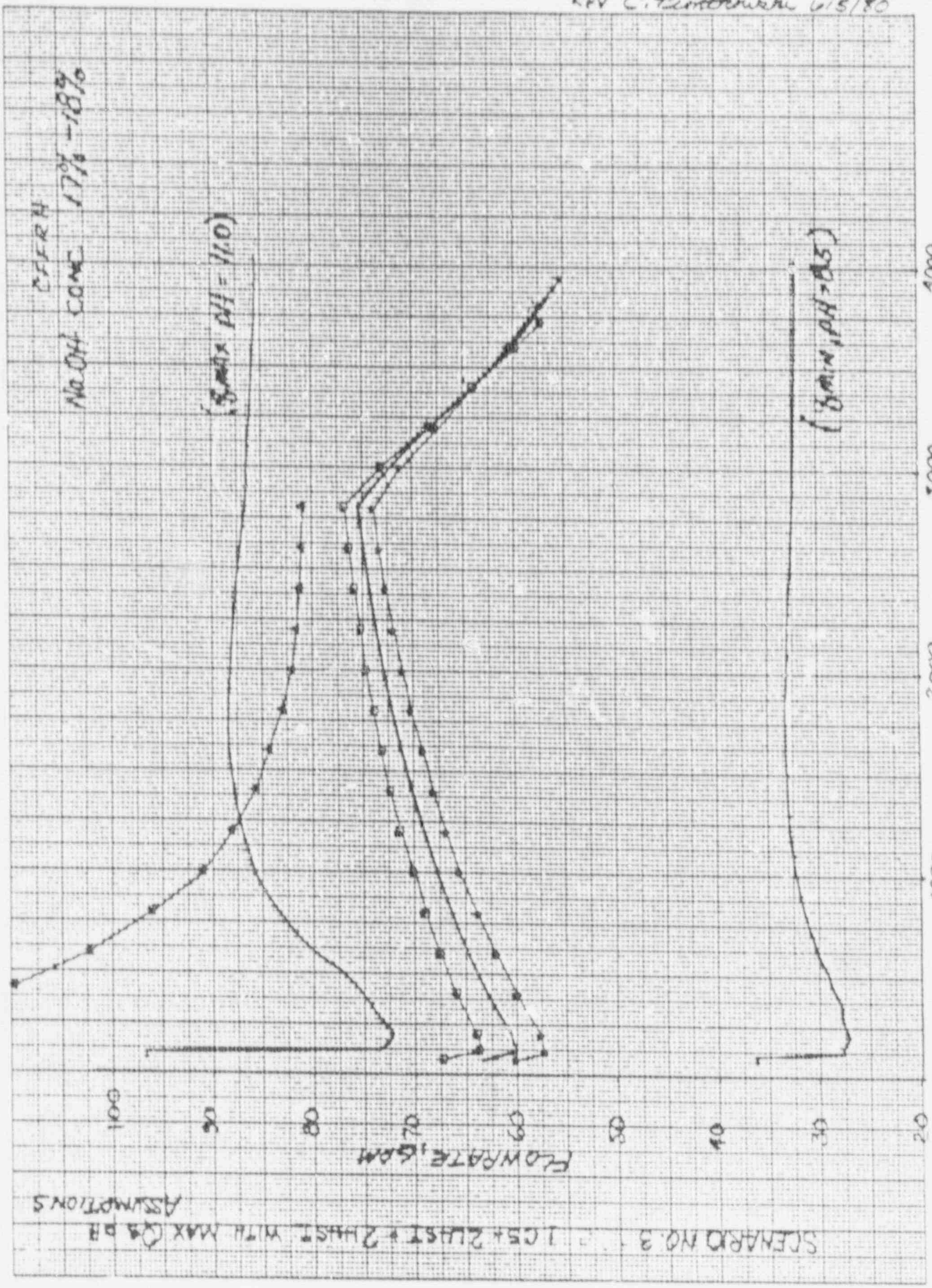
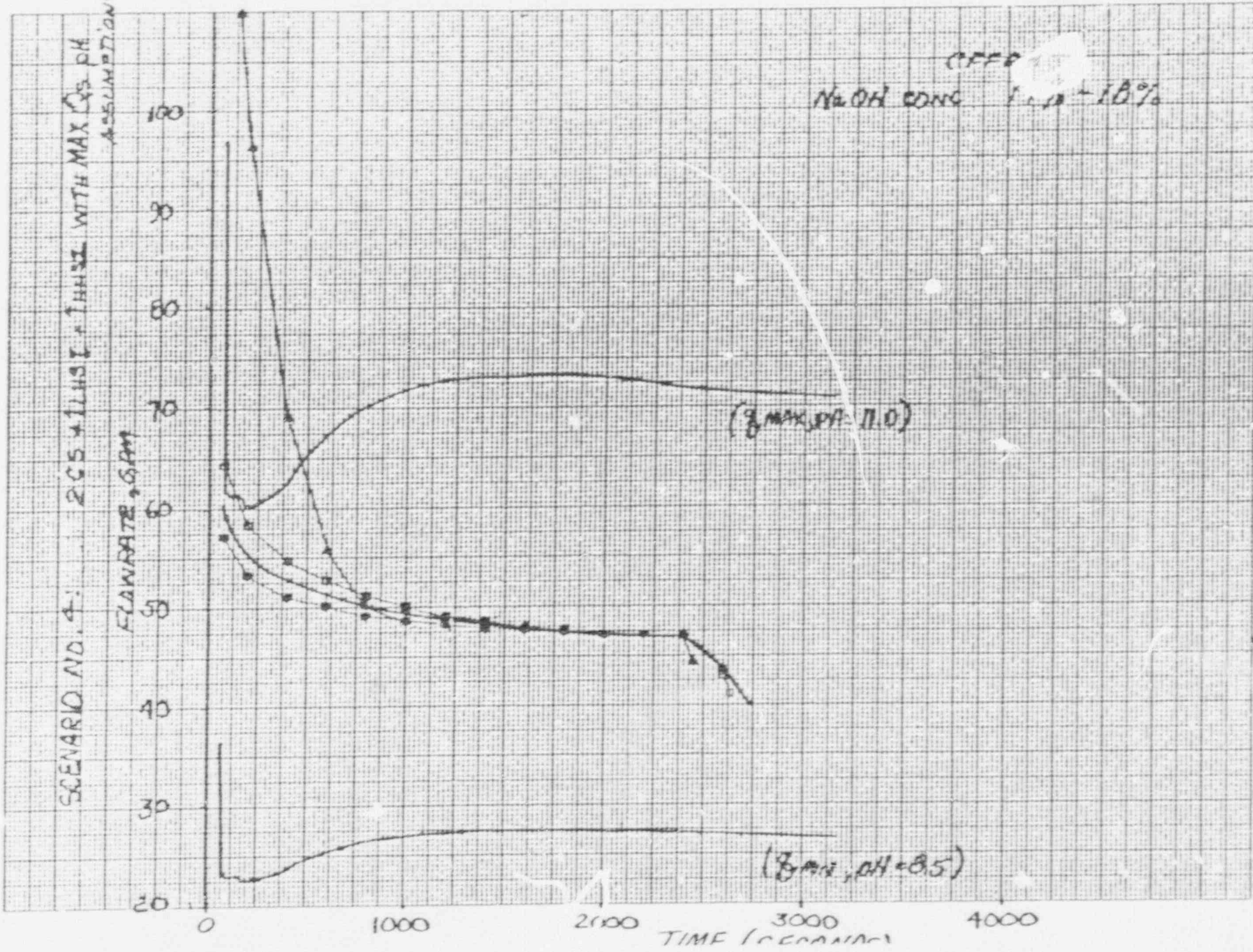
REV C. Christoruski 6/5/80



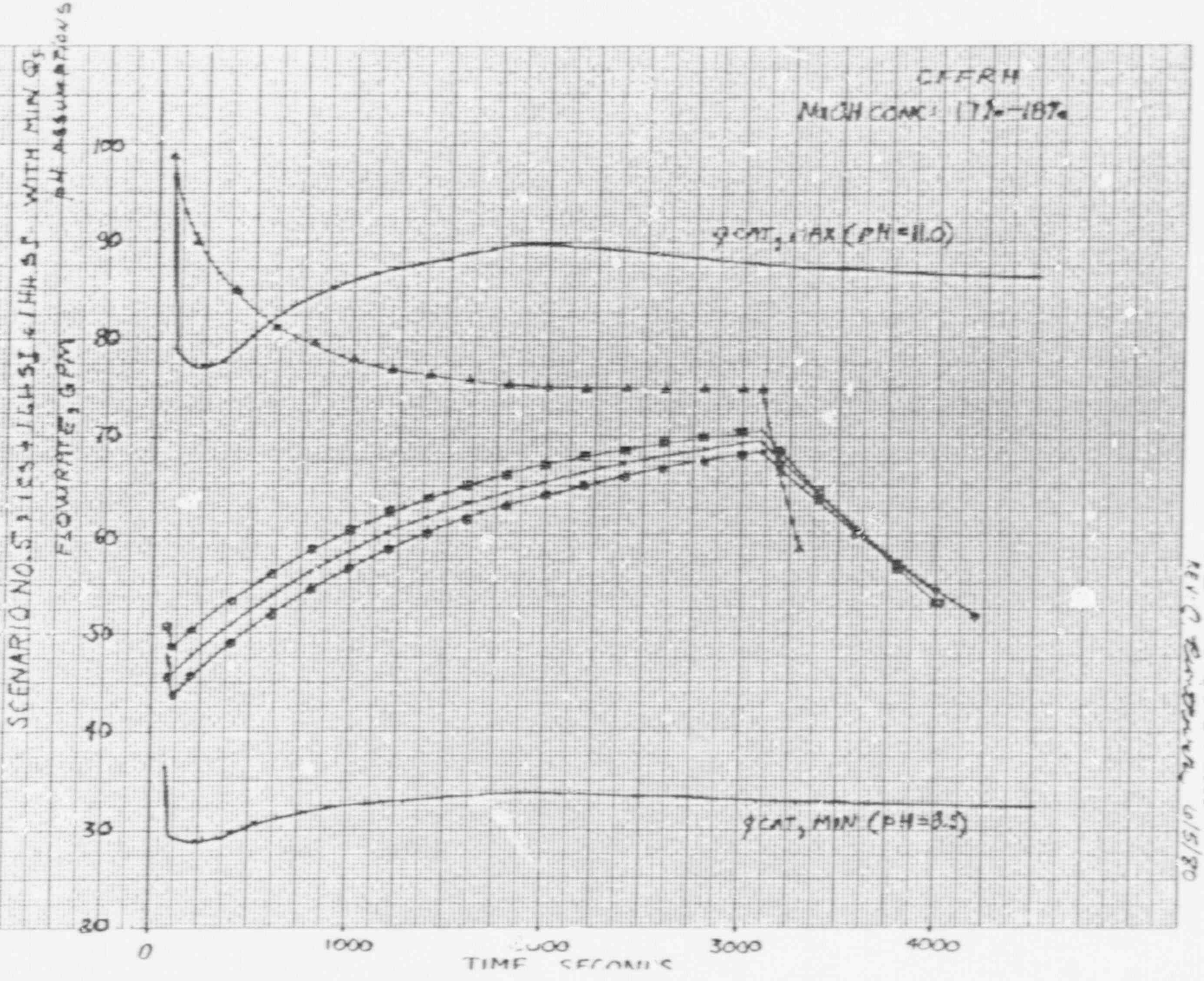
Calc. No 12846.07/35

ATTACHMENT No 5 pg 5/25
PREP: P. ONEIL 23JUN80
REV C. [illegible] 6/15/80


SCENARIO NO. 4: 2CS + 1LHSI + 1HHSI WITH MAX CS pH ASSUMPTIONS

K·E 10 X 10 TO THE CENTIMETER 18 X 25 CM
KEUFFEL & ESSER CO.

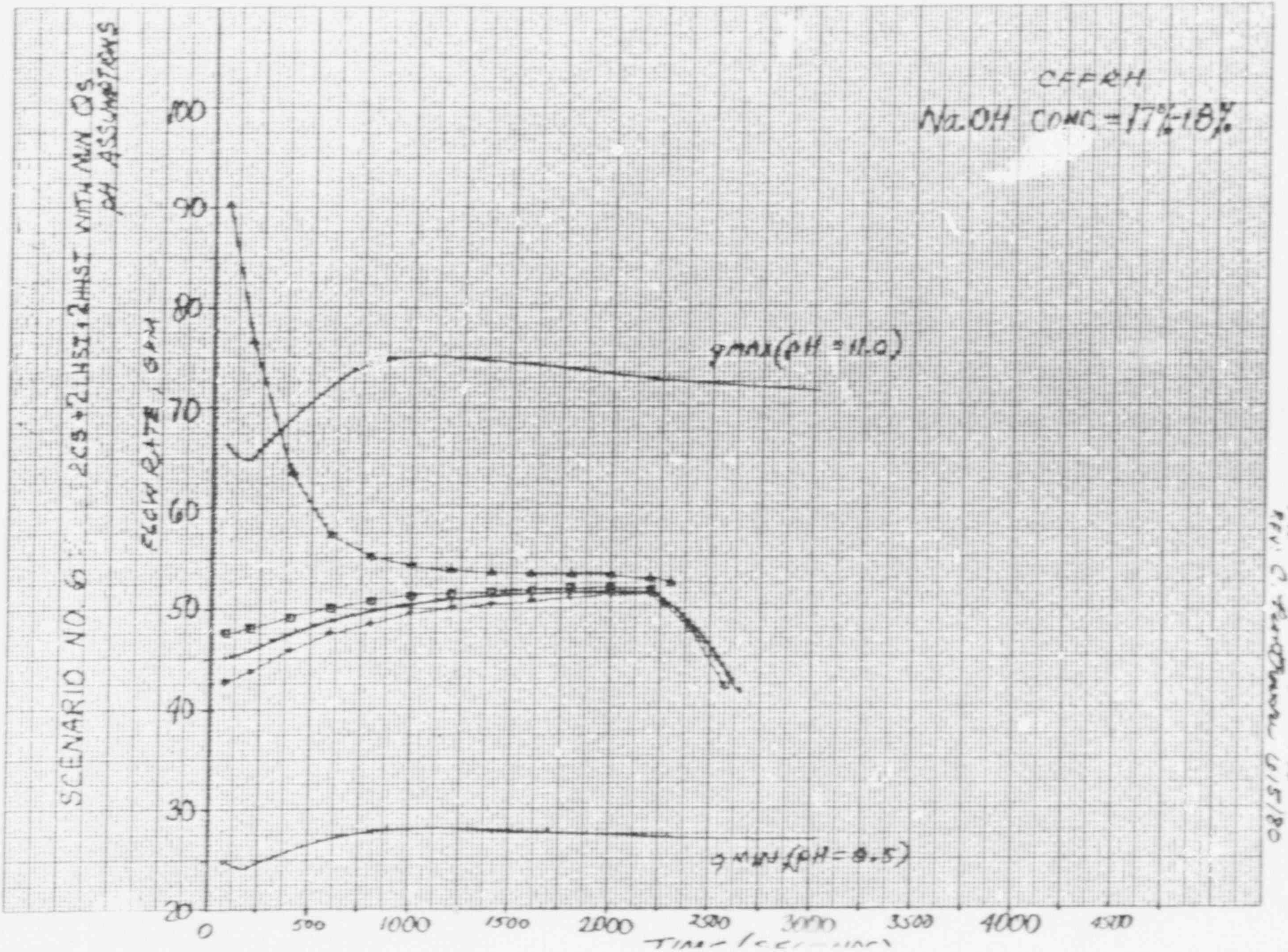
461510



Calc. No 12046.07/35 ATTACHMENT No 5 Pg. 6/25
PREP. P. O'NEIL 5 JUNE 80
REV. C. [illegible] 6/5/80

K·E 10 X 10 TO THE CENTIMETER

461510

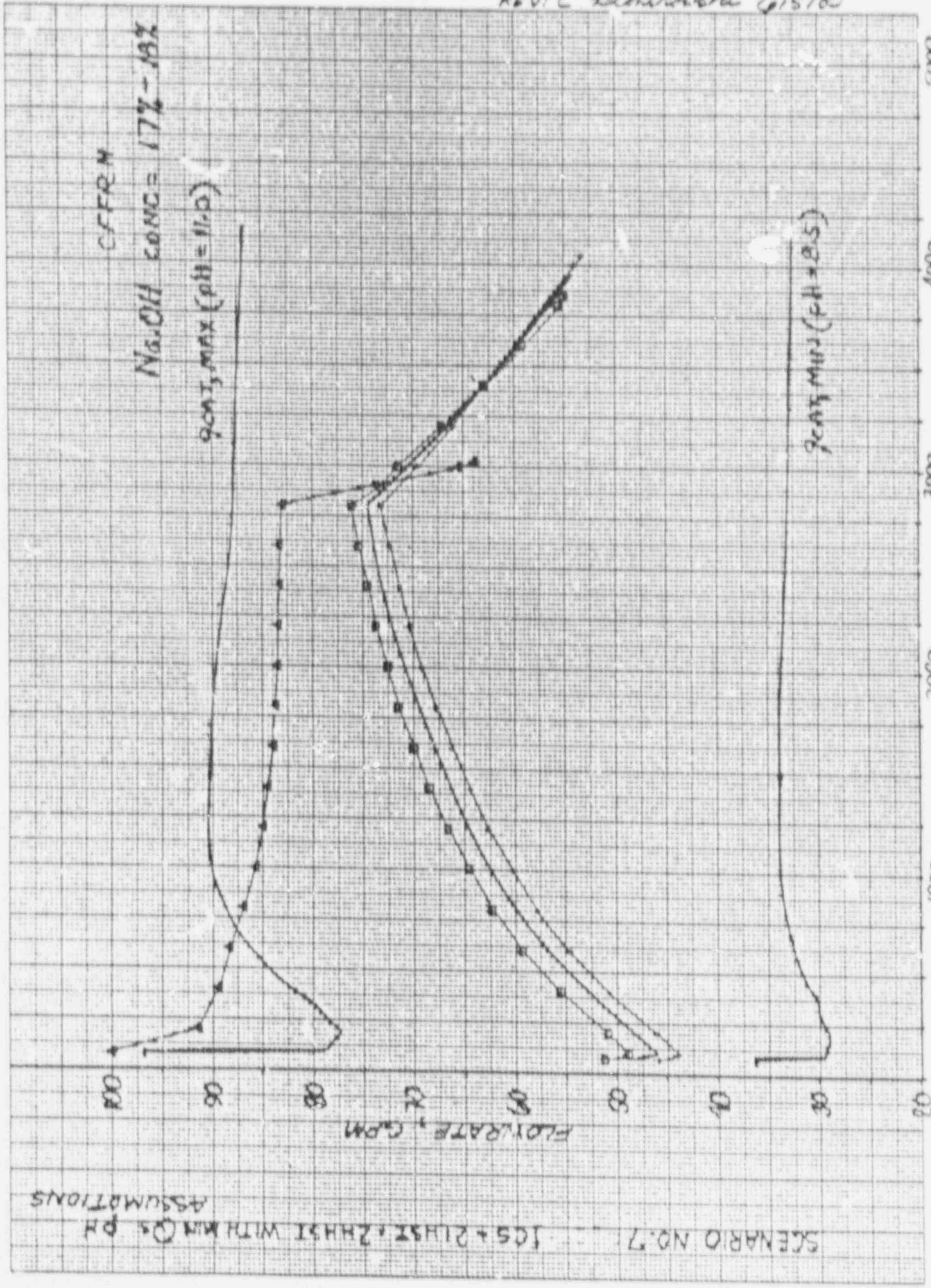

SCENARIO NO. 6: 2CS + 2LHSI + 2HHSI WITH MIN QS pH ASSUMPTIONS

Calc n's 12846.07/35 ATTACHMENT NK 5 pg. 7/25
PREP: P. ONeil 3 June 80
REV: C. [illegible] 6/15/80

Calc. No. 12846.07/35

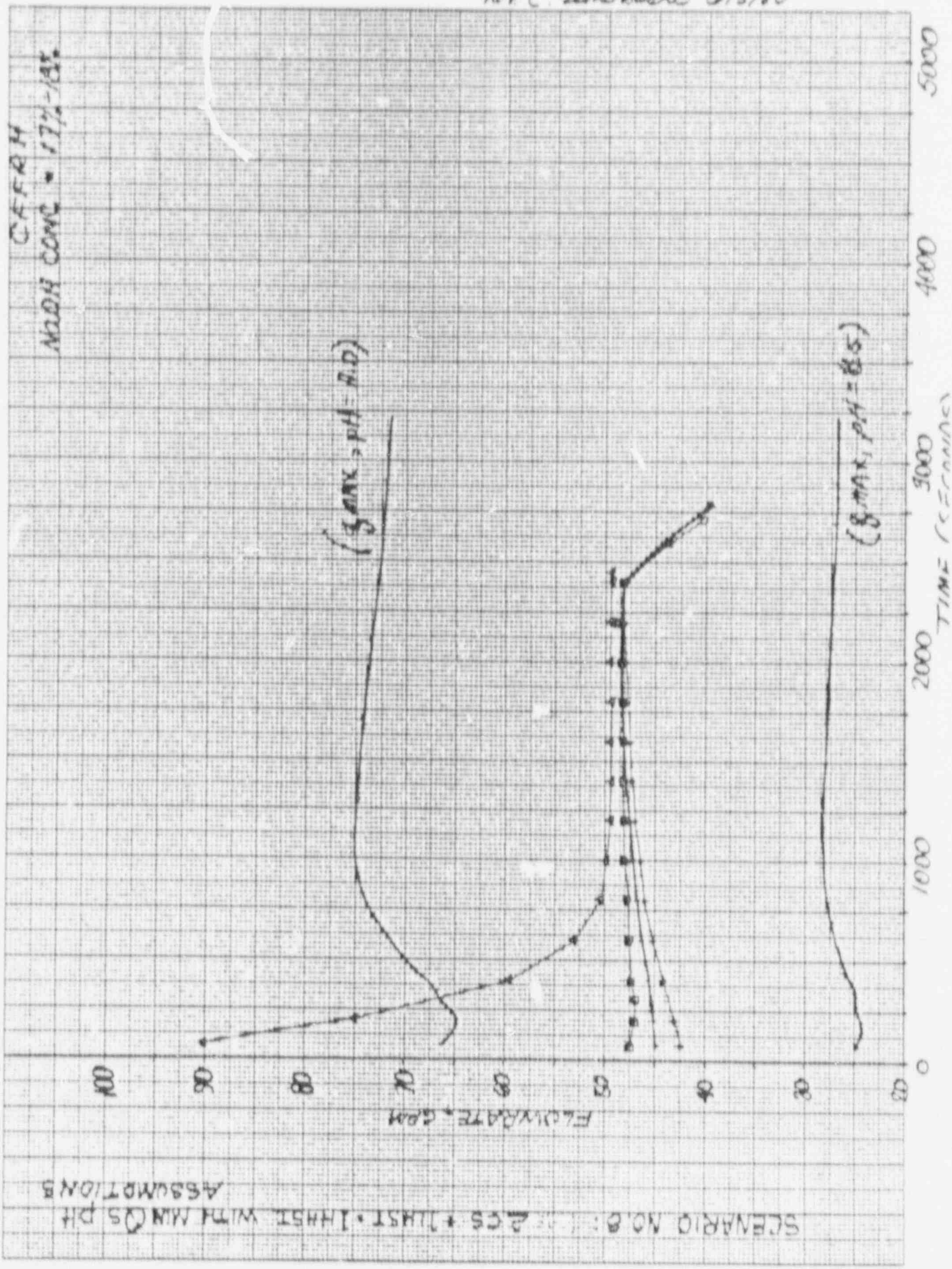
ATTACHMENT NO 5
PREP: P. O'NEIL 3JUNE80
REV: C [illegible] 6/5/80

Pg. 8/25



19

Calc # R846.07/35 ATTACHMENT NO 5 Pg. 9/25
PREP P. O.NEIL 3 JUNE 80
REV C. Bendkowski 6/5/80



Calc No 12846.07/35

ATTACHMENT NO 5 Pg. 10/25
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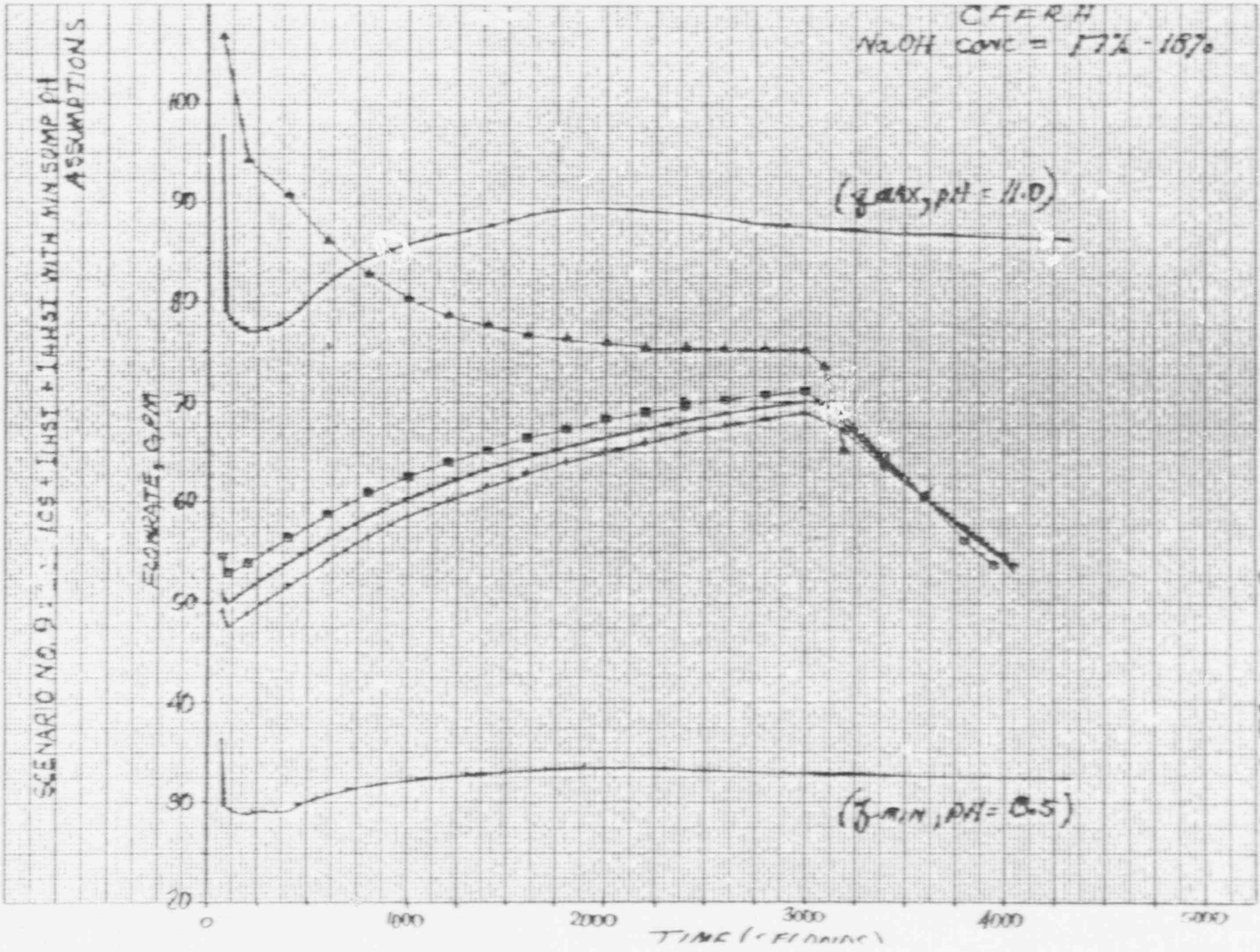
REV: C [illegible] 6/5/80



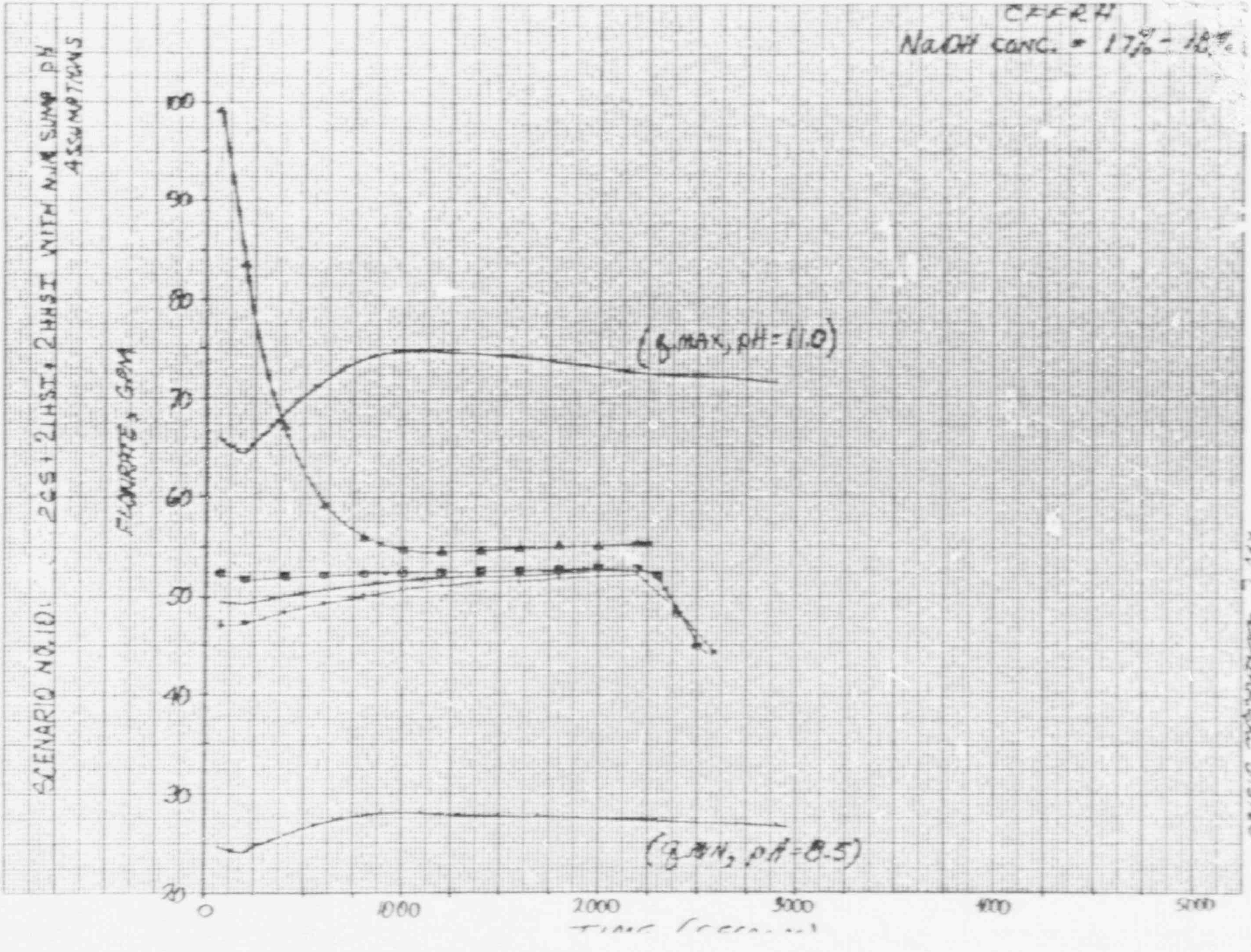
SCENARIO NO. 9 : ICS + 1 HSI + 1 HHSI WITH MIN SUMP pH ASSUMPTIONS

Calc No 12846.07/35

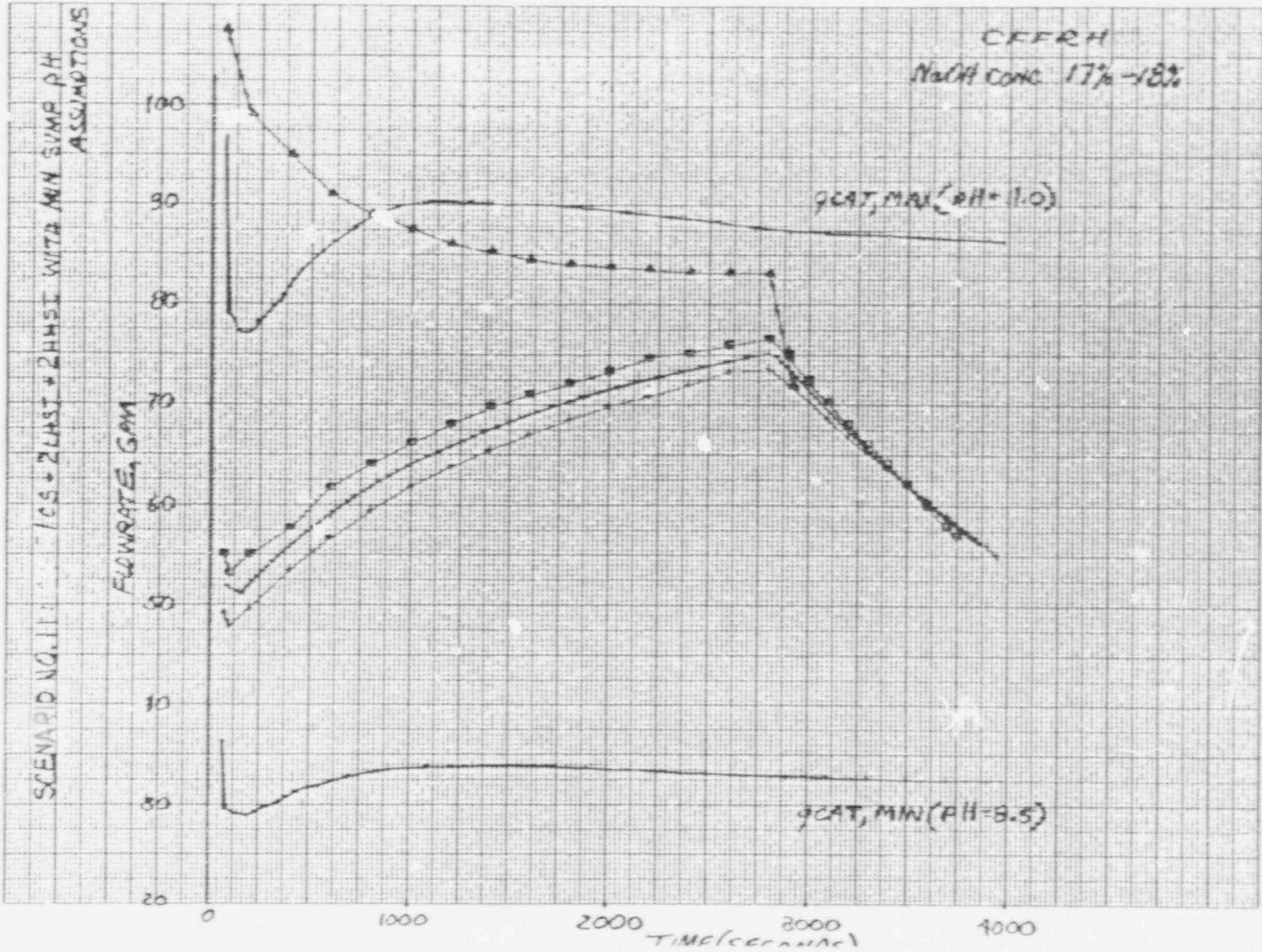
ATTACHMENT NO 5
PREP. P. ONEIL 3JUN80 PG. 11/25
REV C 6/15/80

SCENARIO NO.10: 2CS + 2LHSI + 2HHSI WITH NJR SUMP PH ASSUMPTIONS

CFFRH
NaOH CONC. = 17% - 18%



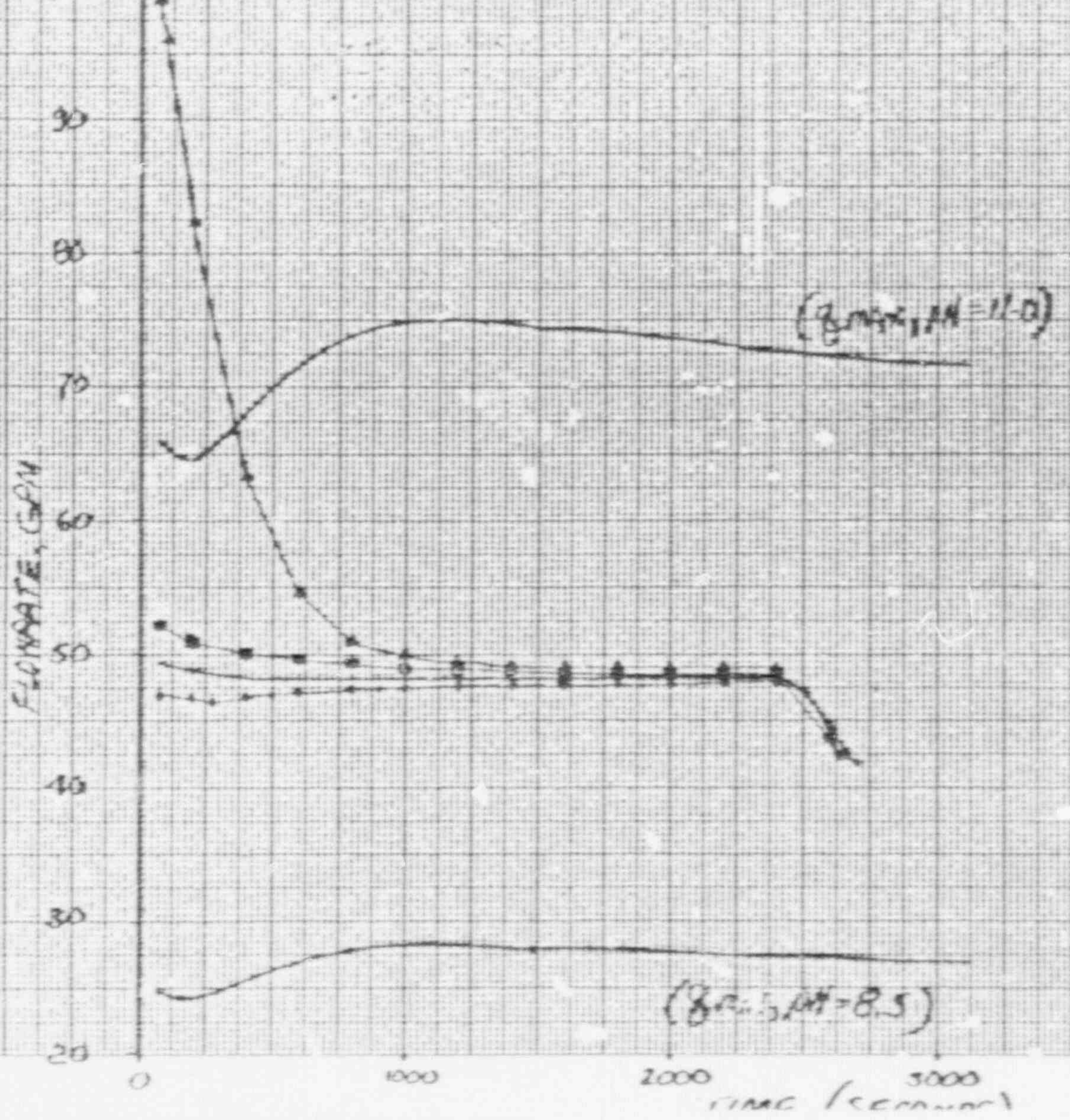
Calc No 12846.07/35 ATTACHMENT No 5
PREP: P. ONEIL 3 June 80 Pg 12/25
REV: C. Lewitrowski 6/5/80



SCENARIO NO. II : 1CS + 2LHSI + 2HHSI WITH MIN SUMP pH ASSUMPTIONS

SCENARIO NO. 12: 2CS + 1LHSI + 1HHSI WITH MIN SUMP
pH ASSUMPTIONS

CFFRH
NaOH CONC 17% - 18%



Calc No 12846.07/35

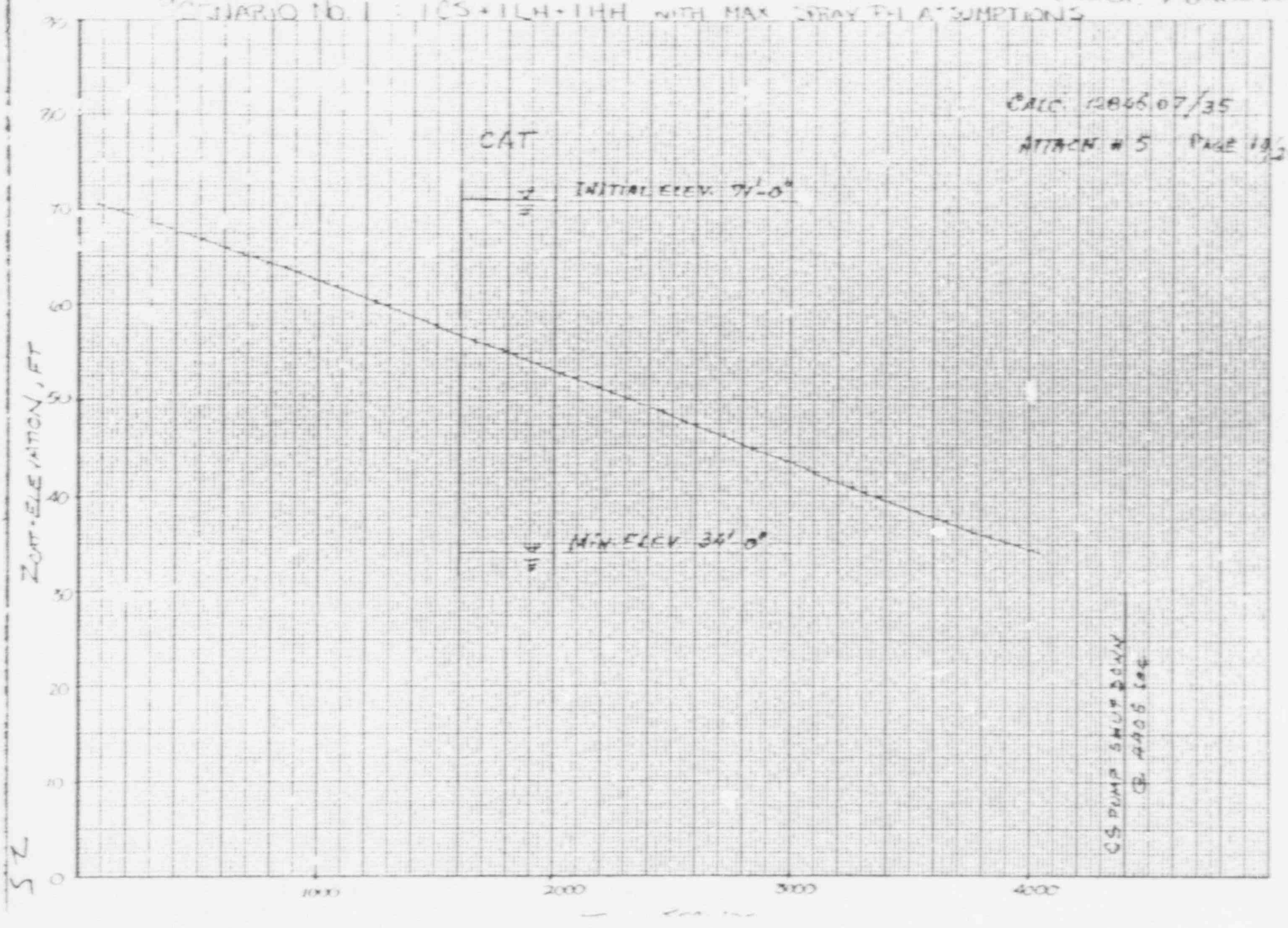
ATTACHMENT NO 5 pg. 13/25
PREP: P. O'NEIL 3.6.80
REV: C Einterrot 6/5/80

6/3/80

PREPARER C [illegible]

CHECKER: P O'NEAL 5 [illegible]

SCENARIO No. 1 : 1CS + 1LH + 1HH WITH MAX SPRAY P-L ASSUMPTIONS

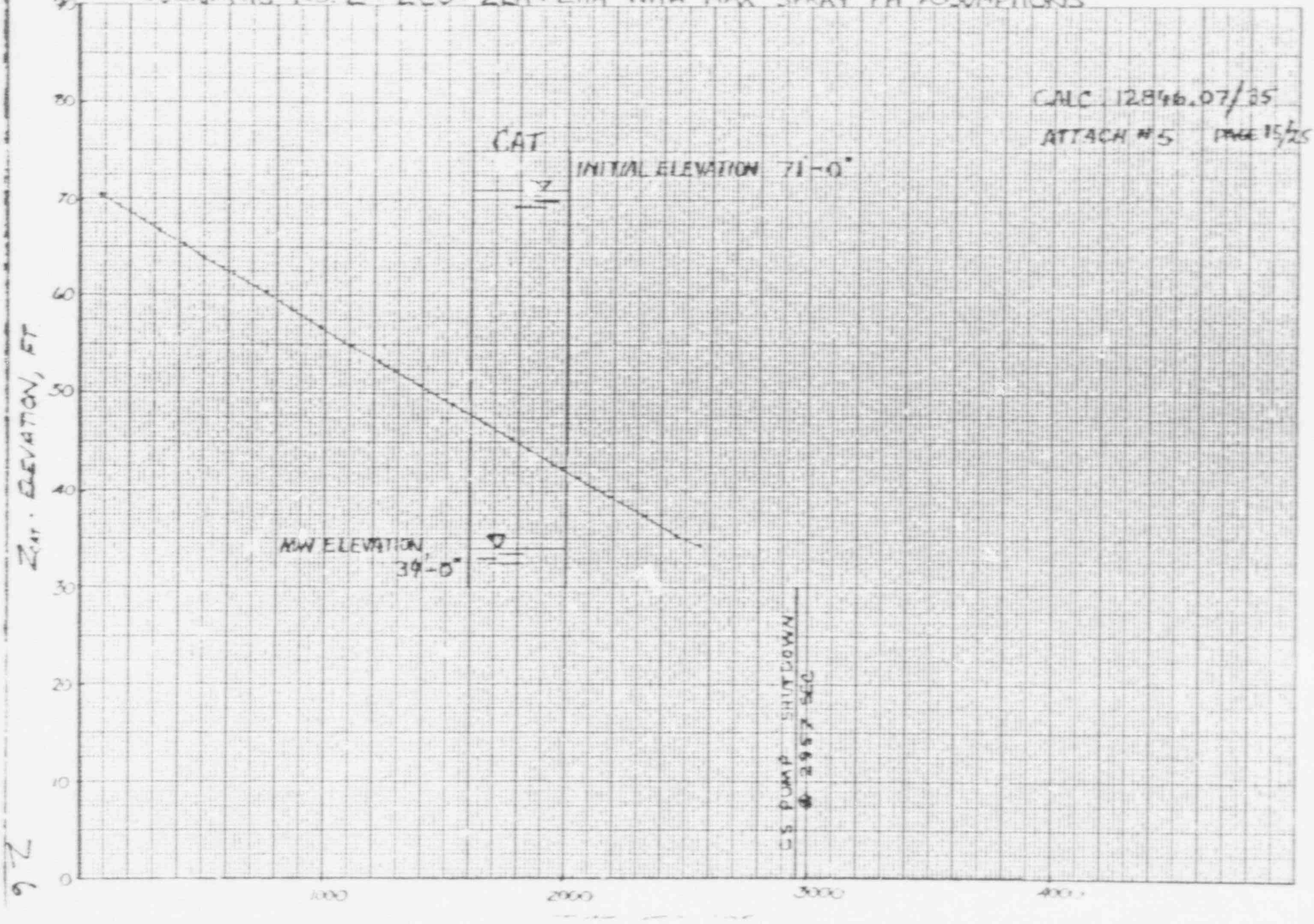


52

PREPARER: C. [illegible] 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

SCENARIO No. 2: 2CS + 2LH + 2HH WITH MAX SPRAY PH ASSUMPTIONS

CALC 12846.07/35
ATTACH #5 PAGE 15/25



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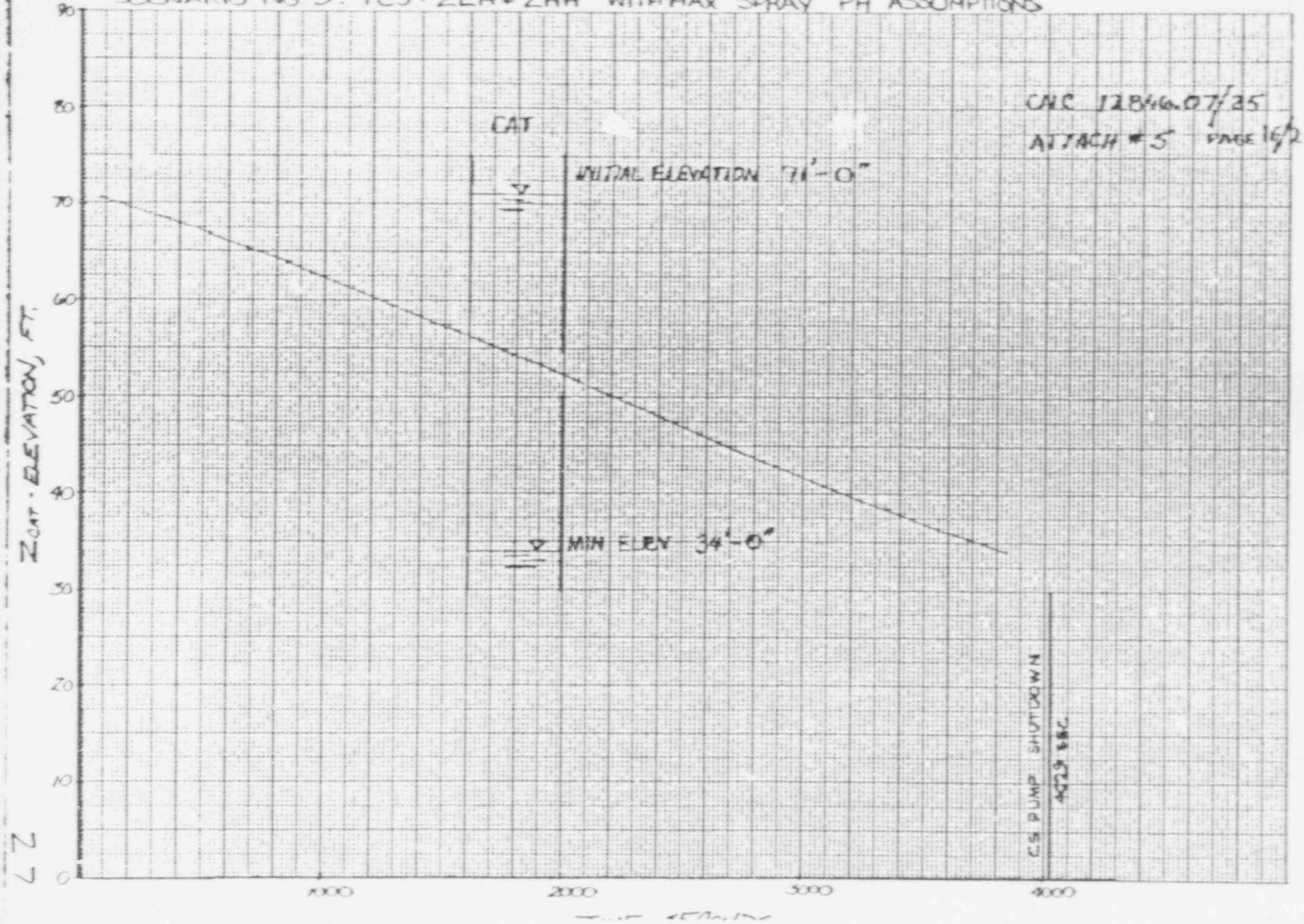
PREPARER: C Lemthroke 6/3/80
CHECKER: P. ONEIL 5 JUNE 80

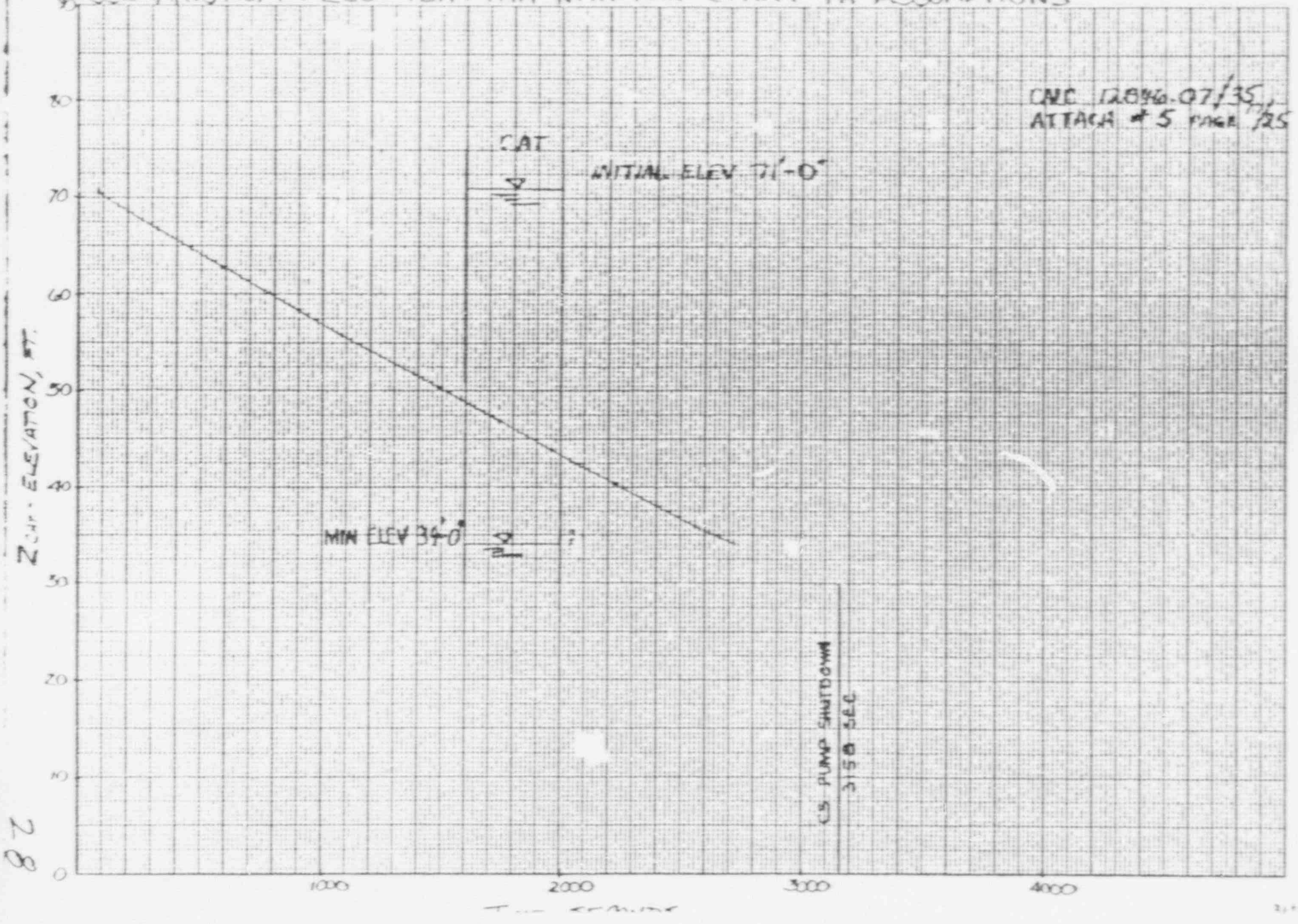
SCENARIO No. 3: 1CS + 2LH + 2HH WITH MAX SPRAY PH ASSUMPTIONS

CALC 12846.07/35
ATTACH #5 PAGE 16/25



PREPARER: C DIMITROVSKI 6/3/80
CHECKER: F ONEIL 5 JUNE 80

SCENARIO No. 4 : 2CS + 1LH + 1HH WITH MAX SPRAY PH ASSUMPTIONS



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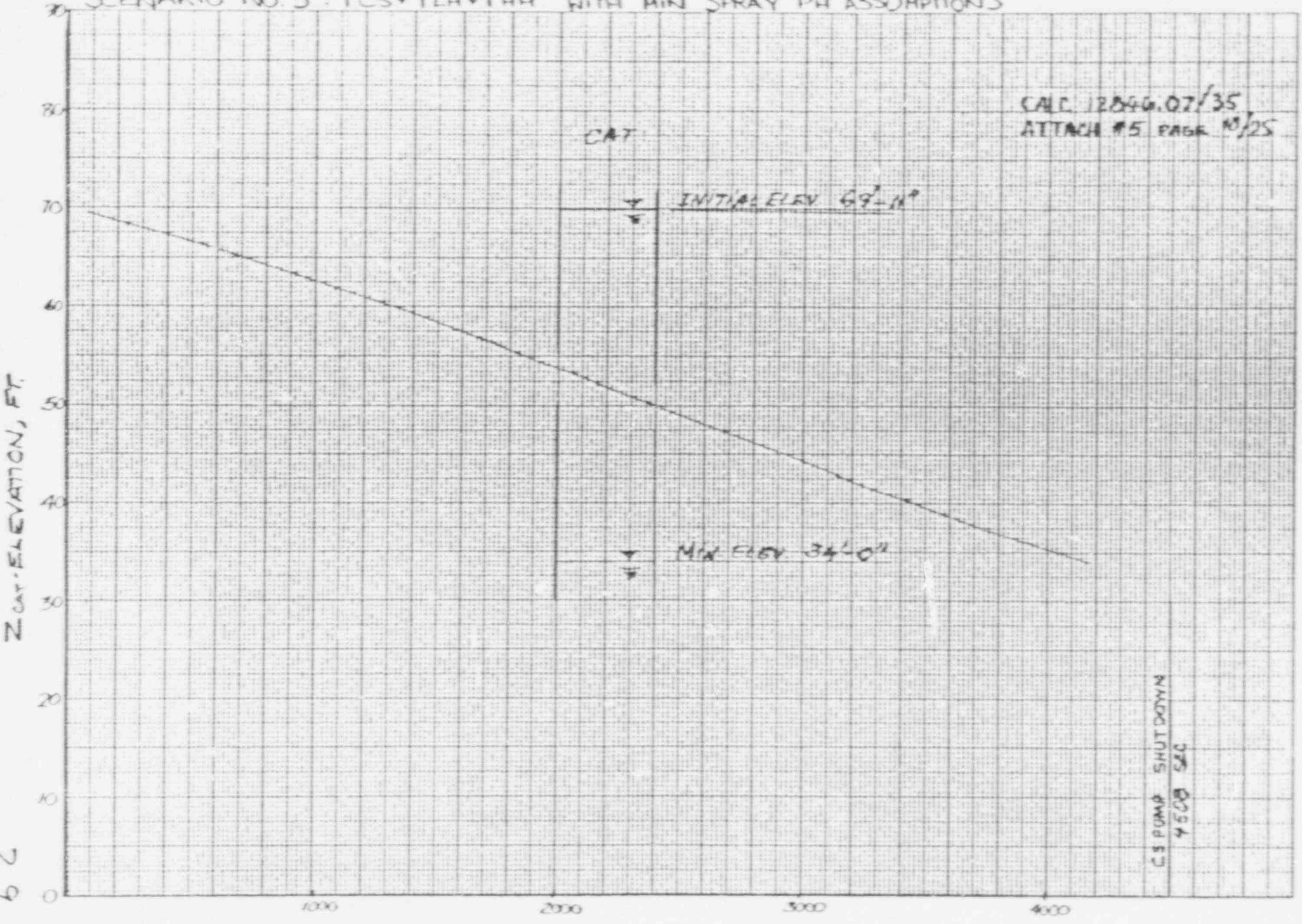
PREPARER: C. [illegible] 6/5/80
CHECKER: P. ONEIL 5 JUNE 80

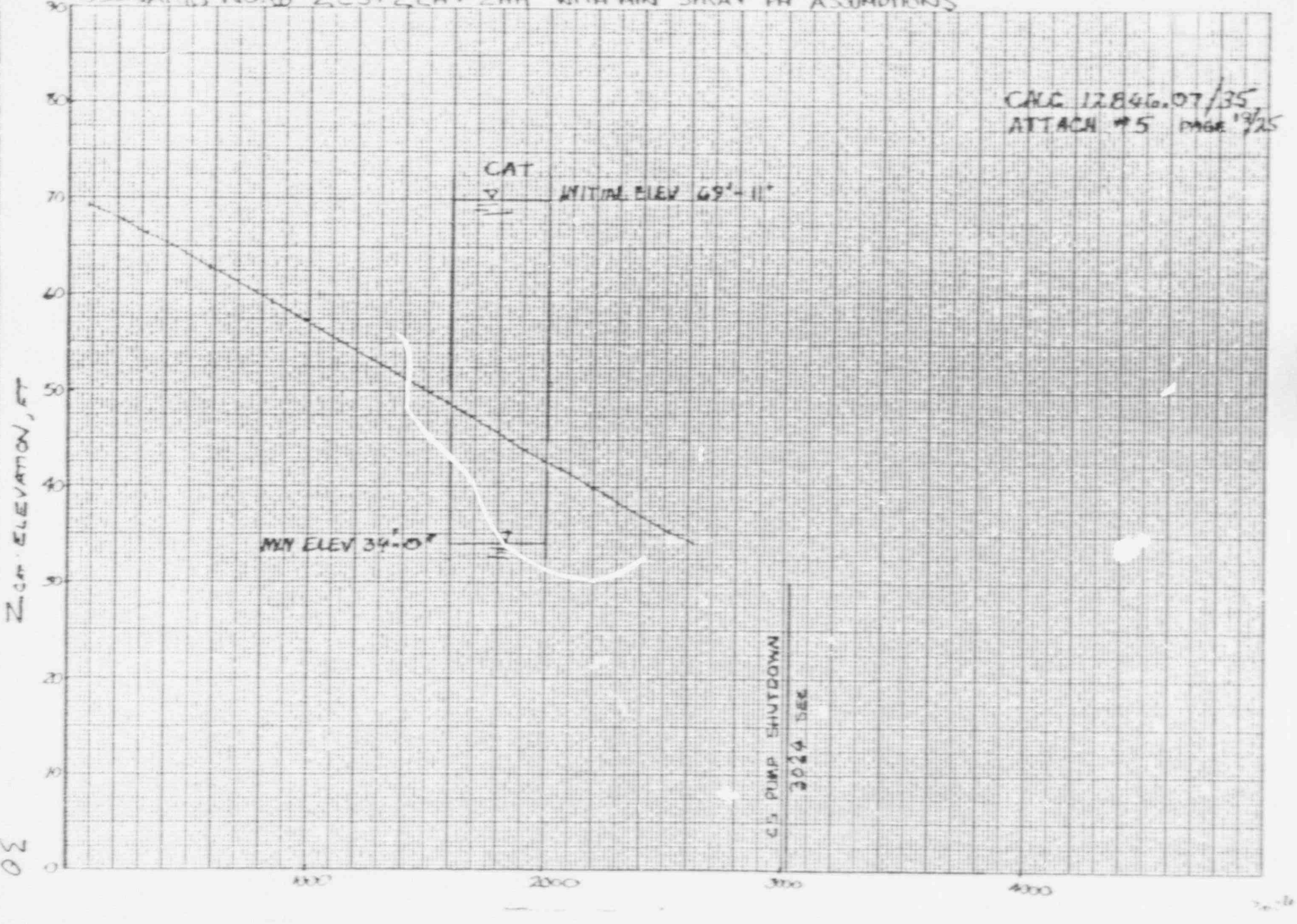
SCENARIO NO. 5 : 1CS + 1LH + 1HH WITH MIN SPRAY PH ASSUMPTIONS



PREPARER: C. 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

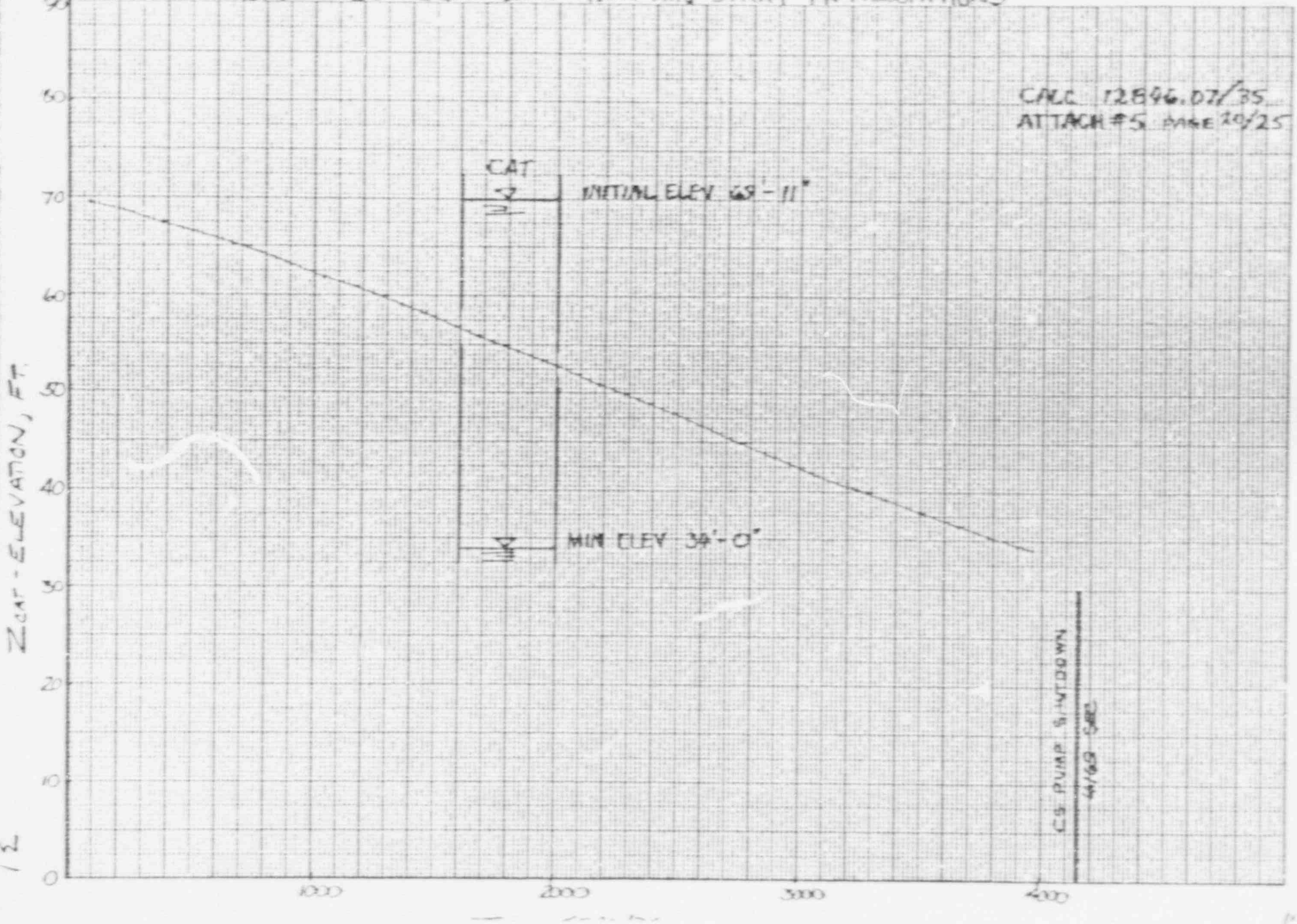
SCENARIO NO. 6 2CS + 2LH + 2HH WITH MIN SPRAY PH ASSUMPTIONS

CALC 12846.07/35
ATTACH #5 PAGE 19/25



PREPARER: C [illegible] 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

SCENARIO No. 7 : 1CS + 2LH + 2HH WITH MIN SPRAY PH ASSUMPTIONS



12

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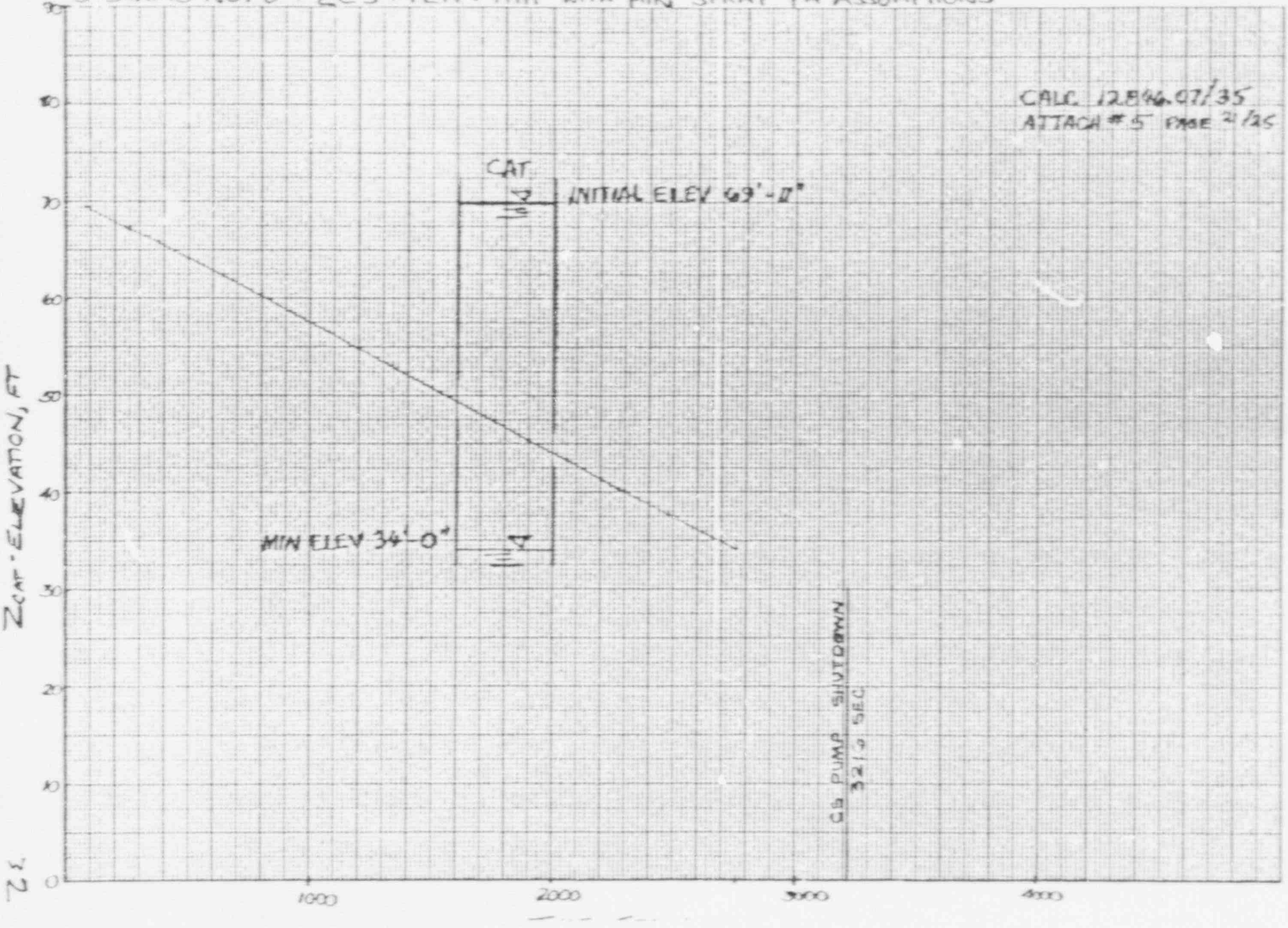
PREPARER: C. [illegible] 6/3/80
CHECKER: P. ONEIL 5 JUNE 80

SCENARIO NO. 8 : 2CS + 1LH + 1HH WITH MIN SPRAY PH ASSUMPTIONS



K·E

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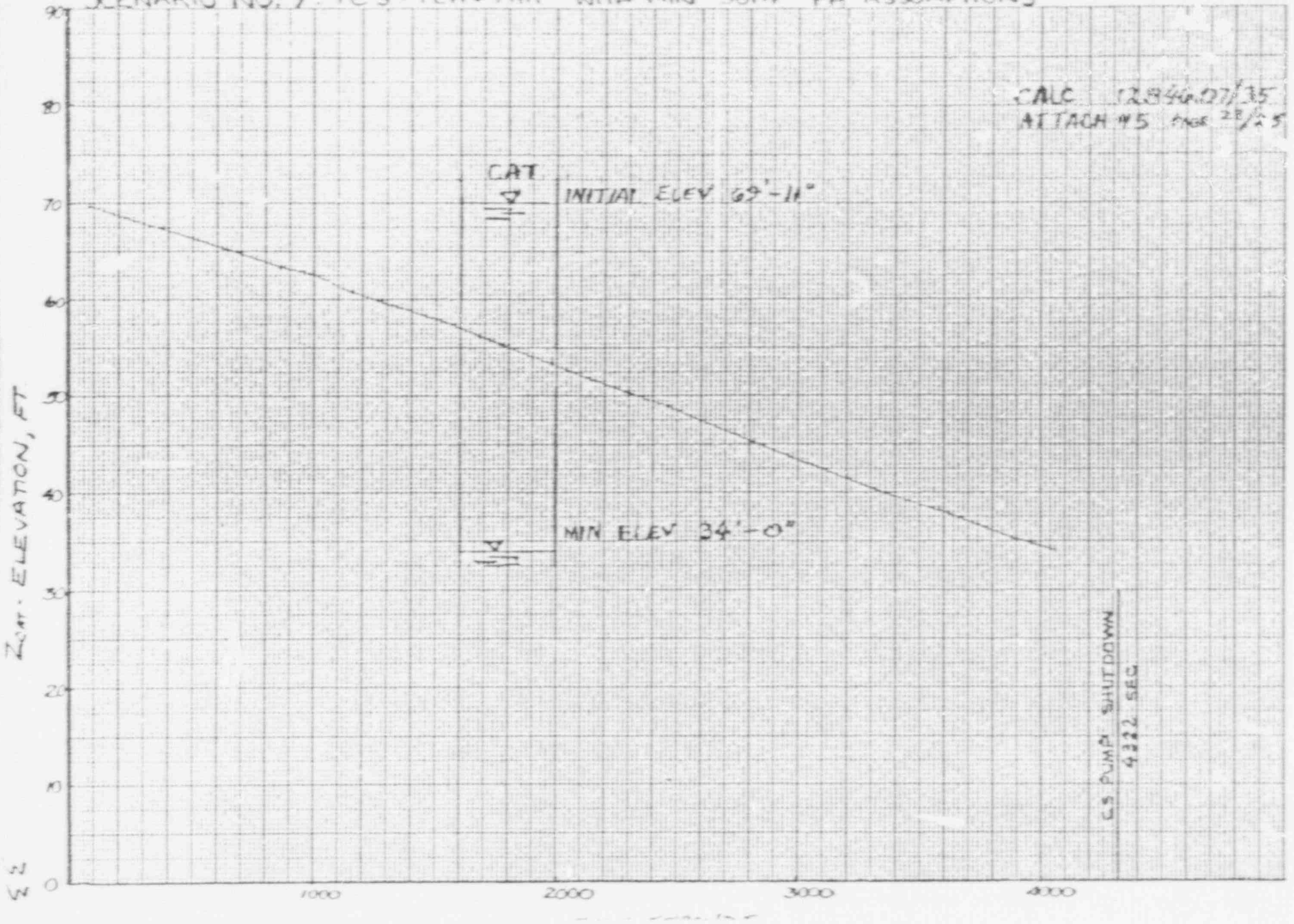
PREPARER: C. [illegible] 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

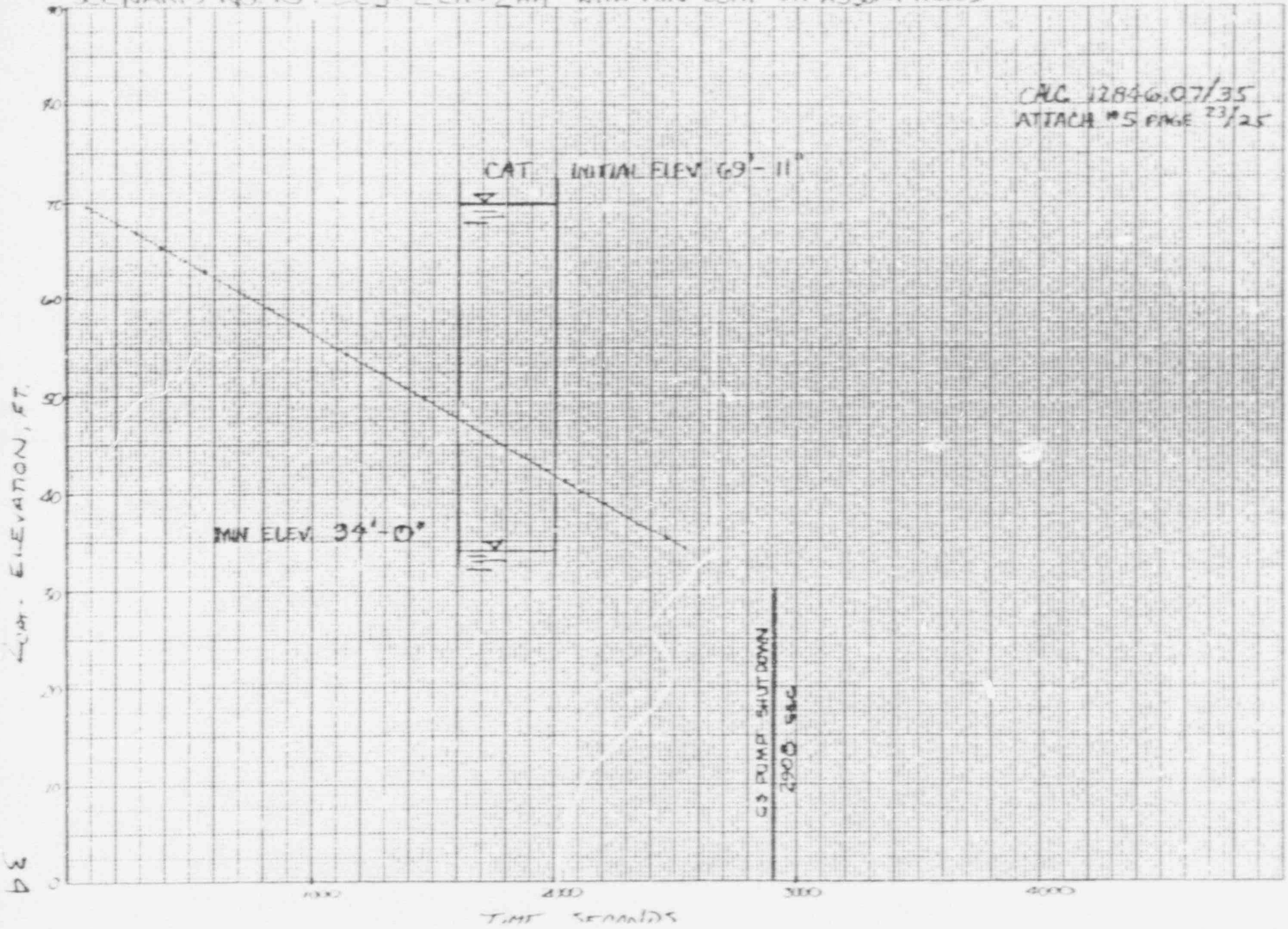
SCENARIO NO. 9: ICS + ILH + IHH WITH MIN SUMP PH ASSUMPTIONS



CALC 12846.27/35
ATTACH #5 PAGE 28/A5

PREPARER: C. [illegible] 6/3/80
CHECKER: P. ONEIL 5 JUNE 80

SCENARIO No. 10: 2CS + 2LH + 2HH WITH MIN SUMP PH ASSUMPTIONS



CALC 12846.07/35
ATTACH #5 PAGE 23/25

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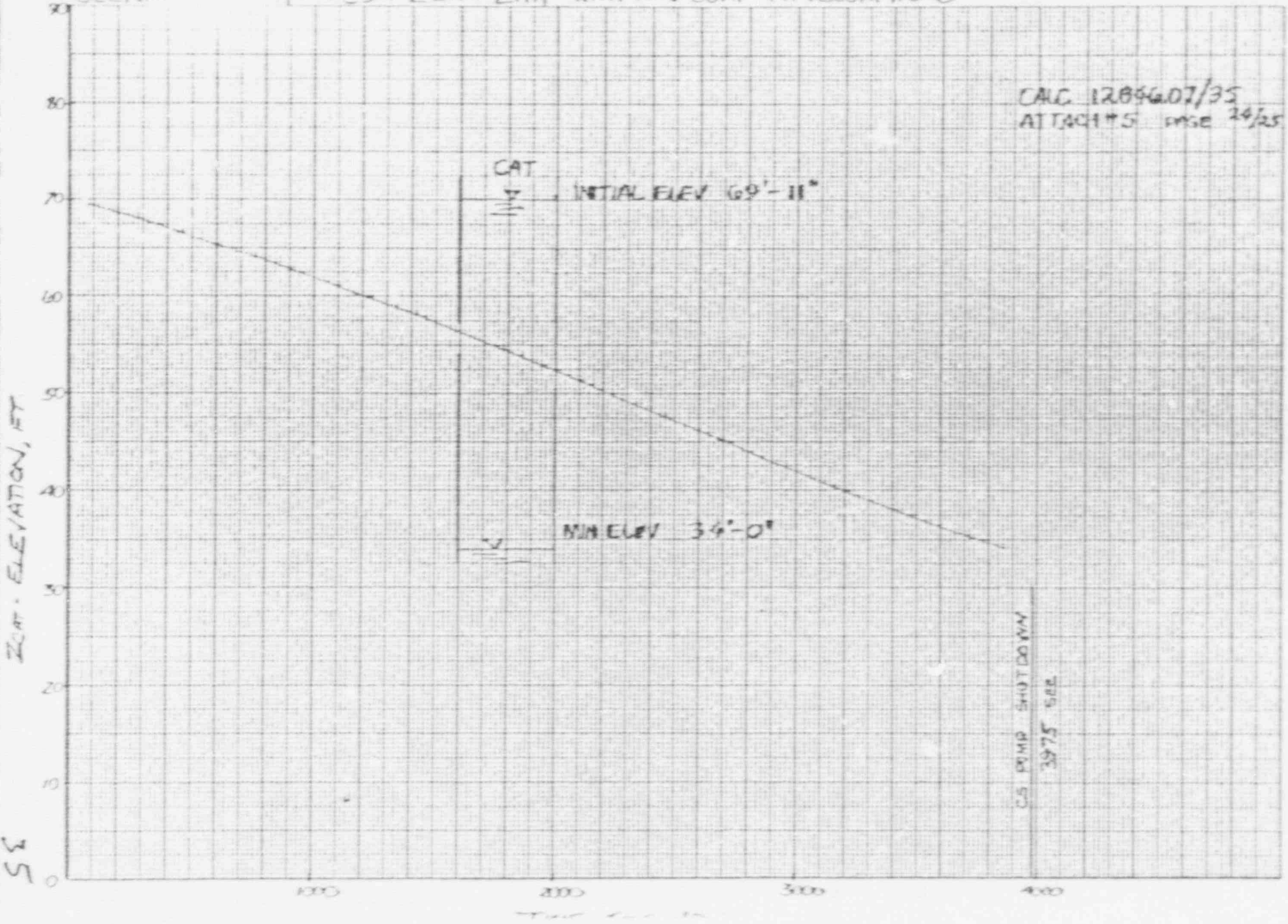
PREPARER: C. Tenttmute 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

SCENA[illegible] 1. 1CS + 2LH + 2HH WITH MIN SUMP PH ASSUMPTIONS



K·E

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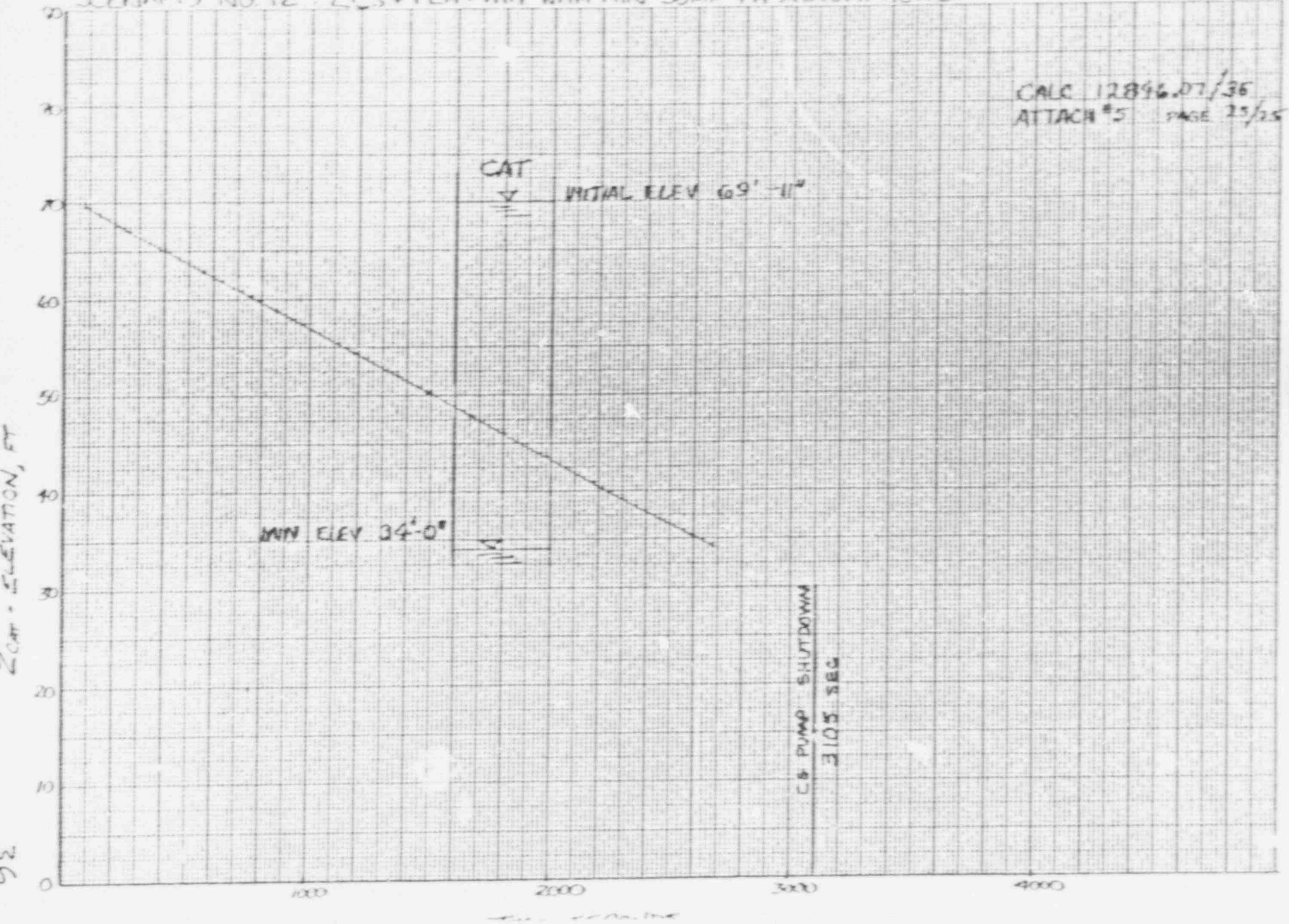
PREPARER: C. 6/3/80
CHECKER: P. O'NEIL 5 JUNE 80

SCENARIO NO. 12 : 2CS + 1LH + 1HH WITH MIN SUMP PH ASSUMPTIONS



CALC 12896.07/36
ATTACH #5 PAGE 25/25