Commonwe[illegible]h Edison
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Regulatory Docket File

March 10, 1975

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Mr. B. J. Youngblood, Chief
Environmental Projects Branch 3
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden Station Environmental
Technical Specification
NRC Dkts. 50-237 and 50-249

Dear Mr. Youngblood:

In response to your letter dated February 4, 1975 concerning this subject, attached is the additional information requested in your letter.

One (1) signed original and 39 copies are submitted.

Very truly yours,

JS Abel

J. S. Abel
Nuclear Licensing Administrator
Boiling Water Reactors

Att.

RECEIVED
MAR 24 1975
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

3098

Regulatory Docket File

Received w/Ltr Dated 3-10-75

Subject: Response to NRC Requests (dated Feb. 4, 1975)
re. Dresden Environmental Technical Specifications

1. An explanation of the assumptions, theory, model and measurements involved in the derivation of the closed cycle curve in Figure 2.1.1 of the November 18, 1974 report is given in the attached Appendix. Similar arguments can be made for the open cycle curve appearing in the same figure.

2. The downstream temperature TL is measured by a Foxboro recorder on the tailwater side of the Dresden Island Lock and Dam. The location was selected by Mr. Robert R. Jaske formerly of Battelle Northwest in cooperation with the USGS in 1967. The USGS owns and maintains the recorder. Data was used by Mr. Jaske in his COLHEAT model for determining thermal load on the upper Illinois River. The temperatures are considered representative of downstream mixed conditions. When plume studies are performed in the field, the TL is determined by making an average of temperature measured horizontally and vertically across the headwater face of the dam. A study is being performed to validate the method described on page 3 with current field data.

3. Enclosed are drawings of four thermal plume measurements. Two were performed on August 10, 1974 and the remainder on October 17 and October 21, 1974. The flow of the Illinois River was determined by using gate openings at the Dresden Island Lock and Dam and a discharge rating curve. TL was determined by making an average of the headwater temperatures at the dam.

   Study of August 10, 1974 (morning):

   The plant load was 1246 MWe (Unit 1=75, Unit 2=650, Unit 3=500). Flow from the Unit 1 discharge canal was 378 cfs. Unit 2/3 discharge was zero. Flow in the river was about 5,450 cfs and the ambient water temperature was 28.1°C. The area contained within the excess 2.8°C isoline was 0.35 acres.

   Study of August 10, 1974 (afternoon):

   The plant load was 1480 MWe (Unit 1 = 128, Unit 2 = 615, Unit 3 = 737). Flow from the Unit 1 discharge canal was 378 cfs and from the Unit 2, 3 canal was 111 cfs. The river flow was about 5,450 cfs and the ambient water temperature was 28.1°C. The area contained within the excess 2.8°C contour was 0.29 acres.

   Study of October 17, 1974:

   The plant load was 1475 MWe (Unit 1 = 75, Unit 2 = 650, Unit 3 = 750). Flow from the Unit 1 discharge canal was 378 cfs and the ambient water temperature was 19.6°C. There was no discernable area 2.8°C above ambient.

Study of October 21, 1974:

The plant load was 819 MWe (Unit 1=100, Unit 2=0, Unit 3=719). Flow from the Unit 1 discharge was 285 cfs and from the Unit 2,3 discharge was 117 cfs. The river flow was 2800 cfs and the ambient water temperature was 16.4°C. There was no discernable area 2.8°C above ambient.

4. Construction of the modification to the Unit 1 discharge canal outfall has been completed. The modification consisted of the removal of an existing rock jetty (see drawing no. B-27 and B-28 attached) and the installation of a slot jet outfall. The new outfall consists of two circular cells twenty feet in diameter. The cells are separated by about eight feet. This separation forms the slot which creates the high velocity discharge necessary for rapid mixing. The cells are formed of sheet metal piling, filled with rubble obtained when the jetty was removed and are capped with concrete. The cells are tied back to the shore with rock filled dikes. The Unit 2, 3 canal was not modified. The mode of operation is for Unit 2, 3 blowdown and the Unit 1 circulating water to be discharged from their respective canals.

5. The chlorine data is attached.

Dresden Station Condenser Chlorination Data

Unit 1

	ppm	
Date	Free Chlorine	Total Residual
1- 3-75	0.1	0.4
1- 8-75	0.2	0.5
	Chlorinator out of Service	
1-28-75	0.1	0.3
	No Chlorination in February	
to Date		

Notes

1. Analysis is conducted immediately after samples are collected.
2. Method of analysis - orthotolidine
3. Collection of samples at discharge of condenser immediately after injection of chlorine.
4. Future samples will be collected at 4, 8, 12, 16 and 20 minutes after injection begins. The average of samples will be the composite of the chlorination period.

Units 2-3

No chlorine monitoring has been conducted in 1975.

Monthly monitoring was conducted during 1974. Samples were collected at the condenser discharge and in the tail water of the spill way at the discharge of the cooling lake. The samples were analyzed using the orthotolidine technique. The condenser discharge samples averaged approximately 0.3 ppm residual chlorine (free chlorine plus chlorimines), and the maximum residual chlorine measured at the condenser discharge was 0.7 ppm. The lake discharge samples were all below the lower limit of residual chlorine detectability using the orthotolidine measuring technique. This lower limit is something less than 0.1 ppm residual chlorine.

APPENDIX

Summary and Interpretation of IIHR Laboratory Data for Compliance-Test Diagrams.

The laboratory experiments on which the compliance-test diagrams are based were conducted in a thermal-hydraulic model at the Iowa Institute of Hydraulic Research with a 1:36 vertical scale and a 1:108 horizontal scale. The model includes a 2500-ft reach of the Illinois River extending from a cross section 400 ft upstream from the discharge flumes to a section 2100 ft downstream. The 3 to 1 vertical distortion was dictated by the available space for the model together with the requirement that depth of flow in the model be sufficiently large to ensure turbulent ambient river flow in the model.

Flow velocities and discharges were scaled according to the densimetric Froude similarity law according to which there is dynamic similarity between a geometrically similar model and prototype if the densimetric Froude number,

$$\mathbb{F}_D = \frac{U}{\sqrt{\frac{\Delta\rho}{\rho} g L}} \tag{A1}$$

has the same value in both model and prototype. In Eq. A1, U = a representative velocity; L = a representive length dimension; g = acceleration of gravity; $\frac{\Delta\rho}{\rho}$ = ratio of density difference between ambient and heated water to density of ambient water.

In a distorted model, L is defined as a representative vertical dimension, usually a representative depth. Due to the relaxation of the geometrical similarity requirement, dynamic similarity in the transverse direction is not preserved so that compensating adjustments are required. In the present case, the rate of transverse turbulent mixing and the outward displacement of the plume trajectory tend to be overpredicted in the model. As compensating adjustments, the bed of the model was roughened, and the slot width of the discharge structure was doubled in order to reduce the turbulent mixing and the outward displacement of the plume by reducing the initial jet velocity at the discharge structure. The factor of two was arrived at through a calibration procedure in an earlier phase of the investigation, wherein results from an undistorted near-field model were compared with results from the distorted model for a similar though not identical outfall configuration. This has been recommended also by Neale and Hecker (2). Although increasing the slot width and reducing the initial jet velocity in the distorted model by a factor of two produced the best overall match between results in the distorted and undistorted models, differences in detail were observed. In particular there was an increased tendency for vertical density and temperature stratification to occur in the distorted model, arising from the reduction in the value of the initial jet densimetric Froude number

$$\mathbb{F}_{DO} = \frac{U_o}{\sqrt{\frac{\Delta\rho_o}{\rho} g\, h_o}} \qquad \text{(A2)}$$

by a factor of two. In Eq. A2 U_o = initial jet velocity, and h_o = initial jet height = 7 ft in the prototype. The slot width in the prototype is b_o = 7.67 ft.

A typical set of surface isotherms of the normalized temperature rise $\Delta T/\Delta T_D$, observed in the model, is shown in Fig. A1. Values of $\Delta T_{26}/\Delta T_D$ for constructing the compliance-test diagrams were obtained from the surface isotherm data by planimetering the areas enclosed by the different isotherms and plotting the $\Delta T/\Delta T_D$ values against the enclosed areas in acres. The point at which the curve connecting the points crosses the line A = 26 acres defines the value of $\Delta T_{26}/\Delta T_D$.

To construct the compliance-test diagrams the resulting values of $\Delta T_{26}/\Delta T_D$ were plotted against Q_{ILL} as shown in Fig. A2 for the mixed-discharge operating mode. Two curves are shown in Fig. A2. The solid curve simulates full plant load with ΔT_{D1} = 19°F, $\Delta T_{D2,3}$ = 28°F, ΔT_{I1} = 0, T_{ILL} = 85°F for summer, and T_{ILL} = 55°F for the months when the ice-melting system is in operation. For these conditions $\mathbb{F}_{DO} \approx 5$ in the model (10 in the prototype). Any reduction in ΔT_{D1}, $\Delta T_{D2,3}$, or T_{I11}, either individually or collectively, would increase the value of $\mathbb{F}_{DO}$, consequently reducing the tendency for vertical temperature stratification to occur, which in turn would reduce the value of $\Delta T_{26}/\Delta T_D$. This tendency is verified in the dashed curve for which $\mathbb{F}_{DO}$ was increased to about 10 in the model (20 in the prototype) by reducing the values of ΔT_{D1} and $\Delta T_{D2,3}$. Note that each of the curves represents both summer and winter conditions. Apparently the reductions in Q_1 and T_{ILL} for the winter conditions have mutually offsetting effects.

Due to the tendency of the distorted model to accentuate stratification effects, it is quite possible that the dashed curve simulates full load conditions in the prototype better than the solid curve. However, the conservative approach was followed in adopting the solid curve for use in the provisional compliance-test diagram in Fig. 3.

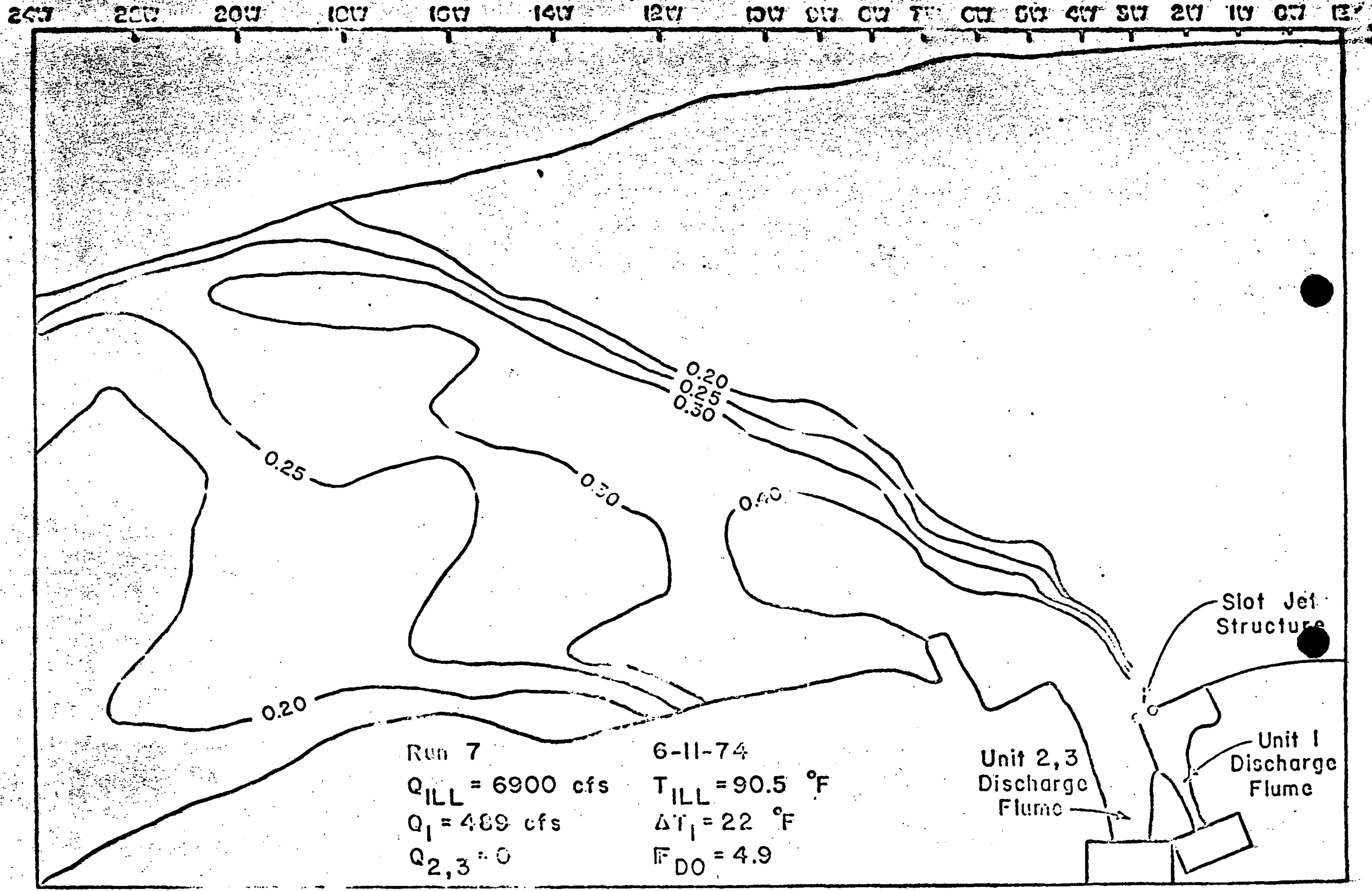
Fig. A3 shows the laboratory data used in constructing the compliance-test diagram for the unmixed-discharge operating mode. Only the summertime conditions were simulated in the laboratory. The third variable $\mathbb{F}_{DO}$ is in this case a hybrid initial jet densimetric Froude number wherein U_o = initial velocity of the Unit 1 discharge through the slot, and $\Delta\rho_o$ = density difference based on the ambient temperature T_{ILL} and the temperature of the combined heated discharges T_D. Two data points are shown for which $\mathbb{F}_{DO} = 10$. For the upper one, $\mathbb{F}_{DO}$ was increased by halving the slot width and doubling U_o. For the lower one, $\mathbb{F}_{DO}$ was increased by reducing ΔT_D. It apparently makes little difference which way $\mathbb{F}_{DO}$ is increased. In comparison with Fig. A2, there seems to be relatively little sensitivity to $\mathbb{F}_{DO}$ in Fig. A3. This result was somewhat unexpected.

The model data used in constructing the compliance-test diagram is summarized in Table A1. Background information on discharges, temperatures and initial conditions is presented in Cols. 4-11. The parameter b'_o/b_o in

Col. 3 is the ratio of the slot width of the discharge structure, as modified to compensate for vertical distortion effects in the model, to the unmodified slot width. The main results of the tests are listed in Cols. 12-14. The $\Delta T_{26}/\Delta T_D$ values in Col. 12 are the same as those in Figs. A2 and A3. In Col. 13, the numerator ΔT_{25} is the temperature rise of the cross-sectional isotherm enclosing the 25 percent of the cross-sectional area within which the temperature rise is highest, for the cross section identified in Col. 14. The sections listed in Col. 14 (see Fig. A1 for their locations), are the ones in which the highest ΔT_{25} values in any given run were observed. The ratio $\Delta T_{25}/\Delta T_{26}$ is thus a measure of the temperature rise at the perimeter of the mixing zone as defined by the zone-of-passage criterion, relative to the temperature rise at the perimeter of the mixing zone as defined by the 26-acre surface area criterion. So long as this ratio is less than one, the 26-acre surface area criterion controls. Thus the $\Delta T_{25}/\Delta T_{26}$ values in Col. 13 clearly indicate that the 26-acre surface area criterion is the controlling one over the range of condition tested. The $\Delta T_{25}/\Delta T_{26}$ values reach one only at Q_{ILL} = 23,000 cfs, when the temperature rise at the mixing zone perimeter would be about 0.8°F at most.

Table A1. Summary of Model Data for Compliance-Test Diagrams

Operating Mode (1)	Run (2)	b'_o/b_o (3)	Q_{ILL} cfs (4)	Simulated T_{ILL} °F (5)	Q_1 cfs (6)	Simulated ΔT_{D1} °F (7)	$Q_{2,3}$ cfs (8)	Simulated $\Delta T_{D2,3}$ °F (9)	Simulated ΔT_D °F (10)	F_{DO} (11)	$\frac{\Delta T_{26}}{\Delta T_D}$ (12)	$\frac{\Delta T_{25}}{\Delta T_{26}}$ (13)	Sect. No. (14)
Mixed	4	2	4800	≈ 85	378	19	111	28	21.0	4.7	0.29	0.24	10W
	5	2	4800	≃ 85	378	4.8	111	7.0	5.3	9.5	0.23	0.39	18W
	7	2	7400	≃ 85	378	19	111	28	21.0	4.8	0.24	0.29	9W
	7R	2	7400	≃ 85	378	19	111	28	21.0	4.9	0.24		
	7a	1	7400	≃ 85	378	19	111	28	21.0	10.0	0.18	0.20	12W
	8	2	7400	≃ 85	378	4.8	111	7.0	5.3	9.2	0.18	0.50	14W
	8R	2	7400	≃ 85	378	4.8	111	7.0	5.3	9.0	0.18	0.33	14W
	9	2	7300	≃ 55	291	19	111	28	21.5	4.7	0.24	0.38	9W
	10	2	7300	≃ 55	291	6.7	111	9.9	7.6	9.4	0.15	0.07	12W
	10R	2	7300	≃ 55	291	6.7	111	9.9	7.6	9.0	0.15	0.27	14W
	11	2	10,000	≃ 85	378	19	111	28	21.0	4.7	0.16	0.38	9W
	12	2	14,500	≃ 85	378	19	111	28	21.0	5.0	0.08	0.63	16W
	13	2	23,500	≃ 85	378	19	111	28	21.0	4.9	0.04	1.0	1[illegible]
	14	2	23,500	≃ 85	378	4.8	111	7.0	5.3	9.0	0.04	1.0	14W
	15	2	23,400	≃ 55	291	19	111	28	21.5	4.5	0.035	1.0	12W
	16	2	23,400	≃ 55	291	6.7	111	9.9	7.6	8.8	0.04	0.75	14W
Unmixed	4	2	4800	≃ 85	378	19	111	28	21.0	5.0	0.33	0.16	16W
	7	2	7400	≃ 85	378	19	111	28	21.0	5.0	0.29	0.09	10W
	7a	1	7400	≃ 85	378	19	111	28	21.0	10.0	0.26	0.14	14W
	8	2	7400	≃ 85	378	4.8	111	7.0	5.3	10.0	0.24	0.22	16W
	11	2	10,000	≃ 85	378	19	111	28	21.0	5.0	0.20	0.18	14W
	12	2	14,500	≃ 85	378	19	111	28	21.0	5.0	0.06	0.57	16W



Run 7
Q_{ILL} = 6900 cfs
Q_1 = 489 cfs
$Q_{2,3}$ = 0

6-11-74
T_{ILL} = 90.5 °F
ΔT_1 = 22 °F
$\mathbb{F}_{DO}$ = 4.9

Fig. A1. - Surface isotherms of normalized temperature rise $\frac{\Delta T}{\Delta T_D}$ for mixed-discharge mode, Q_{ILL} = 6900 cfs.

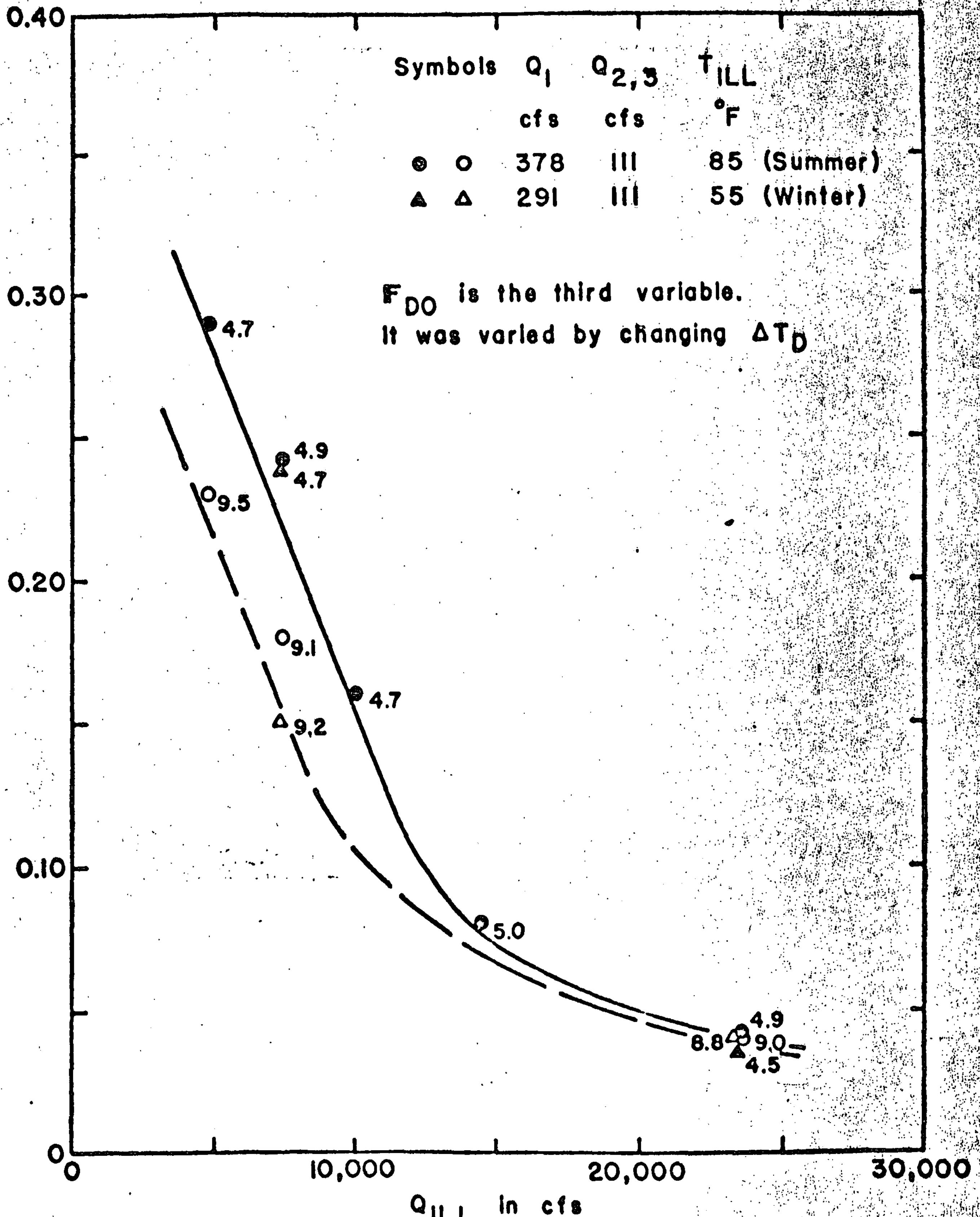


Fig. A2. - Laboratory data for mixed-discharge mode compliance-test diagram.

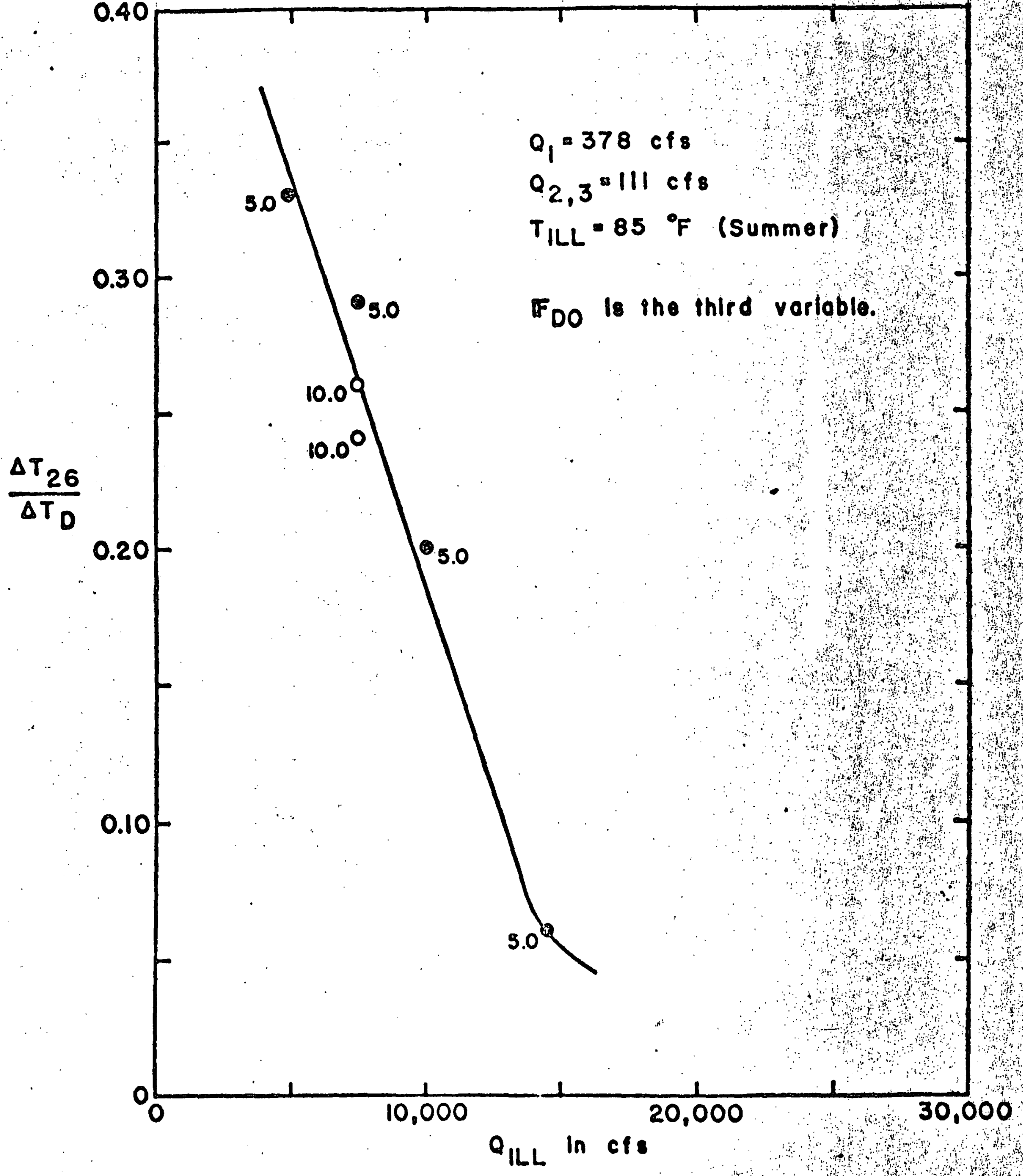
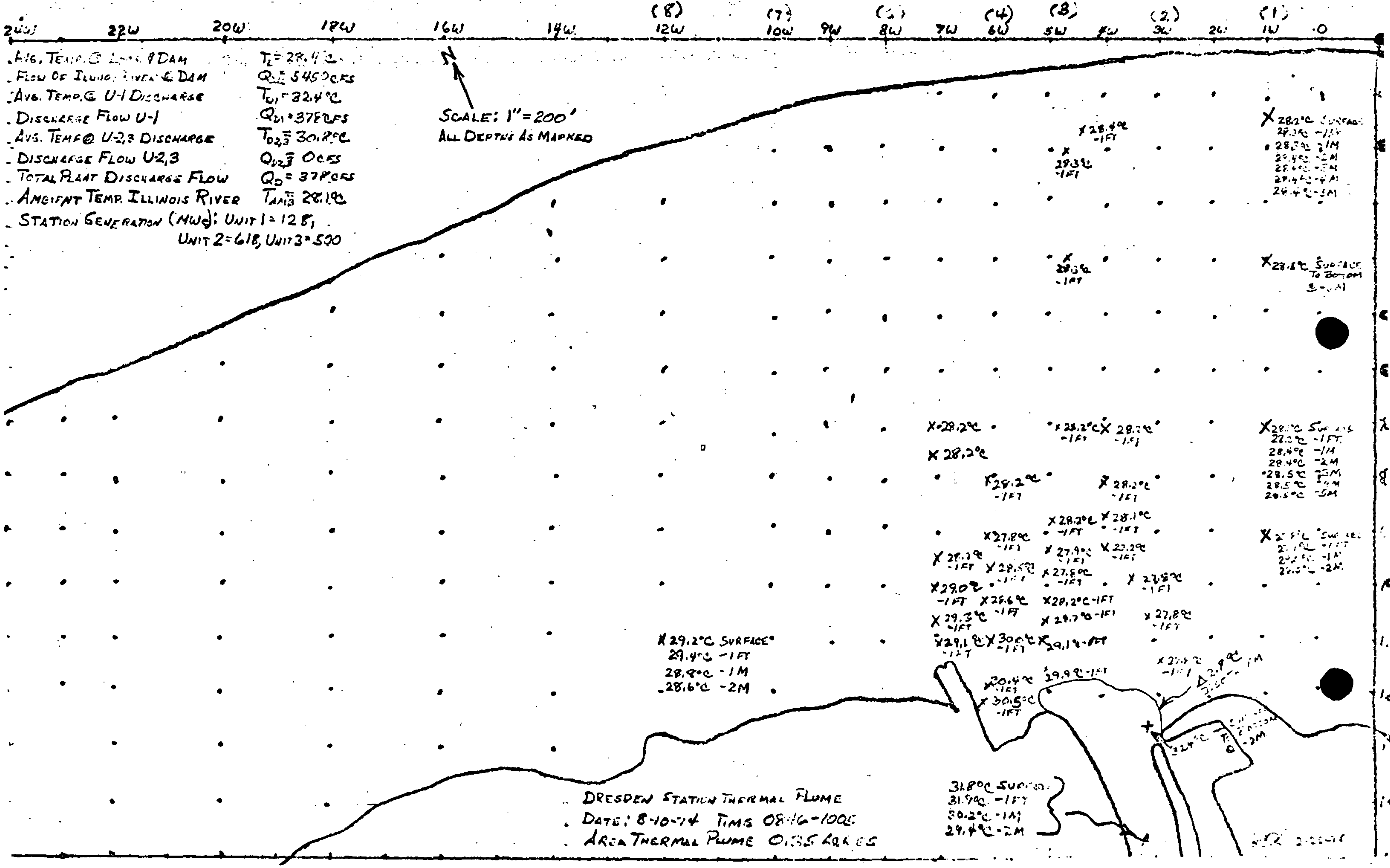


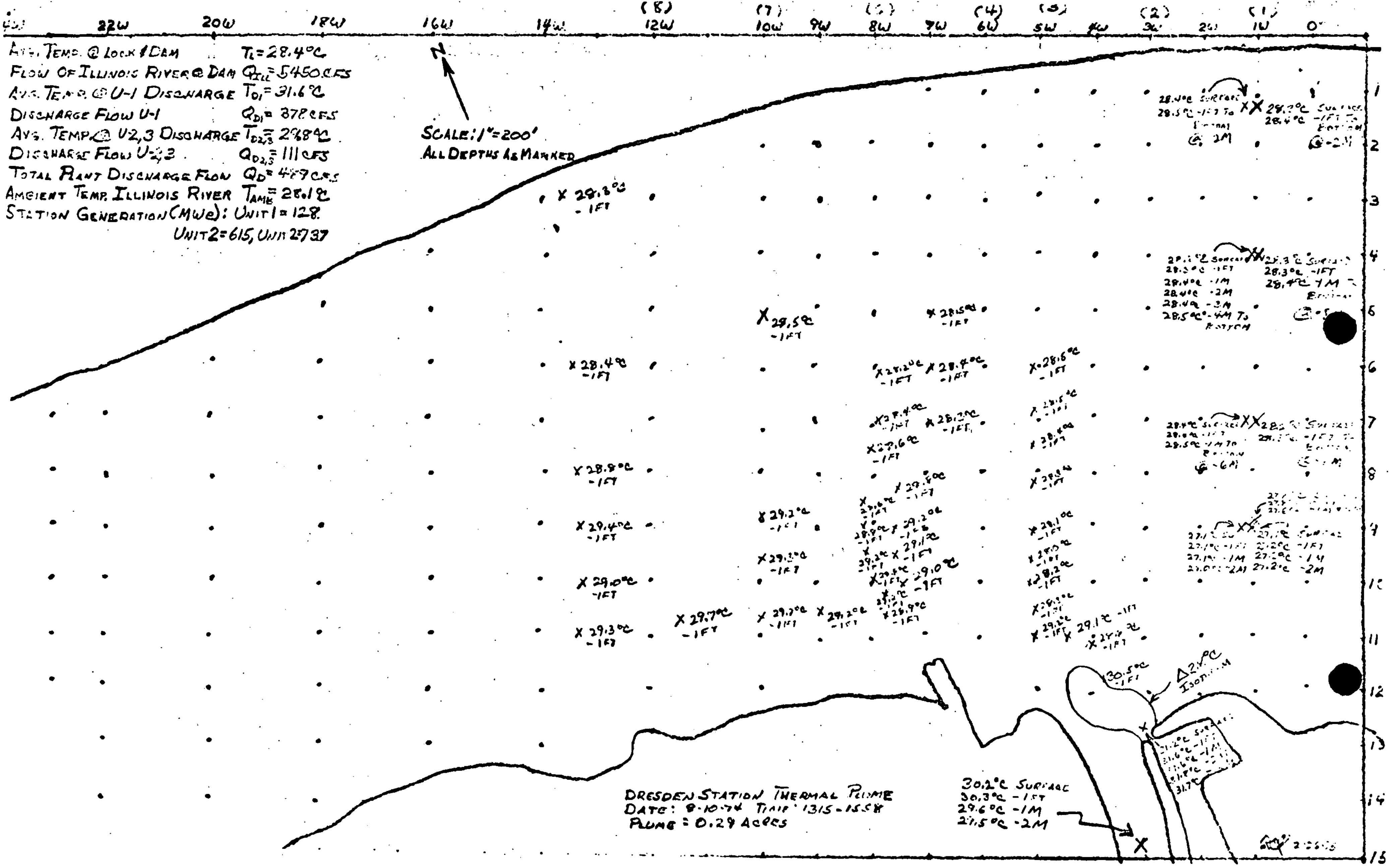
Fig. A3. - Laboratory data for unmixed-discharge mode compliance-test diagram.



Avg. Temp. @ Lock & Dam T_L = 28.4°C
Flow of Illinois River @ Dam Q = 5450 cfs
Avg. Temp. @ U-1 Discharge T_U1 = 32.4°C
Discharge Flow U-1 Q_D1 = 378 cfs
Avg. Temp @ U-2,3 Discharge T_D2,3 = 30.8°C
Discharge Flow U-2,3 Q_D2,3 = 0 cfs
Total Plant Discharge Flow Q_D = 378 cfs
Ambient Temp. Illinois River T_AMB = 28.1°C
Station Generation (MWe): Unit 1 = 128,
Unit 2 = 618, Unit 3 = 500

Scale: 1" = 200'
All Depths As Marked

Dresden Station Thermal Plume
Date: 8-10-74 Time 0846-1005
Area Thermal Plume 0.35 Acres

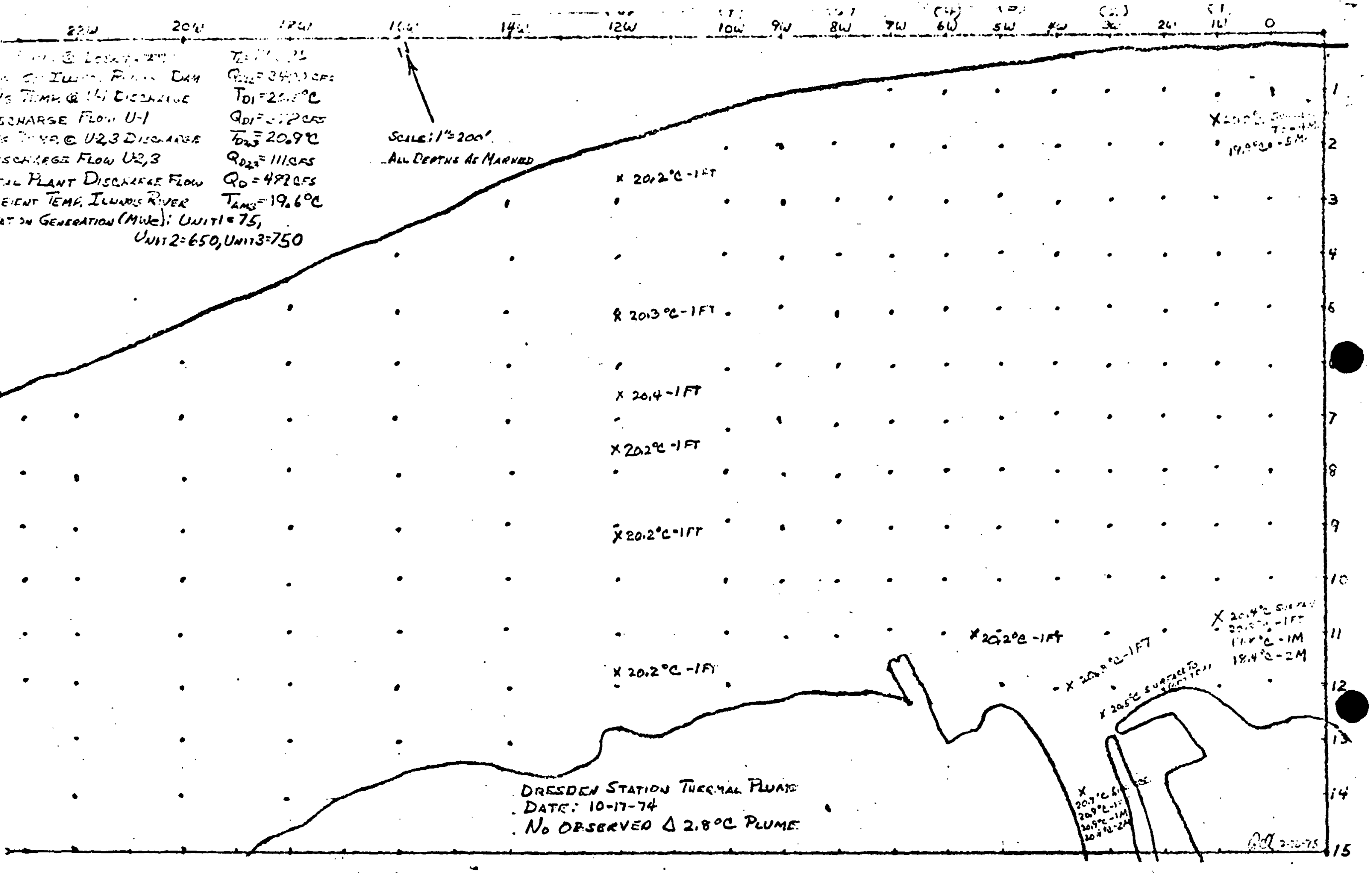


Avg. Temp. @ Lock & Dam T_L

Avg. Temp. @ Lock & Dam $T_L = 28.4°C$
Flow of Illinois River @ Dam $Q_{ILL} = 5450$ CFS
Avg. Temp. @ U-1 Discharge $T_{D1} = 31.6°C$
Discharge Flow U-1 $Q_{D1} = 378$ CFS
Avg. Temp. @ U2,3 Discharge $T_{D2,3} = 29.8°C$
Discharge Flow U-2,3 $Q_{D2,3} = 111$ CFS
Total Plant Discharge Flow $Q_D = 489$ CFS
Ambient Temp. Illinois River $T_{AMB} = 28.1°C$
Station Generation (MWe): Unit 1 = 128.
Unit 2 = 615, Unit 3 = 737

DRESDEN STATION THERMAL PLUME
DATE: 8-10-74 TIME 1315-1558
PLUME = 0.29 ACRES

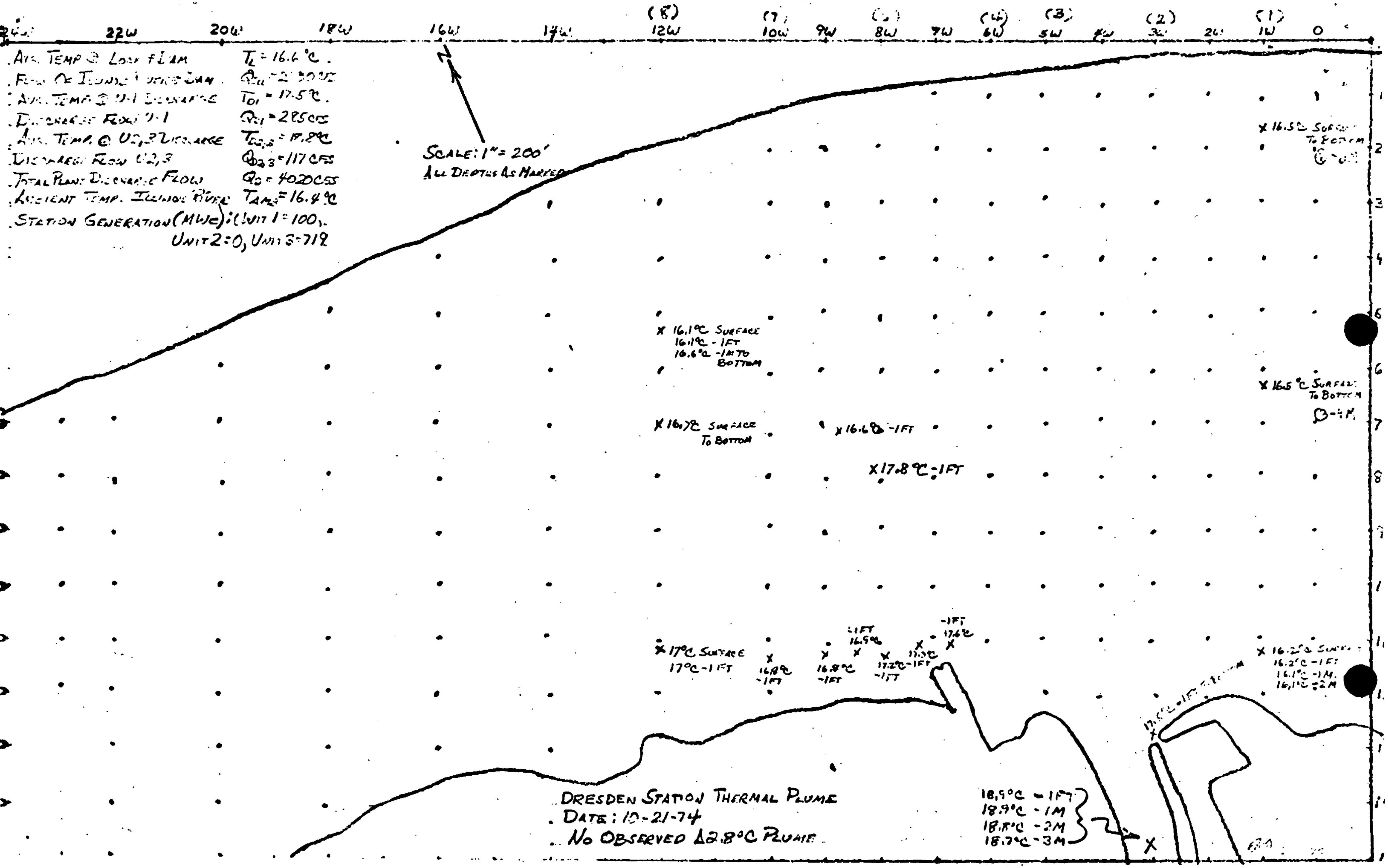
30.2°C SURFACE
30.3°C -1FT
29.6°C -1M
27.5°C -2M



[illegible] @ Lockport [illegible] T [illegible]
[illegible] Illinois River Dam Q [illegible] CFS
[illegible]s Temp. @ U1 Discharge T_{D1} = 2[illegible]°C
scharge Flow U-1 Q_{D1} = [illegible] CFS
e Temp. @ U2,3 Discharge T_{D23} = 20.9°C
scharge Flow U2,3 Q_{D23} = 111 CFS
al Plant Discharge Flow Q_D = 482 CFS
bient Temp. Illinois River T_{AMB} = 19.6°C
at on Generation (MWe): Unit 1 = 75, Unit 2 = 650, Unit 3 = 750

Dresden Station Thermal Plume
Date: 10-17-74
No Observed Δ 2.8°C Plume

2-26-75



AVG. TEMP @ LOCK & DAM $T_L = 16.6°C$

FLOW OF ILLINOIS @ LOCK & DAM Q_{LL} = [illegible]

AVG. TEMP @ U-1 DISCHARGE $T_{D1} = 17.5°C$

DISCHARGE FLOW U-1 $Q_{D1} = 285$ CFS

AVG. TEMP @ U2,3 DISCHARGE $T_{D2,3} = 17.8°C$

DISCHARGE FLOW U2,3 $Q_{D2,3} = 117$ CFS

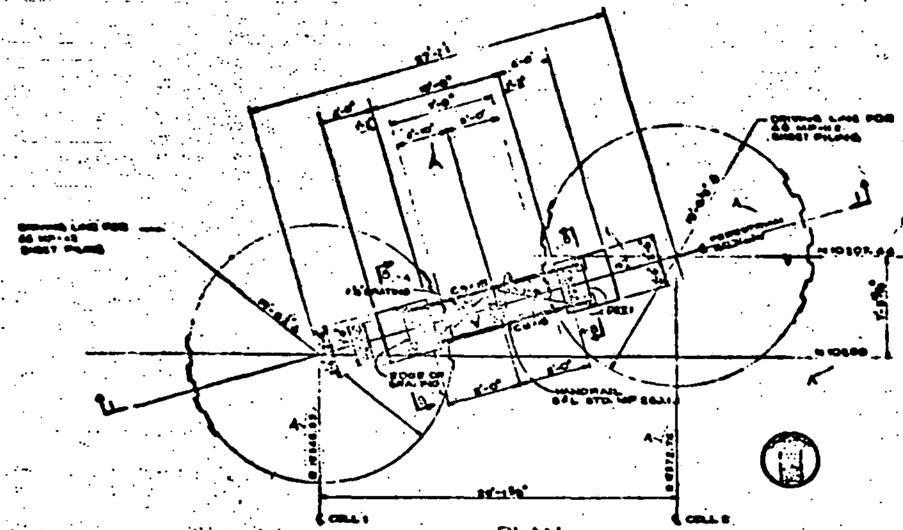
TOTAL PLANT DISCHARGE FLOW $Q_D = 4020$ CFS

AMBIENT TEMP. ILLINOIS RIVER $T_{AMB} = 16.4°C$

STATION GENERATION (MWe): UNIT 1 = 100, UNIT 2 = 0, UNIT 3 = 719

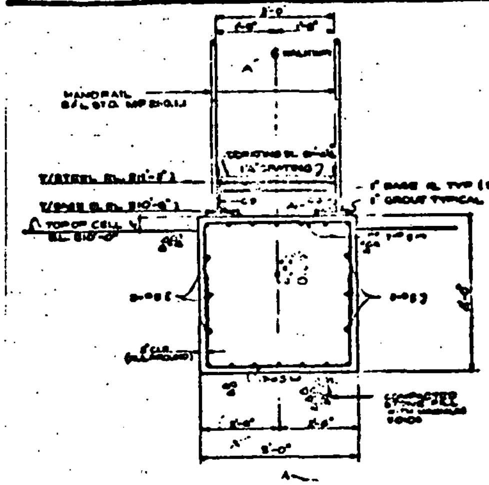
SCALE: 1" = 200'
ALL DEPTHS AS MARKED

DRESDEN STATION THERMAL PLUME
DATE: 10-21-74
NO OBSERVED Δ2.8°C PLUME

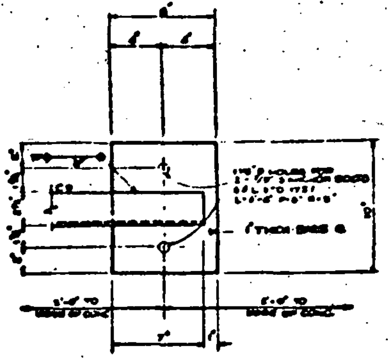


PLAN
DISCHARGE FLUME CELLS

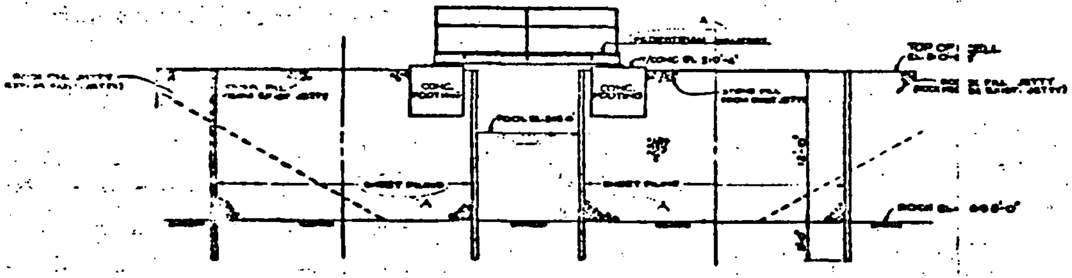
TOP OF CELL & SHEET PILE EL. 510'-0"
TOP OF STEEL EL. 511'-3" UNLESS NOTED
TOP OF GRATING EL. 511'-4 1/2"
SCALE: 1/8" = 1'-0"



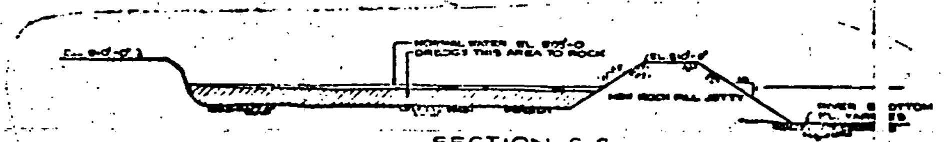
SECTION 8-8



DETAIL 1

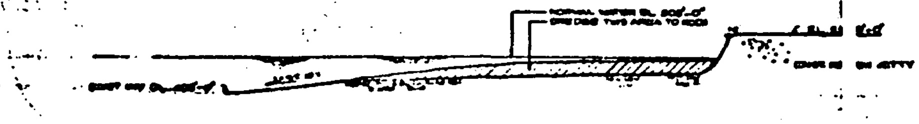


SECTION 1



SECTION 6-6

NOT TO SCALE



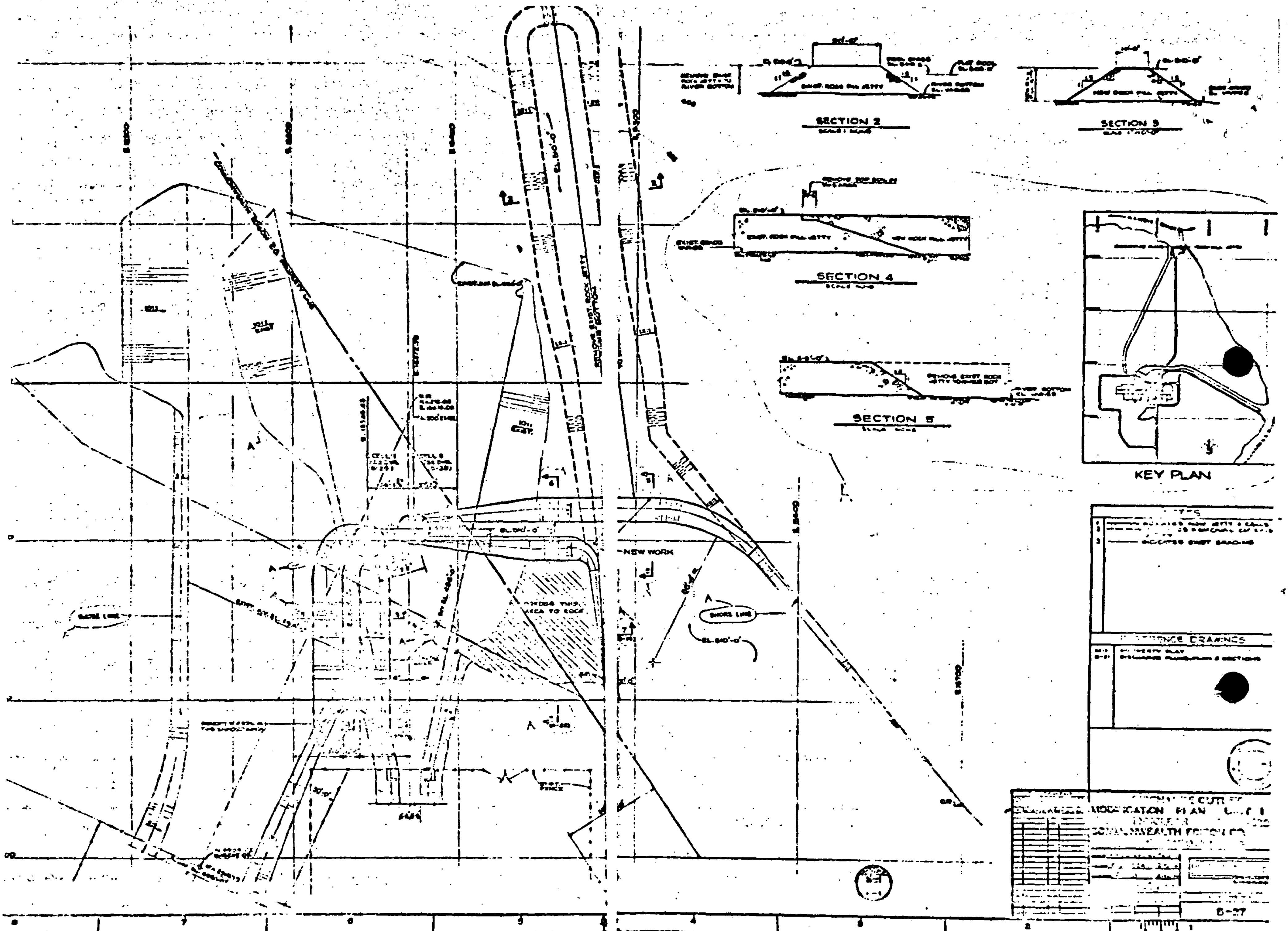
SECTION 7-7

NOT TO SCALE

NOTES

REFERENCE DRAWINGS

[illegible] OUTLET
UNIT 1


SECTION 2
SECTION 3
SECTION 4
SECTION 5
KEY PLAN
NEW WORK
SHORE LINE
EL. 510'-0"
A
NOTES
REFERENCE DRAWINGS
MODIFICATION PLAN
COMMONWEALTH EDISON CO.
B-27

30X S.L.