Industrial **BIO-TEST** *Laboratories, Inc.*
1810 FRONTAGE ROAD
NORTHBROOK, ILLINOIS 60062
AREA CODE 312
TELEPHONE 272-3030

REPORT TO

MONSANTO COMPANY

FOUR-DAY FISH TOXICITY STUDIES ON SEVEN MATERIALS

IBT NO. A7204

DSW 264526

LEXOLDMON008097

Industrial **BIO-TEST** *Laboratories, Inc.*
1810 FRONTAGE ROAD
NORTHBROOK, ILLINOIS 60062
AREA CODE 312
TELEPHONE 272-3030

June 13, 1969

Mr. Elmer P. Wheeler, Manager
Environmental Health
Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166

Dear Mr. Wheeler:

Re: IBT No. A7204 - Four-Day Fish Toxicity
Studies on Seven Materials

We are submitting herewith our laboratory report dated June 13, 1969 prepared in connection with the above study.

Very truly yours,

J. C. Calandra
President

JCC/kjl

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REPORT TO

MONSANTO COMPANY

FOUR-DAY FISH TOXICITY STUDIES ON
SEVEN MATERIALS

IBT NO. A7204

I. Introduction

At the request of Monsanto Company, four-day fish toxicity studies in Rainbow Trout (Salmo gairdnerii) and Bluegills (Lepomis macrochirus) were conducted on the following seven materials:

1) Aroclor 1242, Lot #AK-255
2) Aroclor 1254, Lot #AK-38
3) Aroclor 1260, Lot #AK-3
4) Aroclor 5460, Lot #AK-390
5) Toxaphene
6) Technical DDT (2-1/2#), B0903604
7) Halowax 1099, 52 percent Cl

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II. Summary

The results of the four-day fish toxicity studies are summarized below. Due to the paucity of one of the seven test materials (Halowax 1099), complete data are not available and the figures in parentheses represent only range-finding data.

Test Material	Four-Day LC_{50} (ppm) Rainbow Trout	Bluegill
Aroclor 1242	> 100.0	0.66
Aroclor 1254	> 100.0	0.66
Aroclor 1260	> 100.0	> 100.0
Aroclor 5460	> 100.0	> 100.0
Toxaphene	0.0080	0.0056
Technical DDT	0.0052	0.0078
Halowax 1099	(10-100)	(> 100.0)

Respectfully submitted,

INDUSTRIAL BIO-TEST LABORATORIES, INC.

Carmen Mastri

Report prepared by: Carmen Mastri, B.S.
Section Head
Acute Toxicity Department

M. L. Keplinger

Report approved by: M. L. Keplinger, Ph.D.
Assistant Laboratory Director

Otis E. Fancher

Otis E. Fancher, Ph.D.
Director

June 13, 1969

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III. Procedure

The procedure was generally the same for both bluegills and rainbow trout with each test material.

Healthy, young fish with an average length of 35 to 75 millimeters were used as test animals. All fish were kept under observation for a period of not less than ten days prior to experimental use. During this period, the fish were observed for general health and suitability as test animals. The fish were held in large aerated stock tanks and were fed frozen brine shrimp until three days immediately prior to testing. The rainbow trout were maintained at a temperature of 13°C and the bluegills at a temperature of 24°C. All stock tanks and bioassay vessels contained reconstituted, deionized water. The following compounds were added in the amounts stated per liter of deionized water:

30 mg calcium sulfate
30 mg magnesium sulfate
48 mg sodium bicarbonate
2 mg potassium chloride

Preliminary screening was conducted in order to find the general level of toxicity before beginning the actual bioassay. Once this level had been determined one to five concentrations were selected for the actual bioassay. Bioassay vessels lined with disposable polyethylene bags were filled with ten liters of well aerated reconstituted water. To evaluate the selected concentrations, ten trout were placed in each bioassay vessel. In the case of the bluegills only five fish were placed in each bioassay vessel in order to insure adequate dissolved oxygen concentration (D.O.)

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in the warmer water; therefore two groups of five bluegills were tested at each selected concentration. An untreated control group consisting of 10 fish was also employed.

After a 24-hour acclimatization period, calculated amounts of test material necessary to produce the desired one to five concentration levels were dispensed into the respective vessels. The test solutions were prepared within one hour of the bioassay.

Following the introduction of the test material the fish were observed for 96 hours during which time all mortalities and/or untoward behavioral reactions were recorded. The concentration of dissolved oxygen was determined for all test solutions in which mortalities occurred, to insure that adequate oxygen was available to the test specimens*. Concentrations of dissolved oxygen of 4 mg/l (4 ppm) for warm water fish (bluegill) and 5 mg/l (5 ppm) for cold water fish (trout) were considered to be minimal for valid testing. The pH of the test solution was also determined when mortalities were recorded.

At the end of the observation period all data were collected and arrangements were made to calculate the 96-hour LC_{50} employing the technique of Litchfield and Wilcoxon**.

* Standard Methods for the Examination of Water and Wastewaters, Twelfth Edition, American Public Health Association, Inc., 1790 Broadway, New York, N. Y.: Part III, pp. 406-410.

** J. T. Litchfield, Jr. and F. Wilcoxon, "A Simplified Method of Evaluating Dose-Effect Experiments," J. Pharm. & Exp. Ther., Vol. 96, No. 2, pp. 99-113.

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IV. Results

No deaths or untoward behavioral reactions were noted among any of the animals in the untreated control groups.

A. Rainbow Trout

1. Aroclor 1242, Aroclor 1254, Aroclor 1250, Aroclor 5460, Toxaphene, Technical DDT, Halowax 1099*

a. Mortality, DO, and pH Data

The mortality, dissolved oxygen content, and pH data are presented in Tables I through IV.

* Range finding mortality only.

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TABLE I

TEST MATERIAL: Aroclor 1242, 1260, 5460, 1254

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Test Material	Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
Aroclor 1242	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
Aroclor 5460	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-

Four-Day LC_{50}

Aroclor 1242 > 100.0 ppm
Aroclor 1254 > 100.0 ppm
Aroclor 1260 > 100.0 ppm
Aroclor 5460 > 100.0 ppm

* The test materials were dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual test material as received.

1 - all glass system -
2 - [illegible] - 100,000

~ 0.01 ml added
~ 10^3 ppm acetone
error of 0.001 ml

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TABLE II

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH: 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.0056	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.010	0	9	0	0	0	9	10	90	-	-	8.2	7.4	-	-	-	-	-	-
0.018	0	9	1	-	-	10	10	100	-	-	8.2	7.6	8.0	7.4	-	-	-	-
0.032	0	4	6	-	-	10	10	100	-	-	7.8	6.9	8.1	7.0	-	-	-	-
0.056	0	10	-	-	-	10	10	100	-	-	8.1	7.2	-	-	-	-	-	-

Four-Day LC_{50} = 0.008 ppm

* The test material was dispensed into the bioassay vessels in the form of a 0.01 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Toxaphene as received.

10^{-3} ml 100ppm soln

10^{3} µl ∴ 1 µl = 10^{-3} ml

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TABLE III

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.001	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0056	0	0	4	1	2	7	10	70	-	-	-	-	8.0	7.3	7.8	7.2	8.4	7.2
0.01	0	6	3	1	-	10	10	100	-	-	8.2	7.3	8.0	7.2	7.9	7.2	-	-

Four-Day LC_{50} = 0.0052 ppm

* The test material was dispensed into the bioassay vessels in the form of a 0.001 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Technical DDT as received.

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TABLE IV

TEST MATERIAL: Halowax 1099

Range Finding Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
100.0	0	0	0	0	2	2	2	100	-	-	-	-	-	-	-	-	-	-
10.0	0	0	0	0	0	0	2	0	-	-	-	-	-	-	-	-	-	-

Four-Day LC_{50} = 10-100 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Halowax 1099 as received.

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b. Reactions

The reactions noted following introduction of the Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460, Toxaphene, and Technical DDT are presented in Tables V through X respectively.

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TABLE V

TEST MATERIAL: Aroclor - 1242

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	24	No Recovery Noted	-
	Inverted Swimming	72	No Recovery Noted	-

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TABLE VI

TEST MATERIAL: Aroclor - 1254

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	No Reactions Noted	-	-	-

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TABLE VII

TEST MATERIAL: Aroclor - 1260

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	72	No Recovery Noted	-

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TABLE VIII

TEST MATERIAL: Aroclor - 5460

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	No Reactions Noted	-	-	-

DSW 264541

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TABLE IX

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.0056	No Reactions Noted	-	-	-
0.010	Hypoactivity	24	24	24
0.018	Hyperactivity	24	Until Death	24-48
0.032	Hyperactivity	24	Until Death	24-48
0.056	Hyperactivity	1-6	Until Death	24

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TABLE X

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	Hyperactivity	1-6	No Recovery Noted	48-72-96
0.01	Hyperactivity Prostration	1-6	Until Death	24-48-72

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B. Bluegills

1. Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460 Toxaphene, Technical DDT and Halowax 1099*

a. Mortality, DO, and pH Data

The mortality, dissolved oxygen content, and pH data are presented in Table XI through XVII respectively.

* Range finding mortality only.

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TABLE XI

TEST MATERIAL: Aroclor 1242

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.10	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.18	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.32	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.56	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
1.0	0	10	-	-	-	10	10	100	-	-	7.6	7.2	-	-	-	-	-	-

Four-Day LC_{50} = 0.66 ppm

The test material was dispensed into the bioassay vessels in the form of a 1.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1242 as received.

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TABLE XII

TEST MATERIAL: Aroclor 1254

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.10	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.18	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.32	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.56	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
1.00	0	0	6	3	1	10	10	100	-	-	-	-	7.8	7.2	6.5	7.2	6.2	7.1

Four-Day LC_{50} = 0.66 ppm

* The test material was dispensed into the bioassay vessels in the form of a 1.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1254 as received.

DSW 264546

LEXOLDMON008117

TABLE XIII

TEST MATERIAL: Aroclor 1260

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-

Four-Day LC_{50} > 100.0 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1260 as received.

DSW 264547

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TABLE XIV

TEST MATERIAL: Aroclor 5460

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-

*Four-Day LC_{50} > 100.0 ppm

The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 5460 as received.

DSW 264548

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TABLE XV

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.0010	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0056	0	0	5	0	0	5	10	50	-	-	-	-	7.3	7.2	-	-	-	-
0.01	0	0	7	0	1	8	10	80	-	-	-	-	7.3	7.2	-	-	6.1	7.2

Four-Day LC_{50} = 0.0056

95 percent Confidence Limits of LC_{50} = 0.0036 - 0.0087 ppm

* The test material was dispensed into the bioassay vessels in the form of a 0.01 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Toxaphene as received.

DSW 264549

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TABLE XVI

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
0.001	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.0056	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-
0.01	0	10	-	-	-	-	10	100	-	-	7.6	7.1	-	-	-	-	-	-

Four-Day LC_{50} = 0.0078 ppm

The test material was dispensed into the bioassay vessels in the form of a 0.001 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Technical DDT as received.

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#14167

C only

4 day fish (M) study

by IBT

DSW 264551

TABLE XVII

TEST MATERIAL: Halowax 1099

Range Finding Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead Hours: 1-6	24	48	72	96	Total Number Dead	Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH 1-6 Hr. DO	pH	24 Hr. DO	pH	48 Hr. DO	pH	72 Hr. DO	pH	96 Hr. DO	pH
100.0	0	0	0	0	0	0	2	0	-	-	-	-	-	-	-	-	-	-
10.0	0	0	0	0	0	0	2	0	-	-	-	-	-	-	-	-	-	-

Four-Day LC_{50} > 100.0 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Halowax 1099 as received.

DSW 264552

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b. Reaction

The reactions noted following introduction of Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460, Toxaphene, and Technical DDT are presented in Tables XVIII through XXIII respectively.

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TABLE XVIII

TEST MATERIAL: Aroclor - 1242

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.1	No Reactions Noted	-	-	-
0.18	No Reactions Noted	-	-	-
0.32	Hyperactivity	1-6	24	-
0.56	Hyperactivity	1-6	24	-
1.0	Hyperactivity	1-6	Until Death	24

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TABLE XIX

TEST MATERIAL: Aroclor - 1254

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.1	No Reactions Noted	-	-	-
0.18	No Reactions Noted	-	-	-
0.32	No Reactions Noted	-	-	-
0.56	Hyperactivity	1-6	24	-
	Hypoactivity	24	48	-
1.0	Hypoactivity	24	Until Death	48-72-96

DSW 264555

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TABLE XX

TEST MATERIAL: Aroclor - 1260

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	48	No Recovery Noted	-

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TABLE XXI

TEST MATERIAL: Aroclor - 5460

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	72	No Recovery Noted	-

DSW 264557

LEXOLDMON008128

TABLE XXII

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	Hypoactivity	48	24	48
0.01	Hypoactivity	24	Until Death	48-96
	Prostration	24		
	Loss of equilibrium	48		

DSW 264558

LEXOLDMON008129

TABLE XXIII

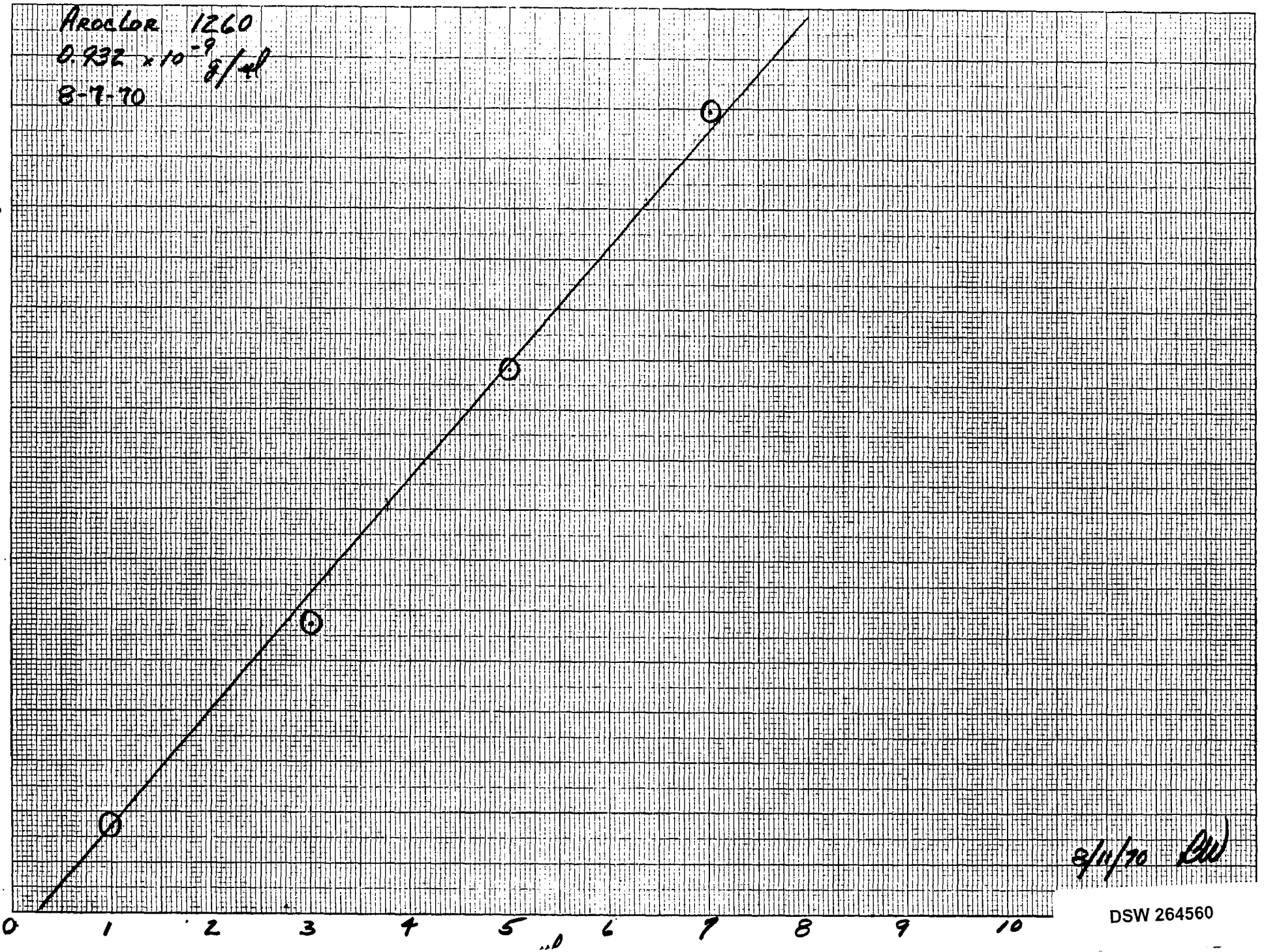
TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	No Reactions Noted	-	-	-
0.01	Hyperactivity	1-6	Until Death	24

K+E 10 X 10 TO THE CENTIMETER 46 1510
10 X 25 C.M. MADE IN U.S.A.
KEUFFEL & ESSER CO.



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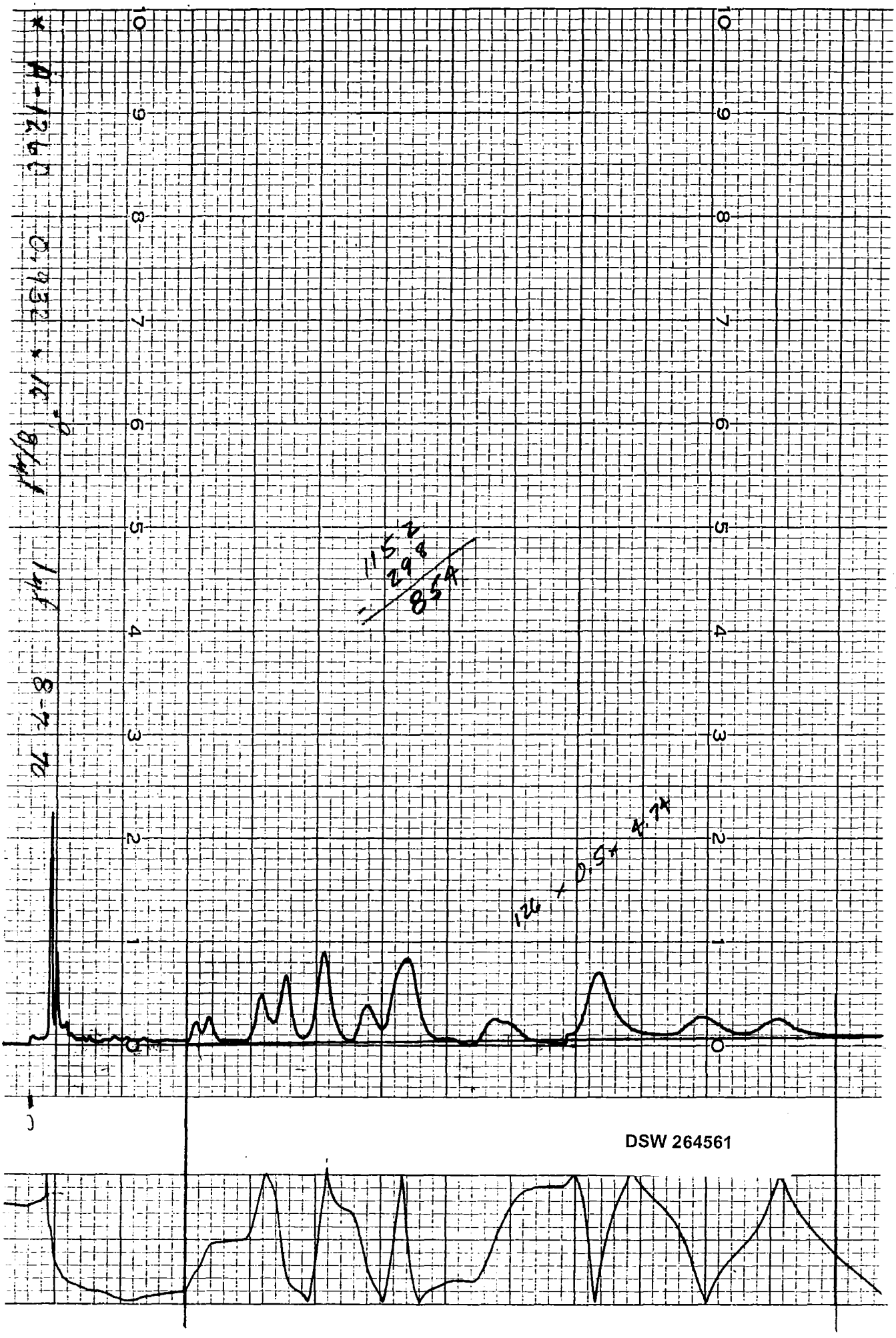
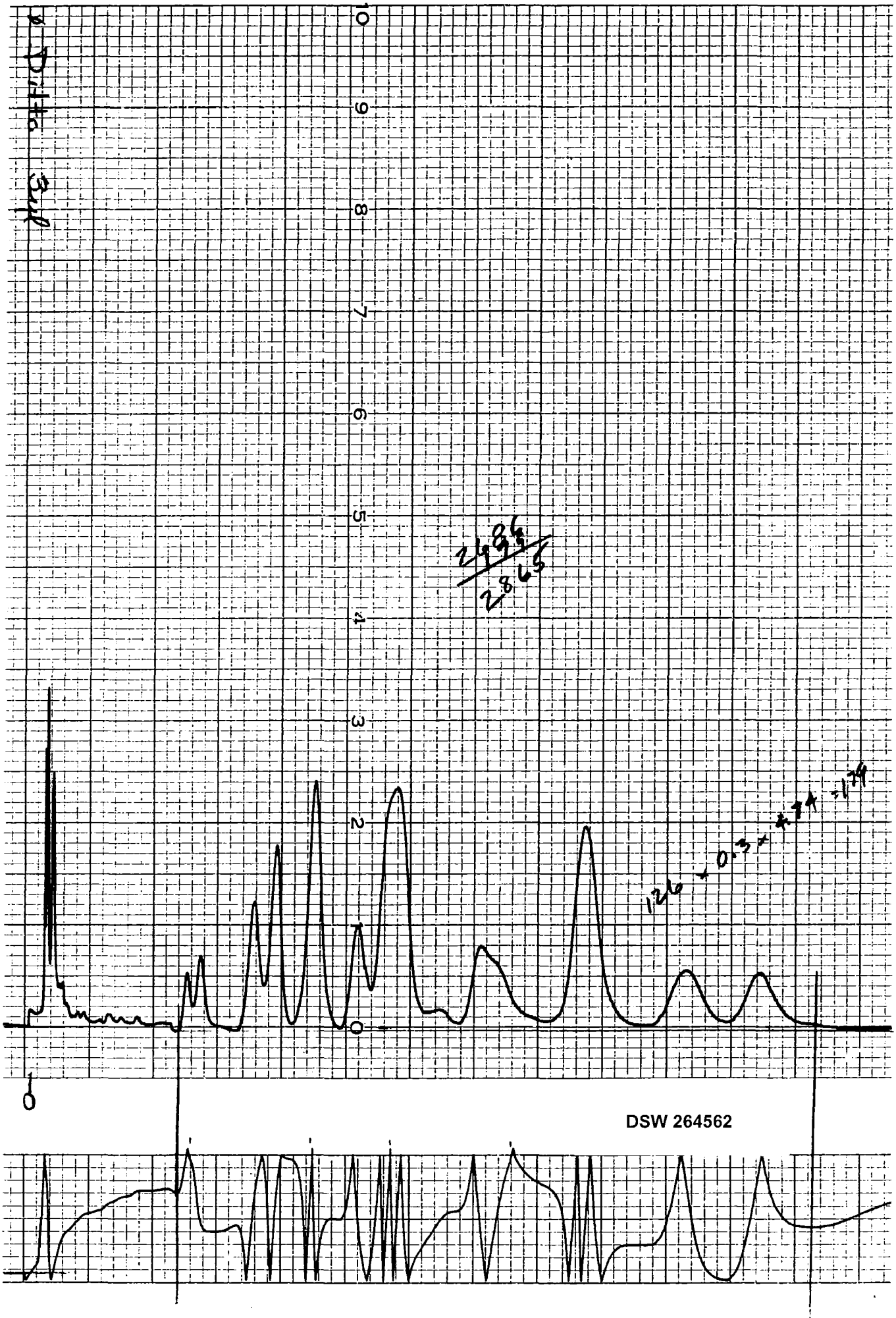
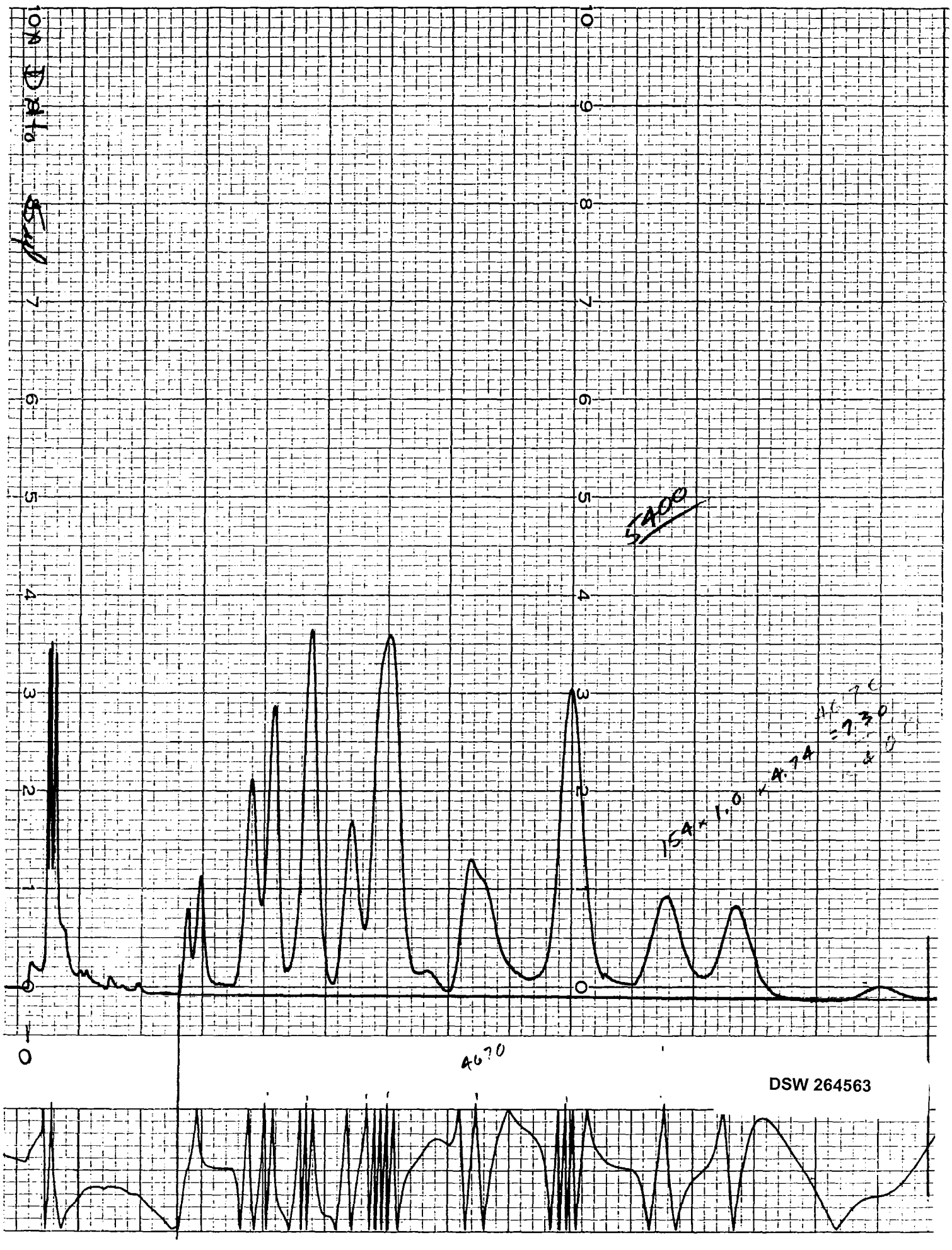


LEXOLDMON008132

LEXOLDMON008133

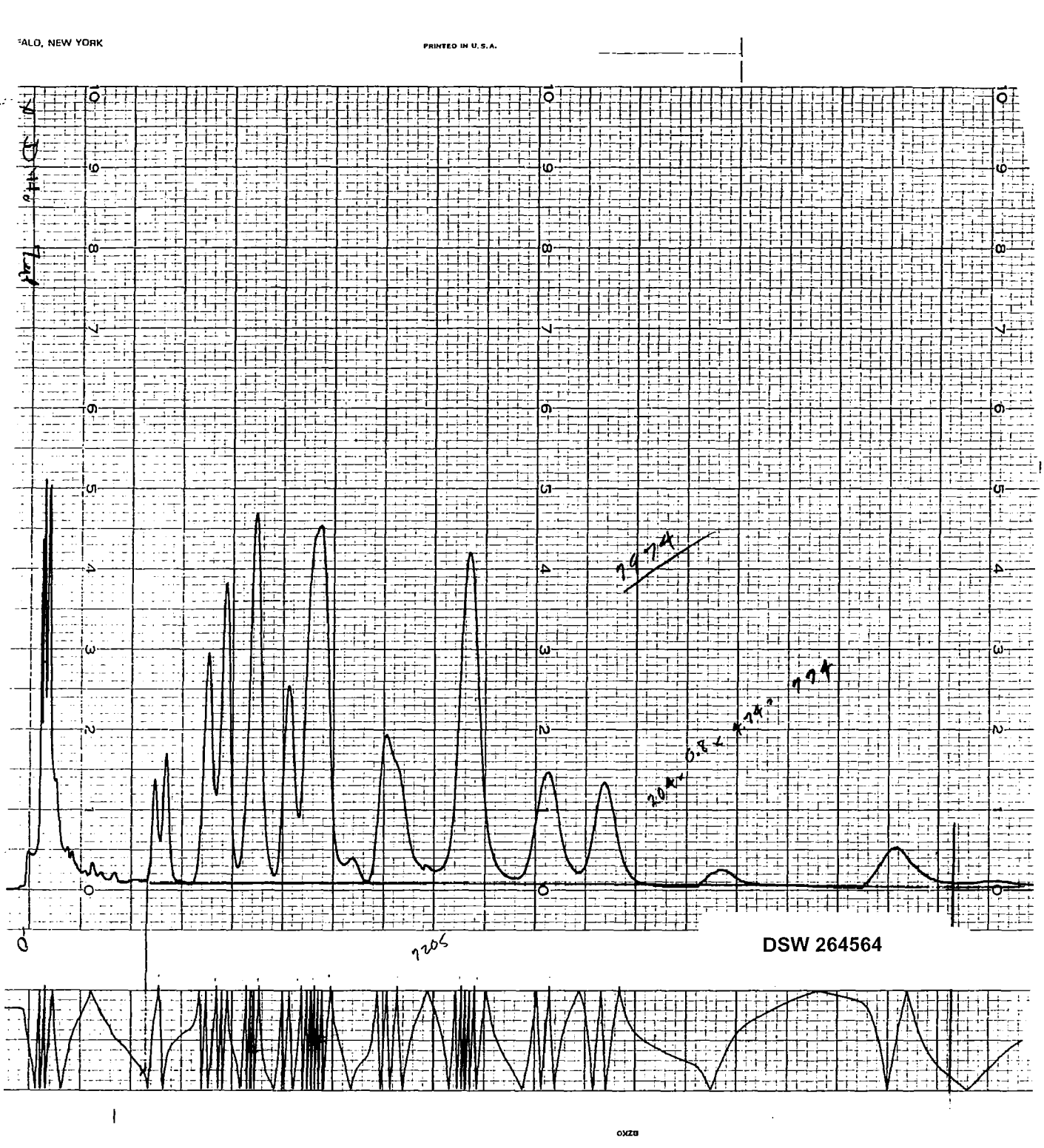




EXOLDMON0081347

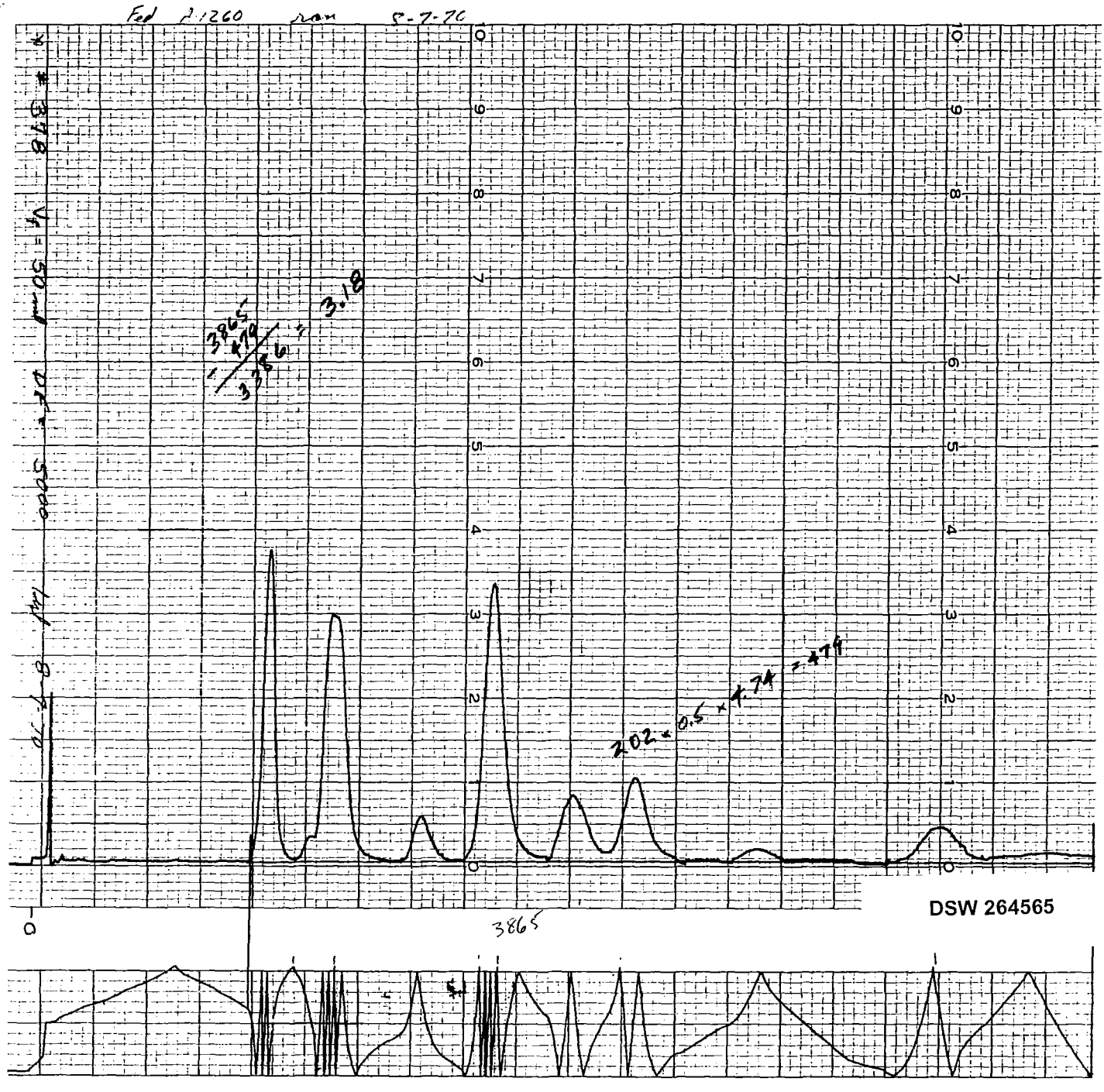
LEXOLDMON00813

FALO, NEW YORK PRINTED IN U.S.A.



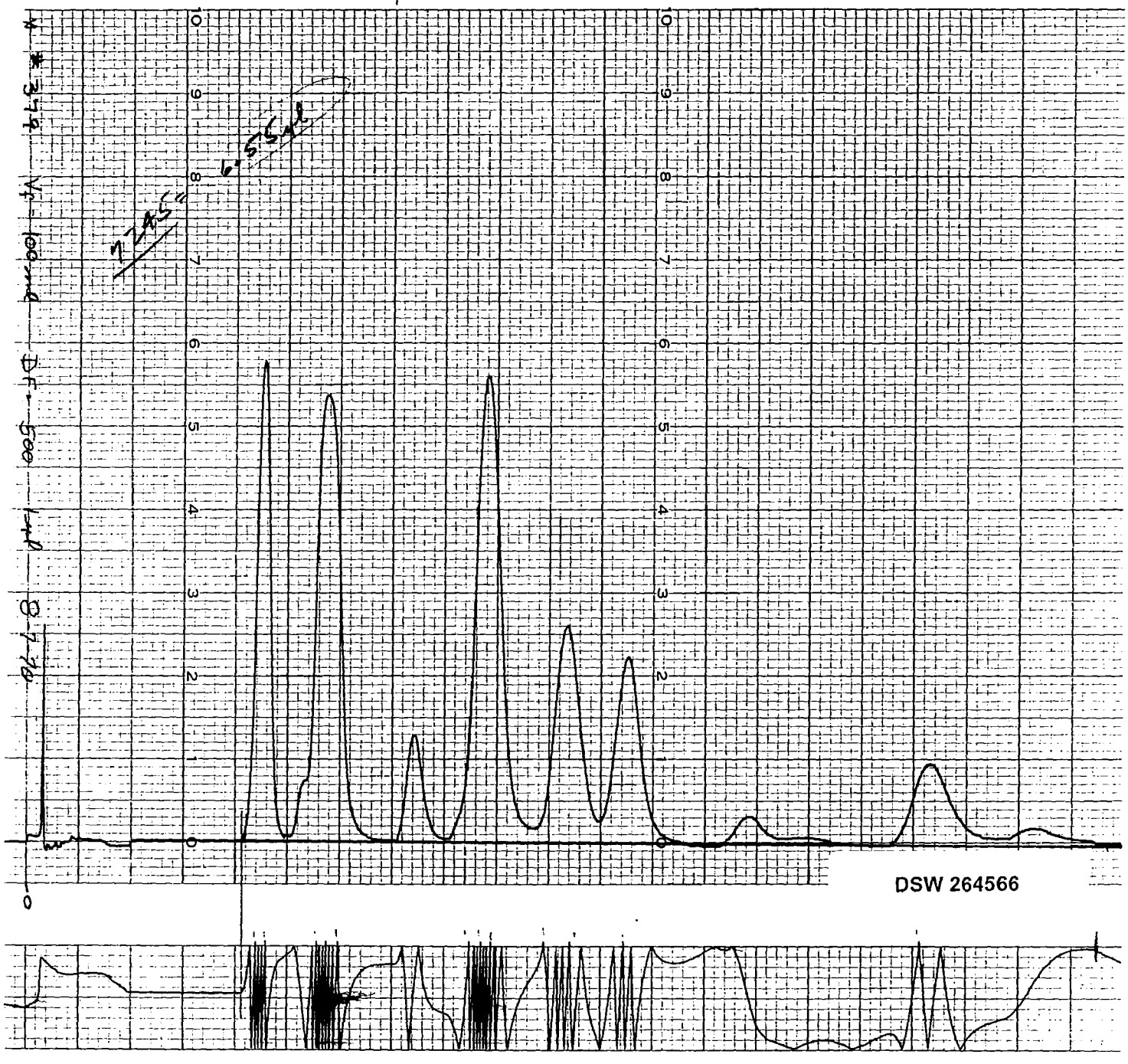
LEXOLDMON008136

No. 9270-1072 RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK



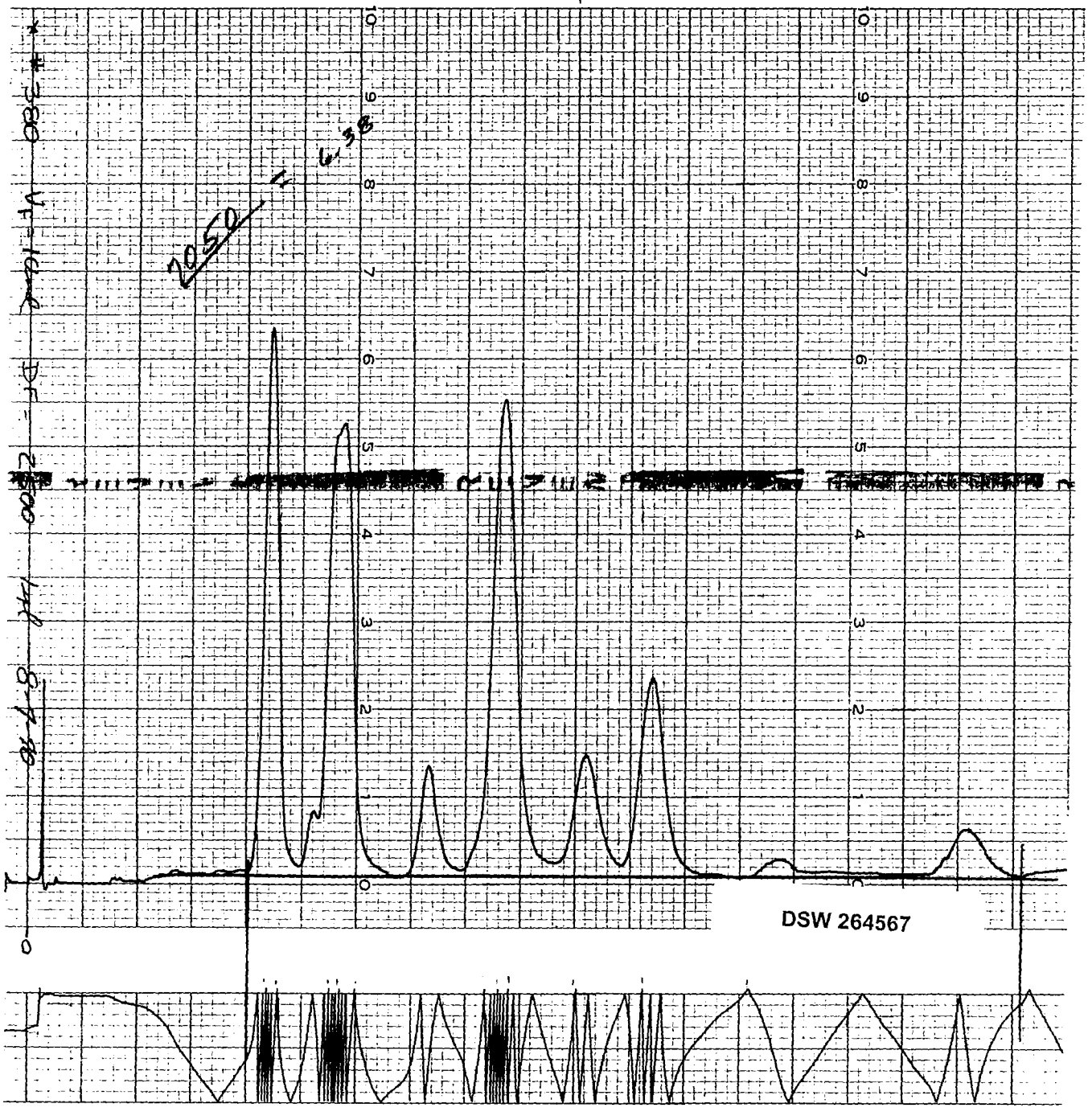
PRINTED IN U.S.A.

No. 9270-1072



PRINTED IN U.S.A.

No. 9270-1072



OXZ8


DSW 264568

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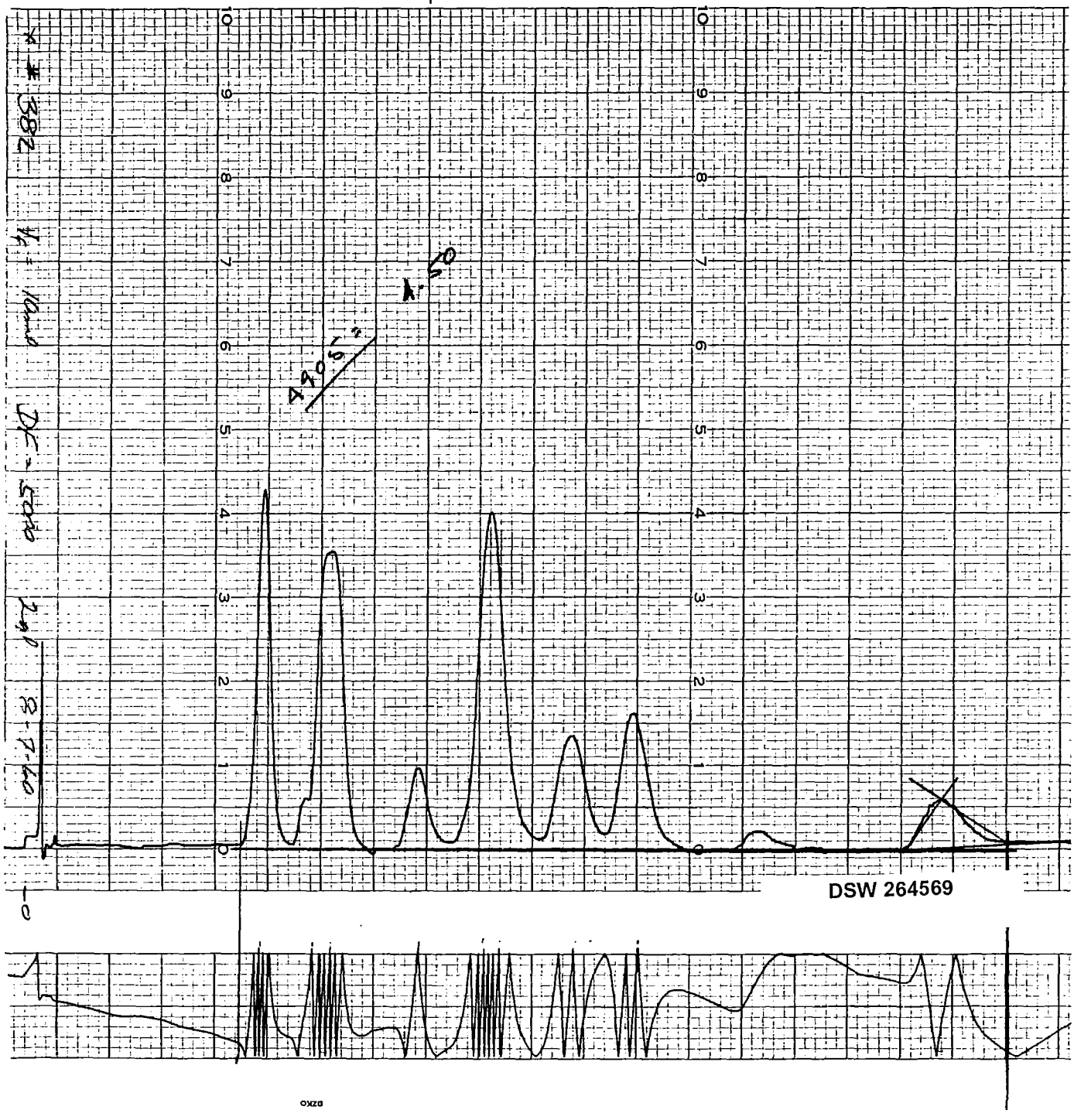
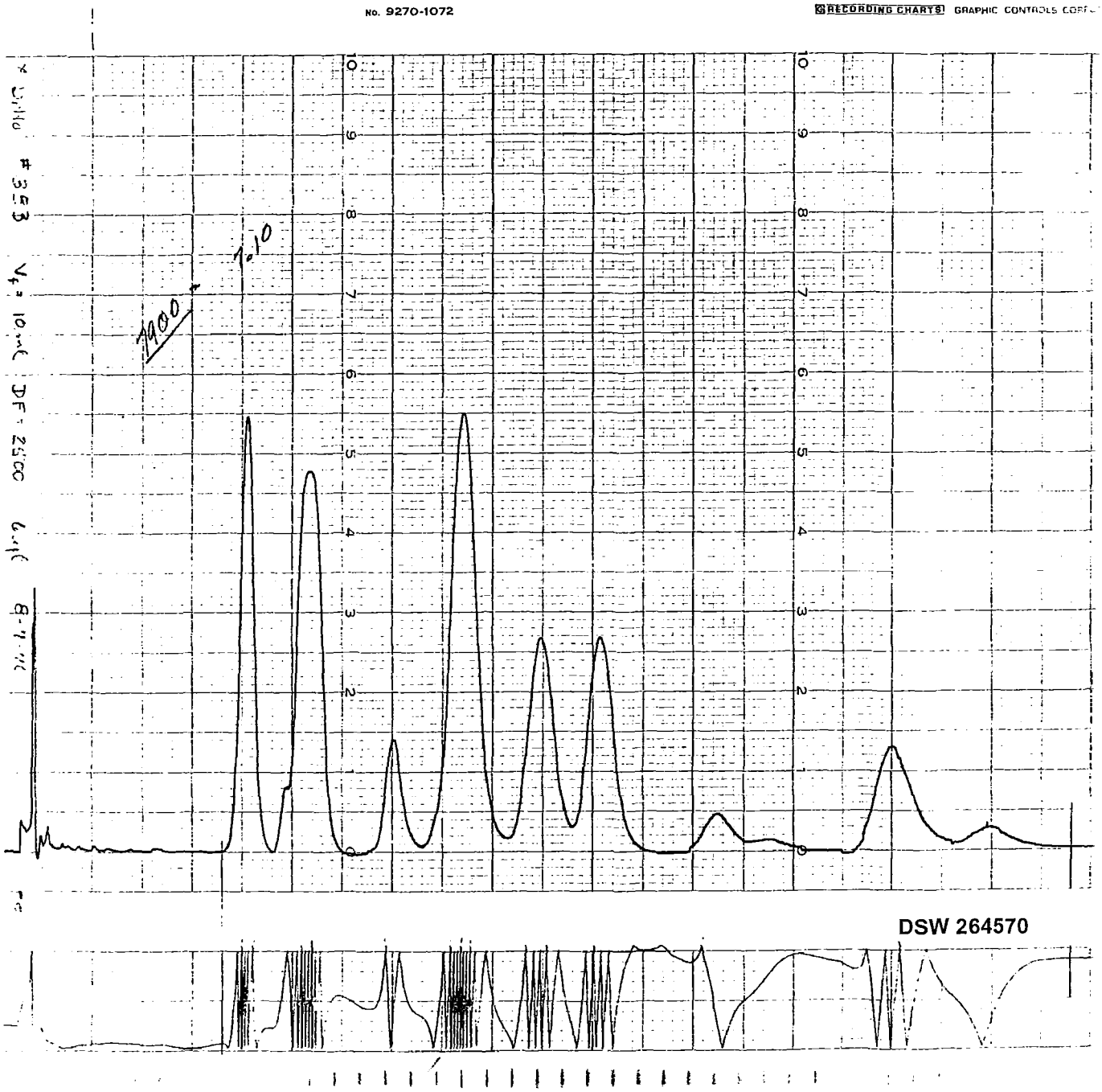
PRINTED IN U.S.A.

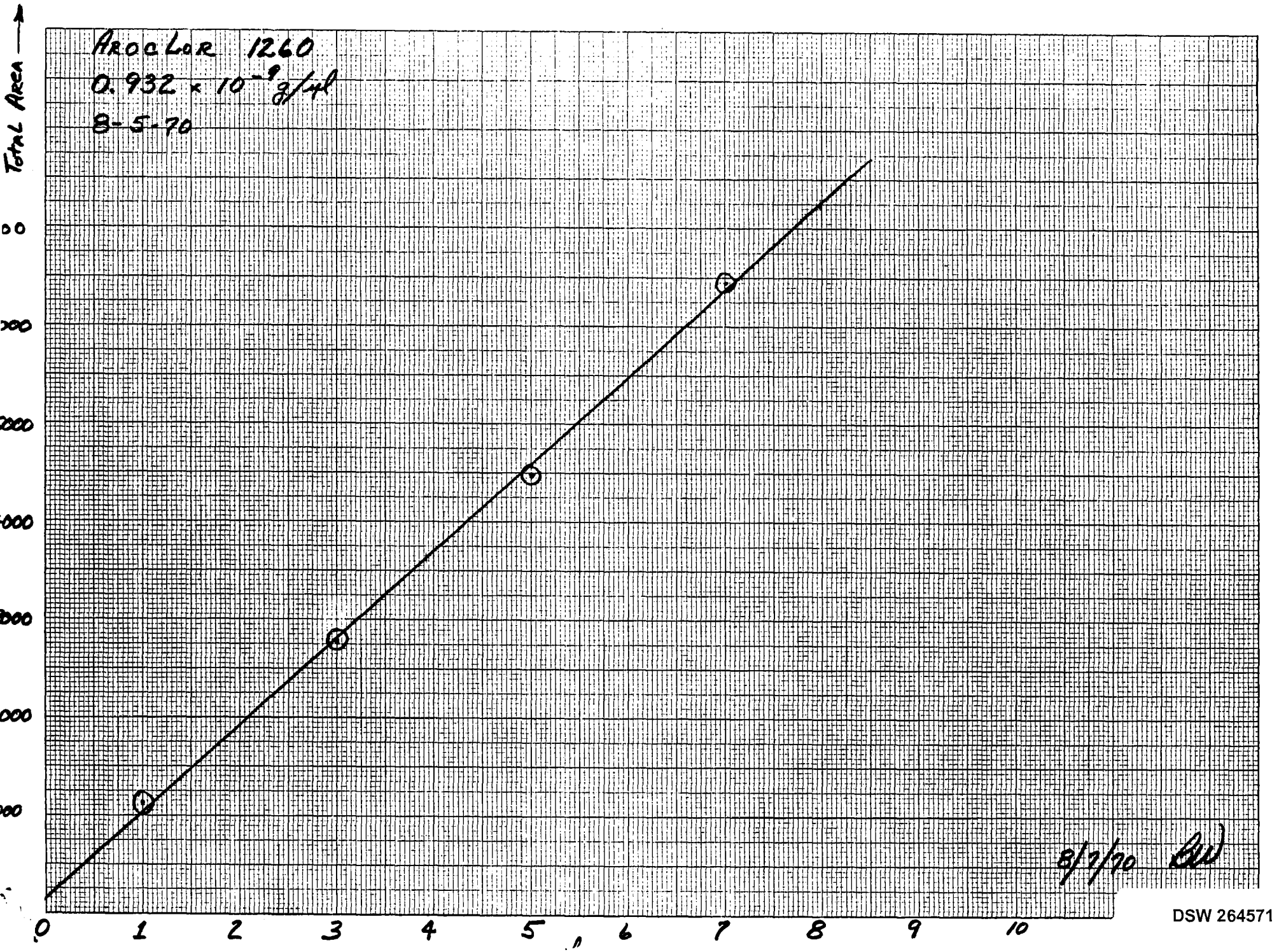
No. 9270-1072




No. 9270-1072
RECORDING CHARTS GRAPHIC CONTROLS CORP.
1900'
7-10
DSW 264570

LEXOLDMON008142

K&E 10 X 10 TO THE CENTIMETER 46 1510
18 X 25 CM. MADE IN U.S.A.
KEUFFEL & ESSER CO.



DSW 264571

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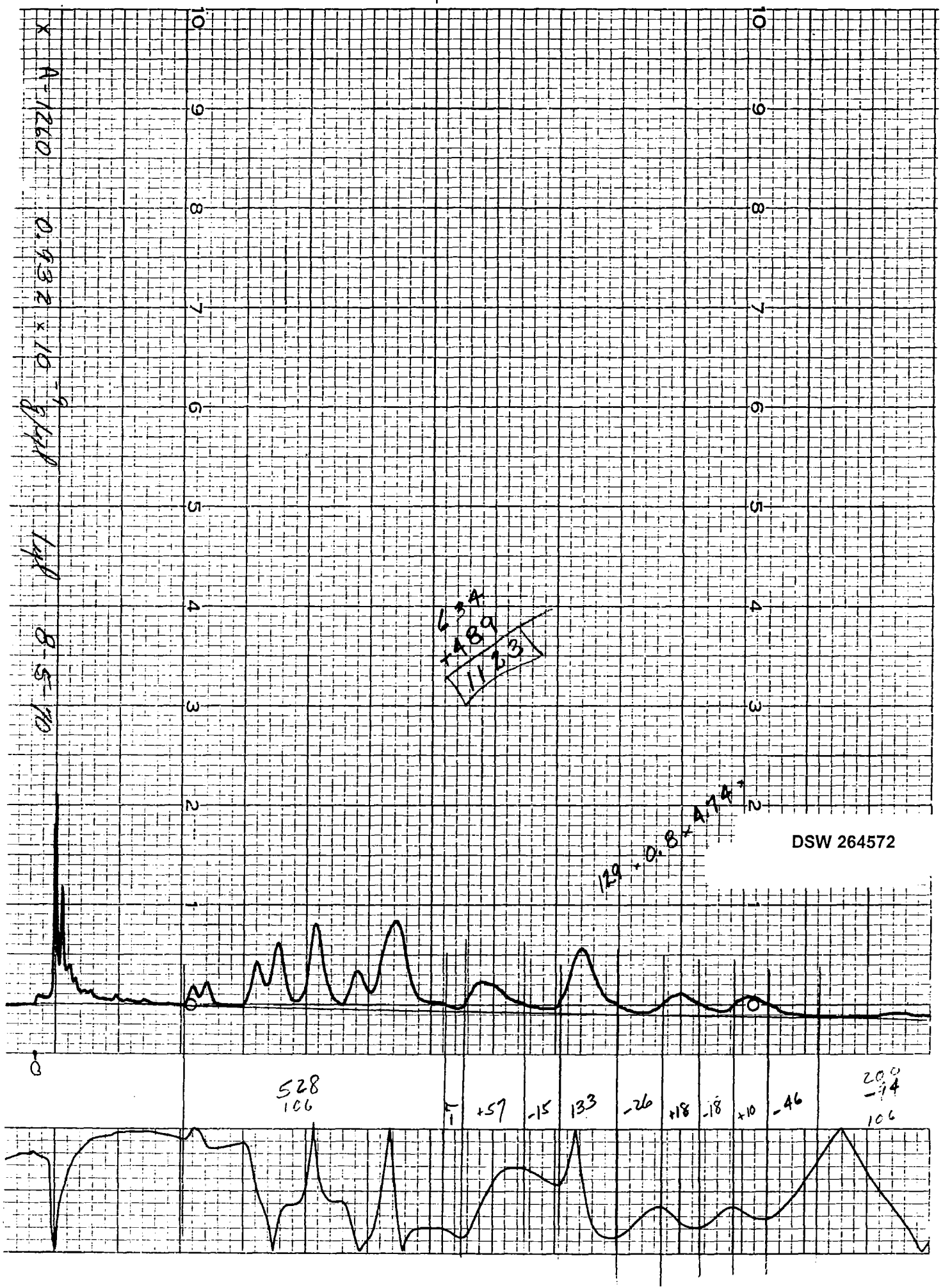
NO. 9270-1072



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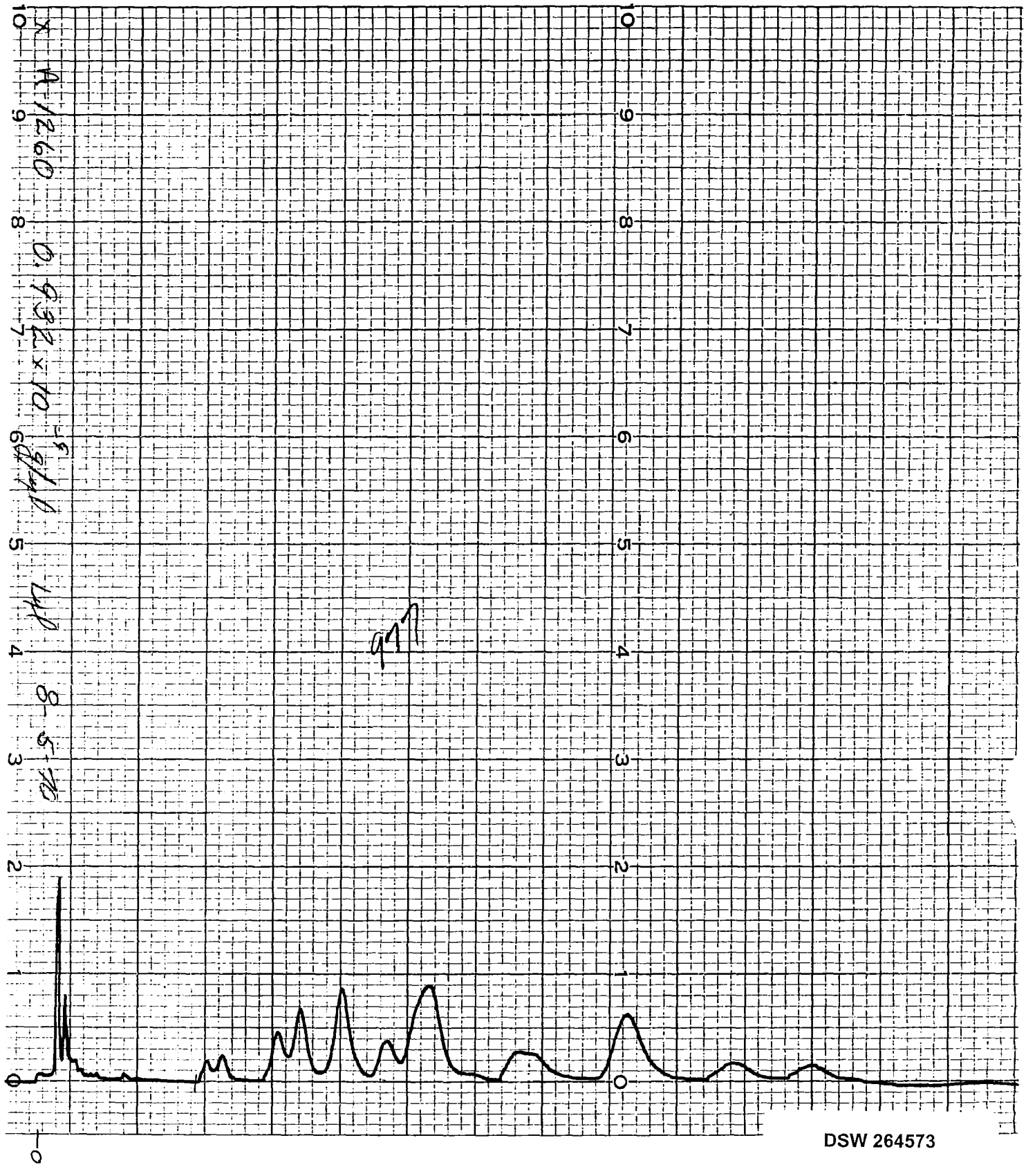



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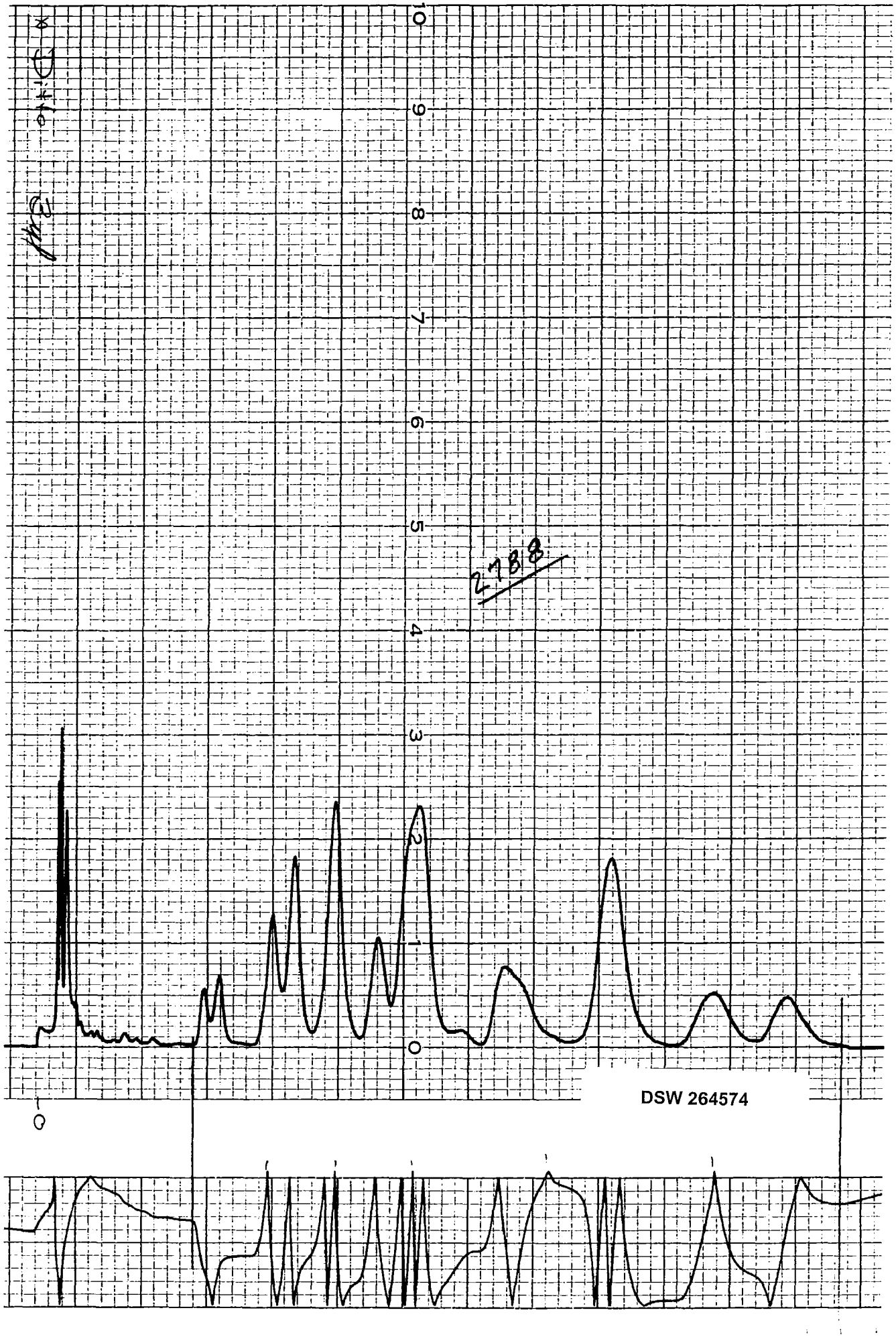
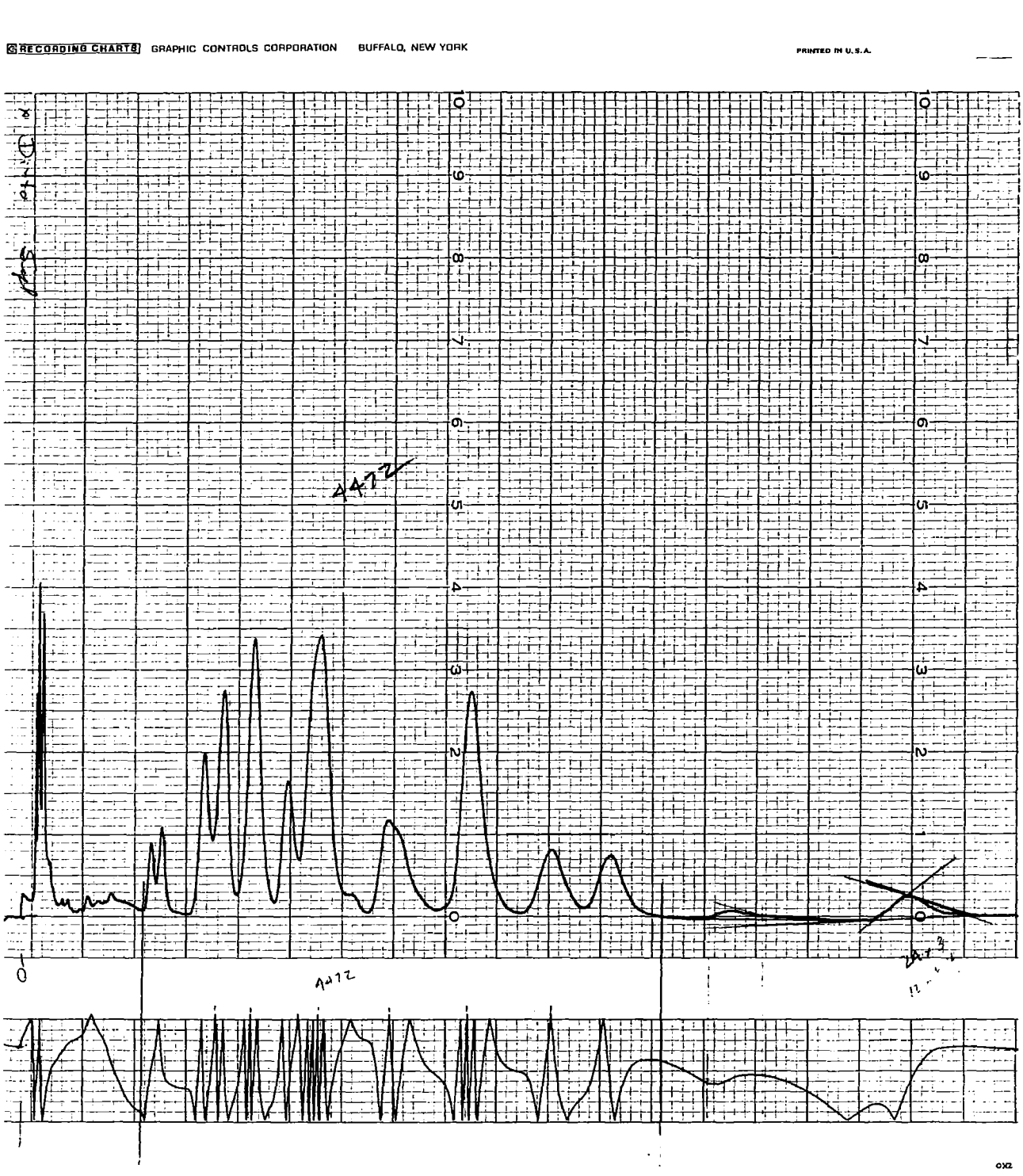


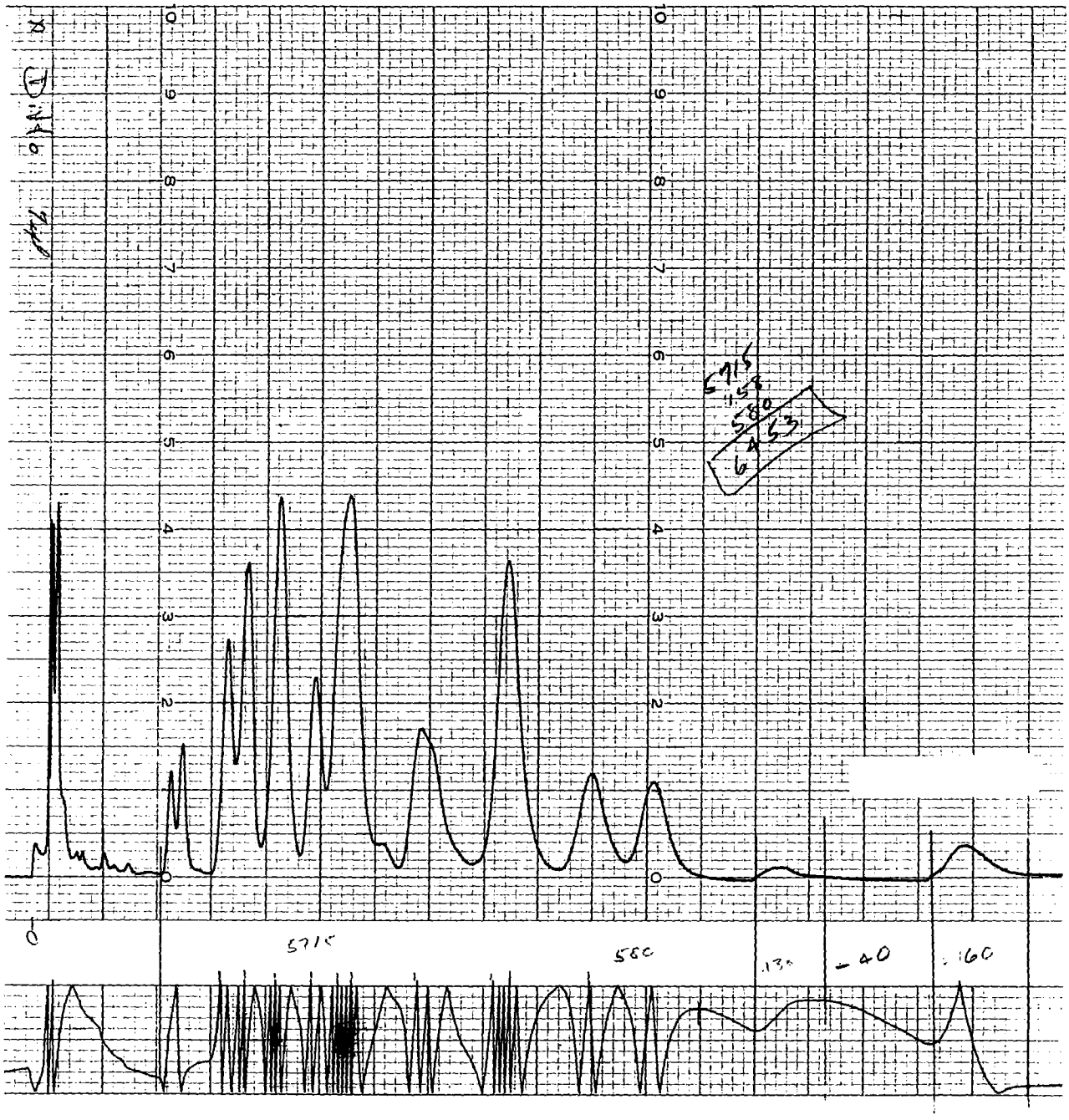
LEXOLDMON008145

LEXOLDMON008146

RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.



DSW 264575



DSW 264576

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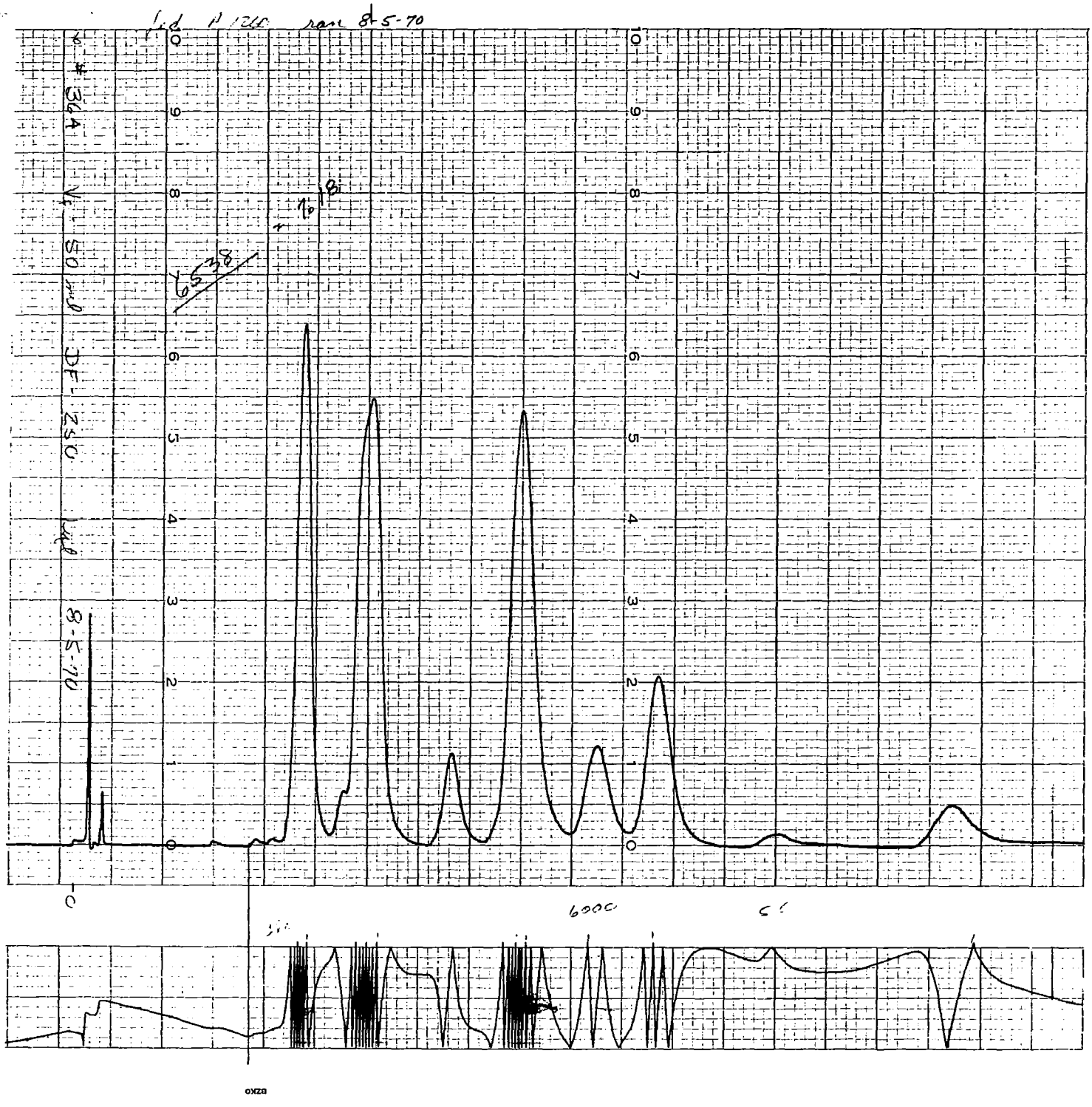
PRINTED IN U.S.A.

No. 9270-1072



DSW 264577

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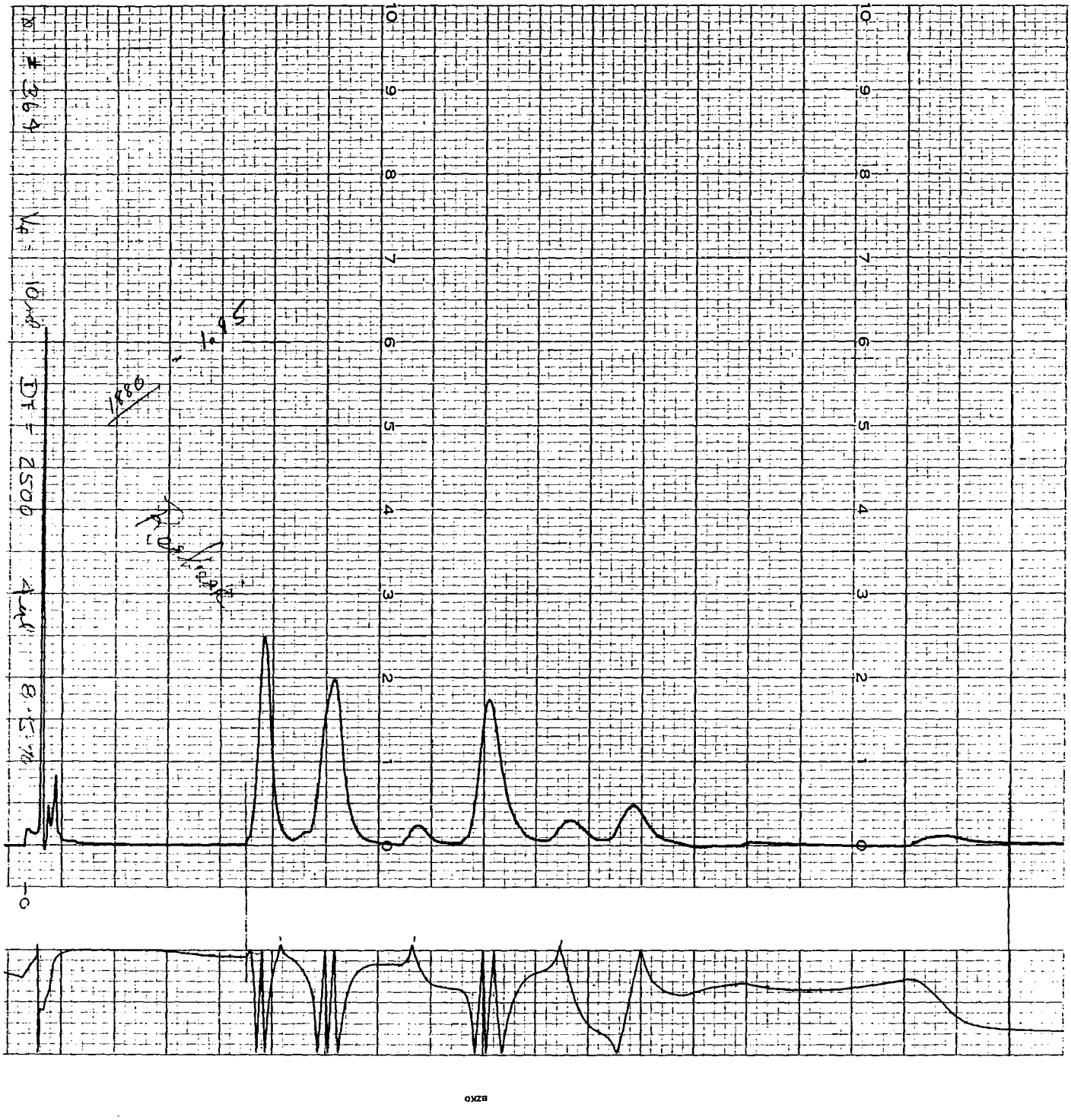
No. 9270-1072



DSW 264578

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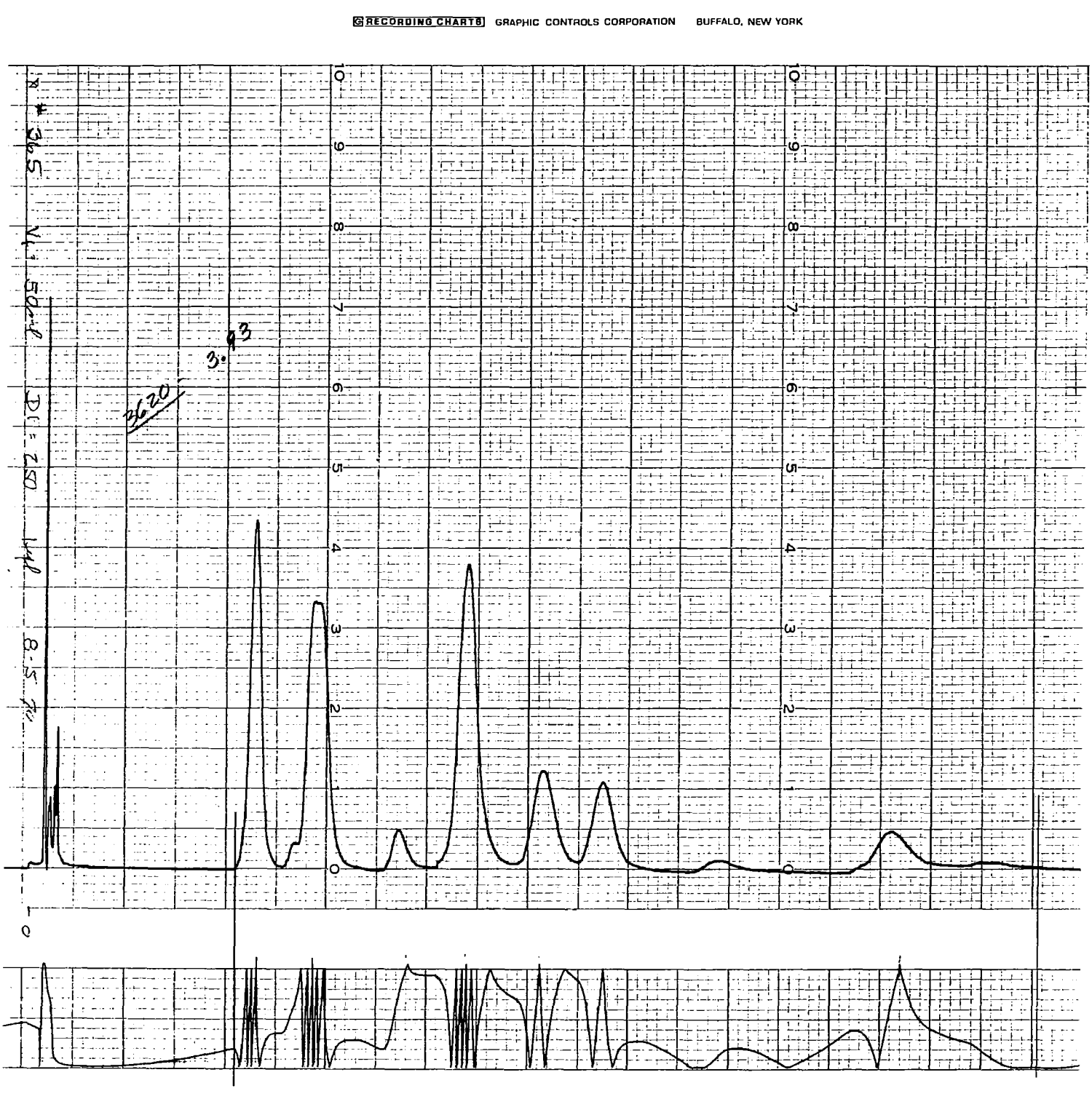
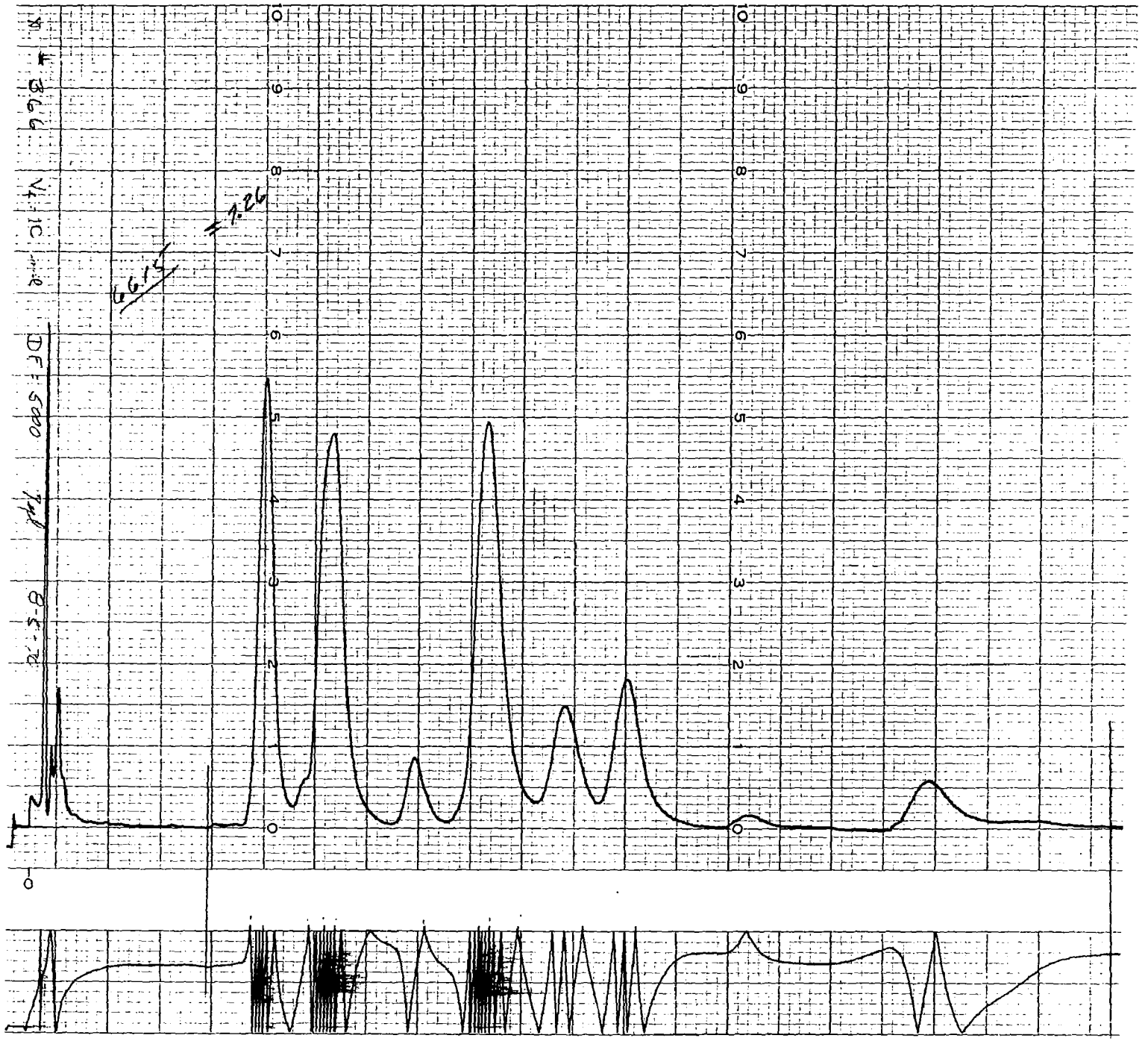
RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK



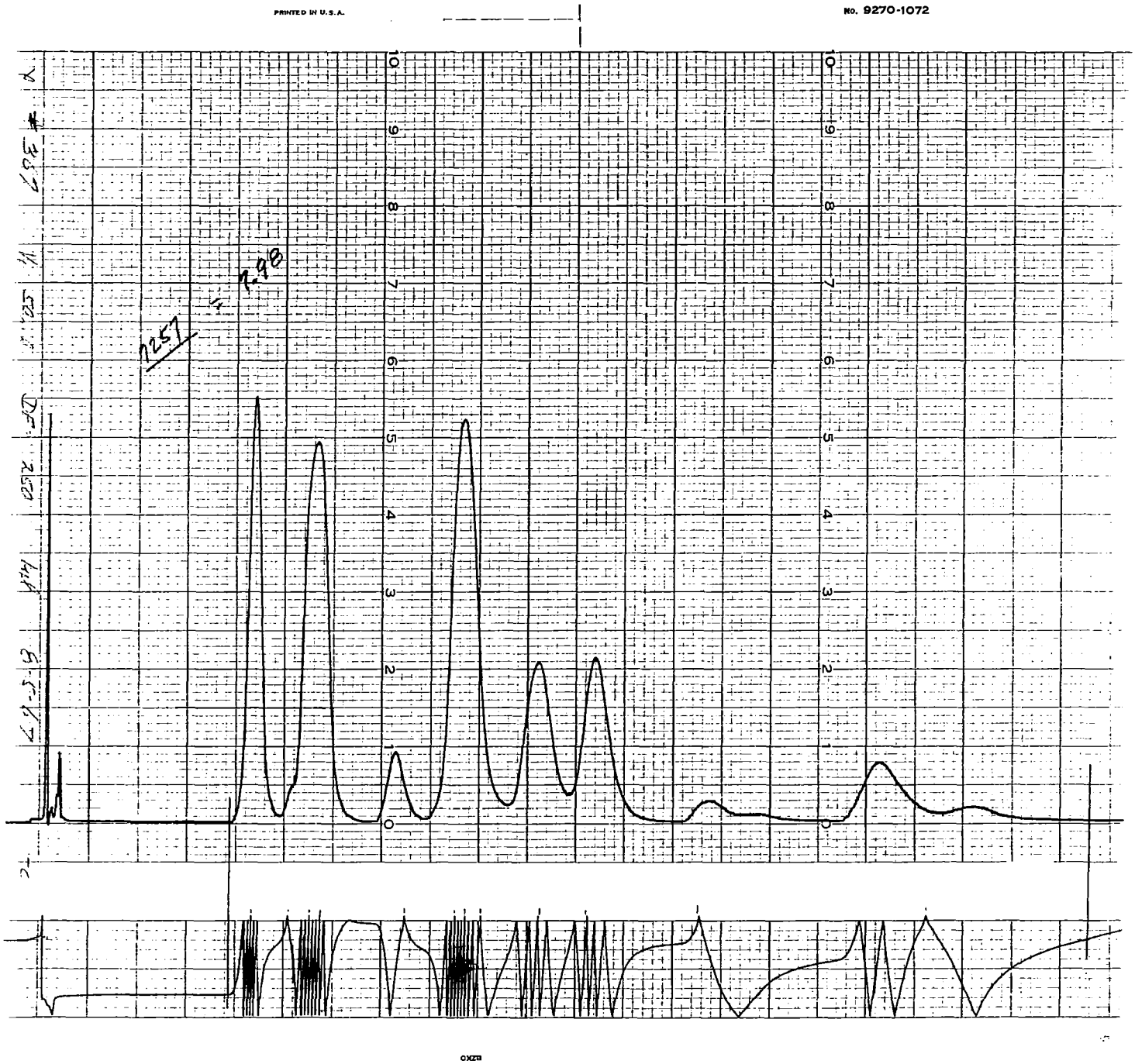
DSW 264579

LEXOLDMON008151

No. 9270-1072 RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFA



DSW 264580



DSW 264581

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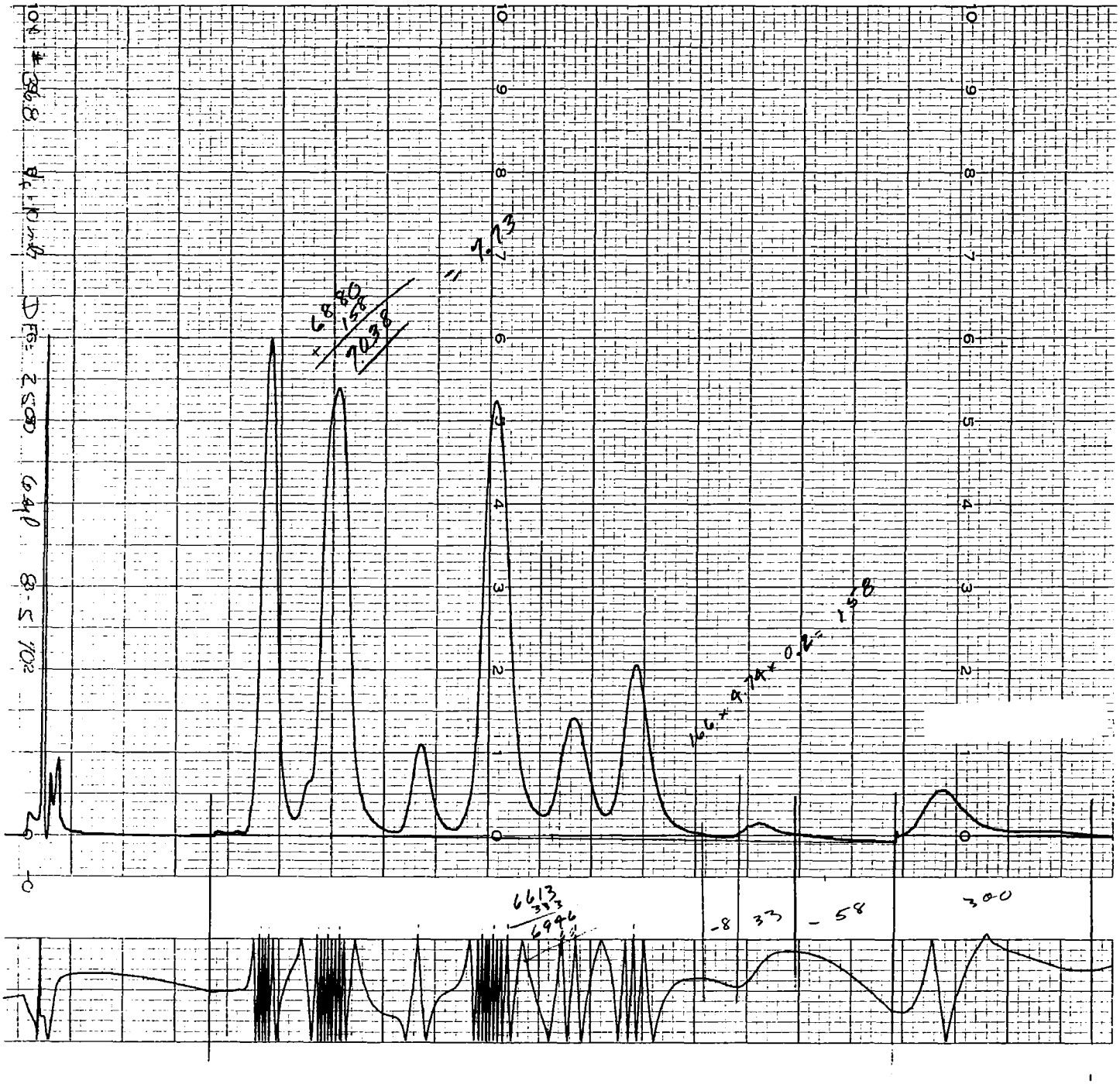
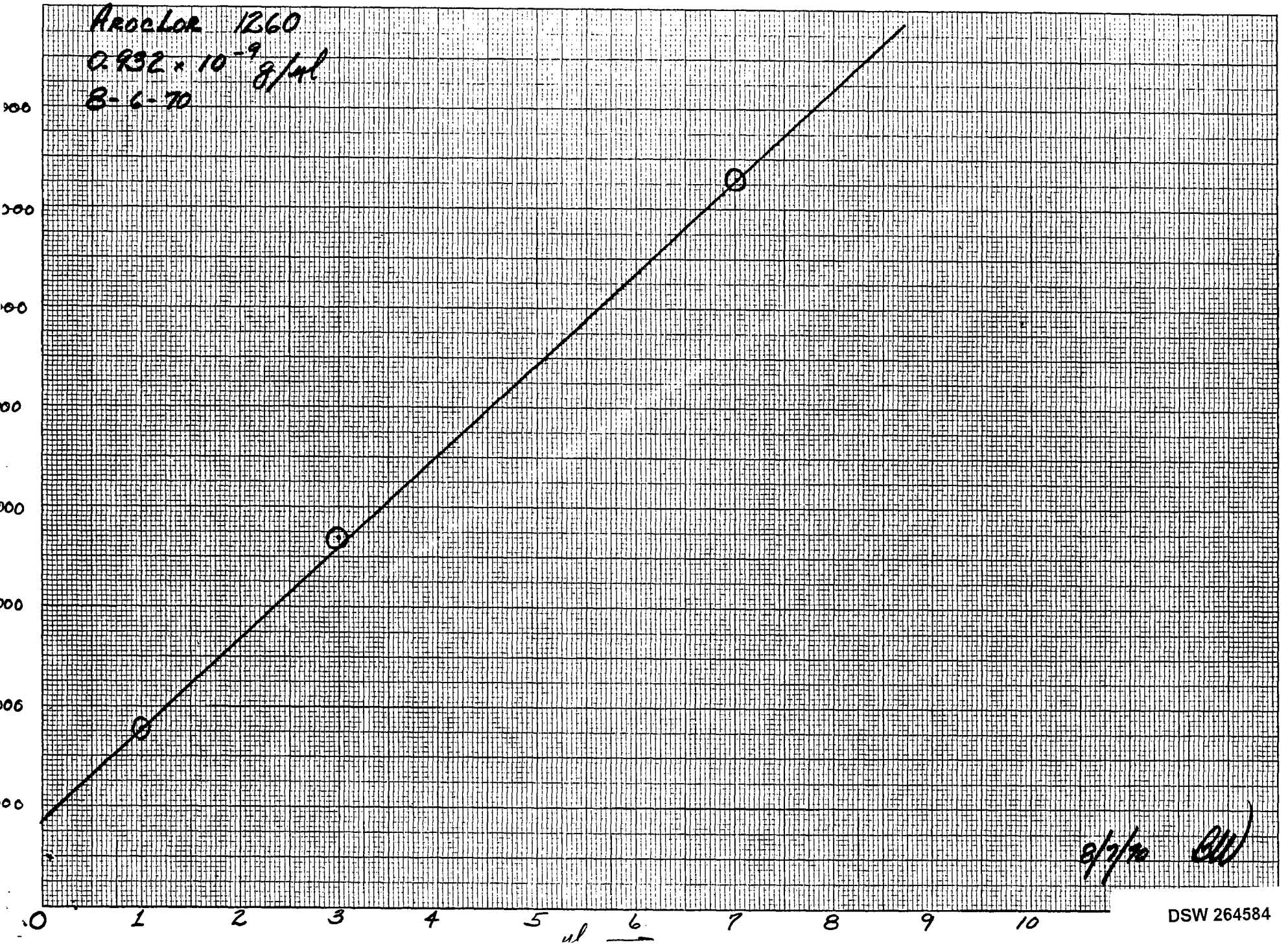


DSW 264582

LEXOLDMON008153

LEXOLDMON008154

K+E 10 X 10 TO THE CENTIMETER 46 1510
18 X 25 CM. MADE IN U.S.A.
KEUFFEL & ESSER CO.



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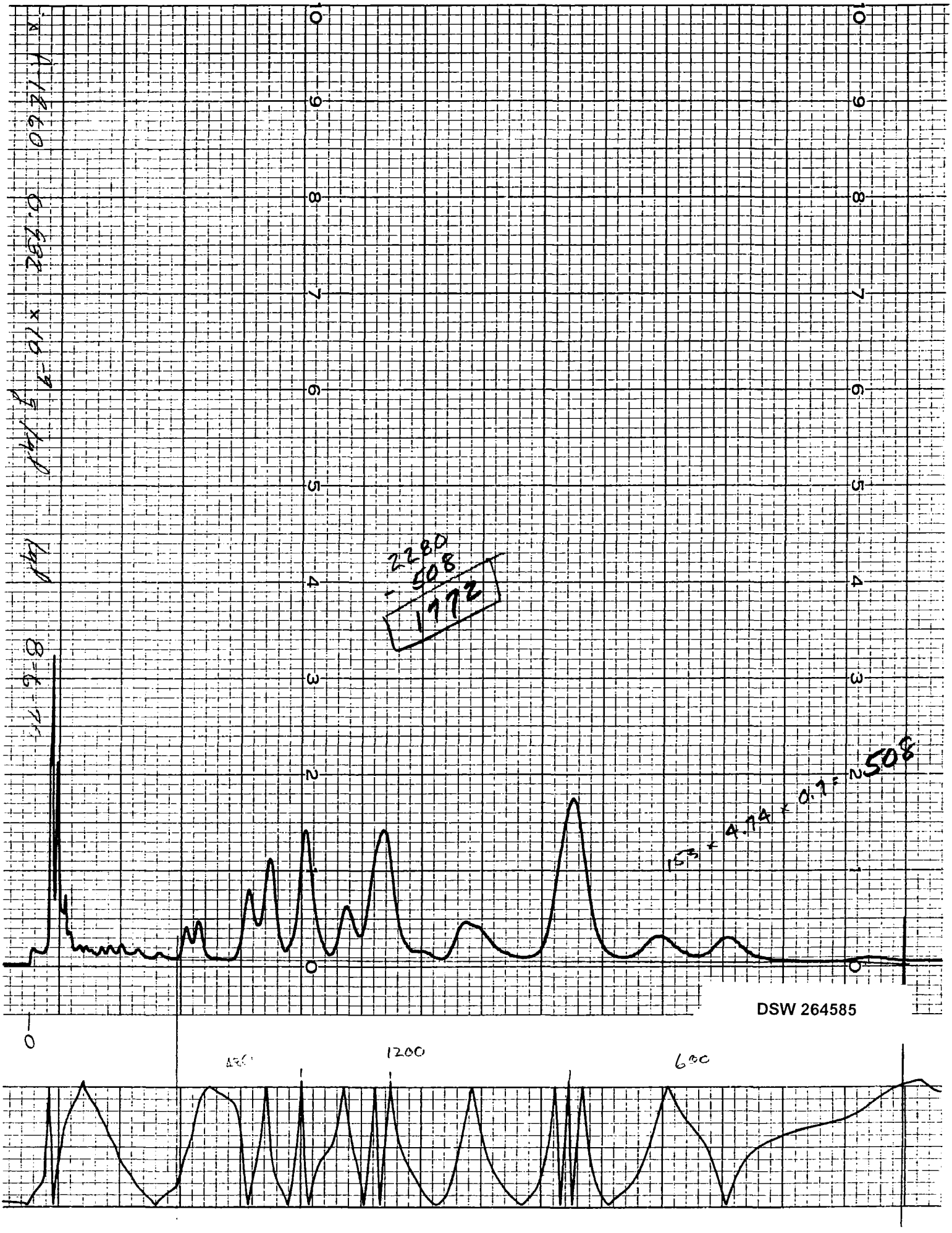

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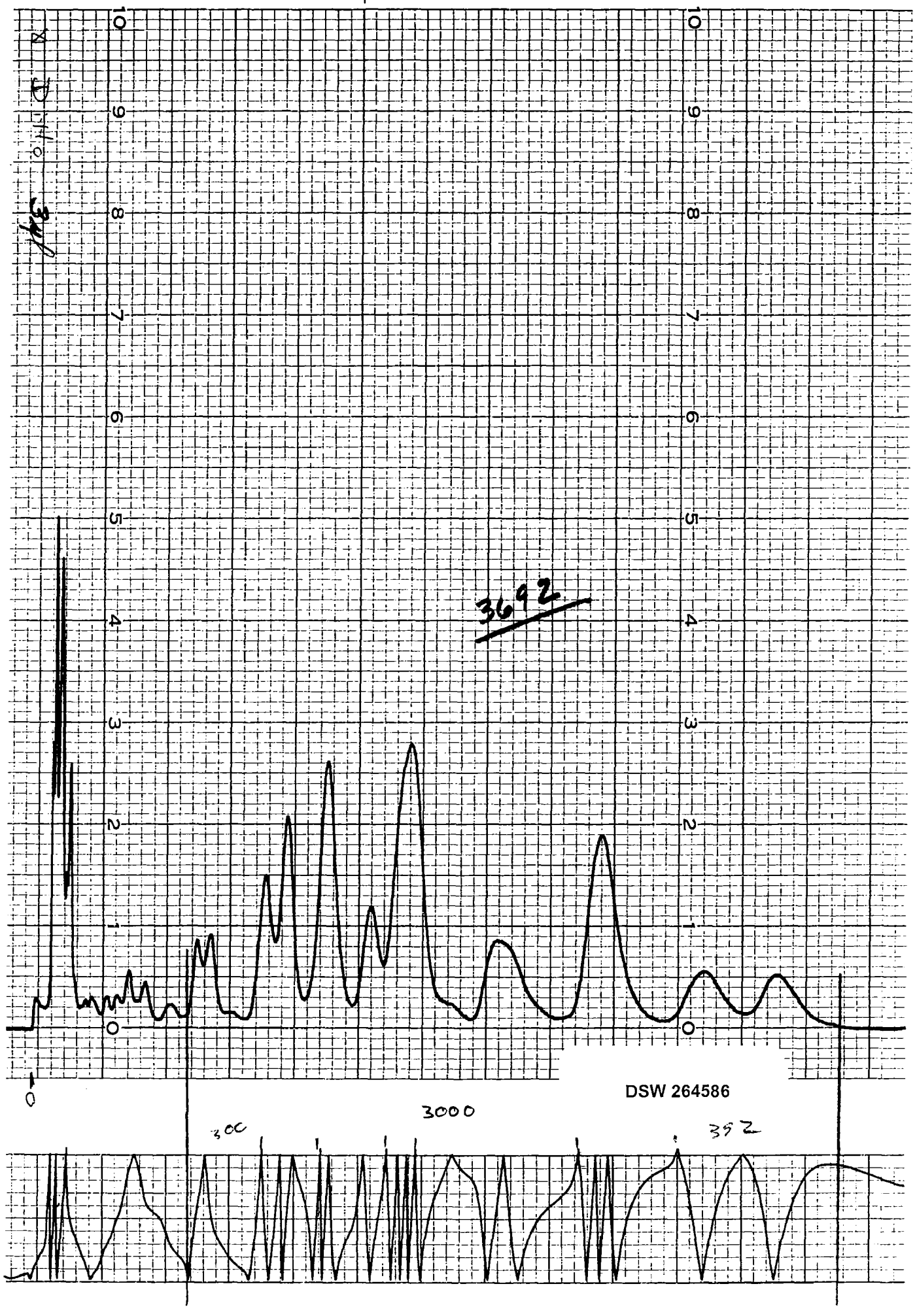

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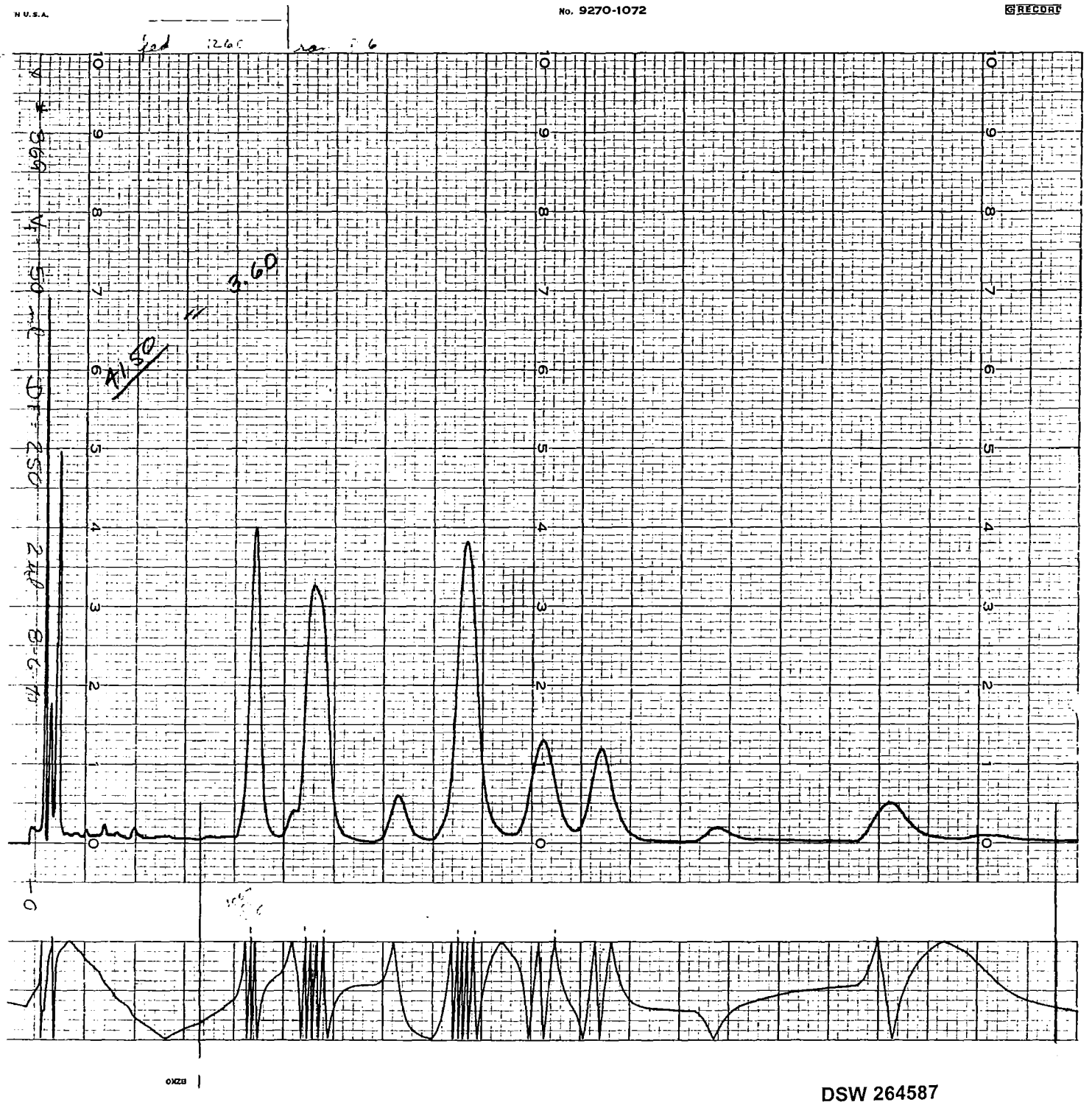
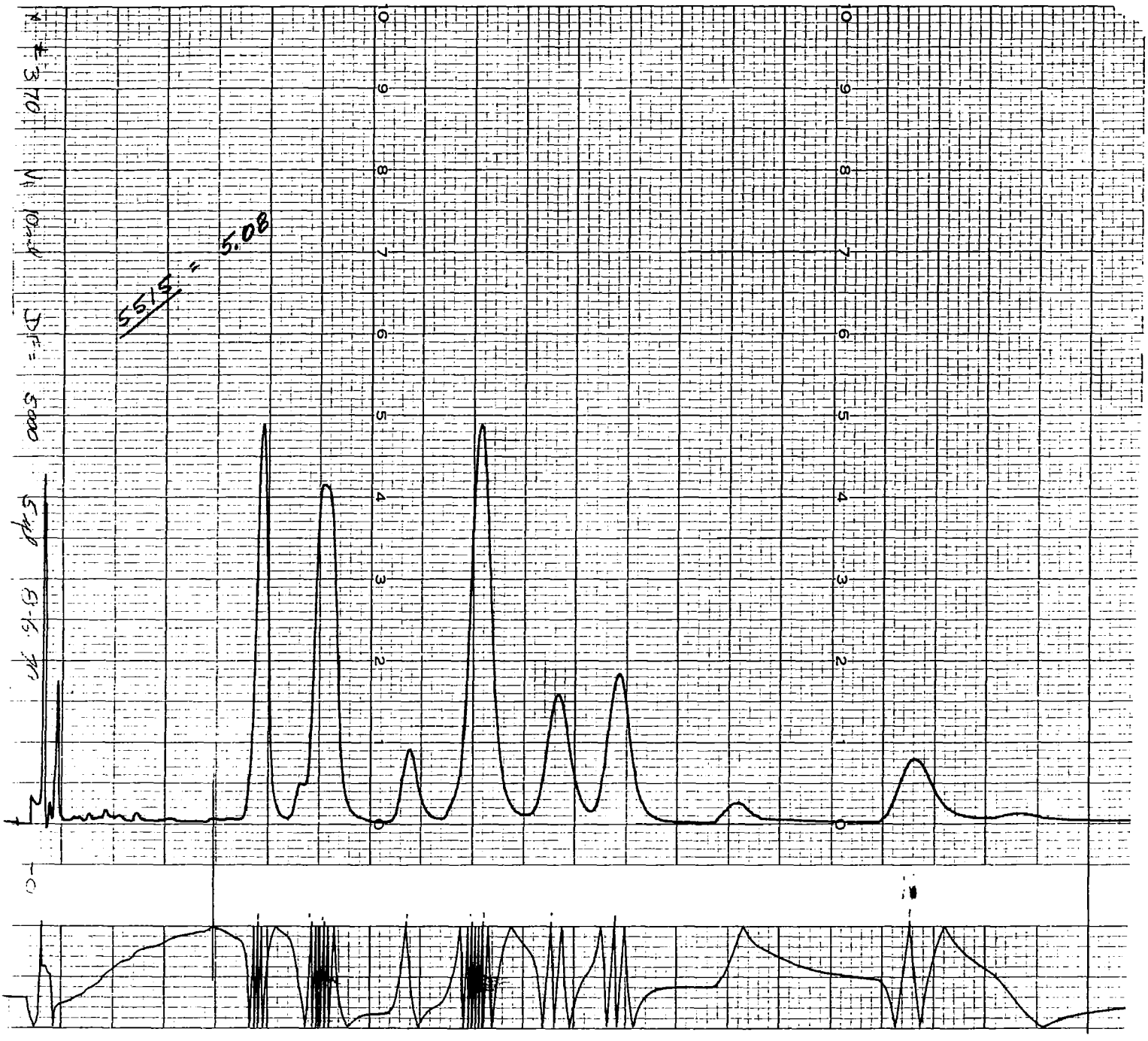


RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK



DSW 264588

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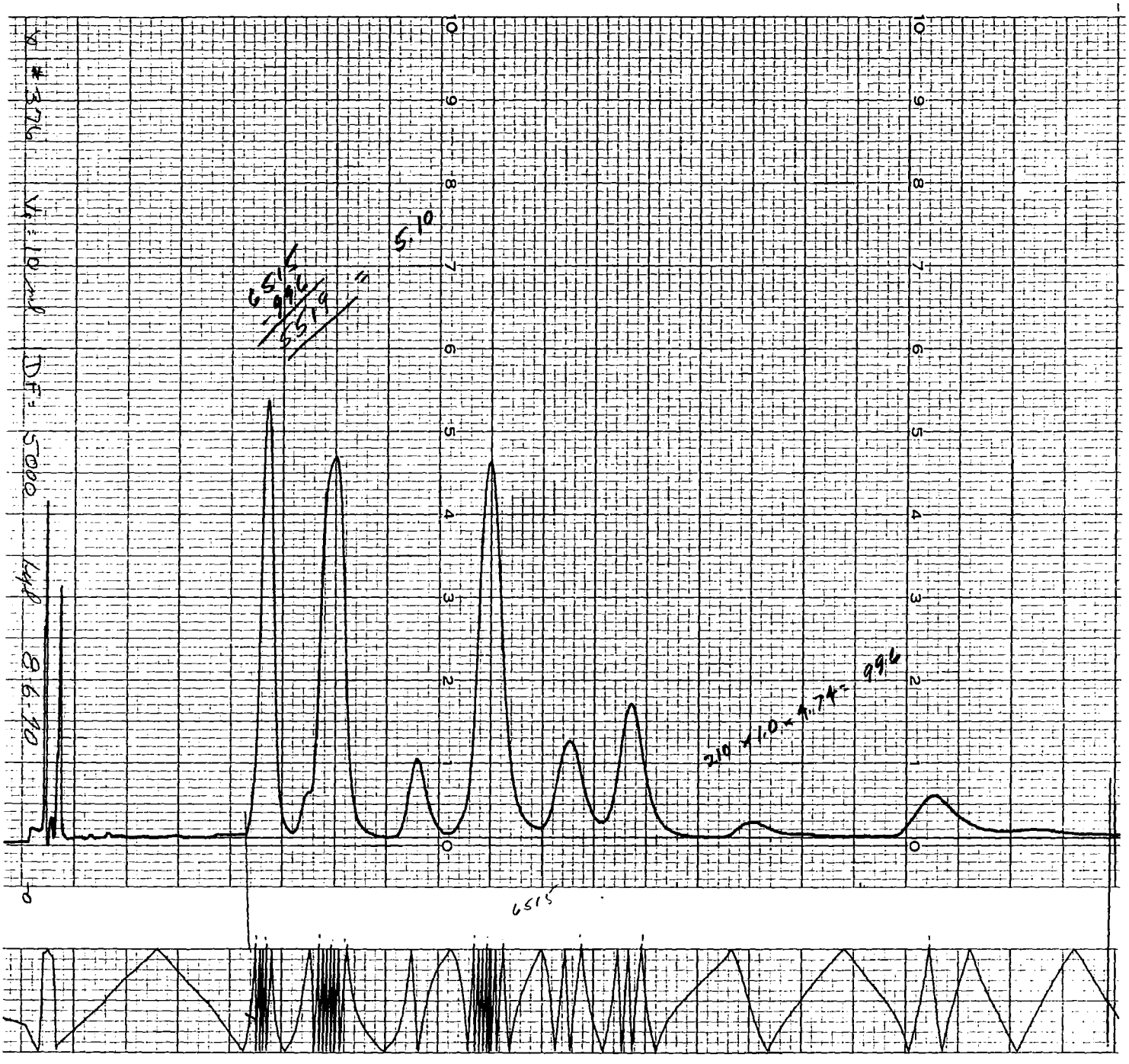
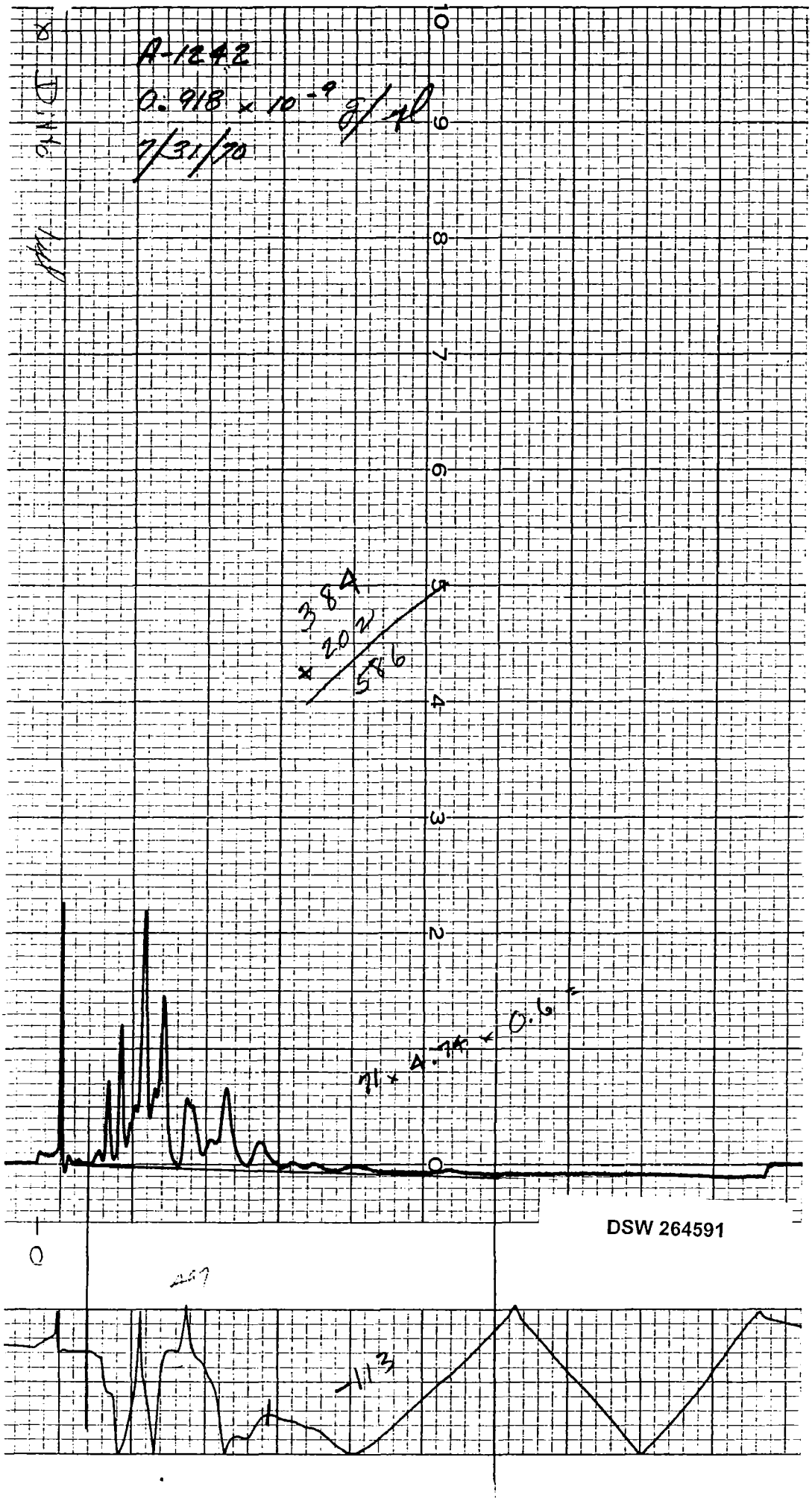
DSW 264589

ECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.



DSW 264590

RECORDING CHARTS, GRAPHS CONTROL



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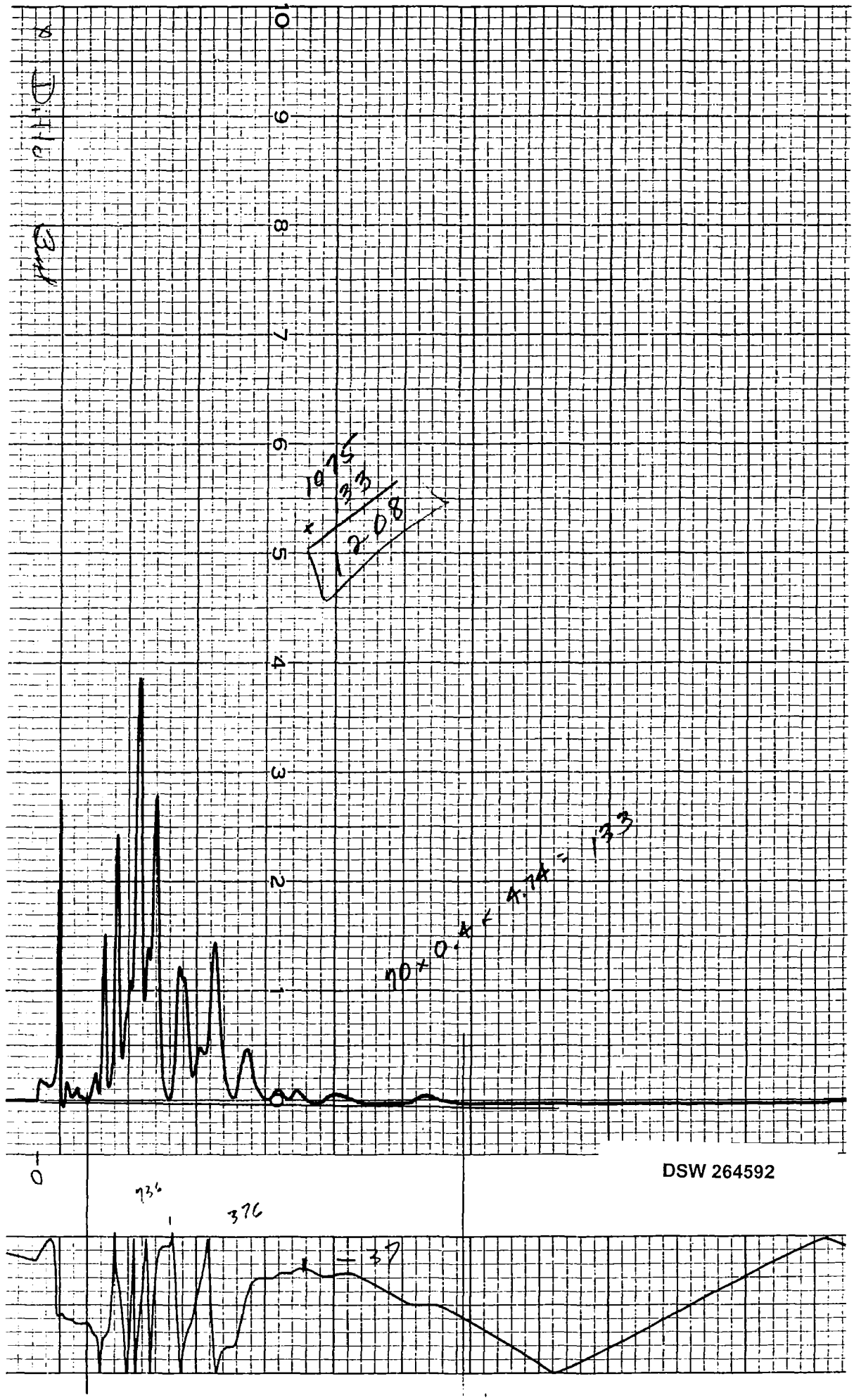

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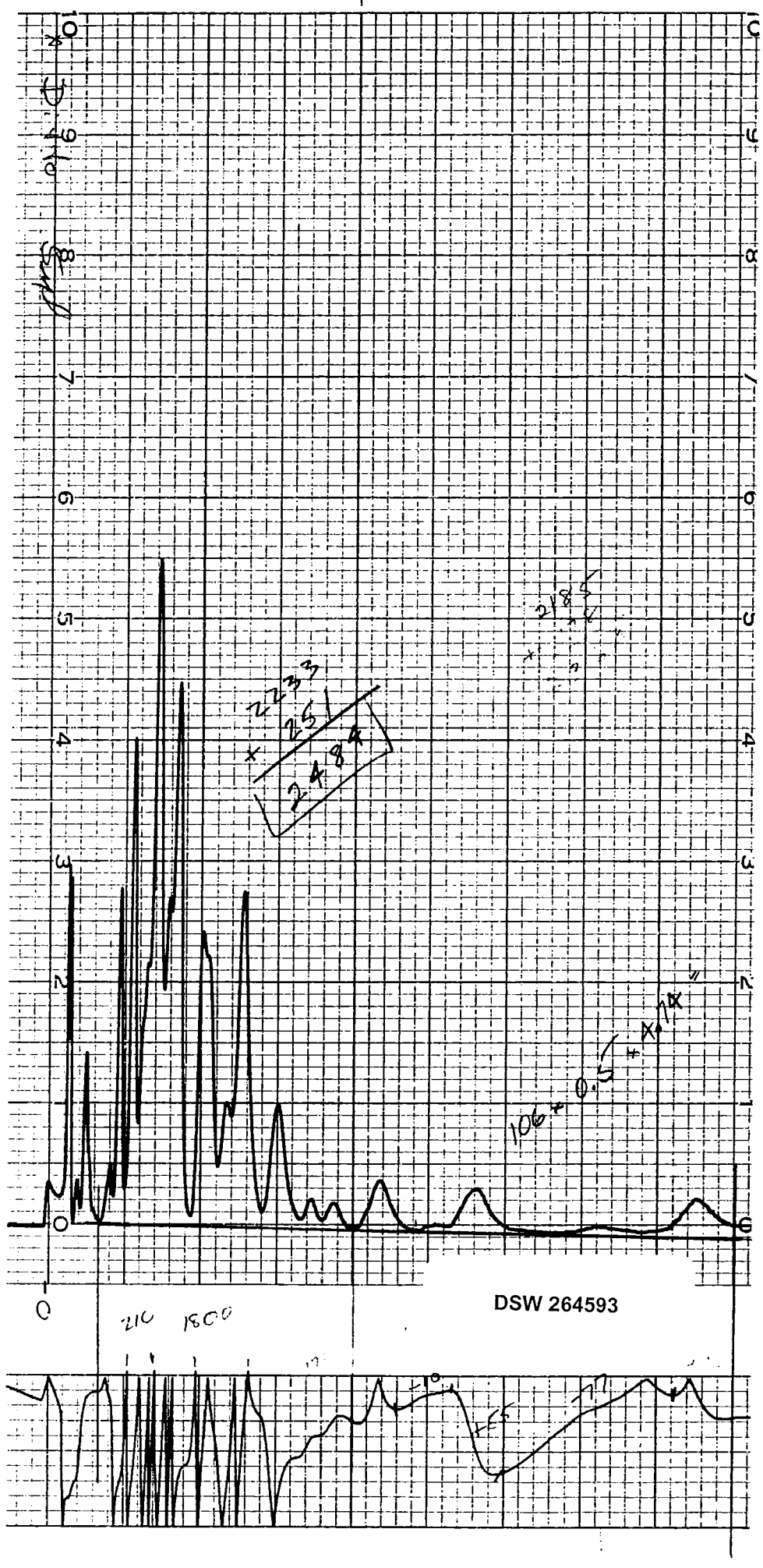

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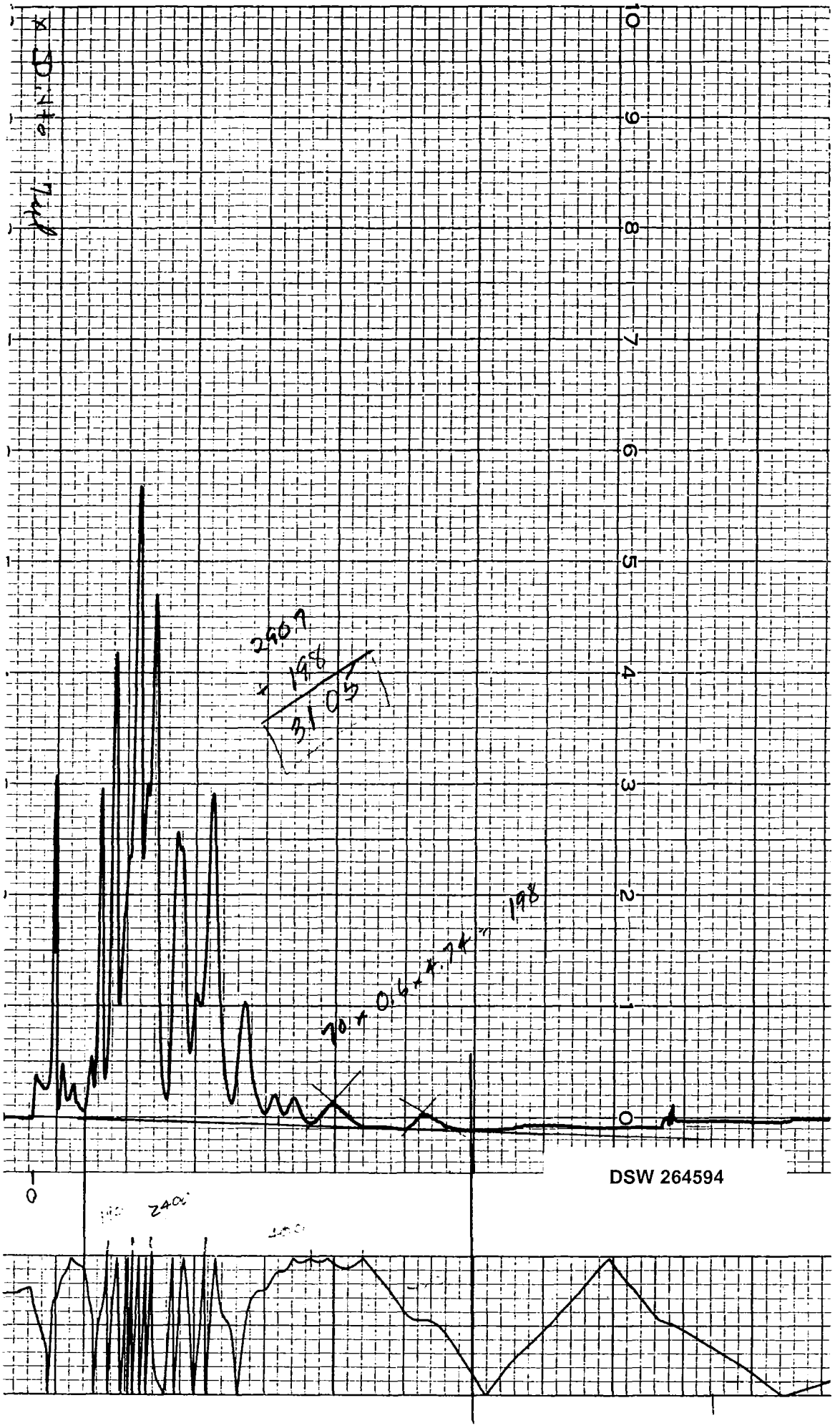

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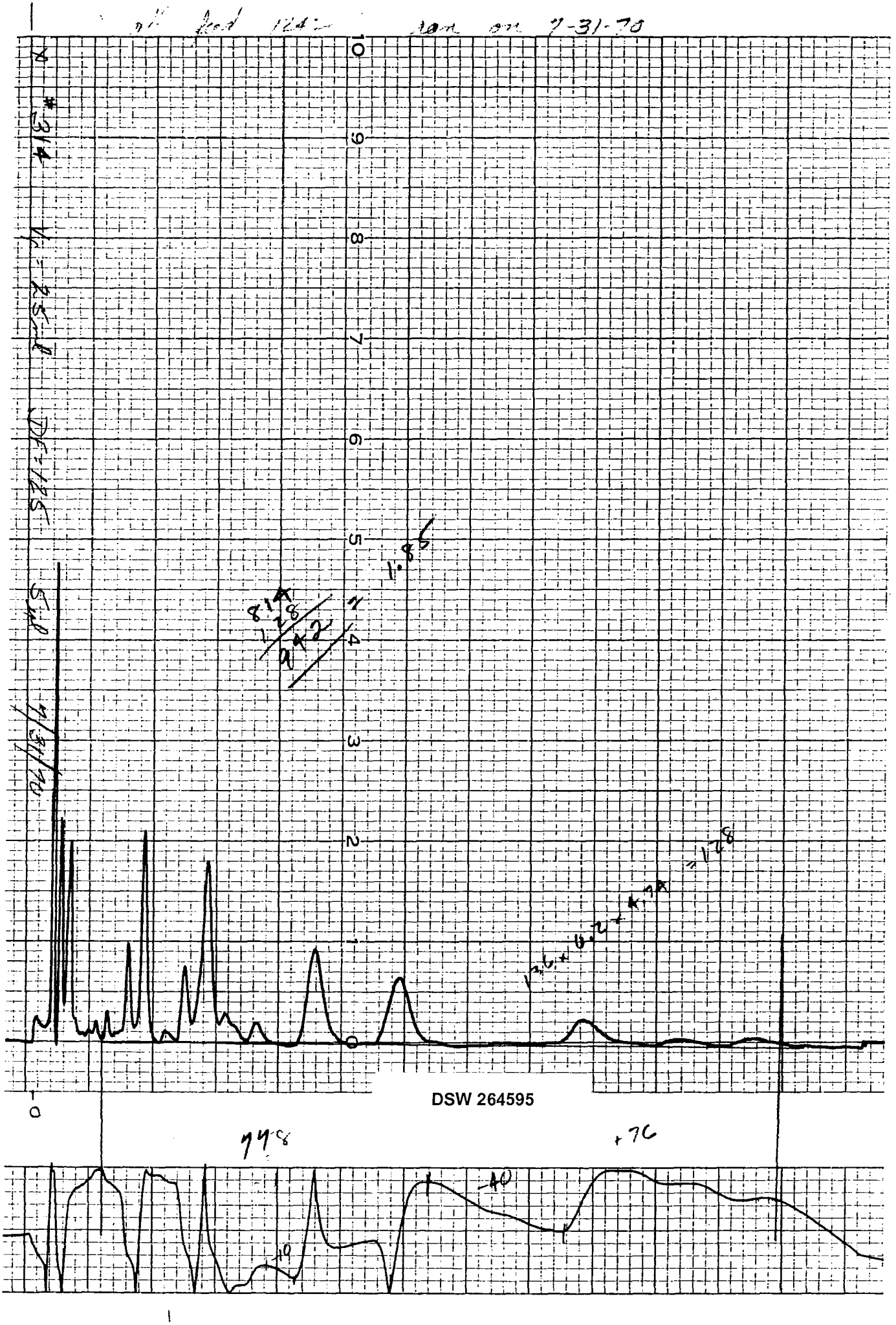
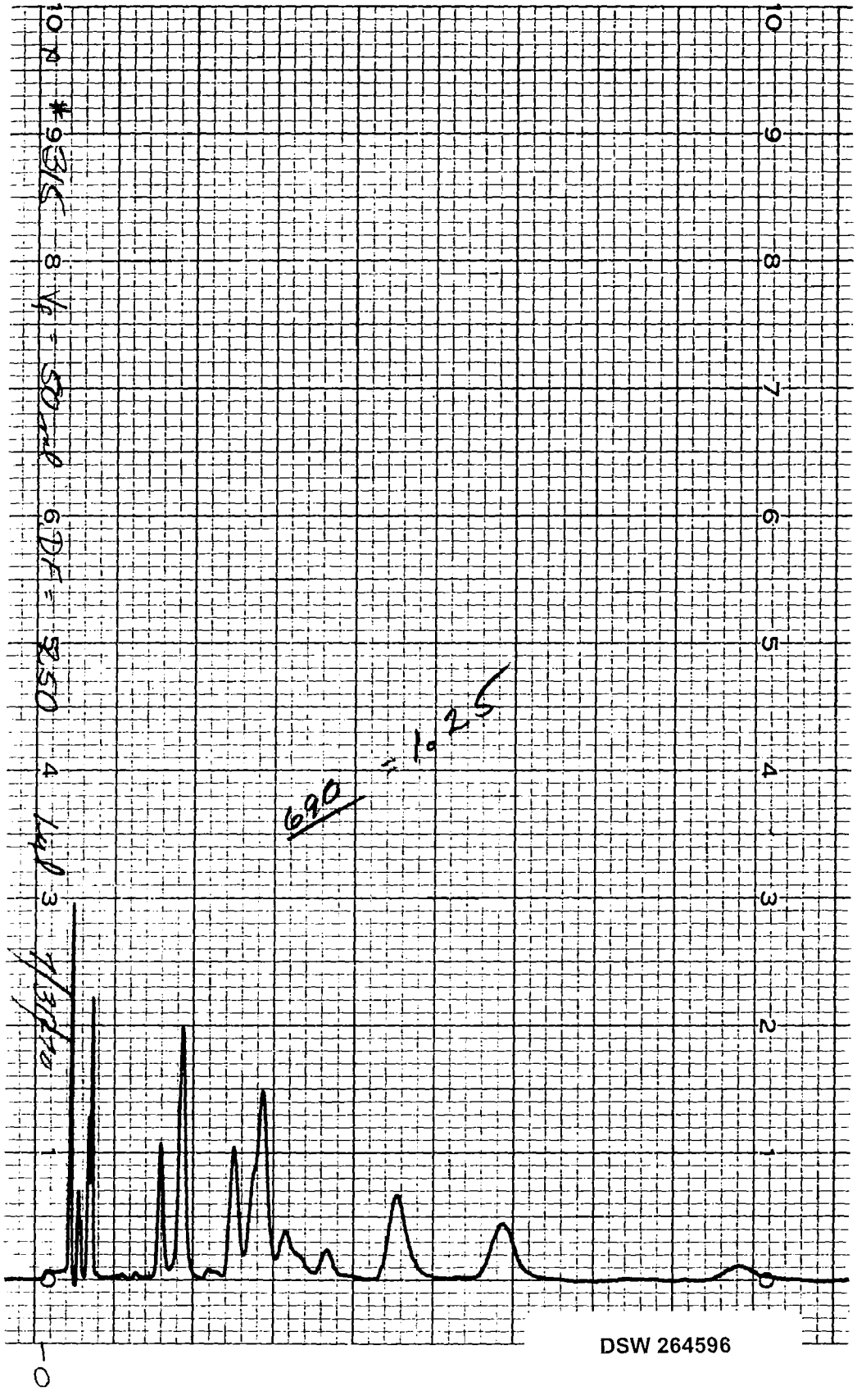
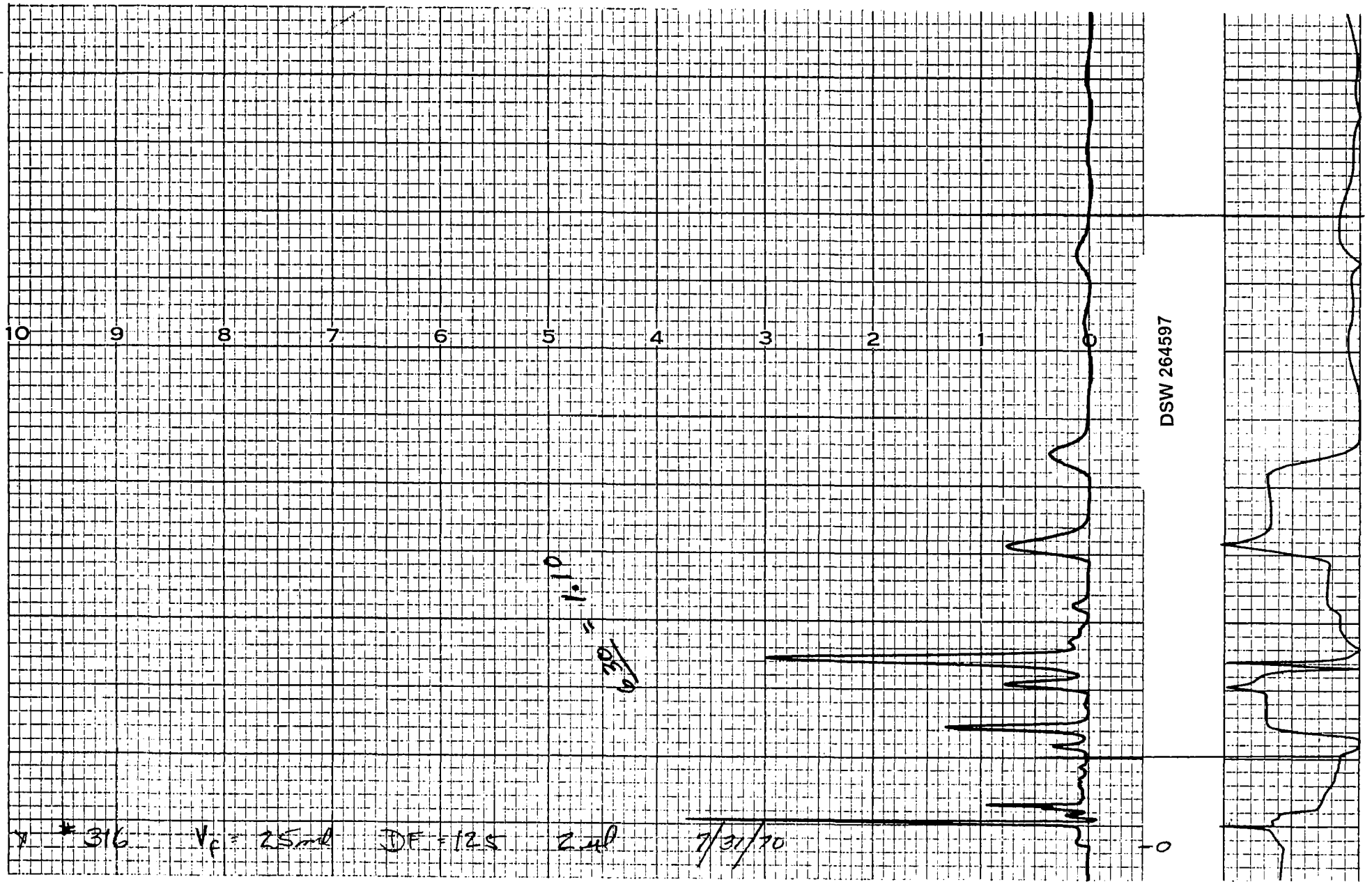



DSW 264596



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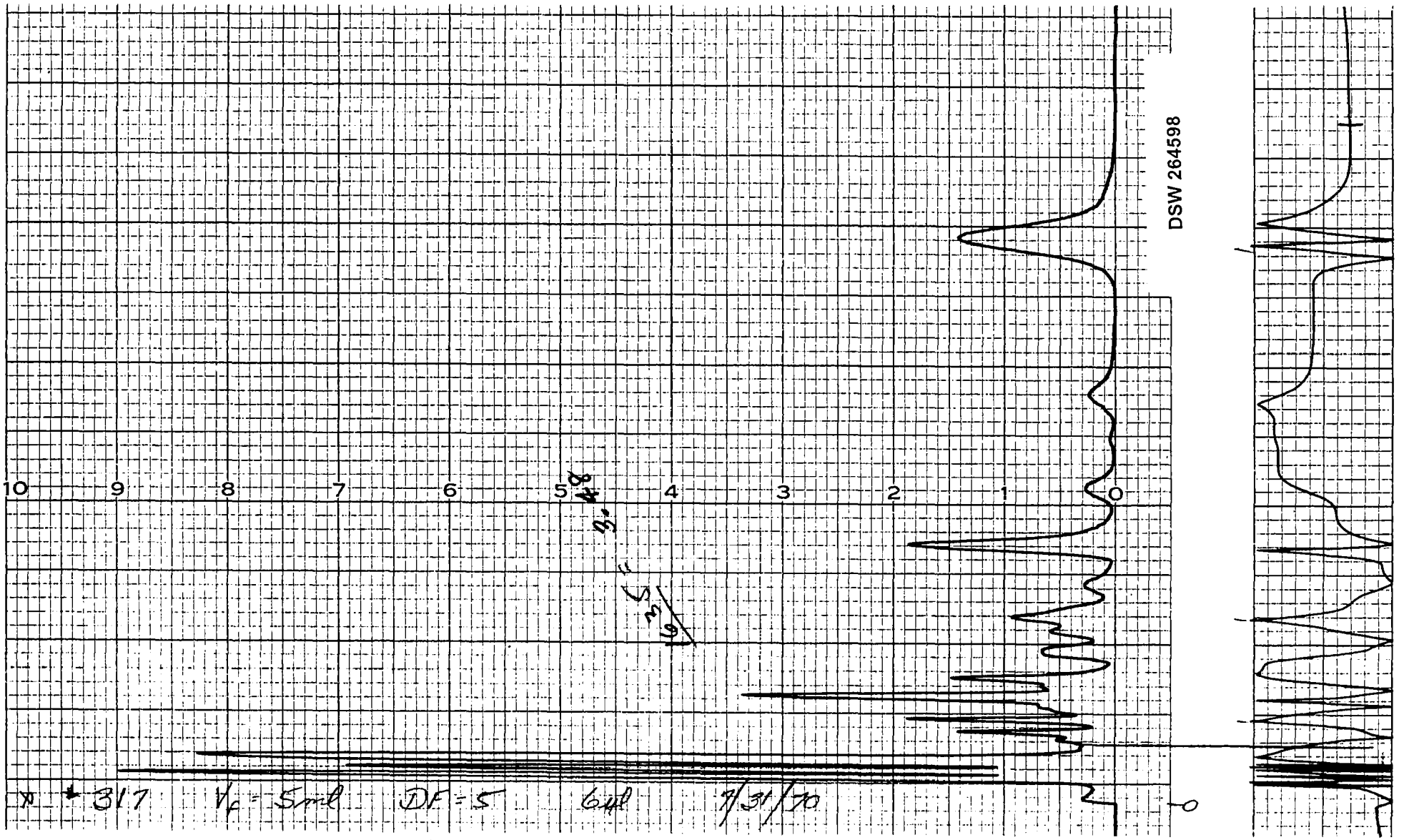

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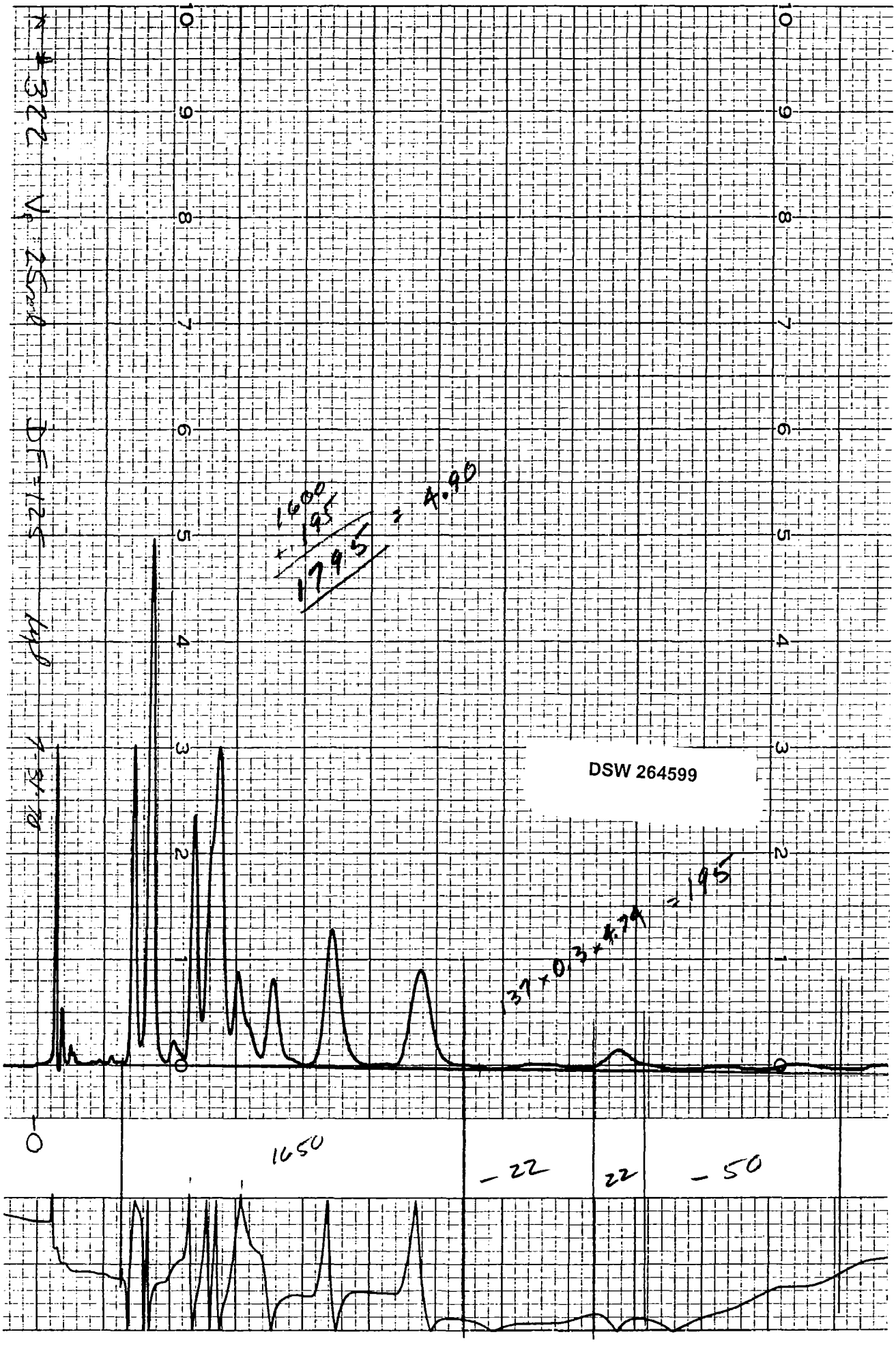

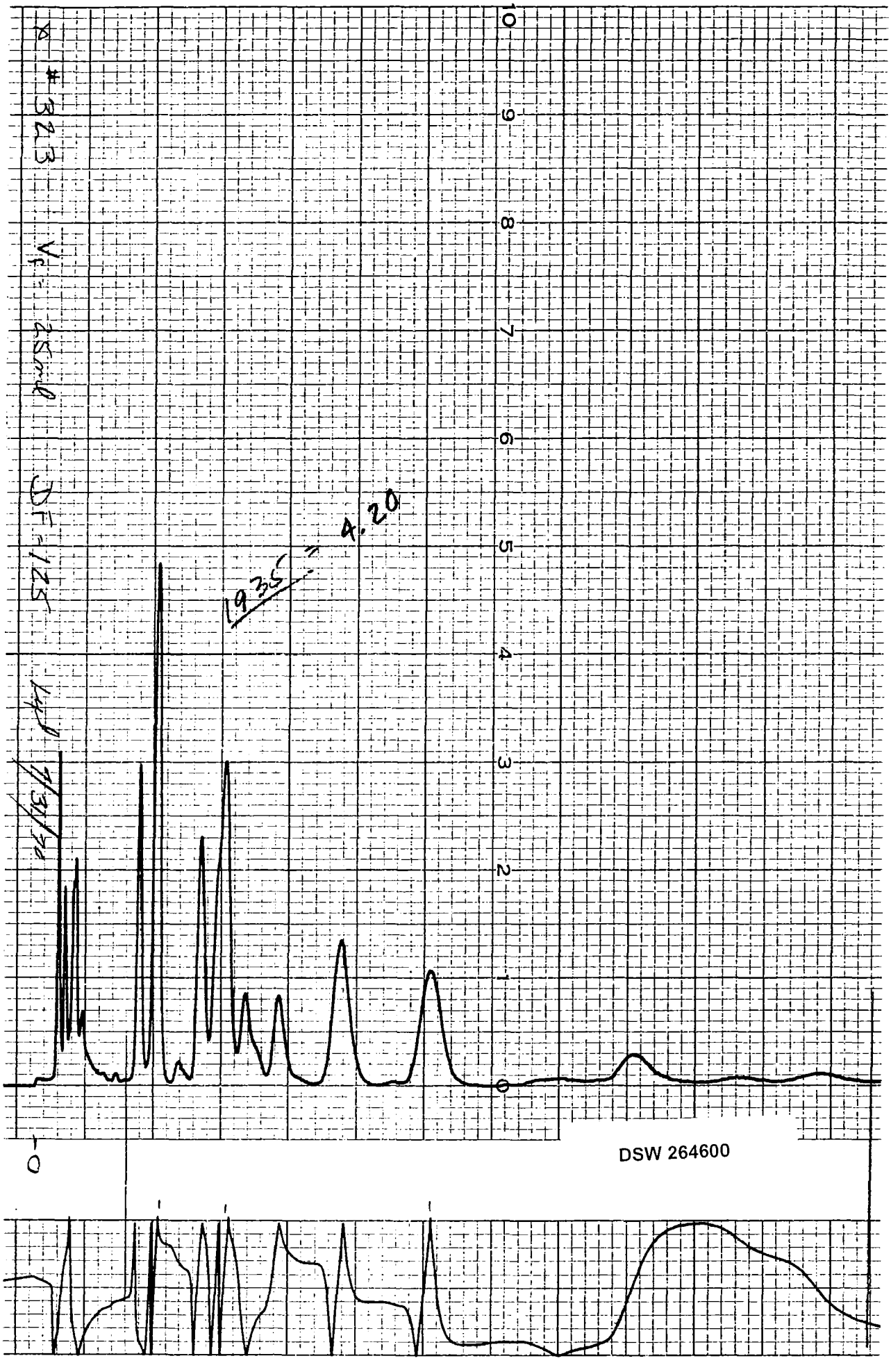

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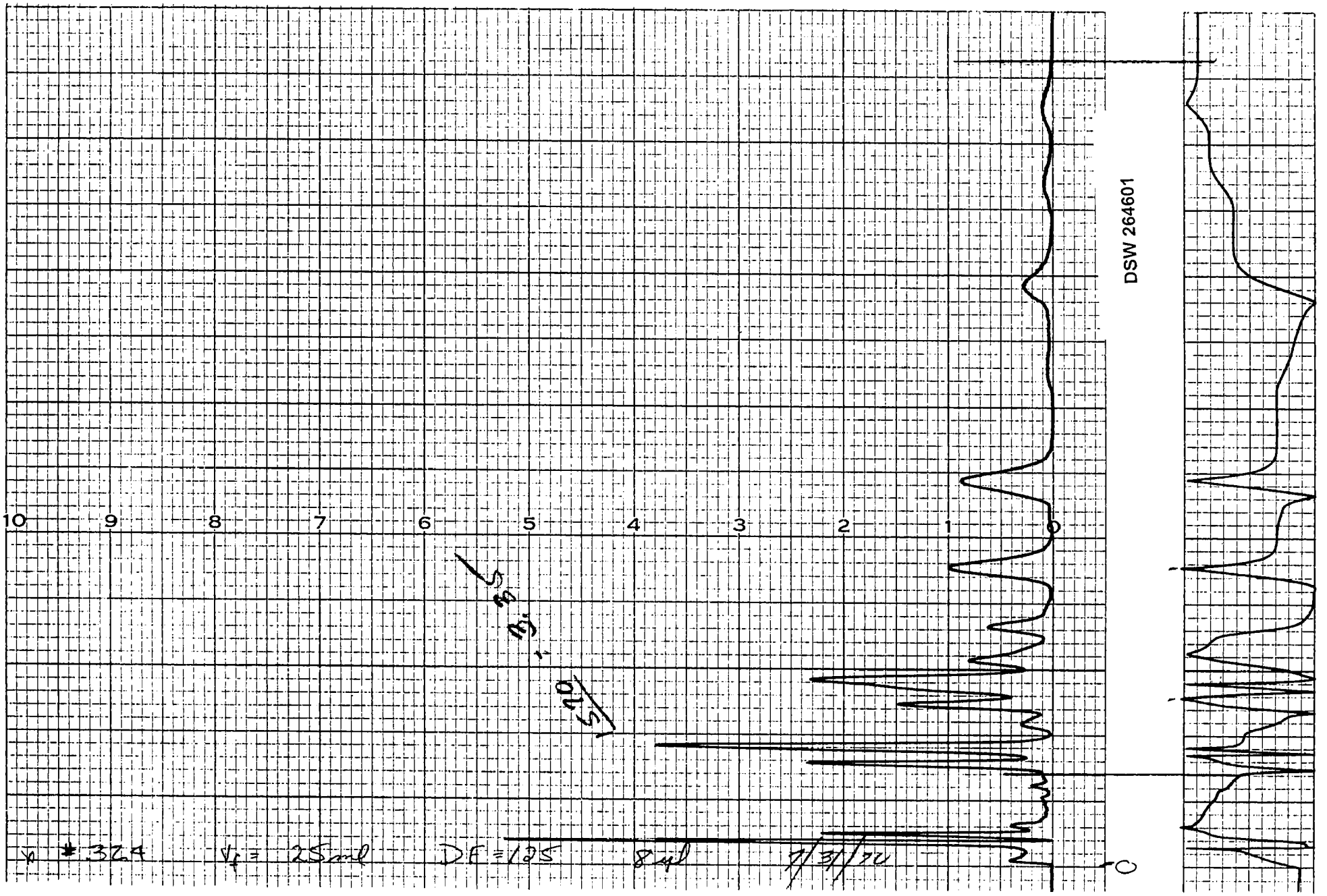

LEXOLDMON008172

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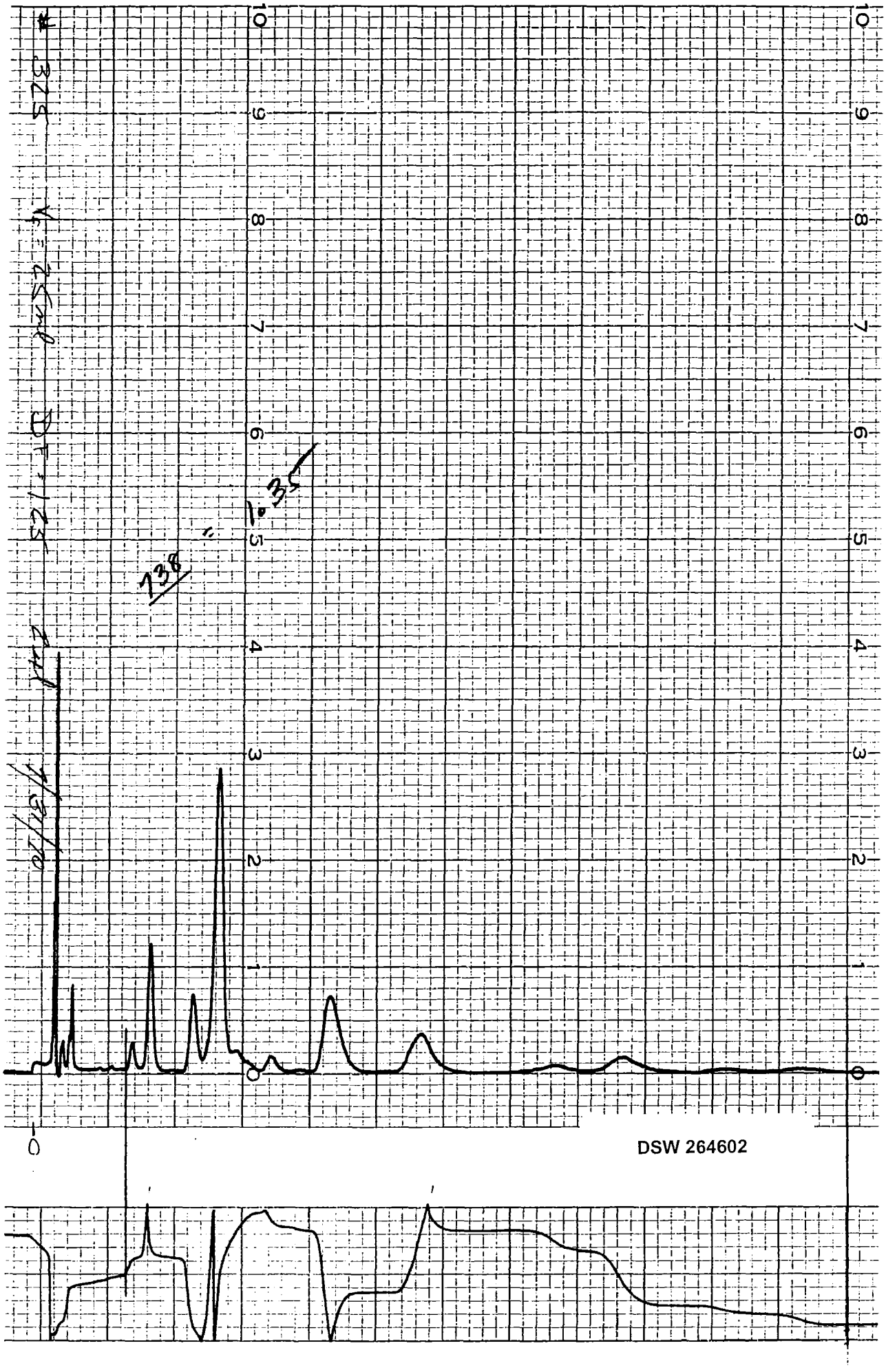

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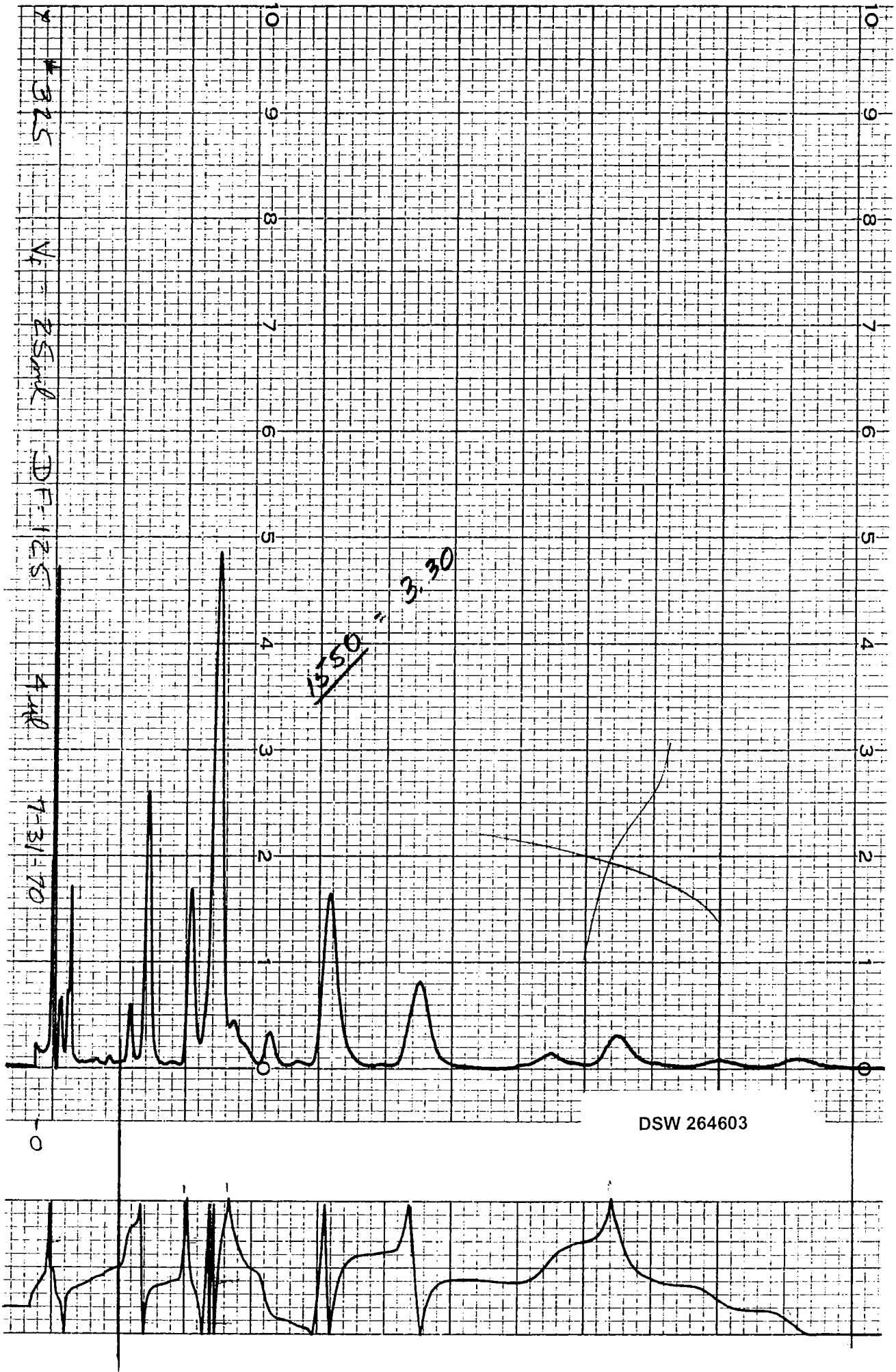

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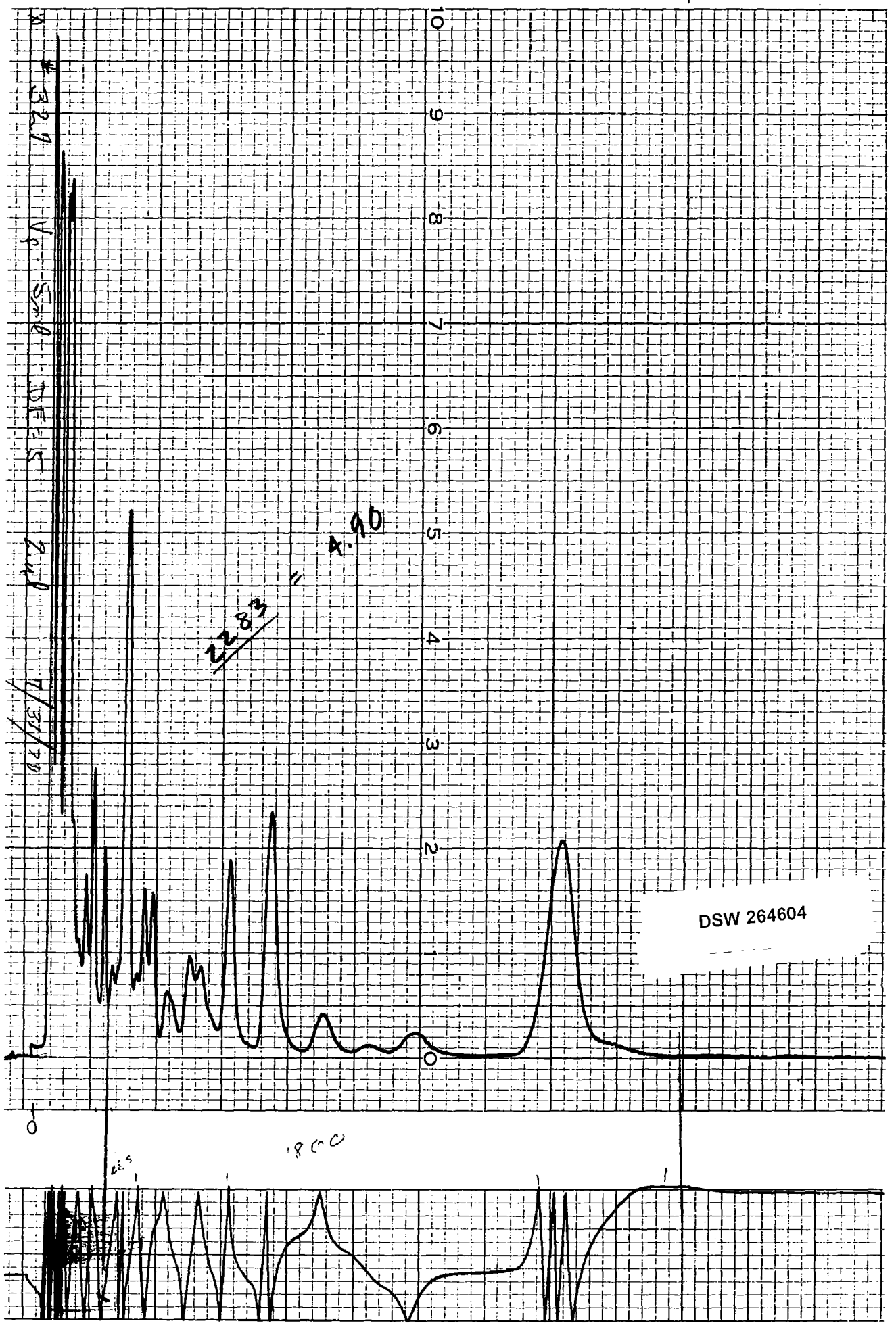

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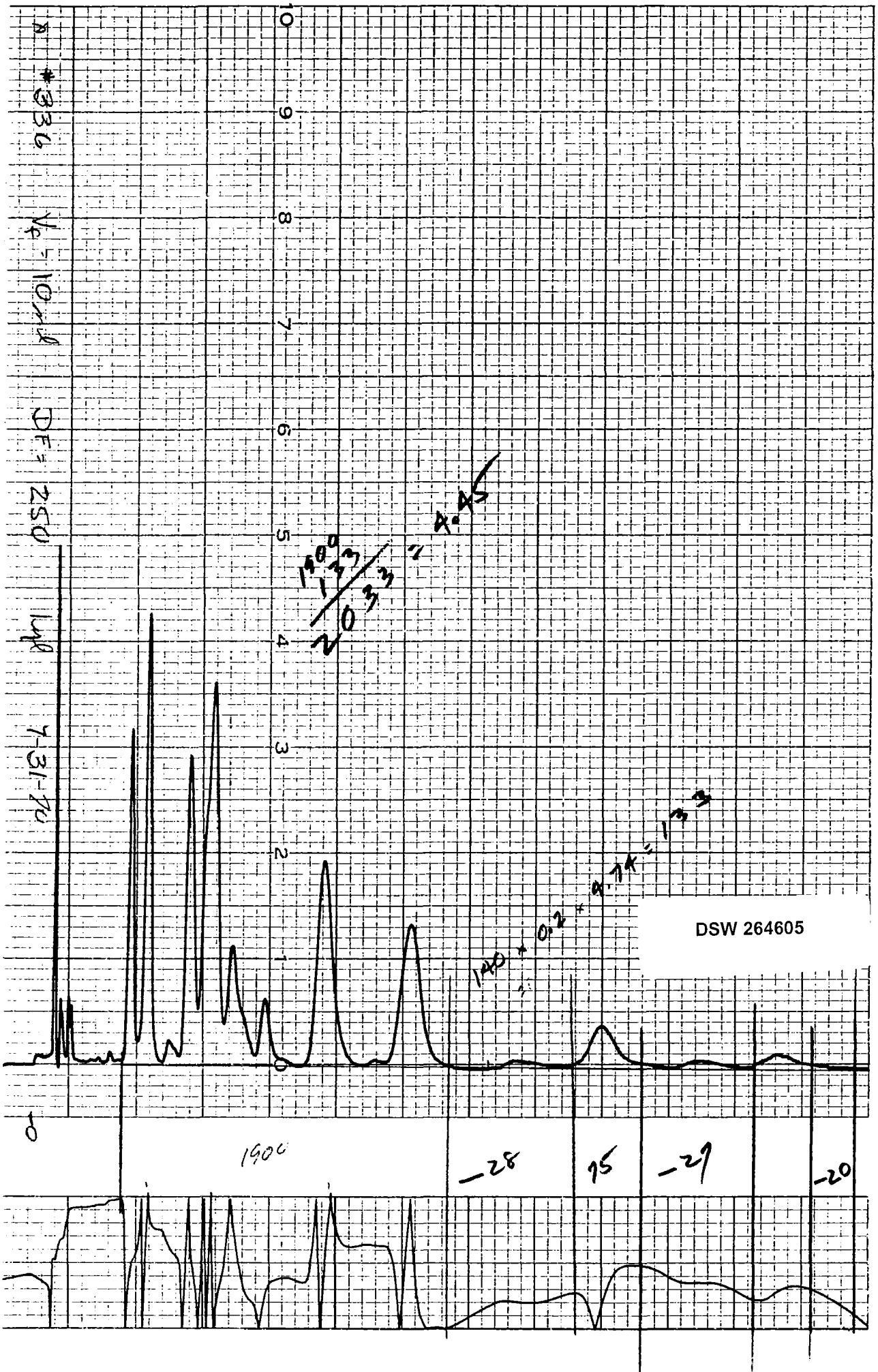

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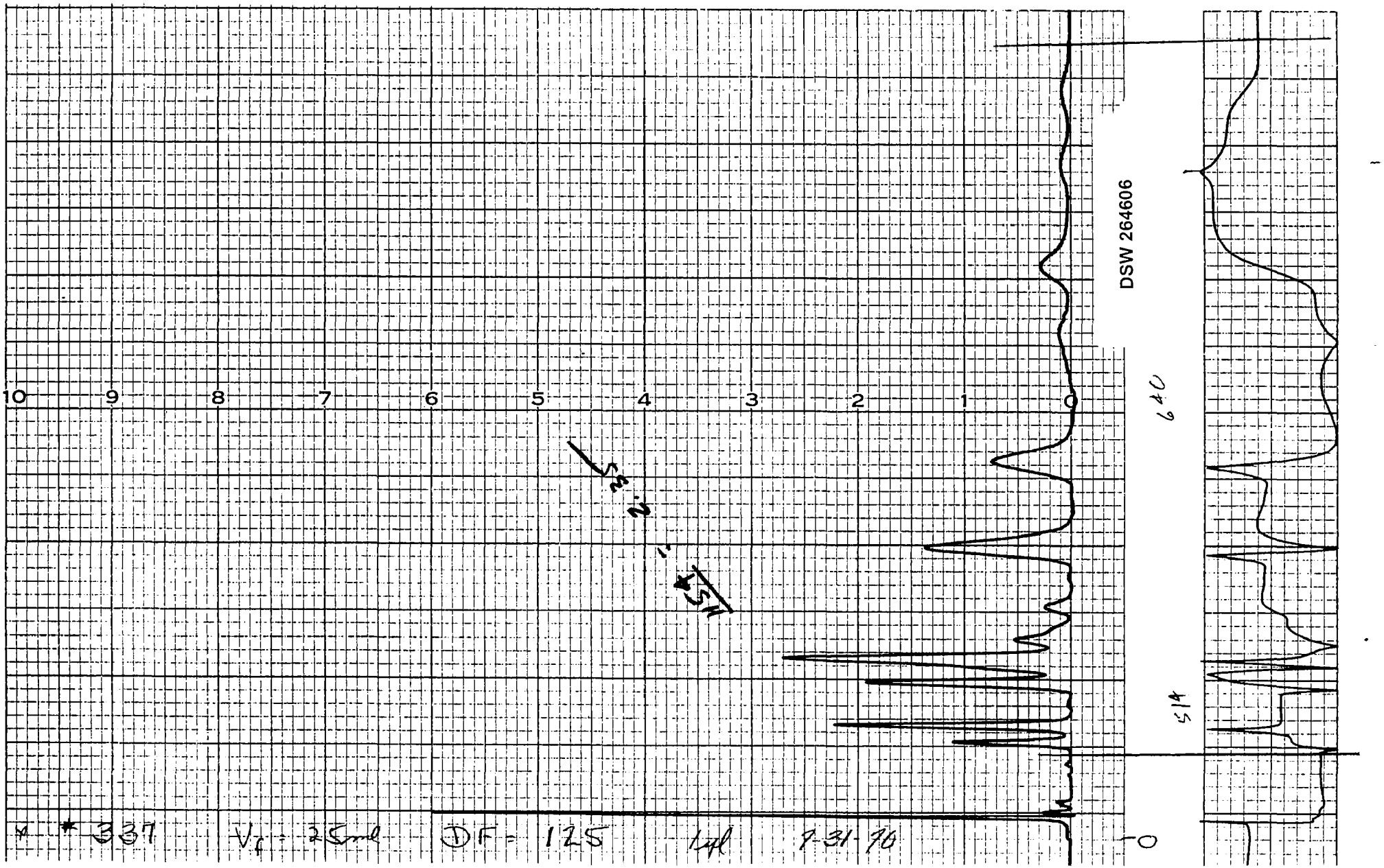
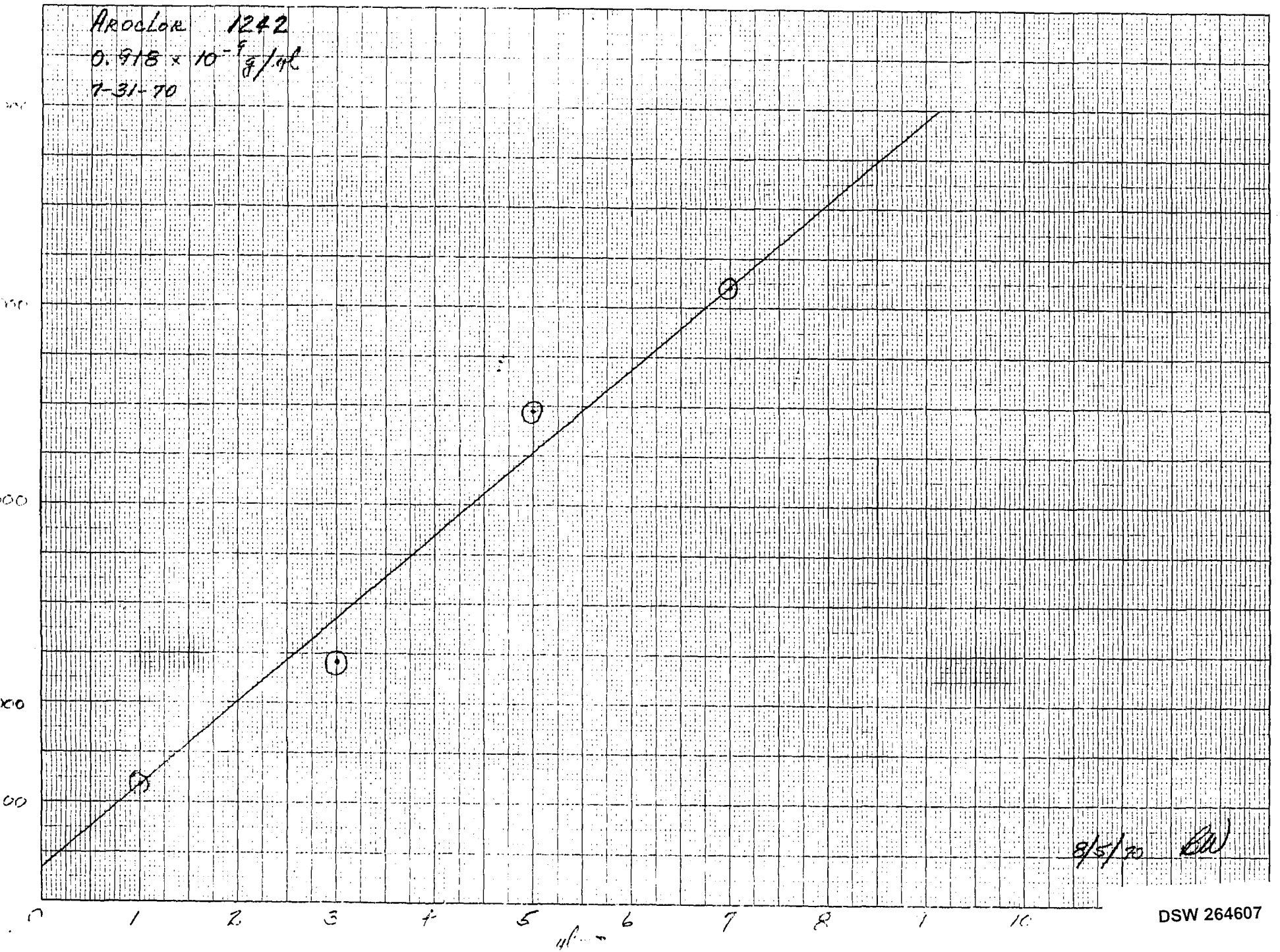


LEXOLDMON008177

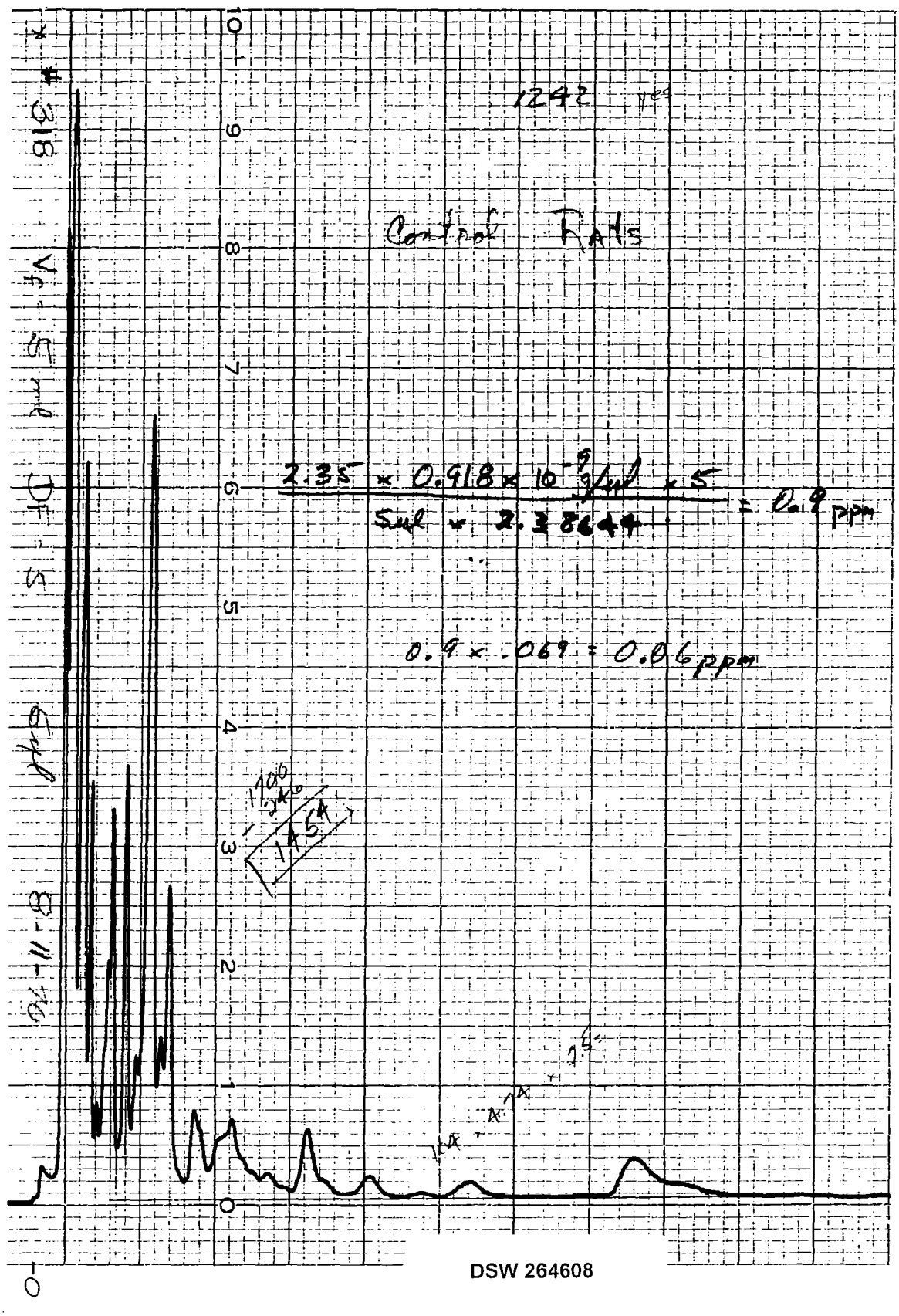
K+E 10 X 10 TO THE CENTIMETER 46 1510
KEUFFEL & ESSER CO.

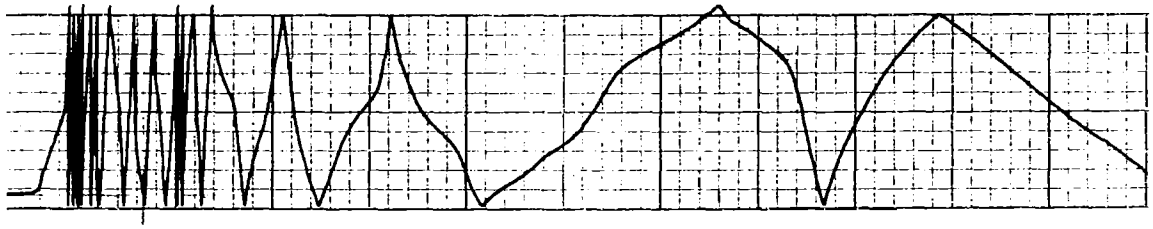


DSW 264607

LEXOLDMON008178

RECORDING CHARTS GRAPHIC CONTROLS CORPORATION





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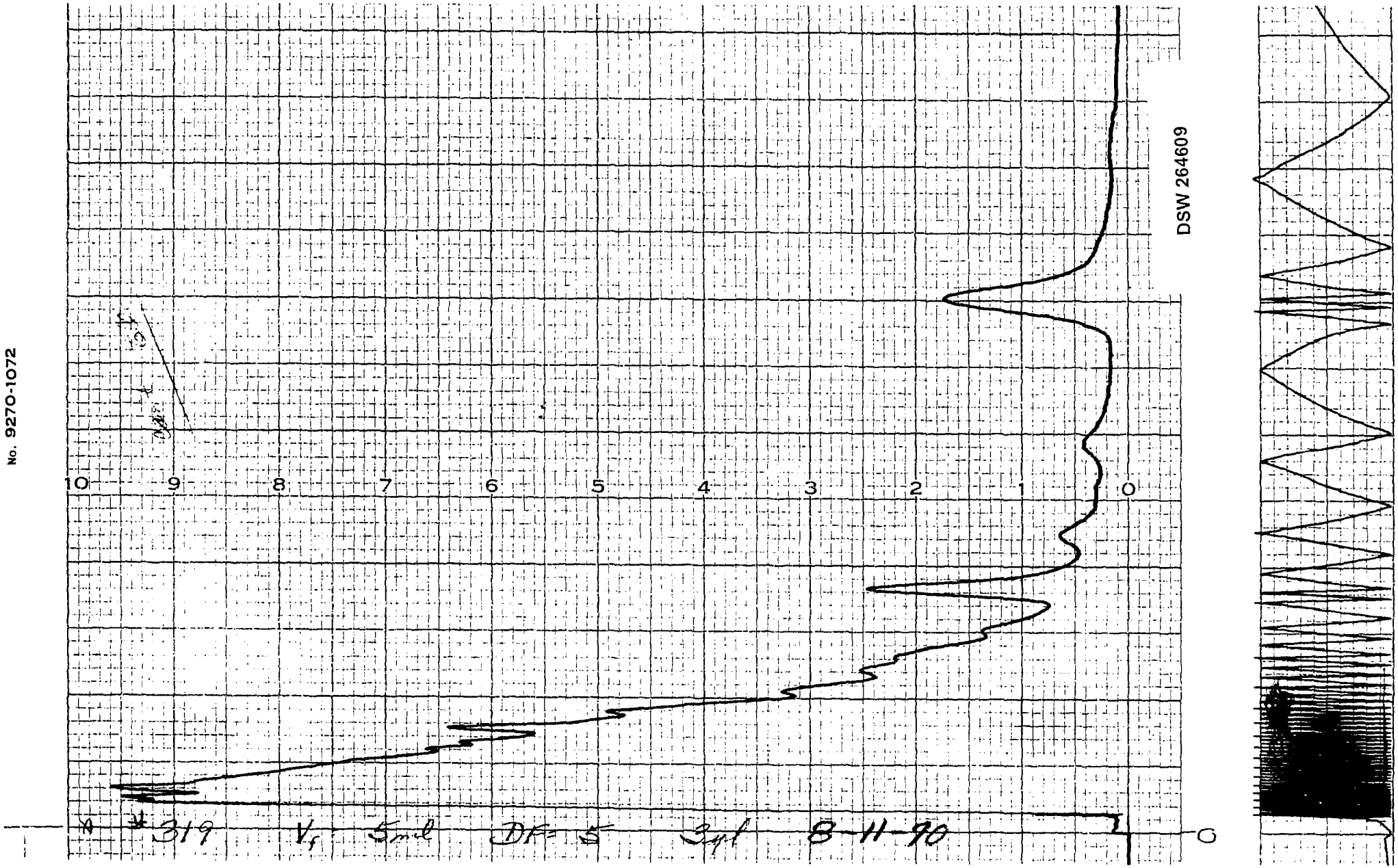

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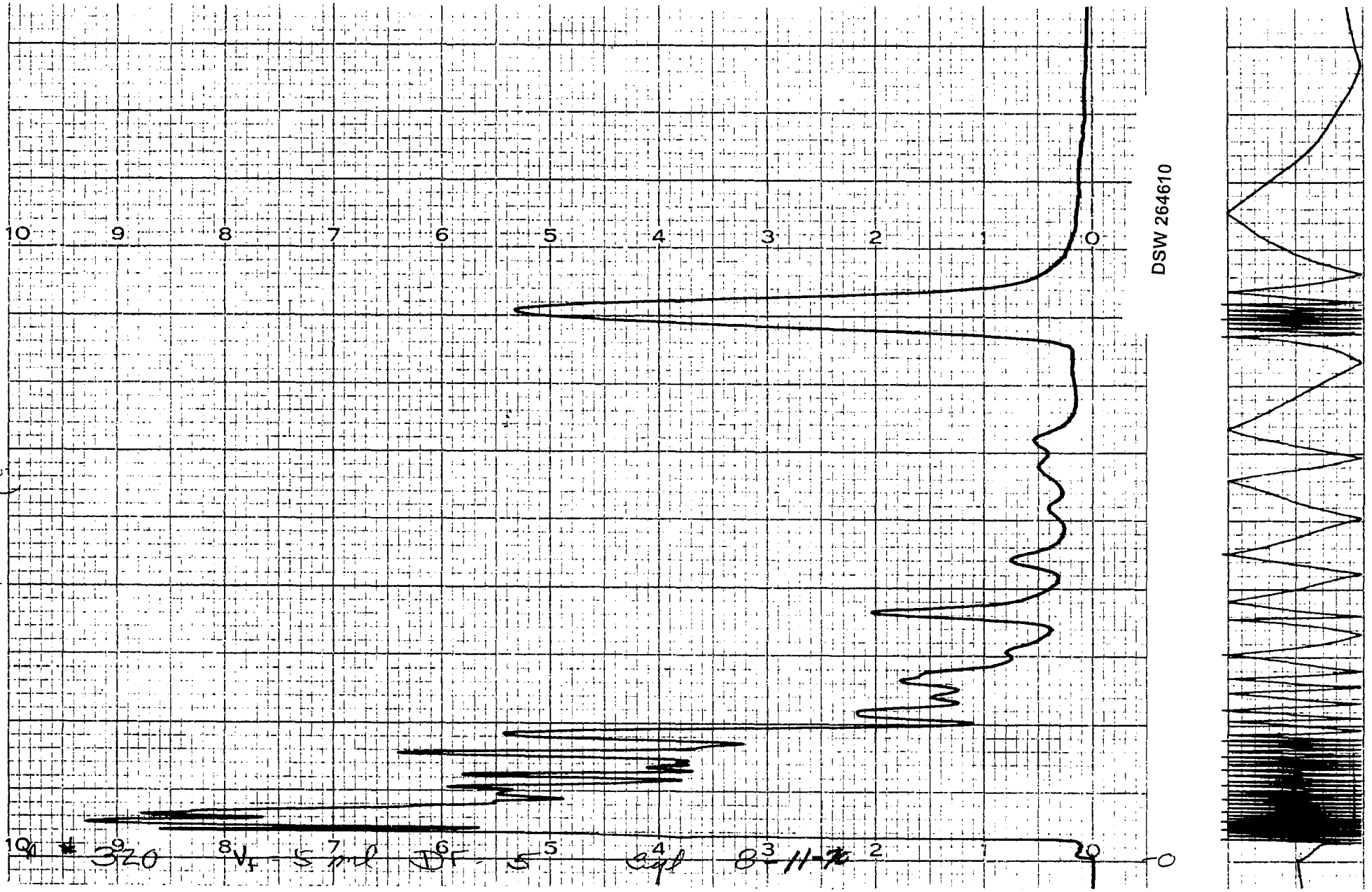

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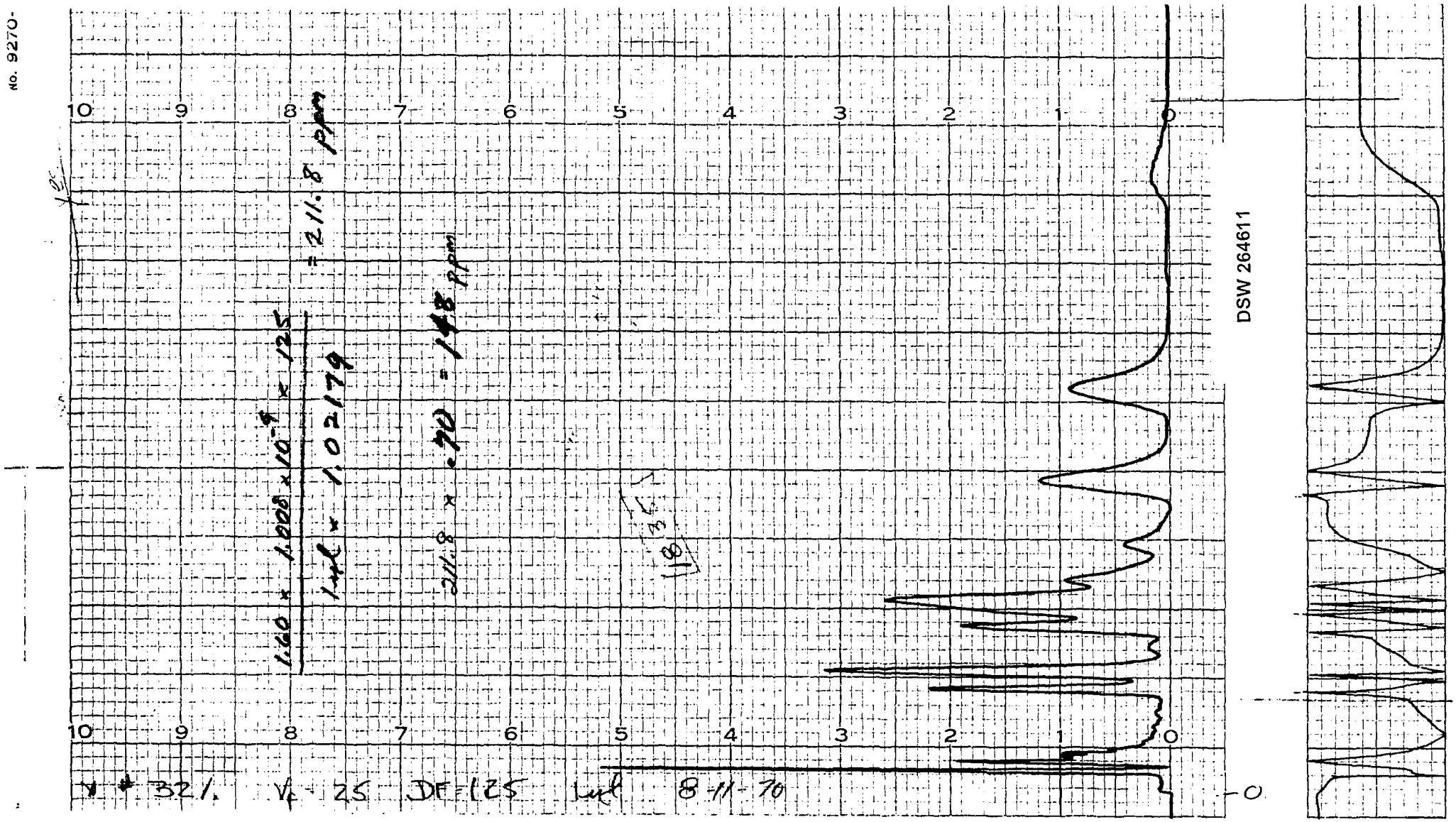
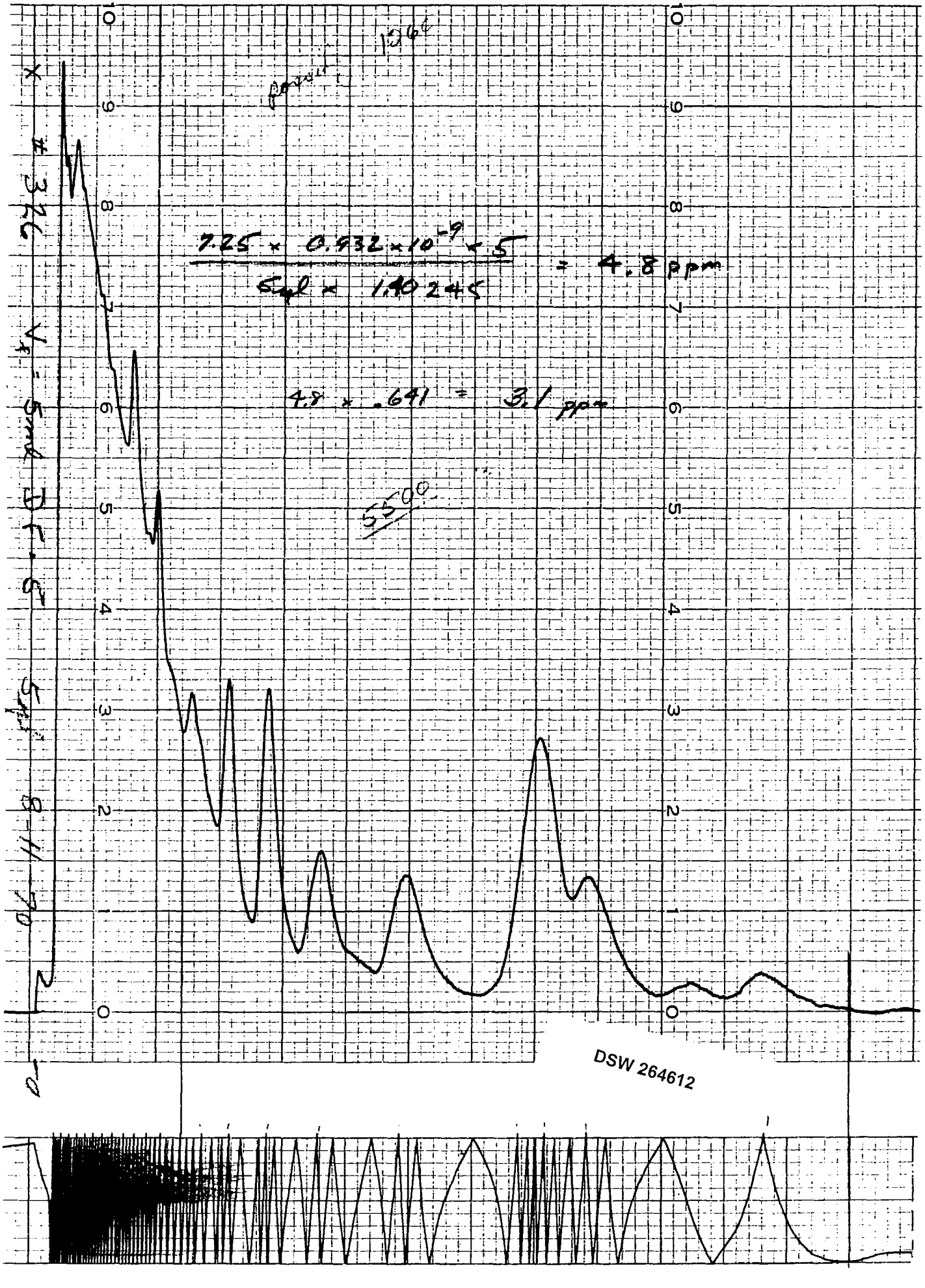


LEXOLDMON008182

RECORDING CHARTS GRAPHIC



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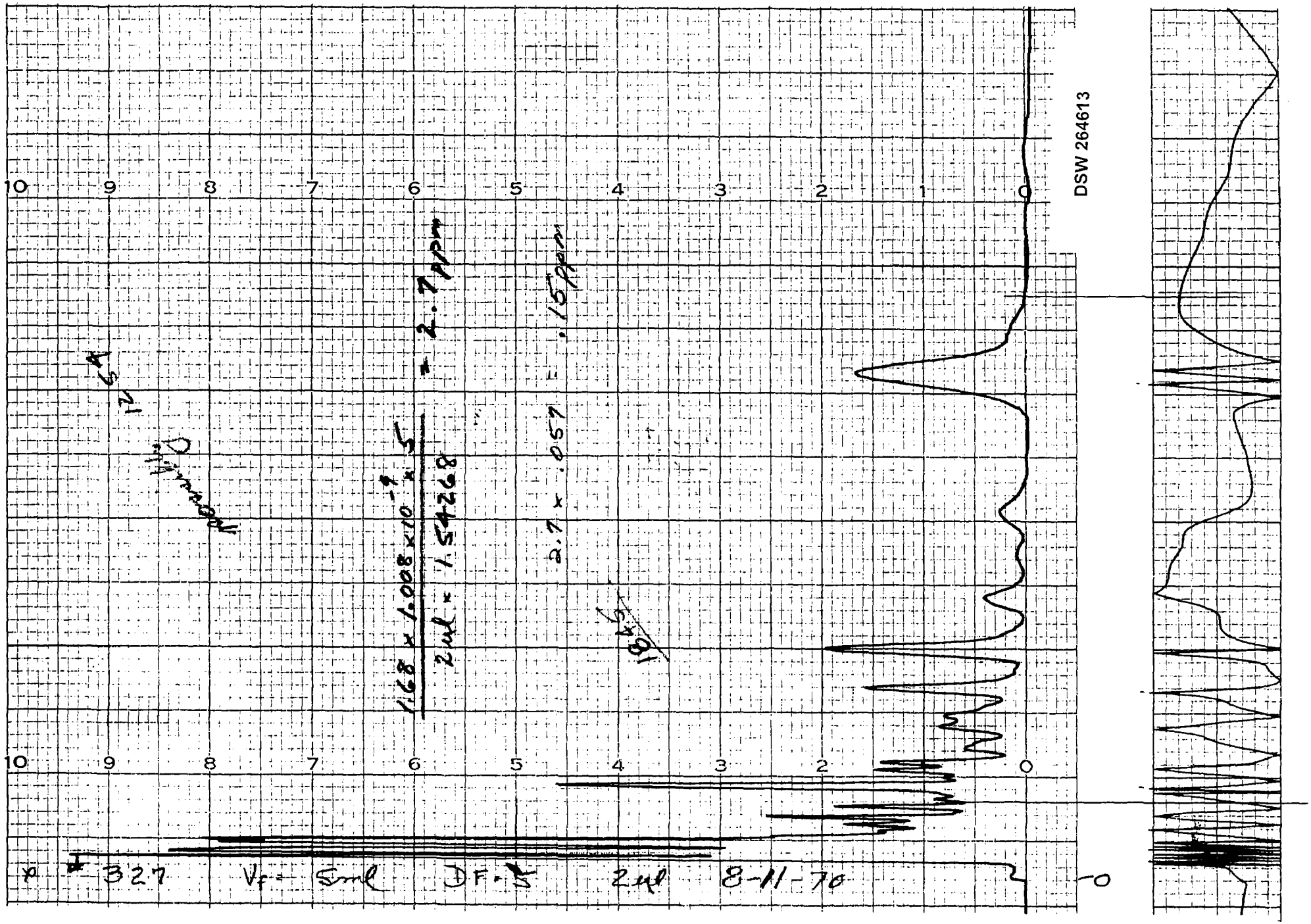
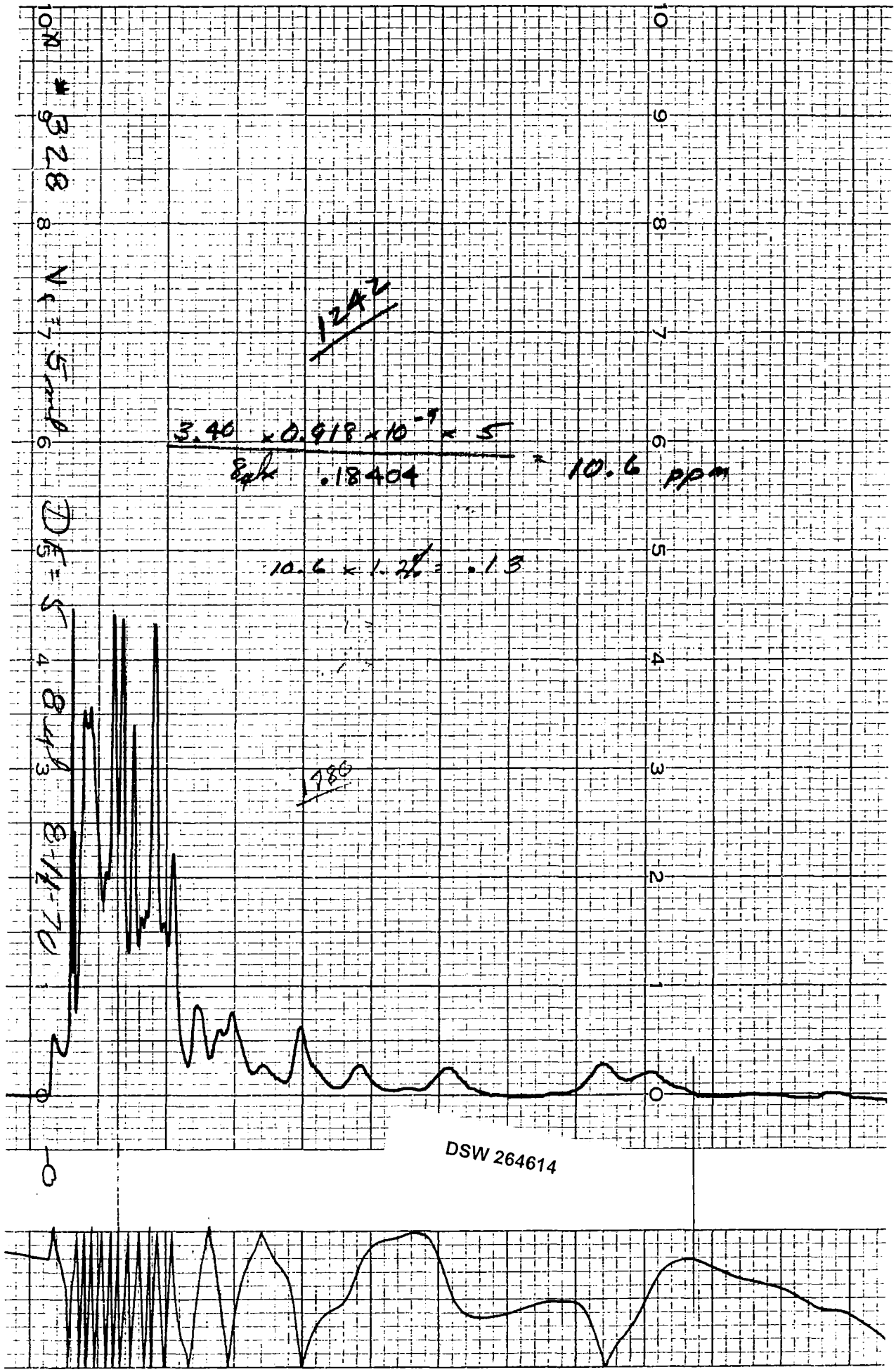


RECORDING CHARTS GRAPHIC CONTROLS CORPORATION

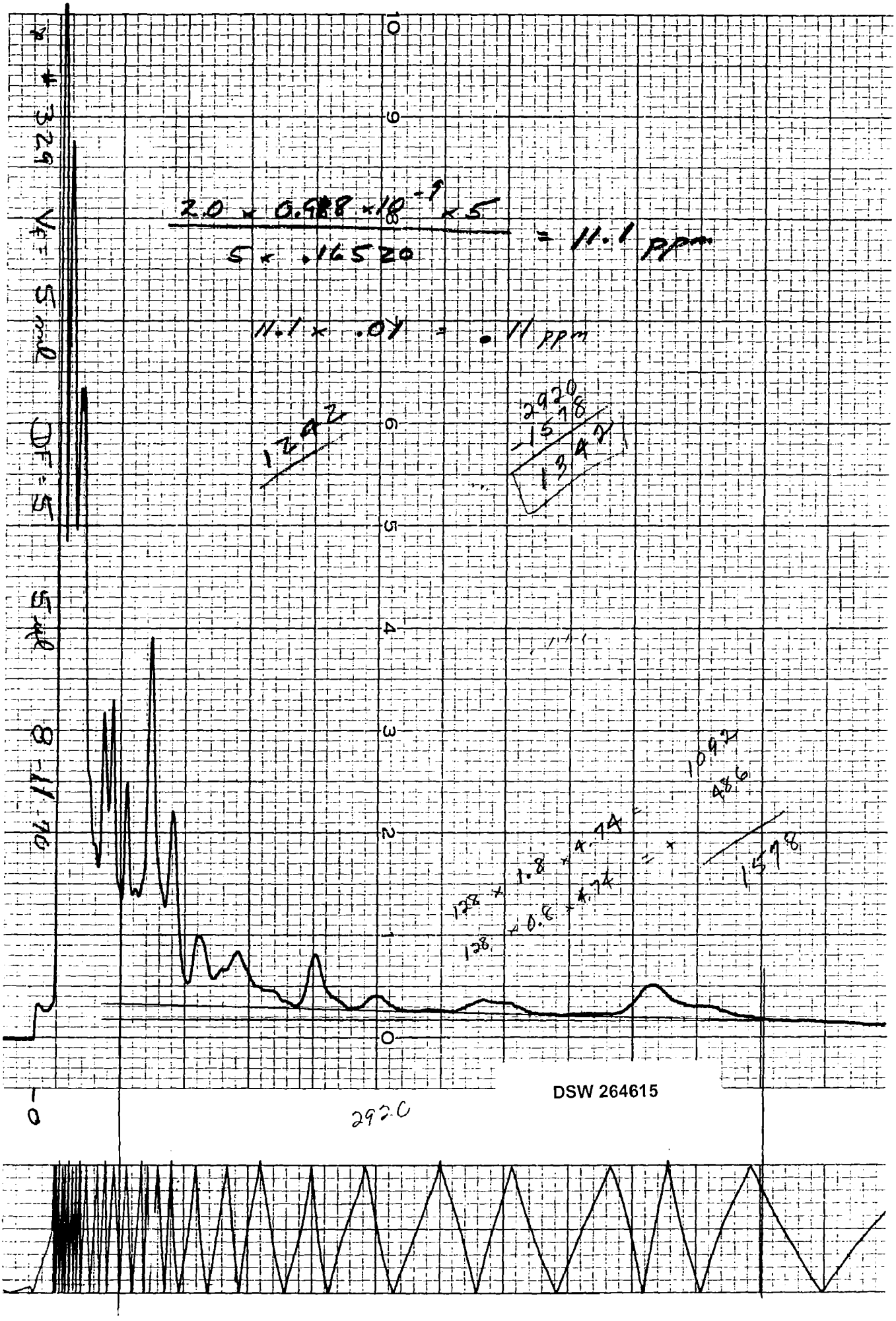
LEXOLDMON008185

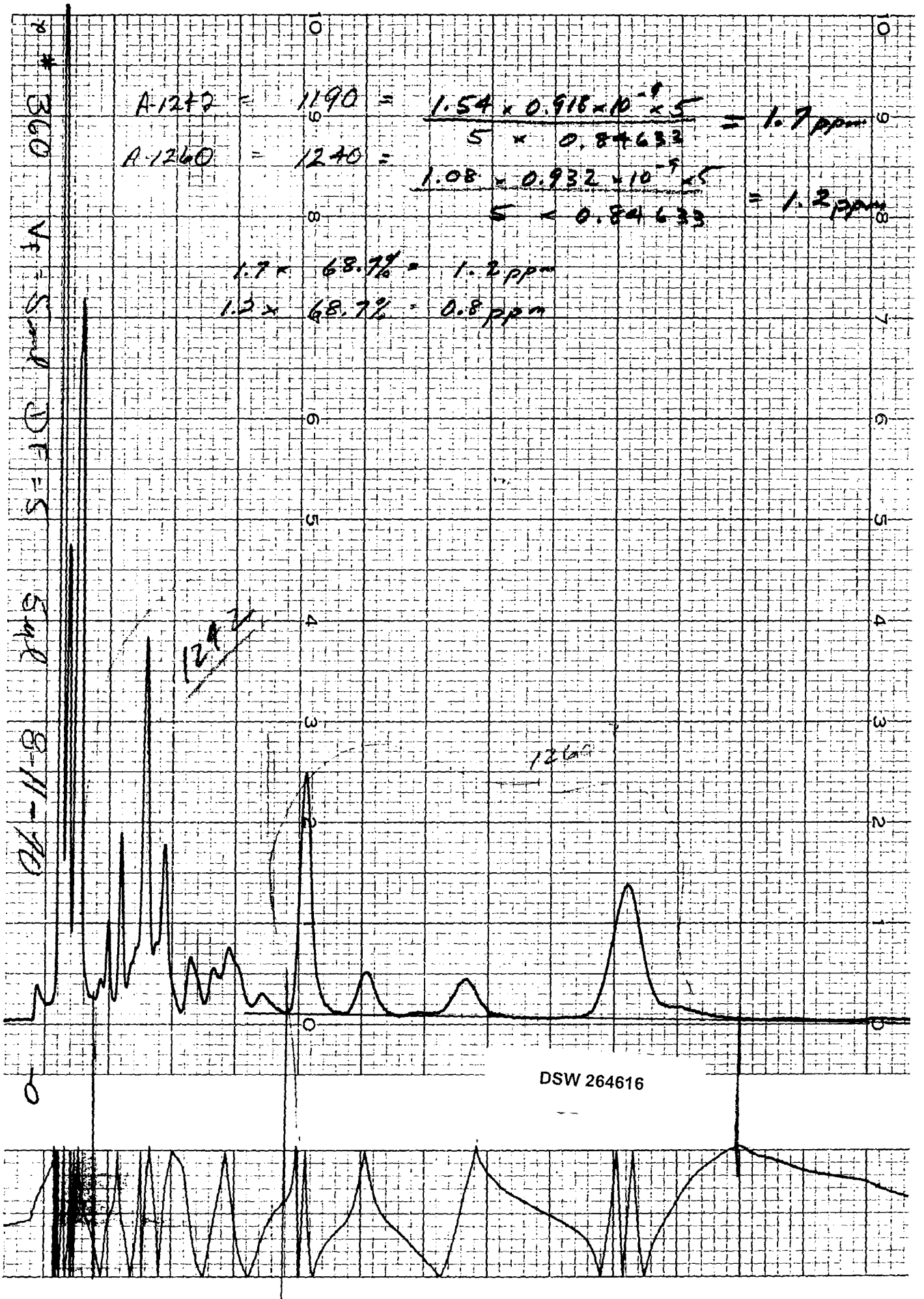
RECORDING CHARTS, GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK



$$\frac{3.46 \times 0.918 \times 10^{-9} \times 5}{\text{Eqk} \quad .18404} = 10.6 \text{ ppm}$$

$10.6 \times 1.2 = .13$


$\frac{2.0 \times 0.988 \times 10^{-9} \times 5}{5 \times .16520} = 11.1$ ppm
11.1 × .01 = .11 ppm
DSW 264615



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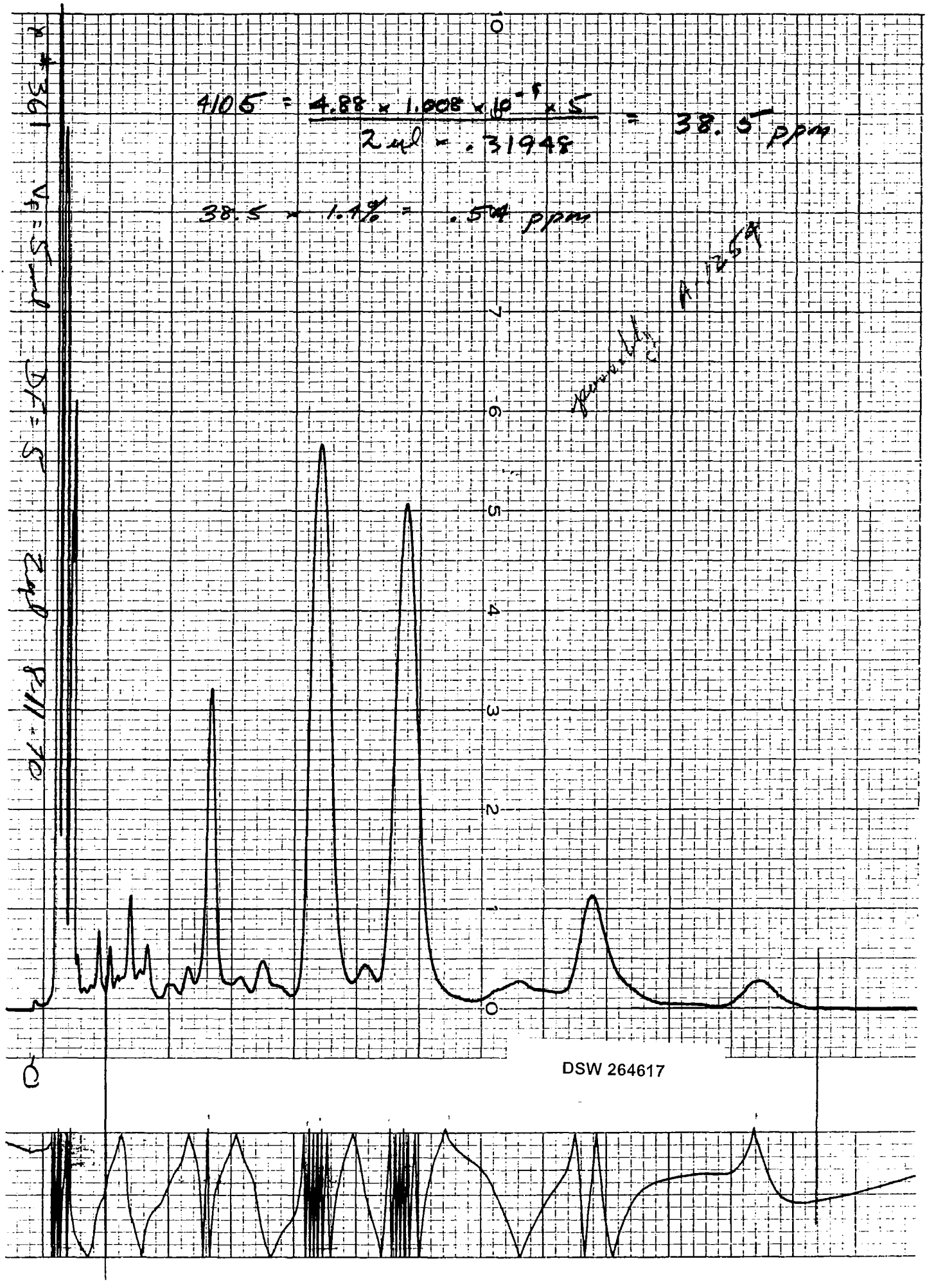
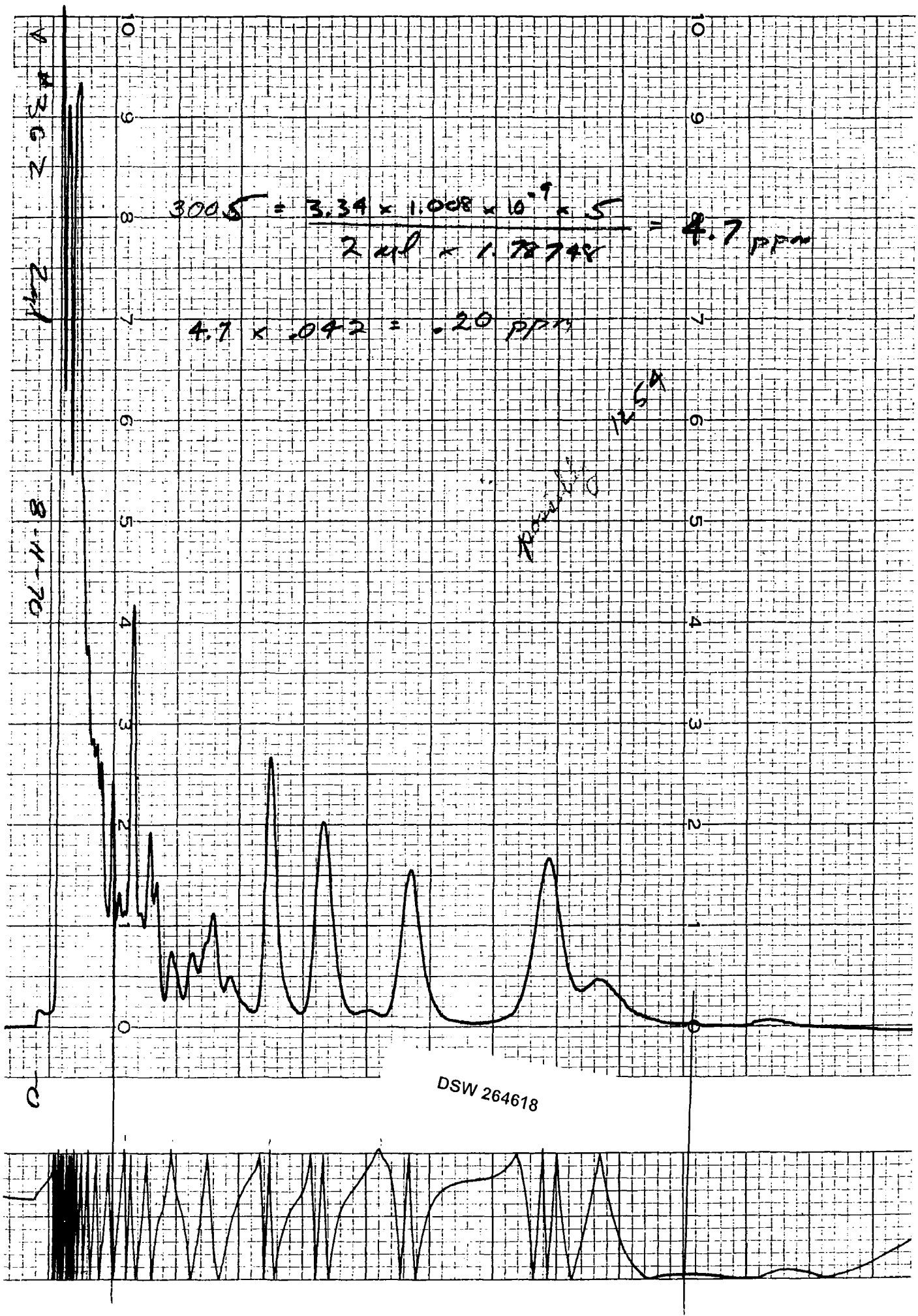
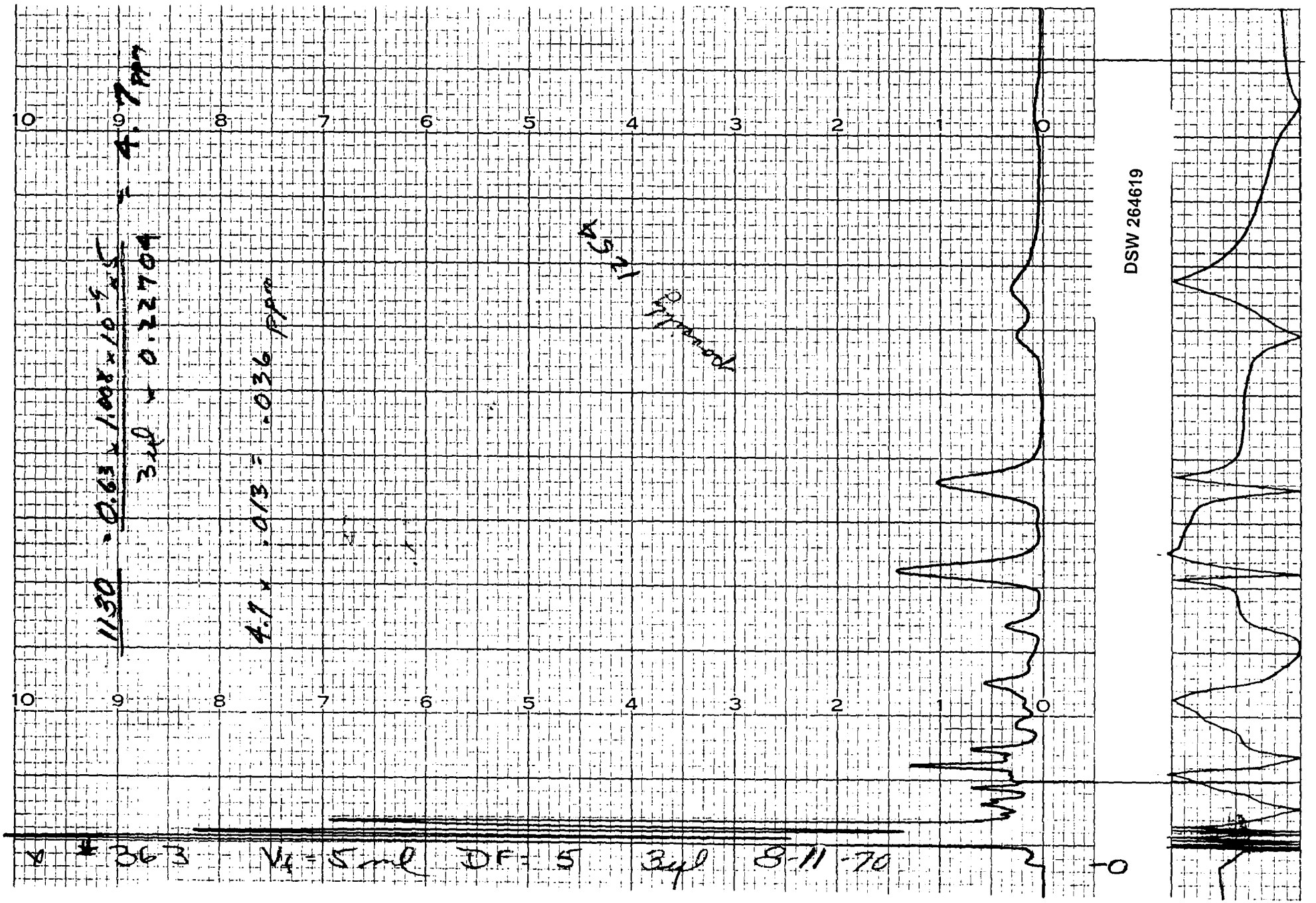


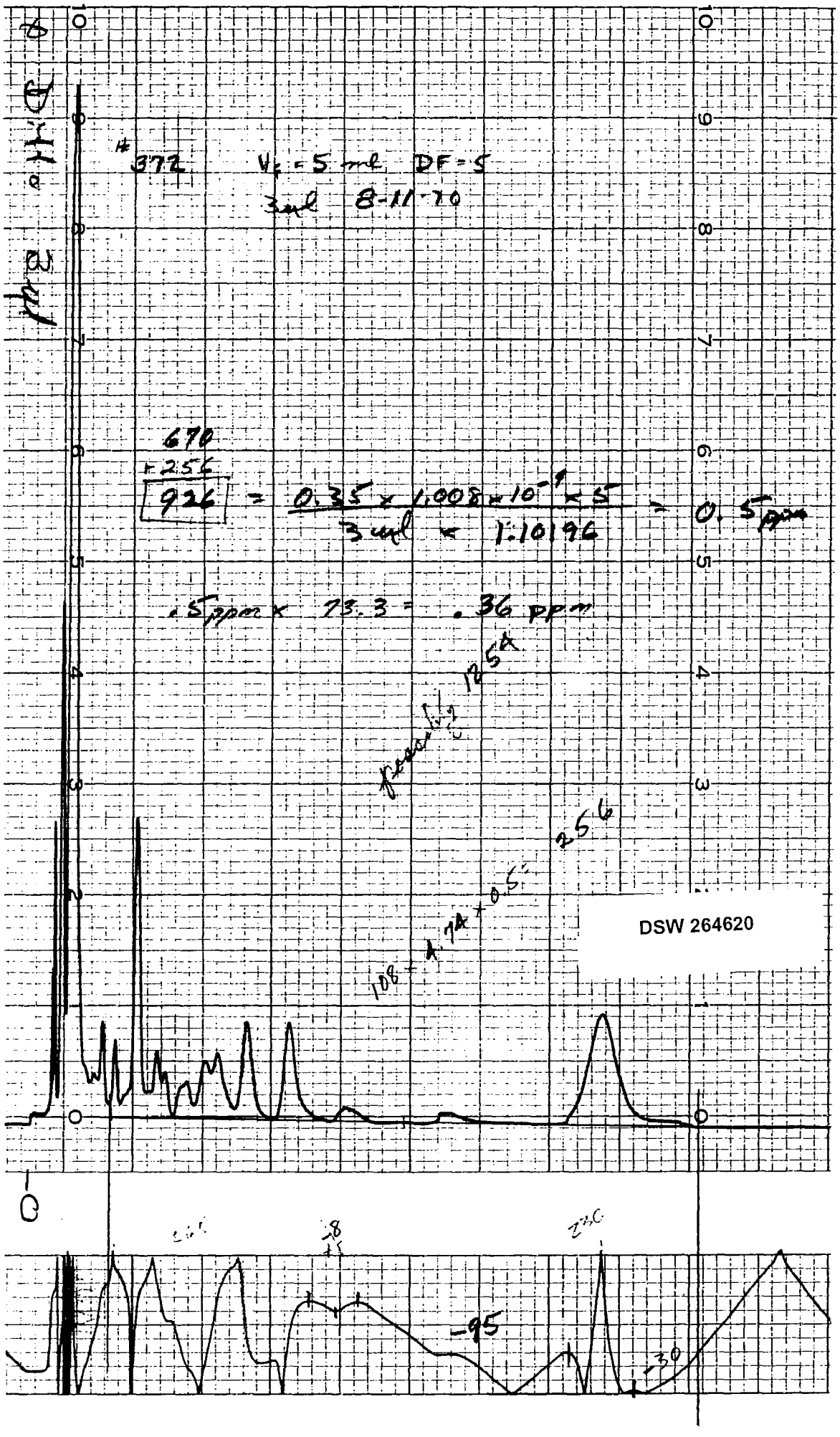
LEXOLDMON008188

LEXOLDMON008189

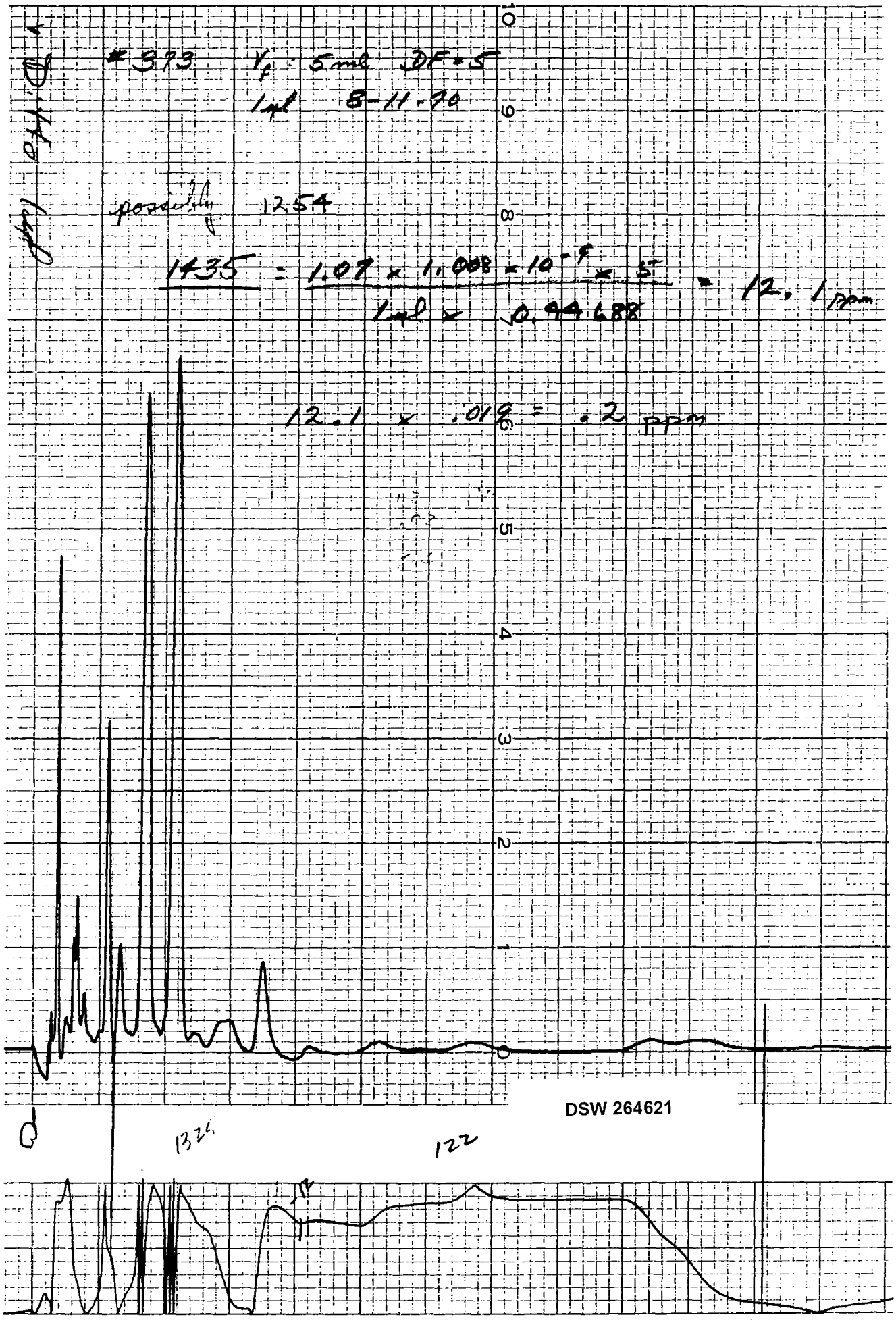




10 9 8 7 6 5 4 3 2 1 0
1130 = 0.63 x 1.008 x 10^-5 x 5 / 3 µl = 0.22704 = 4.7 ppm
4.7 x .013 = .036 ppm
Pyranol 1264
DSW 264619
x #363 Vf = 5 ml DF = 5 3 µl 8-11-70

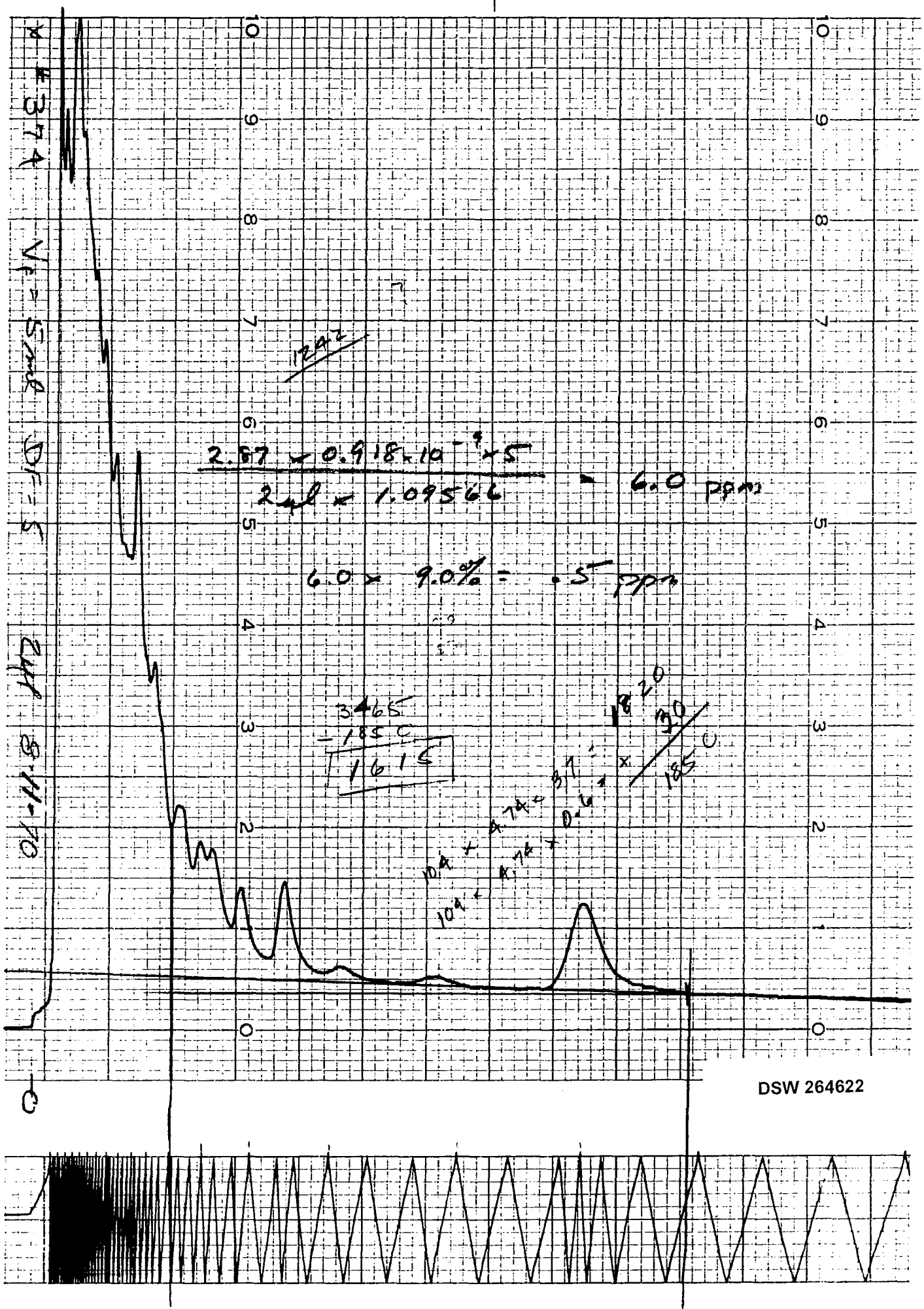


EXXON_DMON008191

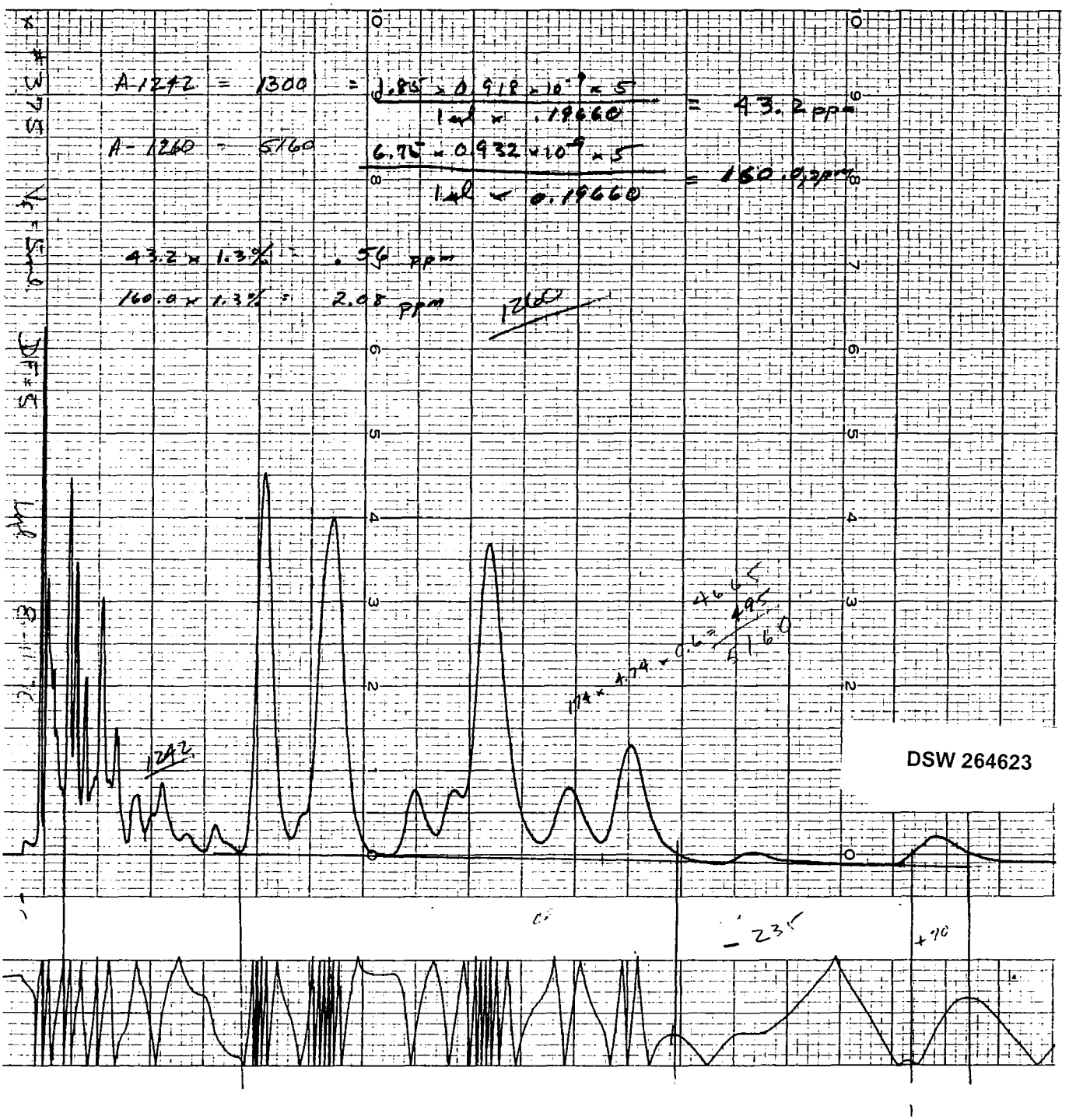


DSW 264621

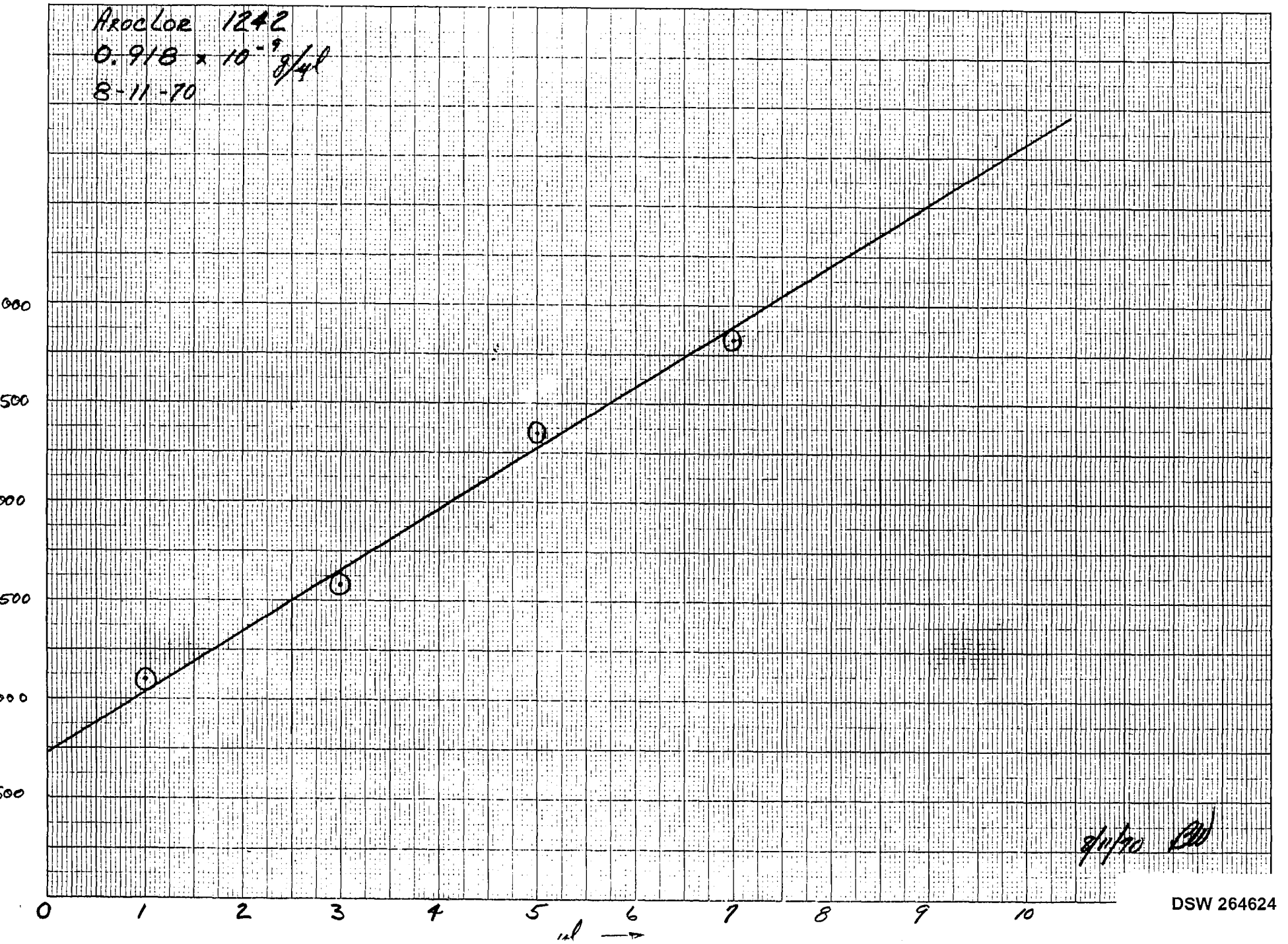
LEXOLDMON008192



LEXOLDMON008193


A-1242 = 1300 = 1.85 × 0.918 × 10⁻⁹ × 5 / 1 ml × .19660 = 43.2 ppm
A-1260 = 5160 6.75 × 0.932 × 10⁻⁹ × 5 / 1 ml × 0.19660 = 160.0 ppm
43.2 × 1.3% = .56 ppm
160.0 × 1.3% = 2.08 ppm
1242
1260
DSW 264623

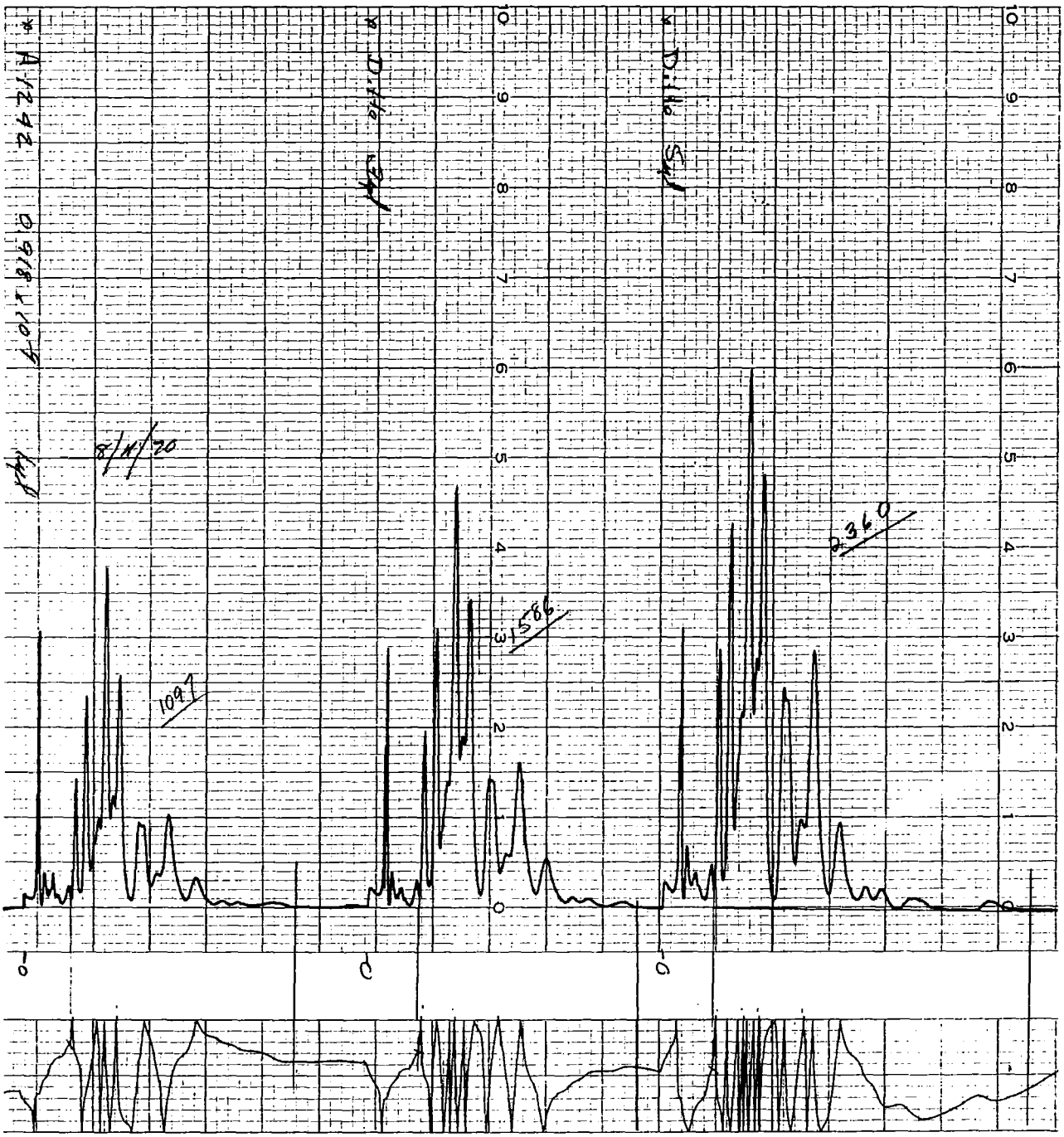
K+E 10 X 10 TO THE CENTIMETER 46 1510
KEUFFEL & ESSER CO.



DSW 264624

LEXOLDMON008195

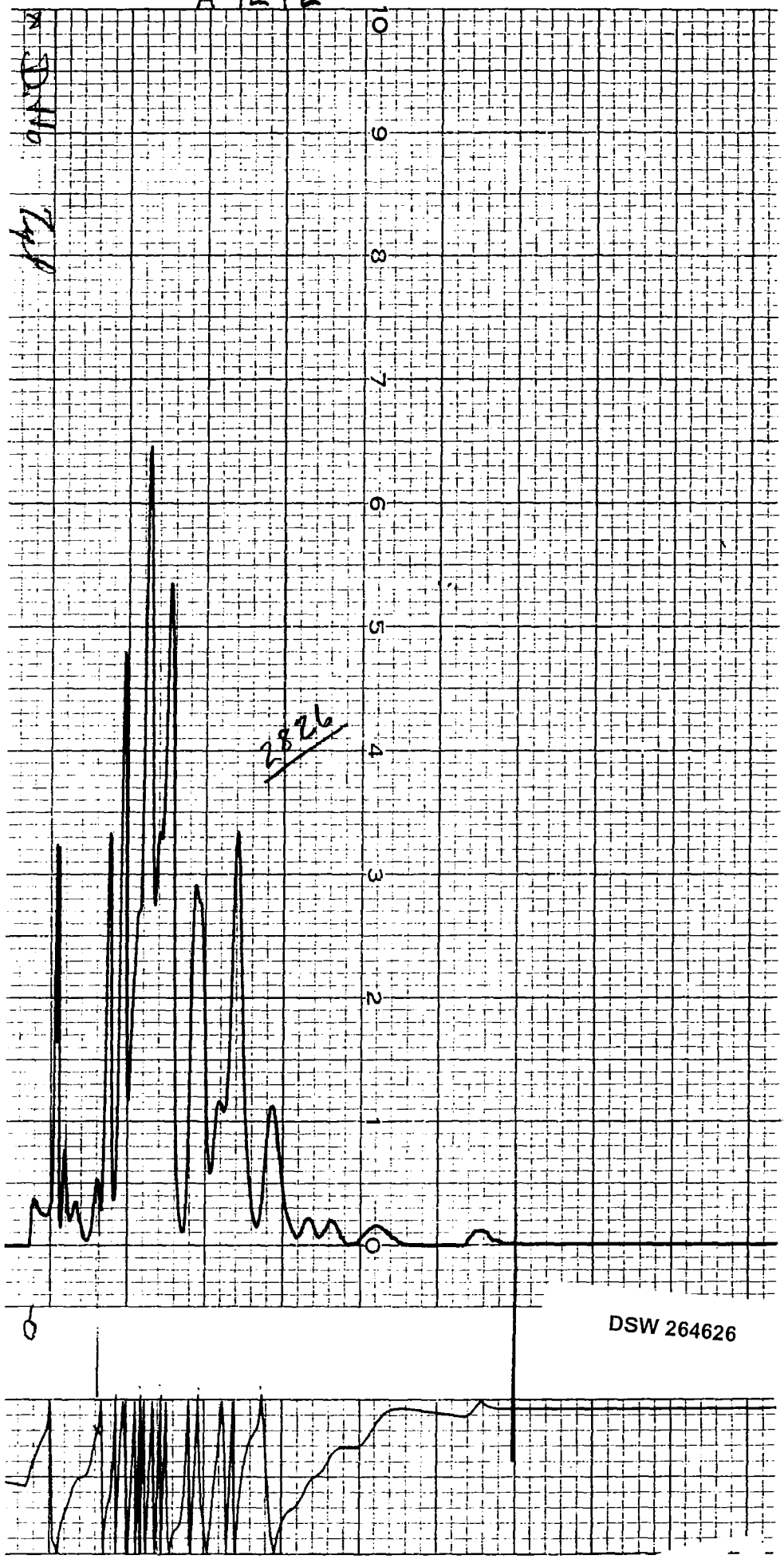
RECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.



DSW 264625

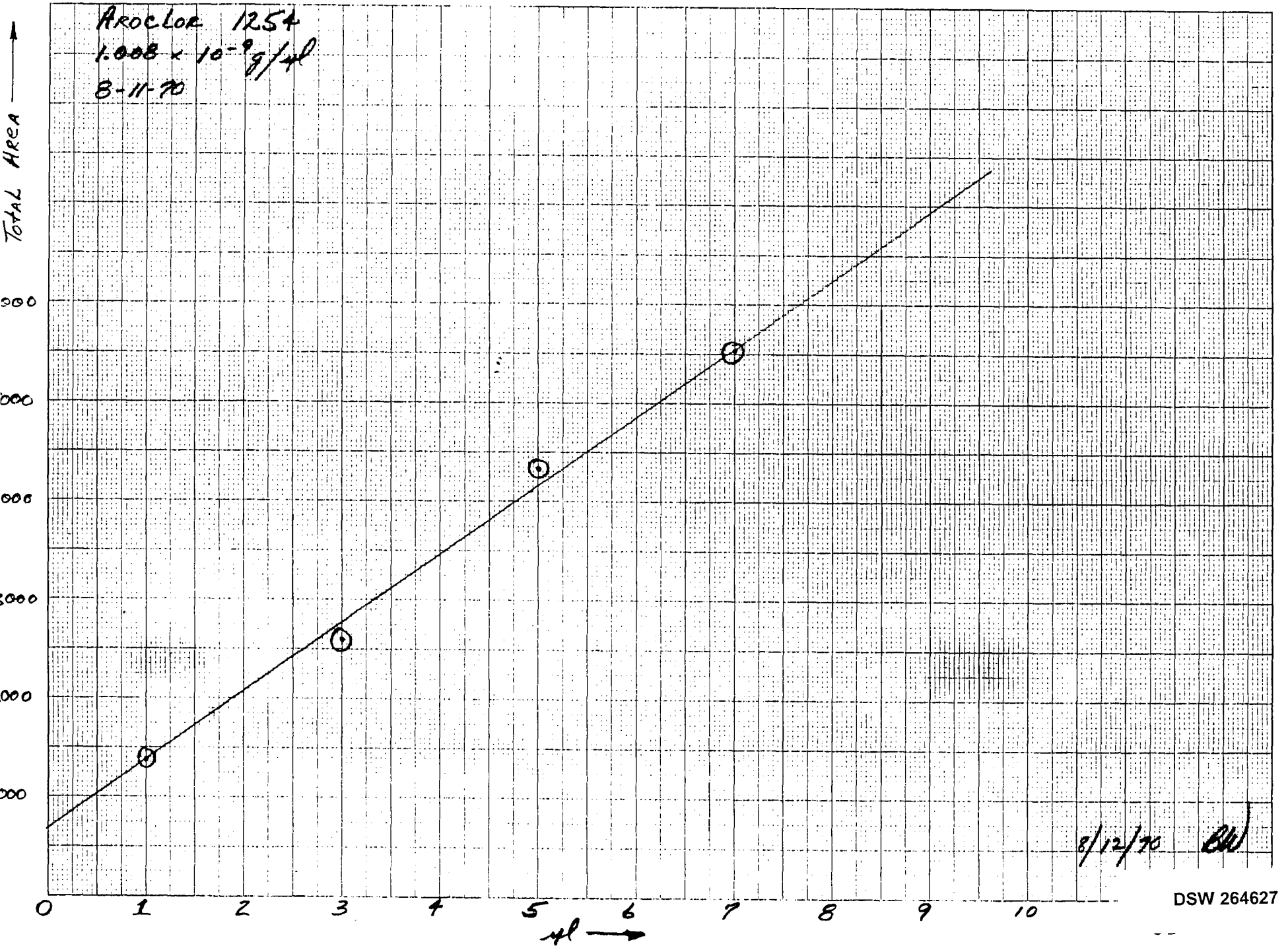
LEXOLDMON008196

A-1242



TEXO DMON0081827

K&E 10 X 10 TO THE CENTIMETER 46 1510



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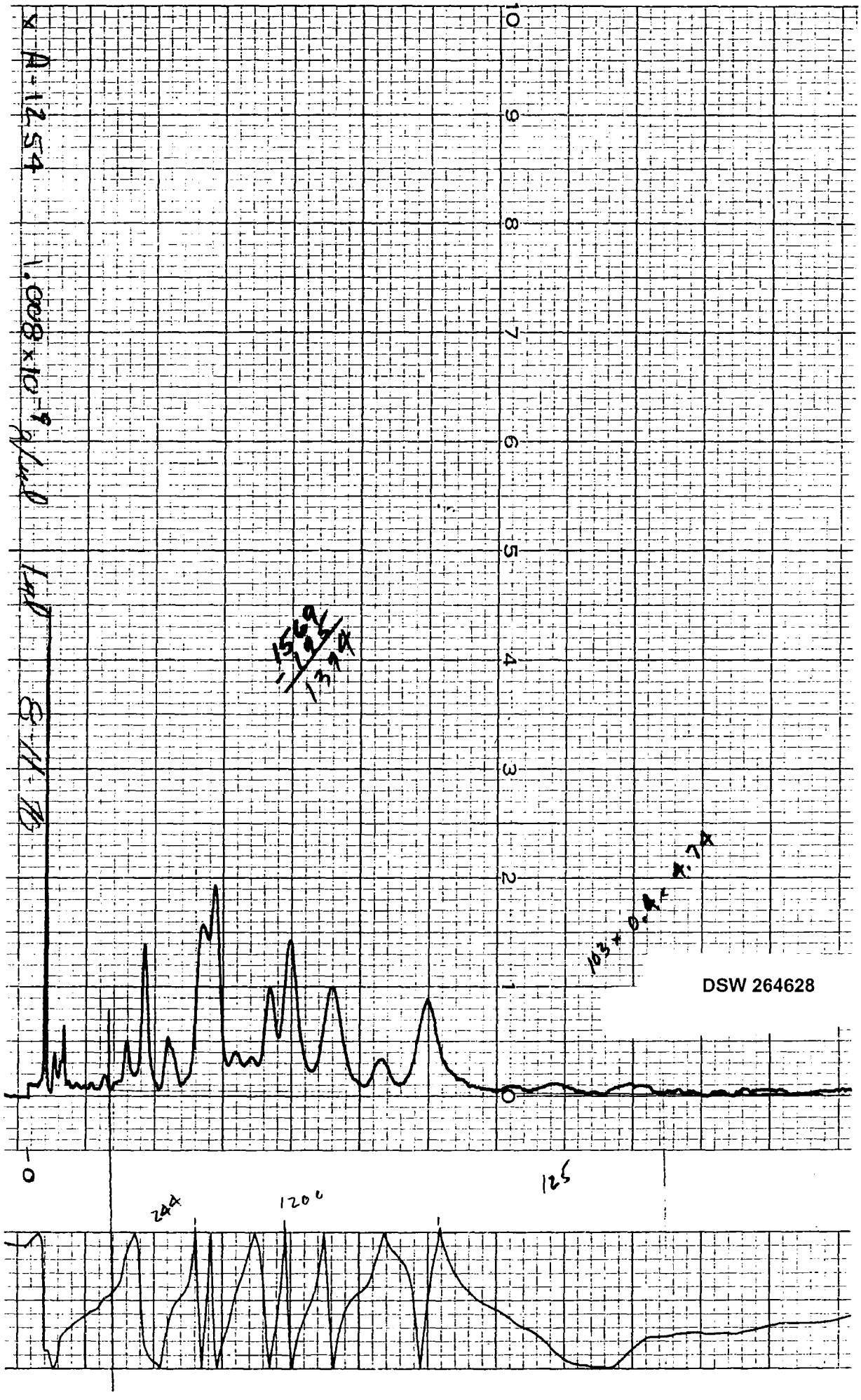
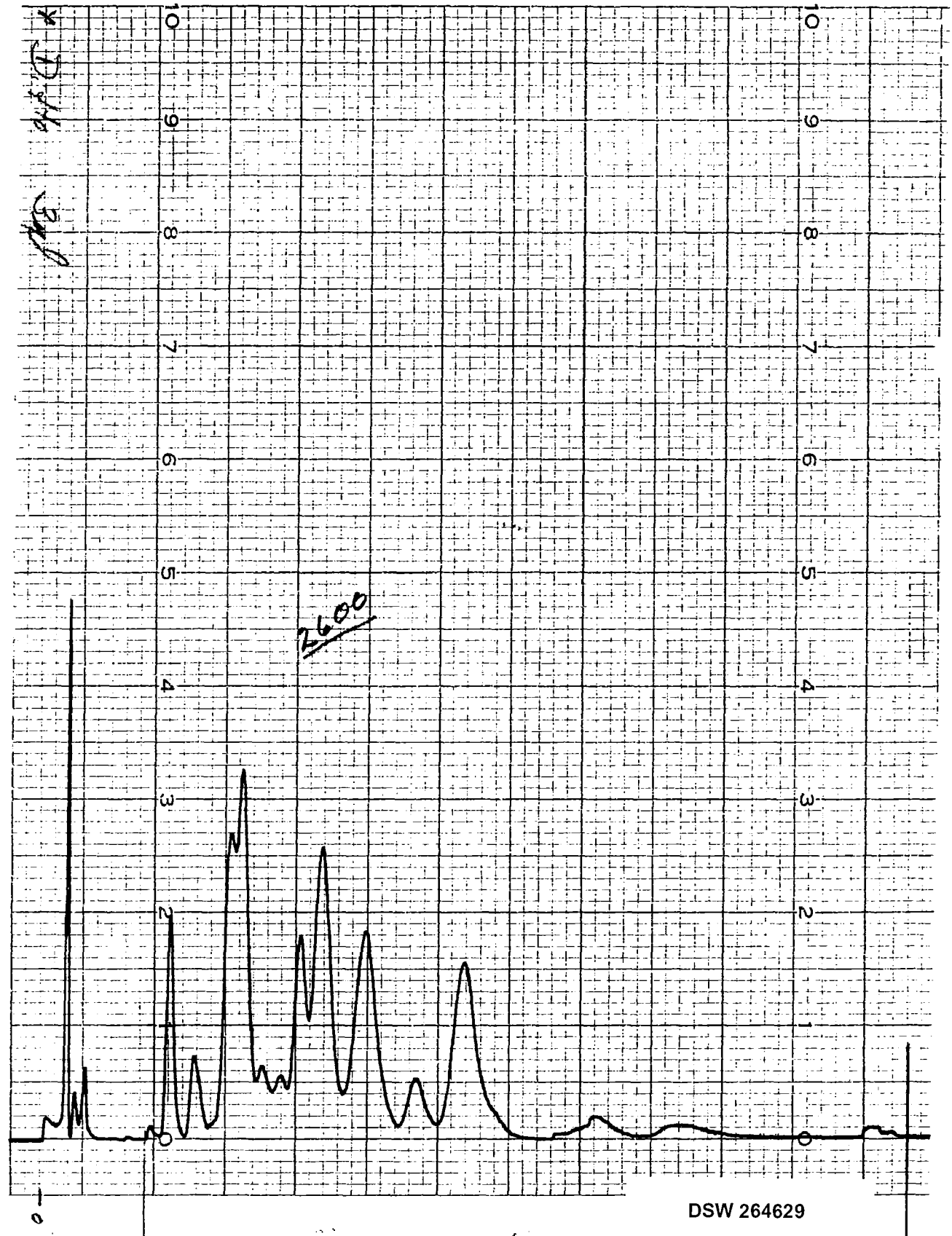
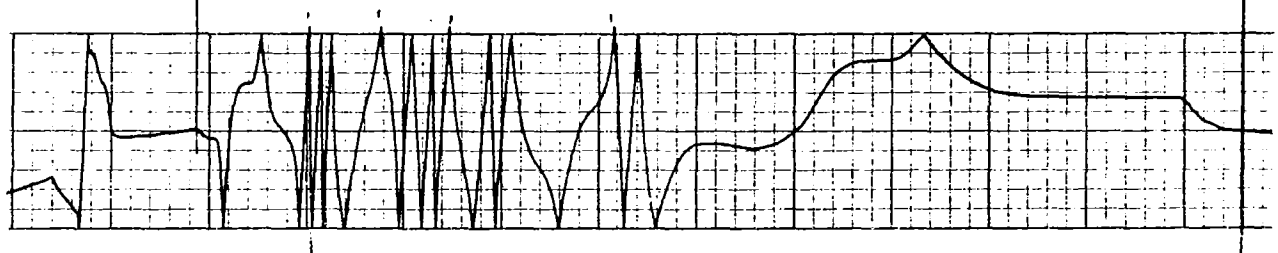


EXOLIMON0081996

TED IN U.S.A.

NO. 9270-107





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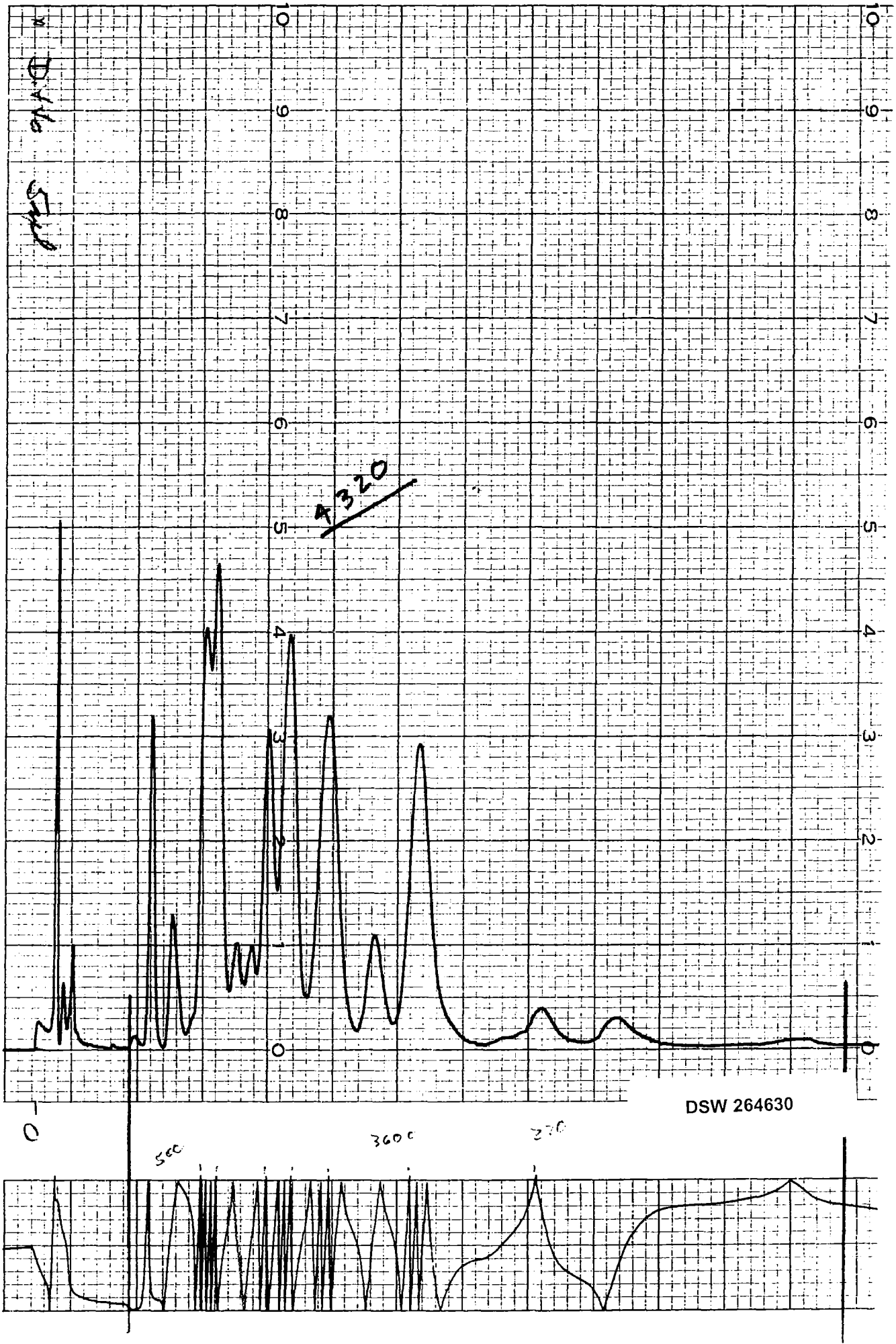

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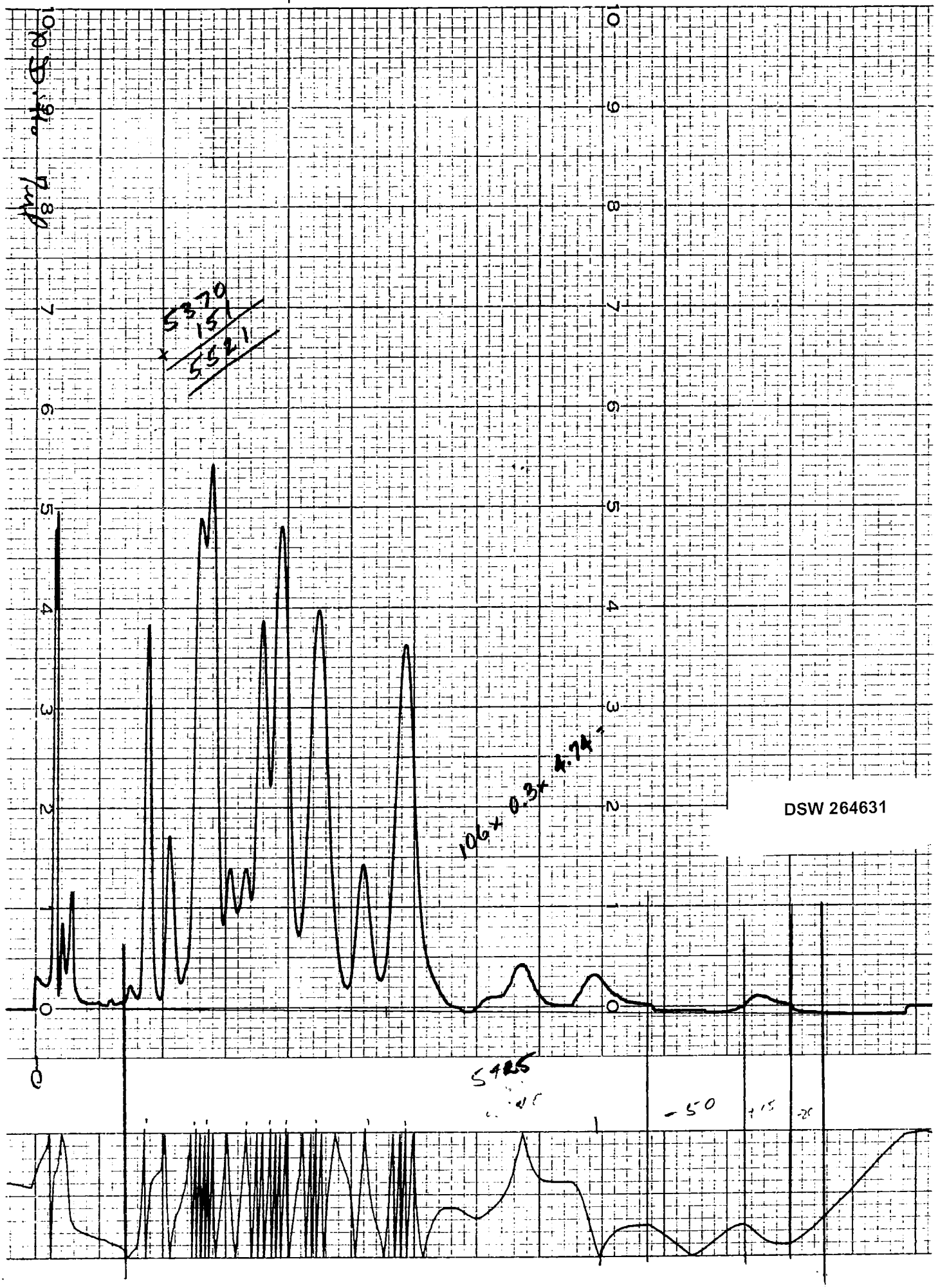
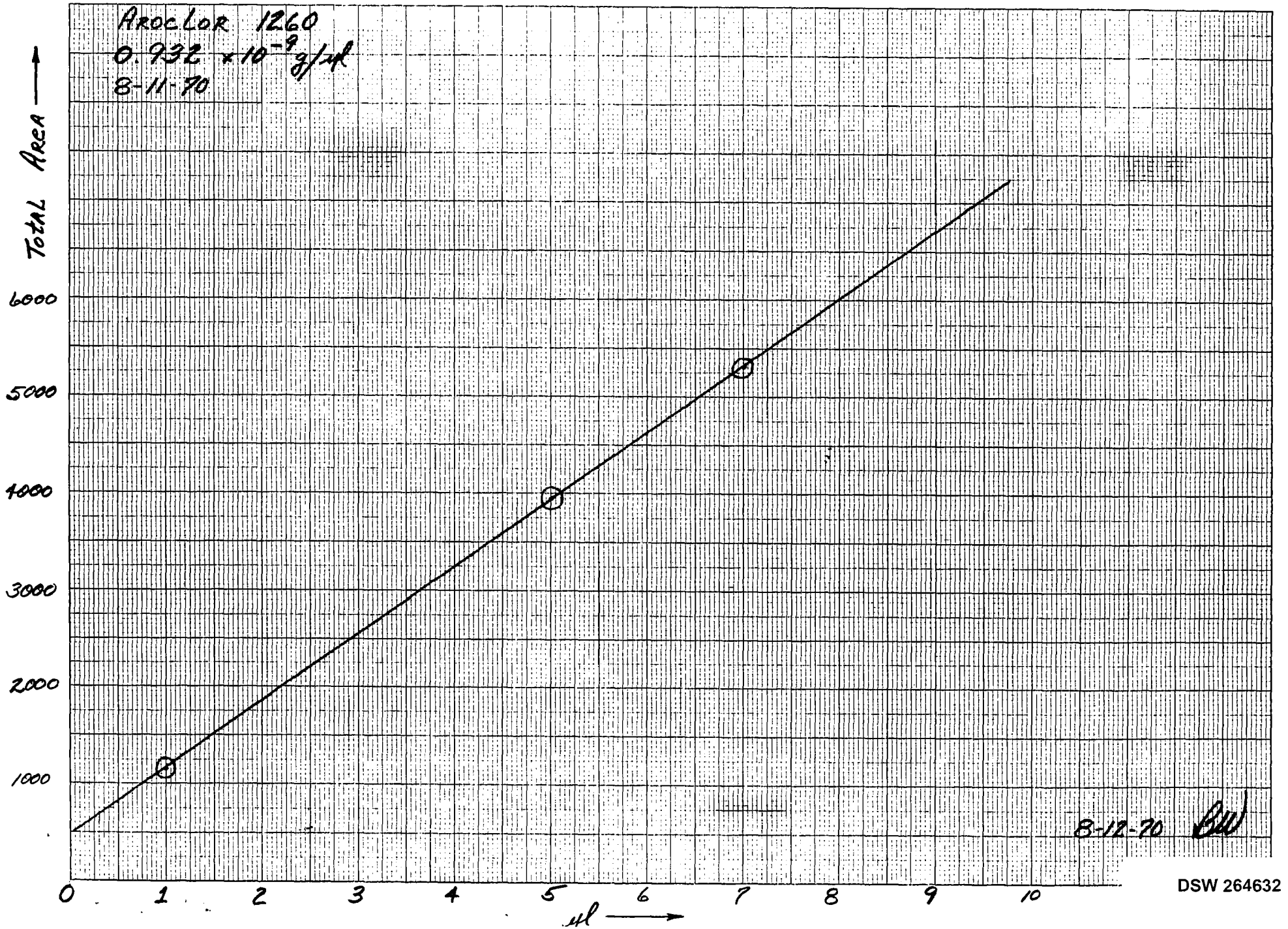


LEXOLDMON008202

K+E 10 X 10 TO THE CENTIMETER 46 1510
18 X 25 C.M. MADE IN U.S.A.
KEUFFEL & ESSER CO.



DSW 264632

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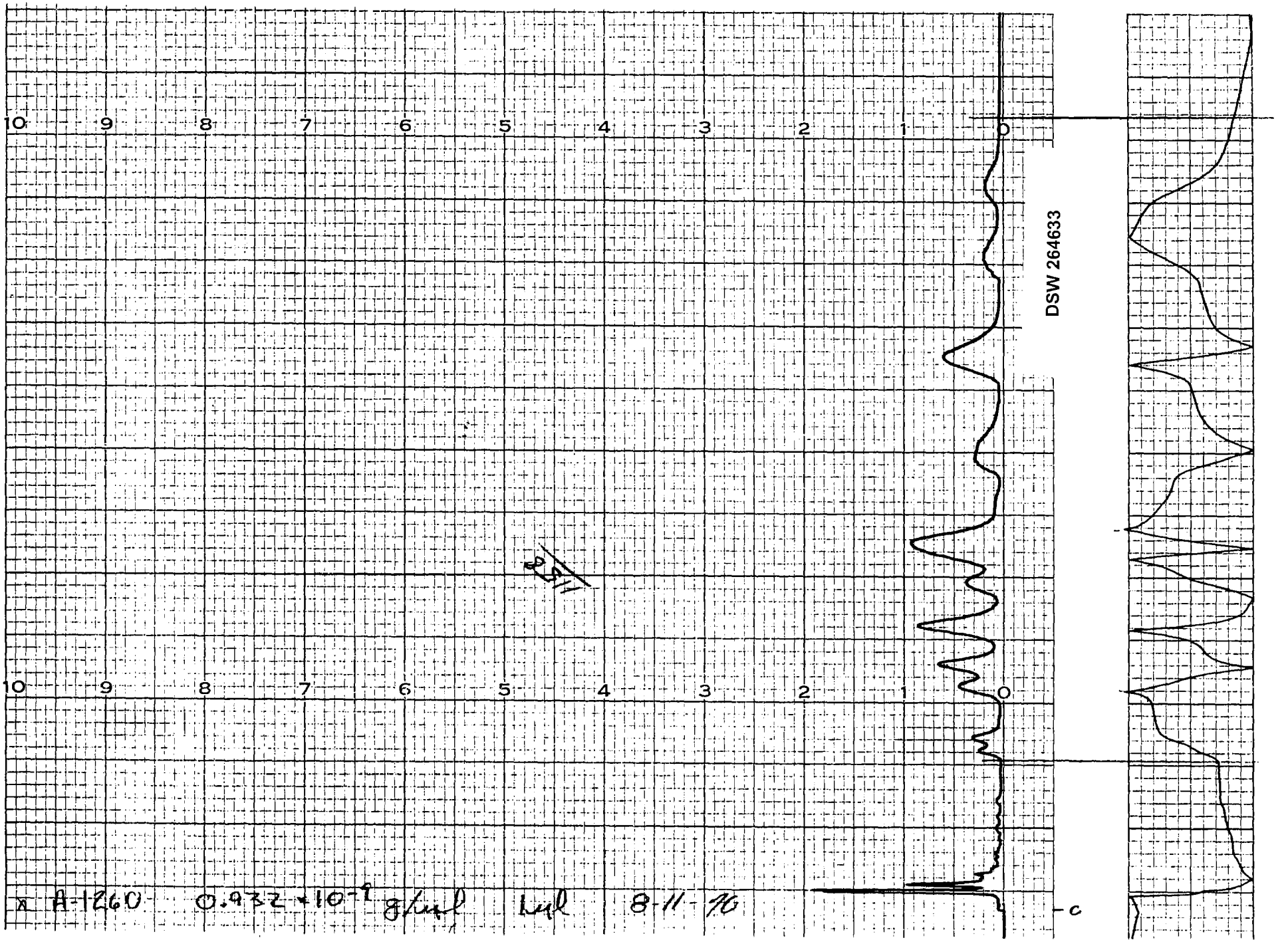
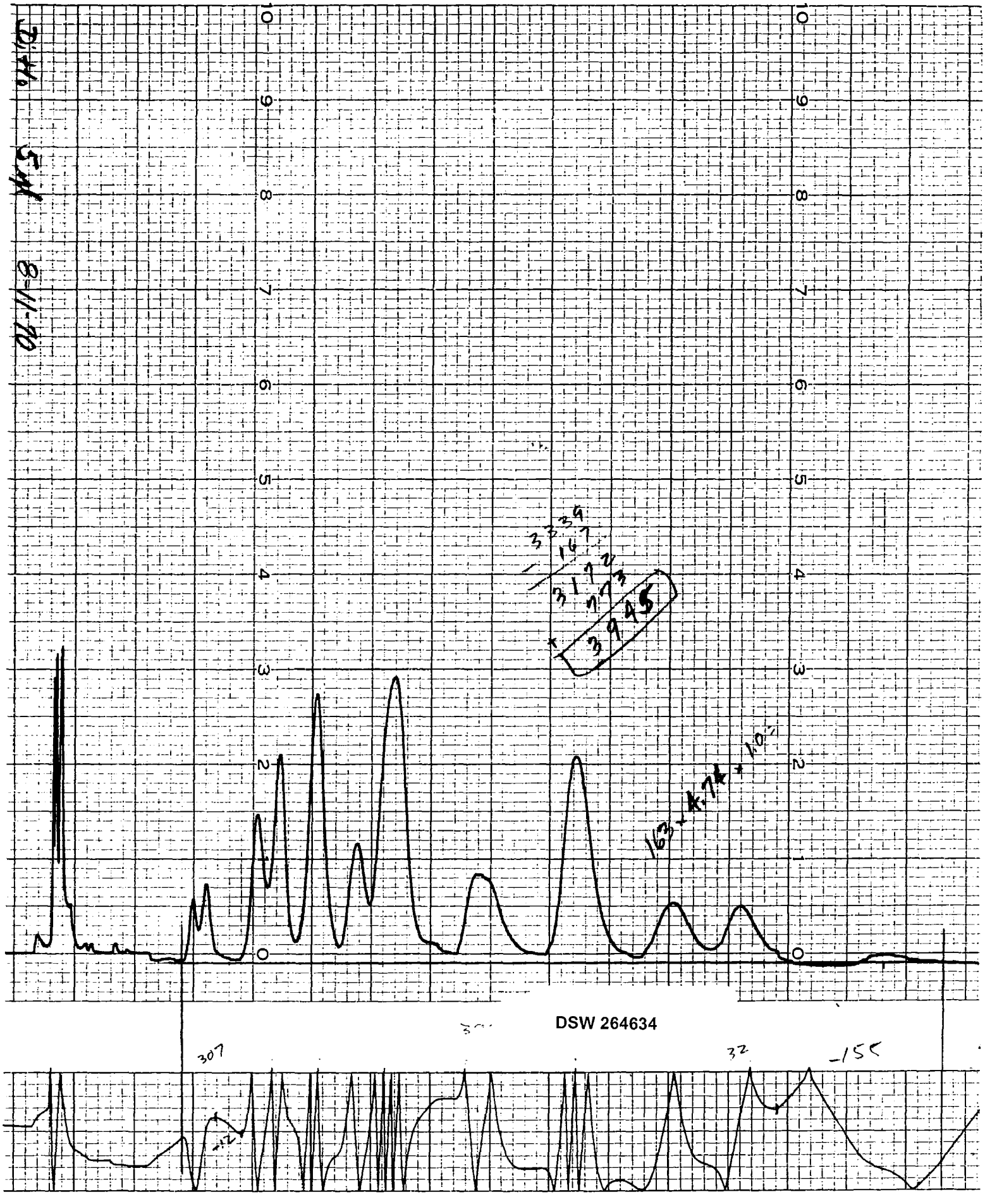


RECORDING CHARTS GRAPHIC CONTROLS CORPORATION

LEXOLDMON008204



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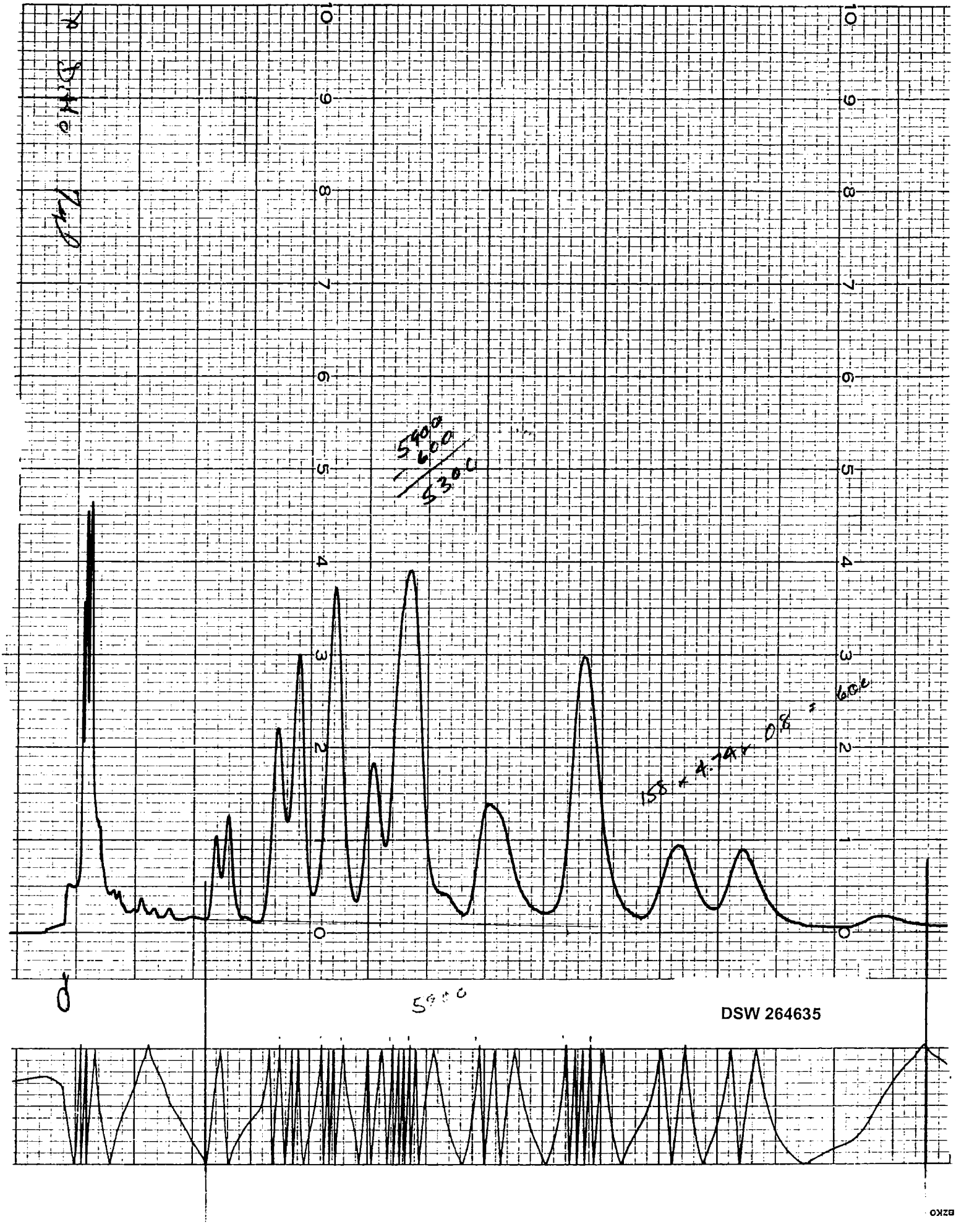
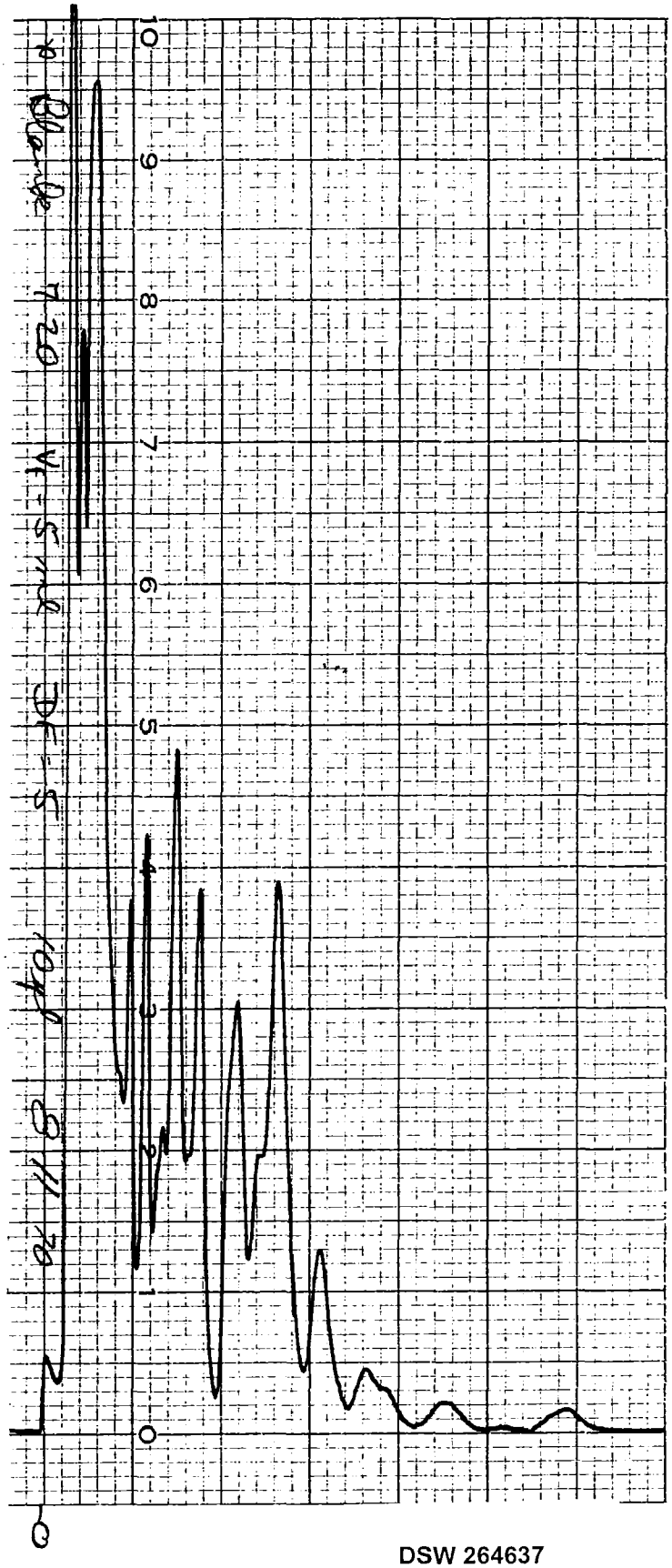
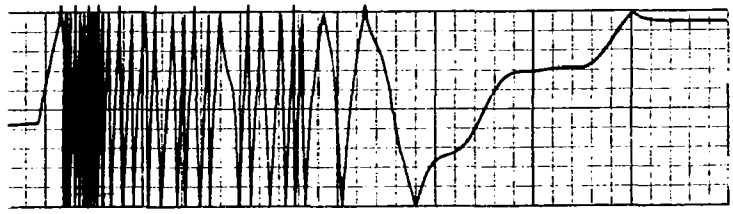


LEXOLDMON008206

LEXOLDMON008207



DSW 264637



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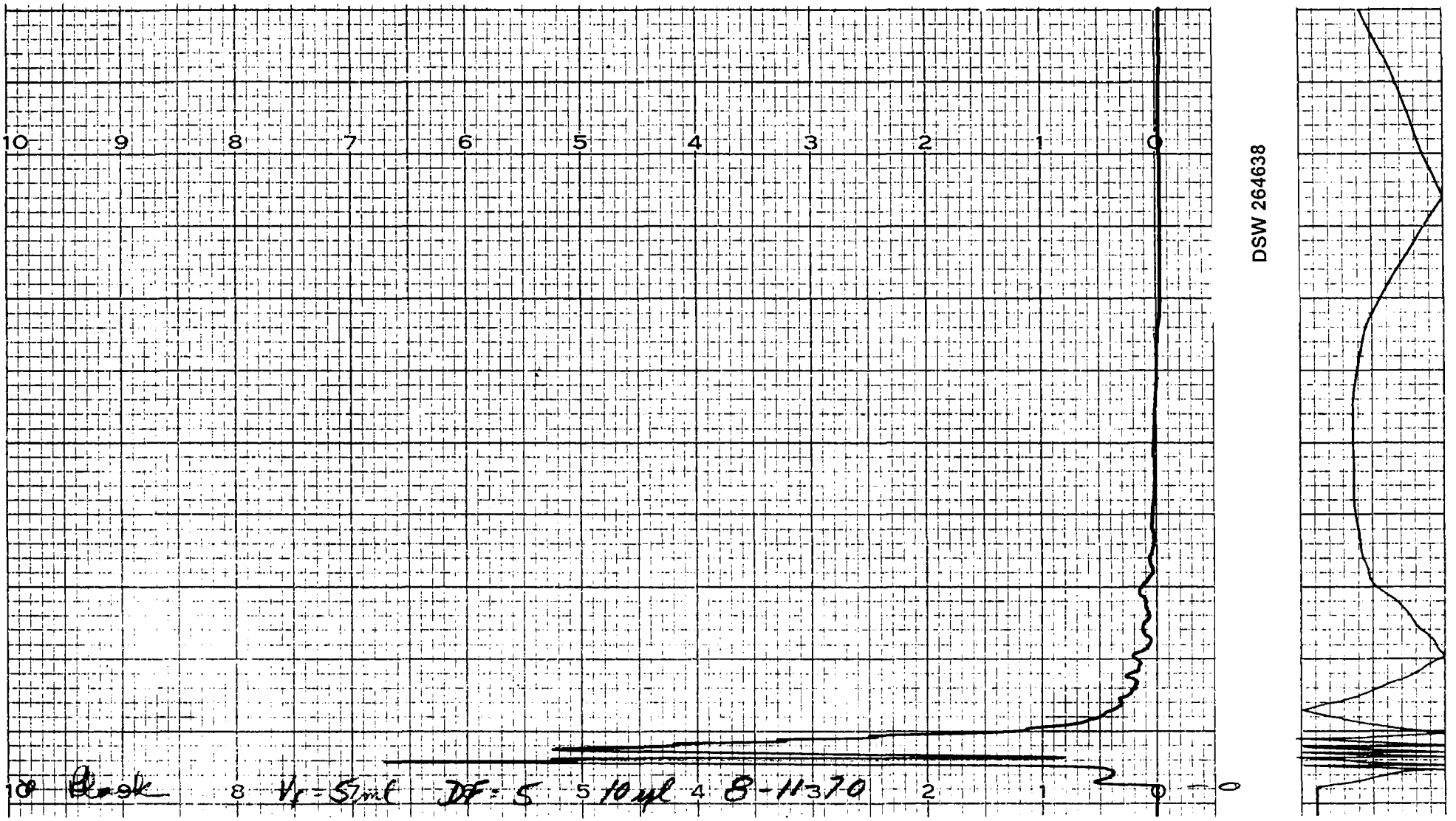

DSW 264638

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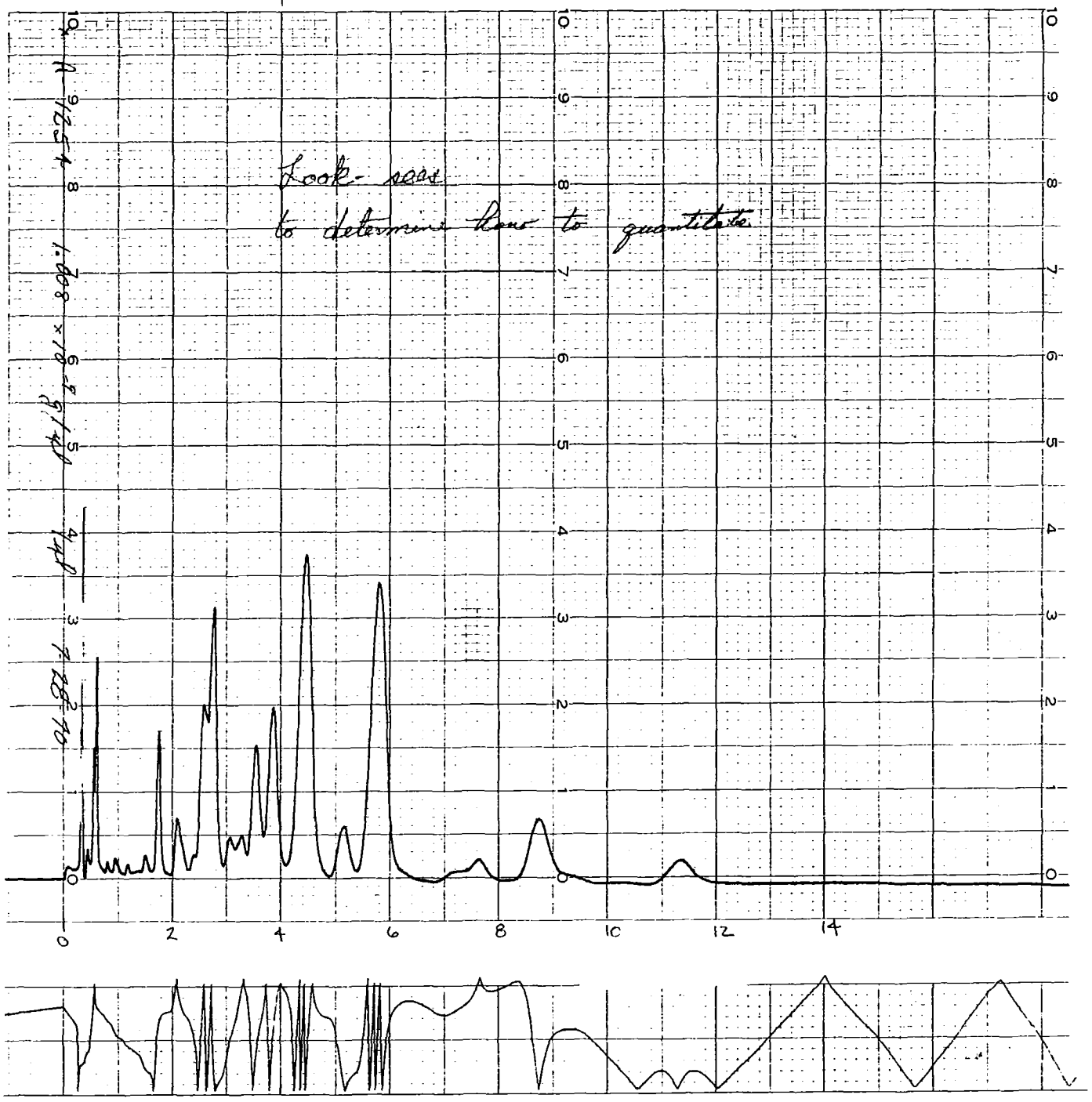
LEXOLDMON008209

No. 9270-1072



DSW 264639

LEXOLDMON008210

N BUFFALO, NEW YORK

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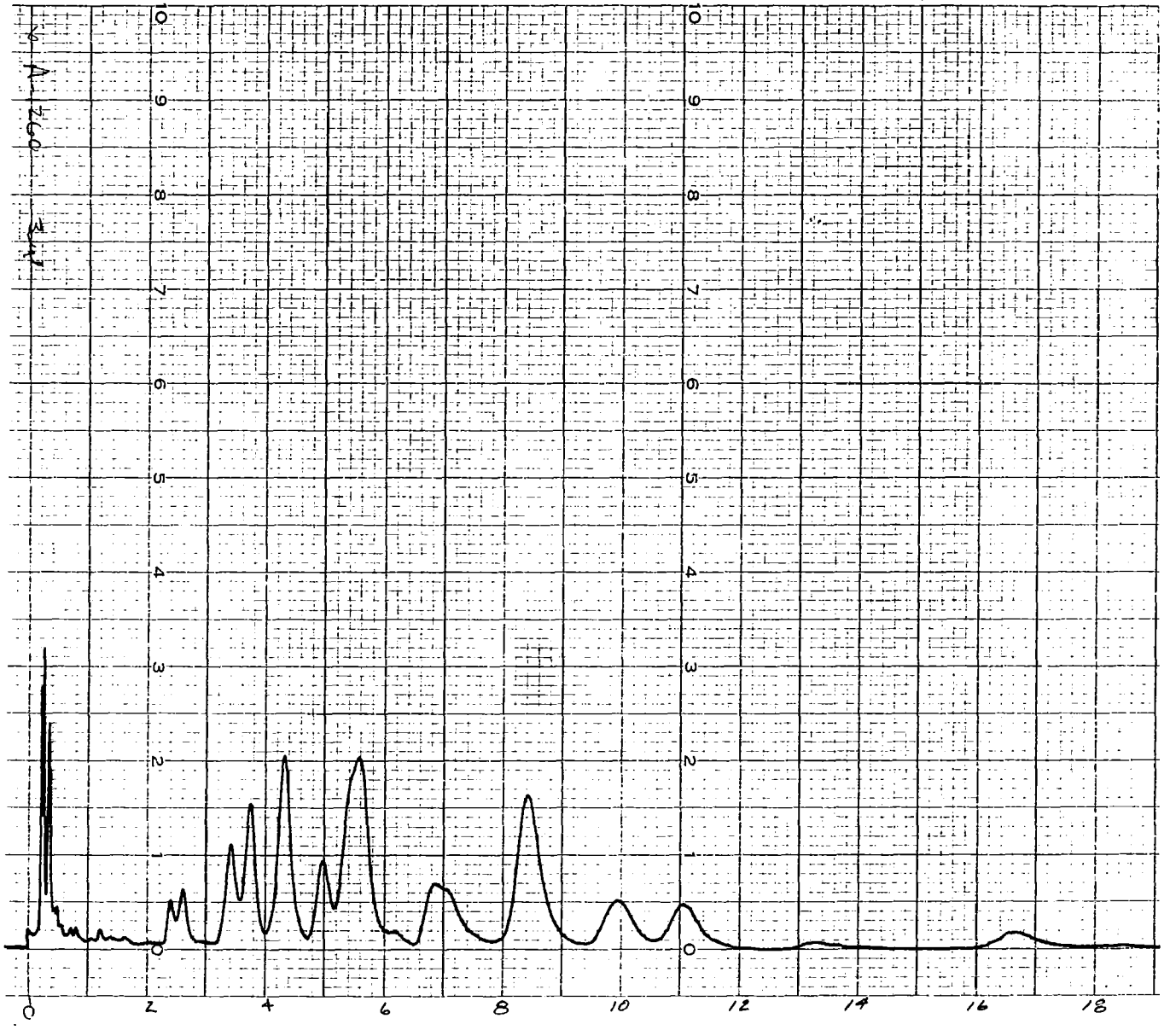

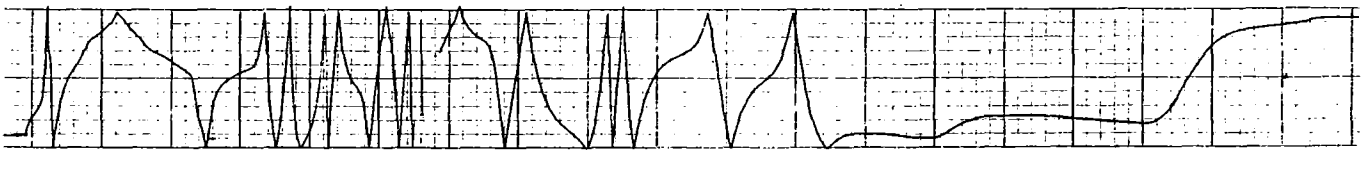

DSW 264640

LEXOLDMON008211

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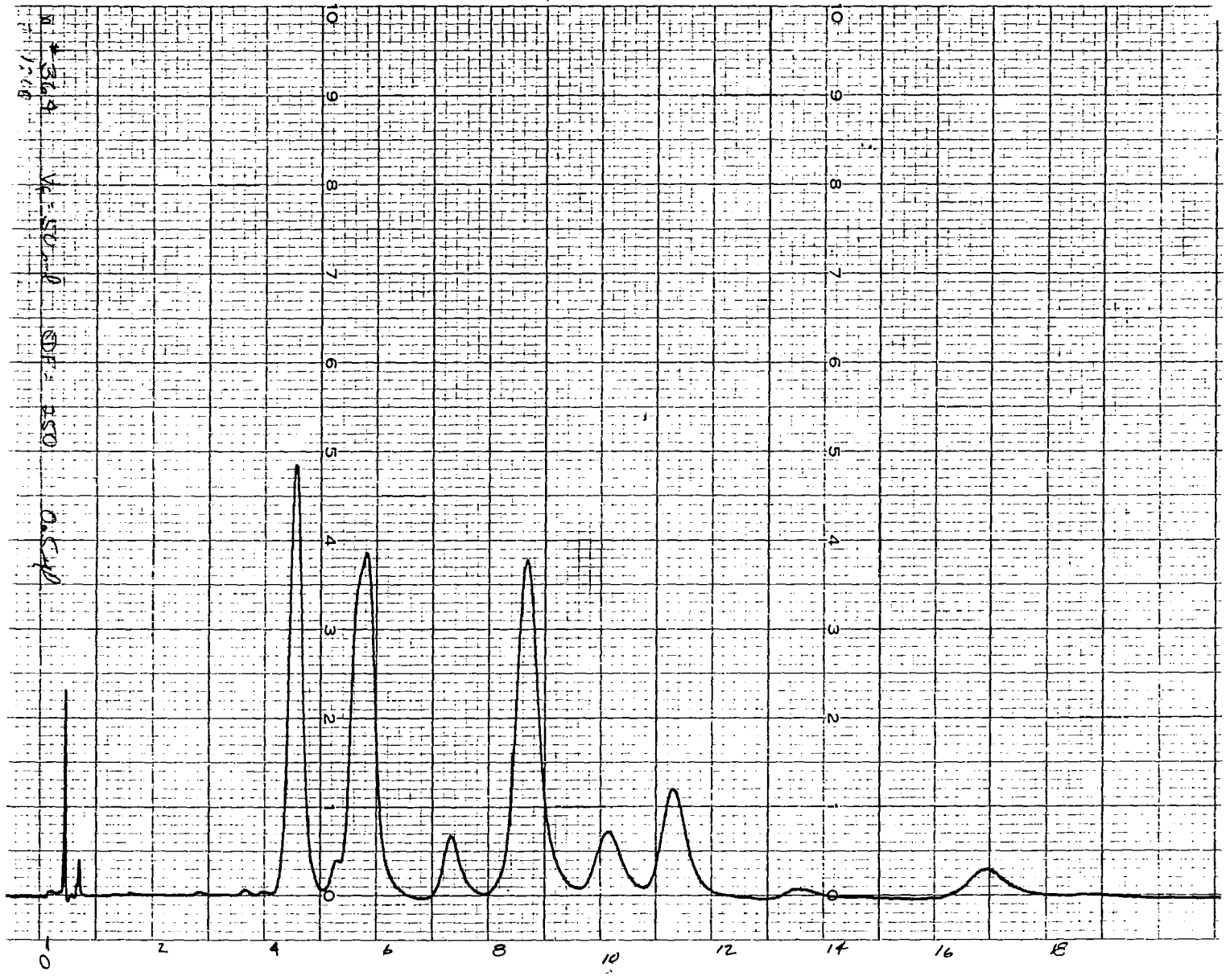

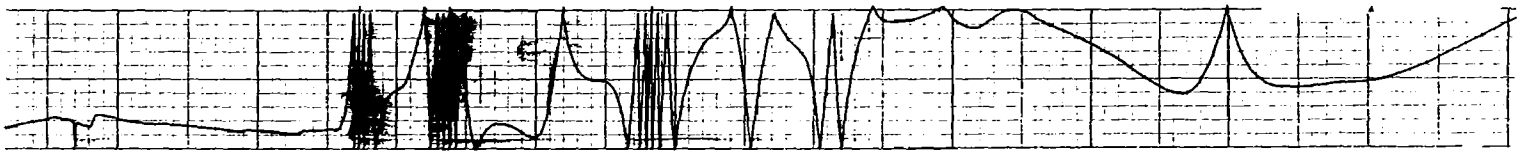

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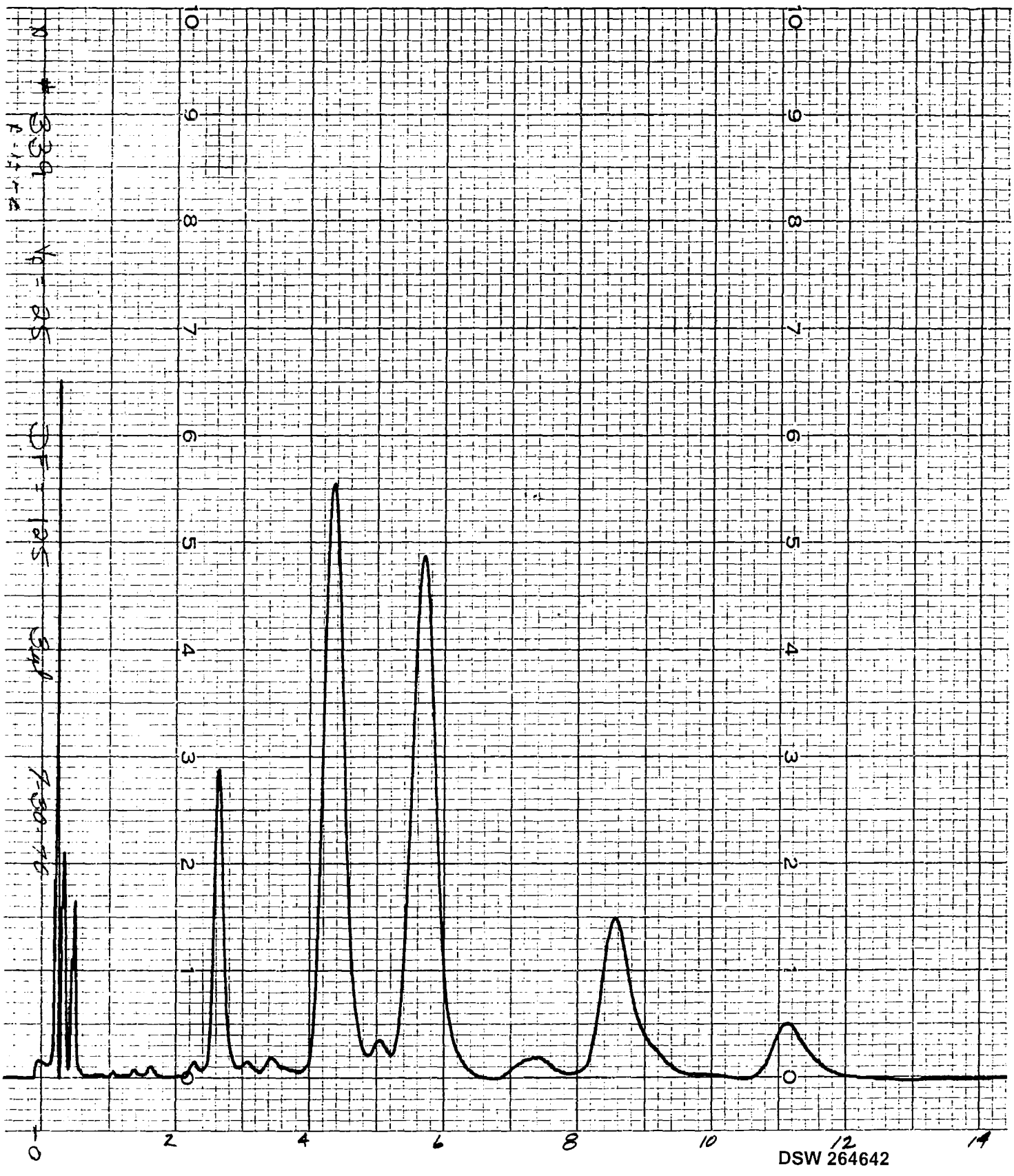

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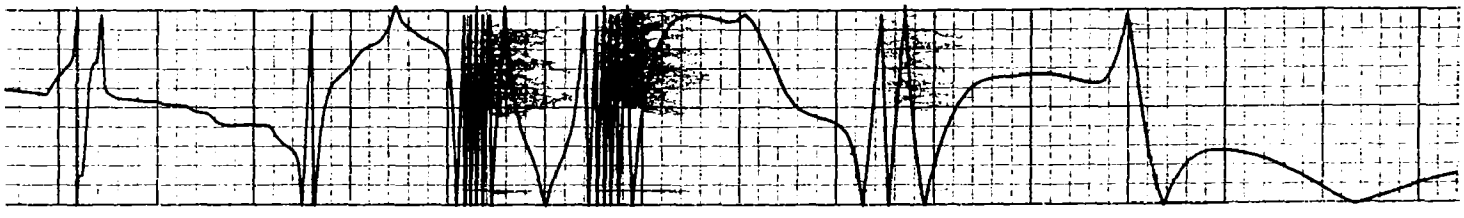

EXCLDMON08213