New York State Department of Environmental Conservation
Region 9

S 760057

GRAY
IRON FOUNDRIES
AP-42 Section 7.10
Reference Number
17

Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

STACK TEST REPORT

Worthington Corporation
Cupola Scrubber Stack
October 22, November 4 & 5, 1976

Frank Shattuck, Senior Sanitary Engineer
A. Donald McKenzie, Senior Sanitary Engineer
Roger McCabe, Principal Engineering Technician
Gary Foersch, Senior Engineering Technician
Dominic Buccilli, Senior Engineering Technician

Certified by _____ P.E. License No. 47232

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Stack Test Calculation Symbols

Arranged by Test Run:

Stack Sample Collection Data

Stack Test Calculations

Orsat Analysis Data

Analytical Data

Process Weight Tabulations and Worthington Cupola Charge Reports

Analytical Data from Syracuse Lab

Visible Emission Evaluation Records

ABSTRACT

A stack test was performed on the Worthington Corp., C & E Division's cupola located on Roberts Avenue in the City of Buffalo.

The test runs were performed on October 22, November 4 and 5, 1976 to determine compliance with 6 NYCRR 213 (Contaminant Emissions from Ferrous Jobbing Foundries) and 6 NYCRR 211 (General Prohibitions).

The testing was performed at the request of the Region 9 Office of the Department of Environmental Conservation by the Region 9 Stack Test Team. The personnel performing the test were Roger McCabe, Principal Engineering Technician; Gary Foersch and Dominic Buccilli, Senior Engineering Technicians. Frank Shattuck and A. Donald McKenzie, Senior Sanitary Engineers were also present to document opacity and gather charging rates during the testing.

The results of the testing show that the cupola is not in compliance with the particulate limits of 6 NYCRR 213.3 (a) Prohibition. The actual emissions are 74.90 lb/hr while the allowable is only 39.8 lb/hr. The source also was not in compliance with the visible emission limitations of 6 NYCRR 211.3 having had opacities of greater than 20% on October 21 for 10.75 minutes and October 28 for 9.75 minutes.

This source was also tested during 1975 by personnel from the Department of Environmental Conservation. At that time the source was shown to be out of compliance by almost 2½ times the allowable. Worthington personnel made some minor modifications which they felt would bring the source into compliance. It is apparent from the results of this second stack test that this system will require major modifications to comply with 6 NYCRR 213 and 6 NYCRR 211.

SOURCE DESCRIPTION

The installation tested consisted of two Whiting #9½ gray iron cupolas manifolding into an American Air Filter "Kinpactor" venturi scrubber system. An induced draft fan between the scrubber system and the stack provides the necessary scrubber draft. Figure 1 on the next page shows a "block form" flow diagram of this system.

During 1976 the scrubber system was modified to insure maximum cleaning efficiency. These modifications included changes in the water supply system to make more water available to the venturi scrubber. A viewing port was installed in the system to facilitate visual checks of the scurbber operation. They also sealed up any leaks in the system, replaced the fan inlet control damper and replaced the stack.

The Worthington foundry operates four days per week (Monday, Tuesday, Thursday, and Friday) alternating the use of the two cupolas. The charging rate for the cupola is approximately 23 tons/hr and the melt times vary between 3 to 4 hours on a normal day.

New York State Department of Environmental Conservation
584 Delaware Avenue, Buffalo, N.Y. 14202

Ogden Reid
Commissioner

Acting Regional Director
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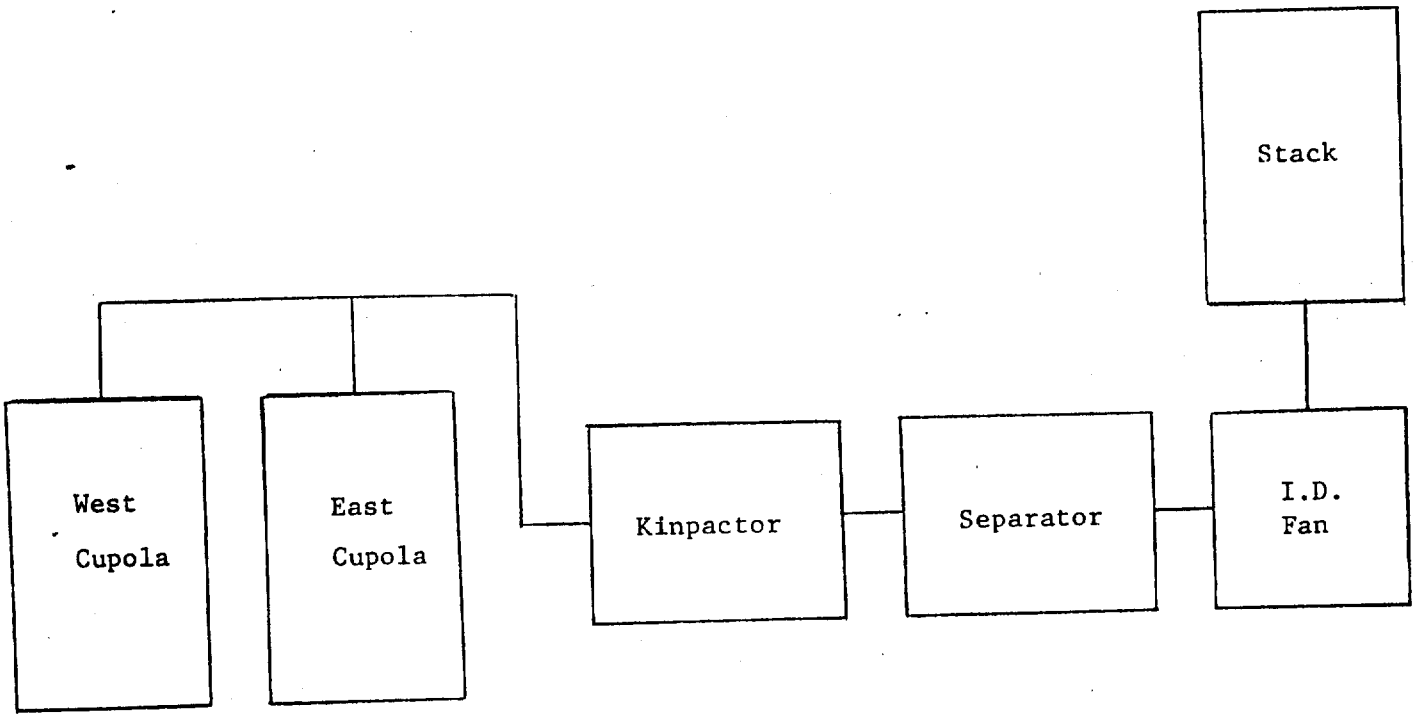
WORTHINGTON CORP. CUPOLAS



FLOW DIAGRAM
Figure 1

TEST PROCEDURES

The procedures used for testing this incinerator were those set forth in the Federal Register, Volume 36, No. 247, December 23, 1971, and New York State Department of Environmental Conservation publications, AIR 100.81 (11/74), AIR 200 (3/73), AIR 200.1 (3/73), AIR 200.3 (3/73), 76-15-7 (9/75) and 76-11-5 (1/76).

The EPA approved sampling train was of the configuration shown in Figure 2 of this section.

Due to space limitations on the platform both a 3' and 5' glass-lined probe had to be used during sampling.

A previous stack test and field measurements supplied the dimensions as shown in Figure 3 of this section. The ports were located 28' downstream from any flow disturbance (a contraction in the stack) and 8' upstream from the exit of the stack. Since this is a 4' diameter stack, the number of "diameters" downstream is 7 and usptream is 2. This number of straight stack diameters down and upstream necessitated that the sampling be performed at 20 points. Figures 4 and 4a in this section show the location of these 20 sampling points in relation to the ports and stack wall.

The analytical procedures used on each of the samples were according to the methods specified in the 76-11-5 (1/76) form, Section 5, Sample Analysis. The wet catch (particulate from the condensate plus impinger wash) is given for information only and is not included in the emission rate calculations. The wet catch data may be found on the 9AIR 224.1 included in the Appendix of this report with the test data for each of the individual runs. The lab work was performed by the Department of Health, Central New York Laboratory, Division of Laboratories and Research located in Syracuse, NY.

The molecular weight of the stack gas was determined by using a Burrel Orsat Analyzer. The composite gas samples were taken in an evacuated mylar sample bag during the particulate testing at thestack site. The gas samples were then analyzed at the stack testing shop. More efficient and accurate Orsat analyses can be performed at the shop than in the field.

The allowable emission rate for foundries is based on the amount of materials introduced into the cupola prior to and during the melt cycle. The process weight per hour equals the process weight divided by the time of the melt cycle. The weights used in determining the process weight are taken off of the Cupola Charge Report as supplied by Worthington Corp. Copies of this charging report and process weight are included in the Appendix section of this report.

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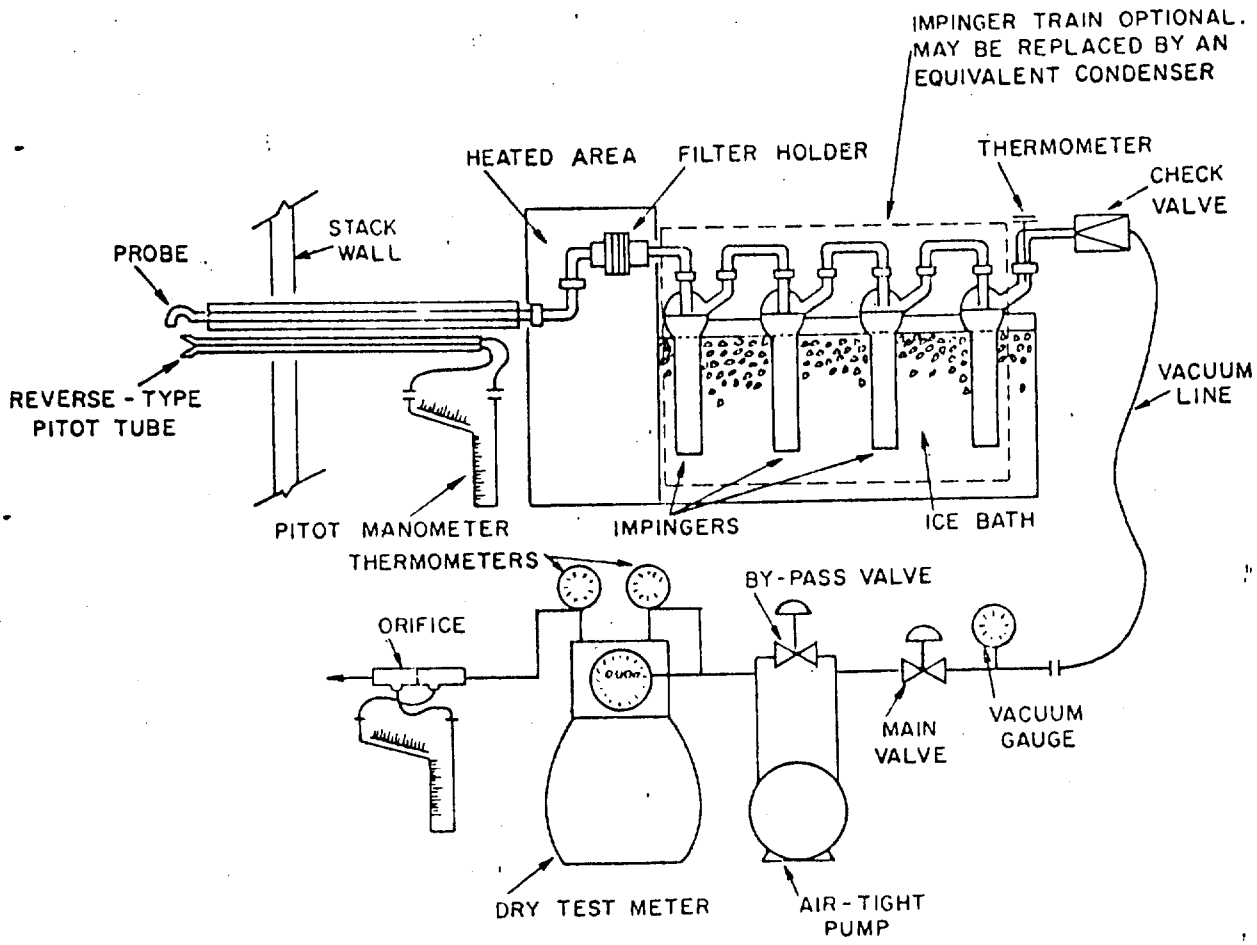
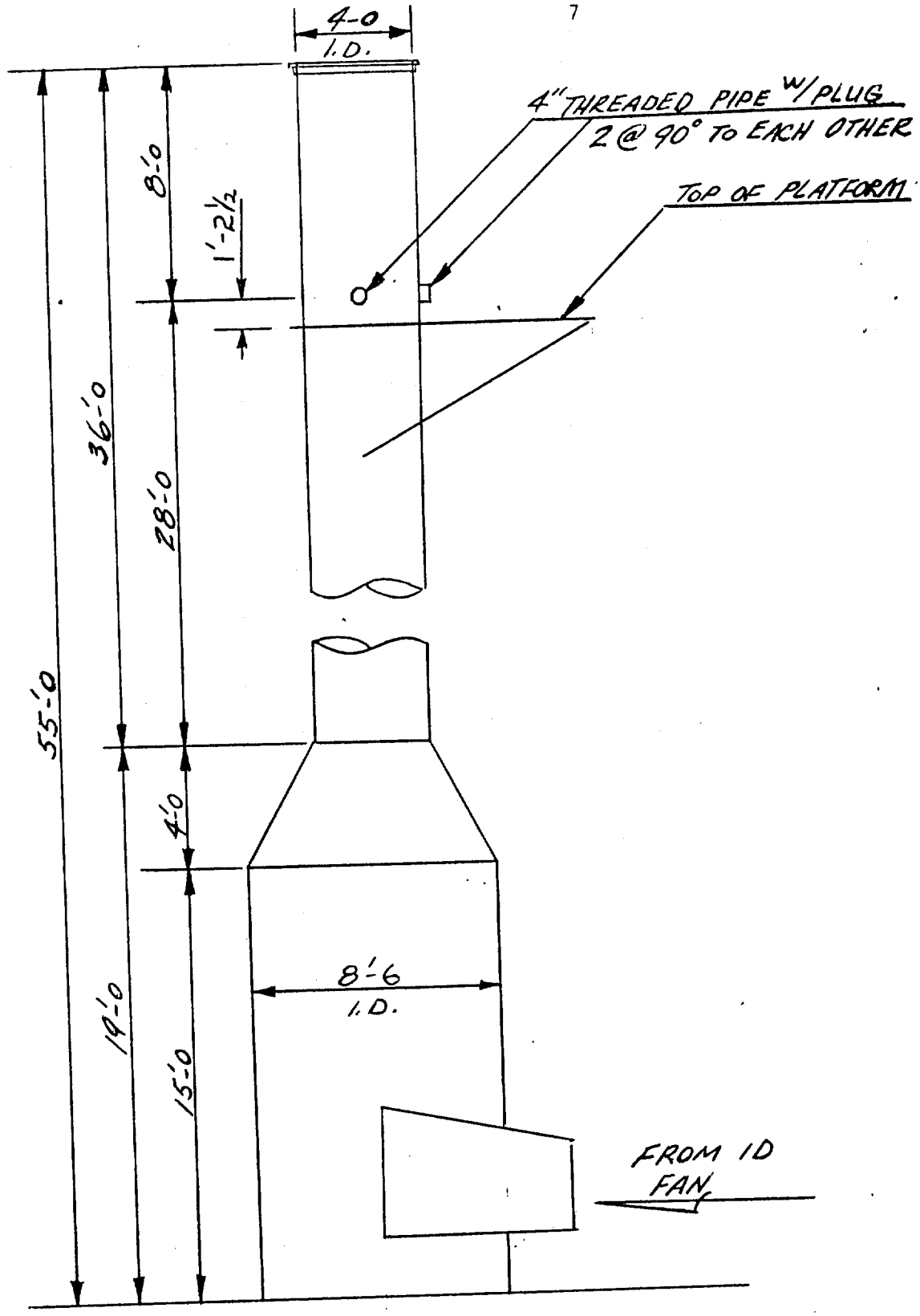


FIGURE 2 - PARTICULATE - SAMPLING TRAIN



STACK ELEVATION

Figure 3

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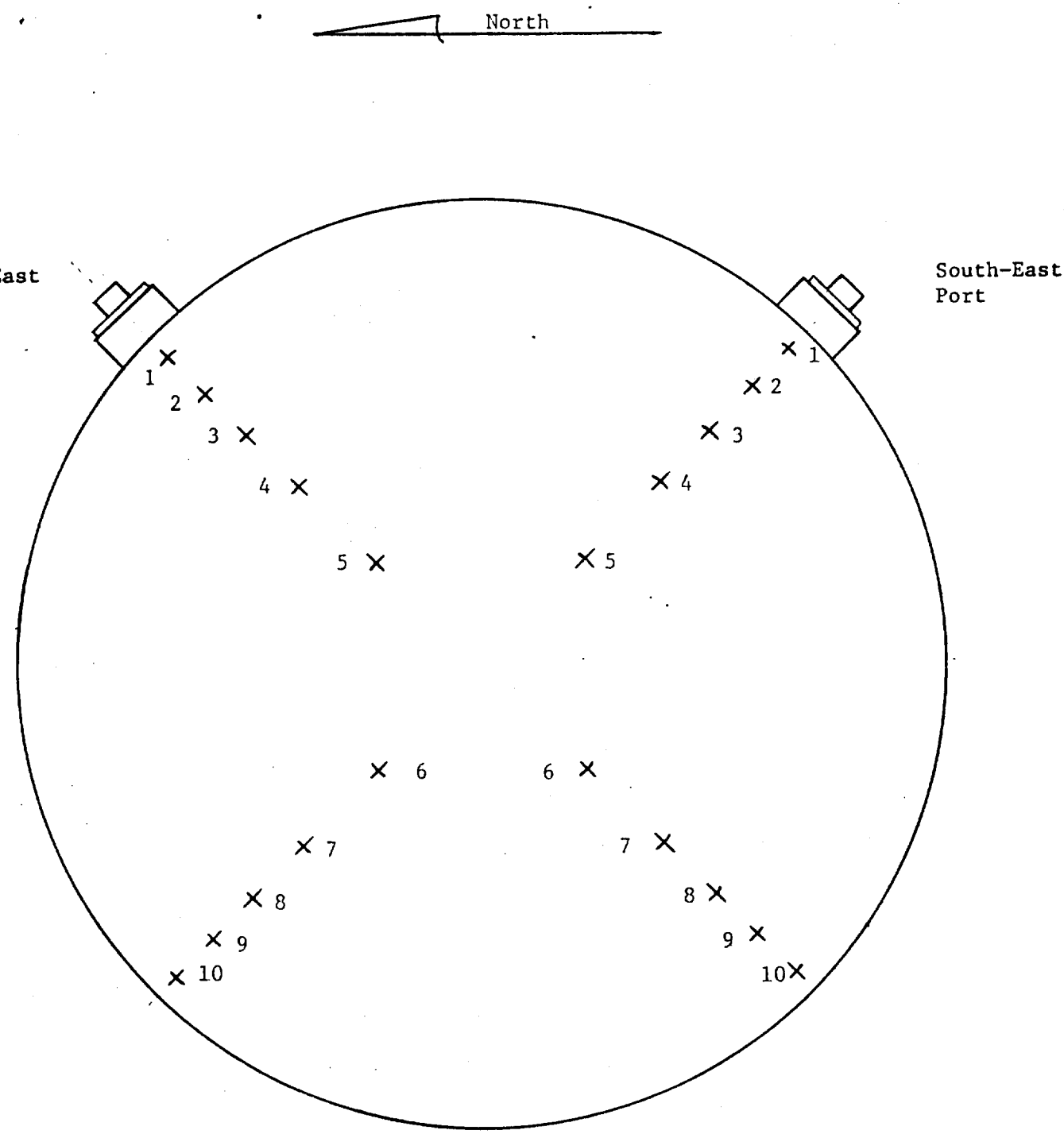

Scale: 1/8" = 1'

POINT LOCATION
Figure 4

CALCULATIONS FOR DETERMINING POINT LOCATION

Point Number	% of Stack Diameter	X	Stack Diameter	=	Inches from Stack Wall
1	2.5		48		1 3/16
2	8.2		48		3 15/16
3	14.6		48		7
4	22.6		48		10 13/16
5	34.2		48		16 7/16
6	65.8		48		31 9/16
7	77.4		48		37 3/16
8	85.4		48		41
9	91.8		48		44 1/16
10	97.5		48		46 13/16

POINT LOCATION
Figure 4a

PLUME OBSERVATIONS

During the testing opacity observations were made by personnel from the Region 9 Office of the NYSDEC. The individuals making the opacity observations included A. Donald McKenzie and Frank Shattuck, Senior Sanitary Engineers and Dominic Buccilli, Senior Engineering Technician; all of whom were certified by the Department of Environmental Conservation as opacity observers.

The opacity observations included in this report were made on the days when testing was being performed on the cupola scrubber stack. The wet scrubber produced an "attached" steam plume of 100% opacity. The observers made their opacity readings at the point where the steam had dissipated, generally about 150' to 200' from the stack.

The rule regulating visible emissions from a jobbing foundry cupola is 6 NYCRR 211, General Prohibitions. Section 211.3 of this rule states that: "No person shall cause or allow any air contamination source to emit any material having an opacity equal to or greater than twenty percent for a period of three or more minutes during any continuous sixty minute period."

During these observations there were two violations of the above rule. The first occurred during test run #2, October 21 when Mr. Buccilli documented 10.75 minutes of greater than 20% opacity. The second occurred during test run #4, October 28 when Mr. Buccilli documented 9.75 minutes of greater than 20% opacity. Although both of these violations occurred during test runswhich were void due to unacceptable isokinetic percentages, the opacity documentations are still valid. Copies of the 76-14-5 (3/76) forms "Visible Emissions Evaluation Record" are included in the Appendix of this report.

DISCUSSION OF RESULTS

The cupola scrubber stack at Worthington Corp., Roberts Avenue, Buffalo is governed by the provisions of 6 NYCRR 213 "Contaminant Emissions from Ferrous Jobbing Foundries". This cupola meets the definition of a jobbing foundry having a melt cycle less than four hours per day and a process weight less than 50,000 lb/hr.

Section 213.3 (a) of this rule states in part that: "After January 1, 1971, no person shall cause, permit or allow the emission of air contaminants, which will exceed the limits specified in Table 1, from any ferrous jobbing foundry cupola . . ."

The Cupola Charging Reports supplied by Worthington personnel during the testing were used to generate the total weight of materials introduced into the cupola during the day. The melt time used was also provided by plant personnel and verified by Region 9 personnel while the testing was in progress. The process weight in pounds per hour was then calculated from this data. The process weights were averaged from the three test runs and the allowable determined based on Table 1 of 6 NYCRR 213. The average process weight was 45,248 pounds per hour which yields an allowable of 39.8 pounds/hour.

Table 1 on the following page summarizes the testing results from the three test runs which will be used for compliance (Runs 3, 5, and 6). Test run 1 was invalid because it could not be completed before the melt cycle ended. Test runs 2 and 4 had to be invalidated when the percent isokinetic was not within the acceptable limits. The field data sheets, calculations, Orsat and analytical data for each of the three test runs (3, 5, and 6) are included in the Appendix of this report.

The average actual emissions from the cupola scrubber stack were found to be 74.90 lb/hr. The source is, therefore, not in compliance with the particulate emission limits of 6 NYCRR 213. As discussed in the Plume Observation section of this report, the source is not in compliance with the visible emission limitations of 6 NYCRR 211. The source was documented as having had visible emissions of greater than 20% on October 21 for 10.75 minutes and October 28 for 9.75 minutes which are violations of the rule.

This source was also tested during 1975 by the same personnel performing these tests. At that time, the source was also shown to be out of compliance having emissions of 85.3 lb/hr and an allowable of 34.9 lb/hr. Worthington personnel felt that the modifications which were discussed in the Source Description section of this report would be sufficient to bring this source into compliance with the regulations. It is now apparent that this system will require some major modifications to comply with 6 NYCRR 213 and 6 NYCRR 211.

SUMMARY OF TEST RESULTS

Date	Run No.	Process Weight (lb/hr)	Allowable Emission (lb/hr)*	Melt Time (hrs)	Isokinetic (%)	Stack Flow Rate (SCF/hr)	Particulate Concentration (gr/SCF)	Particulate Emission Rate (lb/hr)
)/22/76	3	45,583		3.42	102.9	1,826,203	0.3793	62.69
l/4/76	5	47,780		3.58	105.5	1,798,216	0.6205	85.45
l/5/76	6	42,380	—	3.25	93.6	1,833,663	0.4561	76.55
verage		45,248	39.8				0.4853	74.90

llowable Emission: Determined from 6 NYCRR 213, Table 1 using the average process weight, 45,248 lb/hr, is 39.8 lb/hr

Table 1

APPENDIX

STACK TEST CALCULATION SYMBOLS

V_m =	Volume of dry gas sample through dry gas meter (meter conditions) cu. ft.
$V_{m_{std}}$ =	Volume of dry gas sample through dry gas meter (standard conditions) cu. ft.
$V_{w_{std}}$ =	Volume of water vapor in gas sample (standard conditions) cu. ft.
V_{total} =	Total volume of gas sampled (standard conditions) cu. ft.
V_{l_c} =	Volume of liquid collected in impingers and silica gel, ml.
P_{bar} =	Barometric pressure at orifice meters in. Hg.
P_{std} =	Barometric pressure at standard conditions, 29.92 in. Hg.
P_s =	Absolute stack gas pressure, in. Hg.
T_m =	Absolute average dry gas meter temperature, ^oR
T_{std} =	Absolute temperature at standard conditions, ^oR
T_s =	Absolute average stack gas temperature ^oR
θ =	Total sample time, min.
ΔH =	Average pressure drop across the orifice, inches H_2O
M_d =	Dry molecular weight, lb/lb. - mole
M_s =	Molecular weight of stack gas (wet basis), lb/lb. mole
% CO_2 =	Percent carbon dioxide by volume, dry basis
% O_2 =	Percent oxygen by volume, dry basis
% CO =	Percent carbon monoxide by volume, dry basis
% N_2 =	Percent nitrogen by volume, dry basis
V_s =	Average stack gas velocity, feet per second
K_p =	Units constant for velocity formula 85.48 ft/sec $\left(\frac{lb}{lb\text{-}mole\text{-}^oR}\right)^{1/2}$ when using units in formula
C_p =	Pitot tube coefficient, dimensionless 0.85 for Type S pitot tube
$(\sqrt{\Delta P})$ Ave =	Average velocity head of stack gas, inches H_2O
B_{wo} =	Proportion by volume of water vapor in the gas stream, dimensionless

STACK TEST CALCULATION SYMBOLS
(Cont.)

A_s =	Area of stack, sq. ft.
A_n =	Area of nozzle, sq. ft.
d =	Diameter of stack, inches
Q'_s =	Volumetric flow rate, wet basis standard conditions, cubic feet per hour
M_n =	Total amount of particulate matter collected, mg. (filter, probe, cyclone, and flask)
C'_s =	Concentration of particulate matter in stack gas, dry basis, gr/scf
W'_s =	Weight emission rate of particulate, lb/hr
I =	Percent of isokinetic sampling

AIR-224 (3/74)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

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STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	Run No.
11/4/76	Worthington	Roberts Ave	5

Description of Installation: Cupola Scrubber

Tested by: NYSDEC

Sample Box No.	Meter Box No.	Meter ΔH in. Hg	C factor	Ambient Temp. °F	Bar. Pres. in. Hg	Assumed Moisture, %
R-9	R-9	1.84	K-1.32	52	29.12	40

Meter Box Setting, °F	Probe Length, ft.	Nozzle Diameter, in.	Probe Heater Setting, °F	OTHER
250	3 + 5	.250	6 AMPS	Probes #2 + 4

FILTER NOS.: 9-

CONDENSATE; milliliters			SILICA GEL
Impinger	No. 1	No. 2	
Final	526	684	848.8
Initial	200	200	820.7
Difference	326	484	28.1

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	Stack Pressure in. Hg	Stack Gas Velocity fps
	12:49	0	102.285	Start Test									
NE-10		5	104.61	.55	.725	52	51	178	1	275	59	-.39	
9		10	106.81	.48	.635	56	52	177	3	280	58	-.37	
8		15	108.82	.40	.53	60	52	178	4	275	57	-.35	
7		20	110.68	.34	.45	60	54	180	5	250	54	-.30	
6	1:14	25	112.535	.34	.45	62	54	179	6	255	56	-.30	
	1:22	25	112.535	Stop to Change Port									
SE-10		30	114.52	.42	.55	56	55	178	7	280	50	-.30	
9		35	116.51	.40	.53	58	55	177	9	295	51	-.30	
8		40	118.57	.42	.56	61	55	177	11	300	53	-.33	
7		45	120.67	.44	.59	61	55	178	12	275	46	-.36	
6	1:47	50	122.787	.45	.60	62	56	178	14	300	46	-.37	

AIR-224 (3/74)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

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STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source
11/4/76	Worthington	Roberts Ave.

Description of Installation	Tested by	Run No.
Cupola Scrubber	N.Y.S.D.E.C. R-9	5

Sample Box No.	Meter Box No.	Meter ΔH in. Hg	C factor	Ambient Temp. °F	Bar. Pres. in. Hg	Assumed Moisture, %
R9	R-9	1.84	K=1.32	52	29.12	40

Meter Box Setting, °F	Probe Length, ft.	Nozzle Diameter, in.	Probe Heater Setting, °F	OTHER
250	3 & 5	.250	6 amps	Probes 2 + 4 Glass

FILTER NOS.	CONDENSATE; milliliters			SILICA GEL
	Impinger	No. 1	No. 2	
9-246	Final			
9-247	Initial			
	Difference			

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	~~Stack~~ Static Pressure in. Hg	Stack Gas Velocity fps
	1:55	50	122.787	START		NEW		PROBE					
SE-1		55	125.12	.53	.705	57	55	179	16	295	48	-.24	
2		60	127.508	.59	.78	61	56	179	21	265	48	-.34	
				stop To change filter AND first two impingers.									
	2:23	60	128.312	Leak Check OK.				←	NEW	Volume			
3		65	130.83	.57	.75	55	54	180	1	310	49	-.35	
4		70	133.17	.56	.74	59	54	181	4	270	47	-.39	
5	2:38	75	135.462	.53	.705	63	55	180	6	265	47	-.39	
	2:41	75	135.462	STOP To Change Port									
NE-1		80	138.06	.71	.94	61	55	178	8	240	49	-.29	
2		85	141.09	.83	1.10	64	55	178	11	230	52	-.38	
3		90	143.62	.83	1.10	68	56	180	14	245	53	-.42	
4		95	146.34	.81	1.07	72	57	178	16	250	56	-.48	
5	3:07	100	149.007	.72	.95	67	57	178	19	250	58	-.46	
				End of Test									
			-.804	Volume adj. for leak Check									

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 10-22-76

Source: Cupola Scrubber Stack Run No. 3

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 52.730 C.F.

θ = 100 min.

P_{bar} = 29.22 in. Hg

P_s = 29.20 in. Hg

T_s = 166 °F + 460 = 626 °R

T_m = 50 °F + 460 = 510 °R

Ave$\sqrt{\Delta p}$ = 0.749 in. H_2O

ΔH = 0.986 in. H_2O

V_{lc} = 656.7 mL

A_n = 0.00034 Sq. ft.

M_n = 1321.1 mg

$$\frac{11.1}{29.92} \times 100$$

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp Test Date 10-22-76

Source: Cupola Scrubber Stack Run No. 3

Dry Gas Volume (Standard Conditions) (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 52.730 (17.71) \left[\frac{29.22 + \frac{.986}{13.6}}{510} \right]$$

$$= \underline{\underline{53.637 \text{ SCF}}}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{1_c} (0.0474)$$

$$= 656.7 (0.0474)$$

$$= \underline{\underline{31.128 \text{ SCF}}} \times \left(\frac{460 + 168}{530} \right)$$

$$=$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Worthington Corp. Test Date 10-22-76

Source: Cupola Scrubber Stack Run No. 3

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{31.128}{31.128 + 53.637}$$

$$= .367 = 36.7\%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44\,(11.5) + .32\,(9.3) + .28\,(0 + 79.2)$$

$$= 30.212\ \text{lb/lb-mole}$$

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 10-22-76

Source: Cupola Scrubber Stack Run No. 3

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.21(1-.367) + 18(.367)$$

$$= \underline{\underline{25.73 \text{ lb/lb-mole}}}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p})_{Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.836)(.749)\sqrt{\frac{626}{(29.20)(25.73)}}$$

$$= \underline{\underline{48.857 \text{ fps}}}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 10-22-76

Source Cupola Scrubber Stack Run No. 3

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\left[\frac{3.1416\,(48)^2}{4}\right]}{144}$$

$$= \underline{\underline{12.566 \text{ sq. ft.}}}$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600\,(V_s)\,(A)\left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= 3600\,(48.857)\,(12.566)\left(\frac{530}{626}\right)\left(\frac{29.20}{29.92}\right)$$

$$= \underline{\underline{1,826,203 \text{ scf/hr}}}$$

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 10-22-76

Source Cupola Scrubber Stack Run No. 3

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154 \left(\frac{M_n}{V_{m_{std}}} \right)$$

$$= .0154 \left(\frac{1321.1}{53.637} \right)$$

$$= \underline{\underline{.3793 \text{ gr/scf}}}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 53.637 + 31.128$$

$$= \underline{\underline{84.765 \text{ SCF}}}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 10-22-76

Source: Cupola Scrubber Stack Run No. 3

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n\ Q's}{V_{total}}$$

$$= \left[\frac{(1/454{,}000)\ 1321.1}{84.765}\right] 1{,}826{,}203$$

$$= \underline{\underline{62.69 \text{ lb/hr}}}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(84.765)\ (626)}{(0.00034)(48.857)(29.20)(100)}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \underline{\underline{102.9\ \%}}$$

9AIR201.08 (1/76)

ORSAT ANALYSIS DATA

Name of source Worthington Corp. Date Oct 22, 1976

Addressof source Roberts Ave. Buffalo

Description of equipment Cupola Scrubber Stack

Tested by NYS DEC R-9 Sample No. 3

Remarks Burrel Orsat

Pass No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% N_2
1	11.8	11.8	21.0	9.2	21.0	0	79.0
2	11.1	11.1	20.4	9.3	20.4	0	79.6
3	11.7	11.7	21.1	9.4	21.1	0	78.9
Avg		11.5		9.3		0	79.2

76-00-93 (7/76)

Plant Worthington Corp
Source Cupola Scrubber Stack
Date Oct 22, 1976 Run No. 3

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

33.3 mg = 37.2 mg - (400 ml X .0097 mg/ml)

Impinger Wash

5.7 mg = 8.4 mg - (275 ml X .0097 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s) 9-241 9-242			759.7 528.1 mg
2 Probe, Cyclone & Flask Wash			33.3 mg
TOTAL			1321.1 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	5.7 mg
3 Impinger Condensate Suspended Solids	——— mg
3 Impinger Condensate Evaporated Solids	4.4 mg
TOTAL WET CATCH	10.1 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	628 ml	200 ml		428 ml
3 Impinger #2 & #3	406 ml	200 ml		206 ml
4 Silica Gel	880.0 g	857.3 g	22.7 g*	22.7 ml
TOTAL CONDENSATE VOLUME				656.7 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1 \text{ g./ml}} = \text{Volume Water ml.}$$

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-4-76

Source: Cupola Scrubber Stack Run No. 5

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 45.918 C.F.

θ = 100 min.

P_{bar} = 29.12 in. Hg

P_s = 29.09 in. Hg

T_s = 179 °F + 460 = 639 °R

T_m = 58 °F + 460 = 518 °R

Ave$\sqrt{\Delta p}$ = 0.735 in. H_2O

ΔH = 0.723 in. H_2O

V_{1c} = 838.1 mL

A_n = 0.00034 Sq. ft.

M_n = 1845.2 mg

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-4-76

Source: Cupola Scrubber Stack Run No. 5

Dry Gas Volume (Standard Conditions) (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 45.918 (17.71) \left[\frac{29.12 + \frac{0.723}{13.6}}{518} \right]$$

$$= \underline{\underline{45.799 \text{ SCF}}}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{l_c} (0.0474)$$

$$= 838.1 (.0474)$$

$$= \underline{\underline{39.726 \text{ SCF}}}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Worthington Corp. Test Date 11-4-76

Source: Cupola Scrubber Stack Run No. 5

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{39.726}{39.726 + 45.799}$$

$$= .464 = 46.4\ \%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44(17.6) + .32(3.2) + .28(0.3 + 78.9)$$

$$= 30.94\ lb/lb\text{-mole}$$

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp Test Date 11-4-76

Source: Cupola Scrubber Stack Run No. 5

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.94(1 - .464) + 18(.464)$$

$$= \underline{\underline{24.94 \text{ lb/lb-mole}}}.$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p})_{Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.836)(.735) \sqrt{\frac{639}{(29.09)(24.94)}}$$

$$= \underline{\underline{49.293 \text{ fps}}}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-4-76

Source Cupola Scrubber Stack Run No. 5

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\left[\frac{3.1416\ (48)^2}{4}\right]}{144}$$

$$= \underline{\underline{12.566 \text{ sq. ft.}}}$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600\ (V_s)\ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= (3600)\ (49.293)(12.566)\ \left(\frac{530}{639}\right)\left(\frac{29.09}{29.92}\right)$$

$$= \underline{\underline{1,798,216 \text{ SCF/hr}}}$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-4-76

Source Cupola Scrubber Stack Run No. 5

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154 \left(\frac{M_n}{V_{m_{std}}} \right)$$

$$= .0154 \left(\frac{1845.2}{45.799} \right)$$

$$= \underline{\underline{0.6205 \text{ gr/scf}}}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 45.799 + 39.726$$

$$= \underline{\underline{85.525 \text{ SCF}}}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-4-76

Source: Cupola Scrubber Stack Run No. 5

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q's$$

$$= \left[\frac{(1/454{,}000)\ 1845.2}{85.525}\right] 1{,}798{,}216$$

$$= \underline{\underline{85.45 \text{ lb/hr}}}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(85.525)\ (639)}{(.00034)(49.293)(29.09)(100)}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \underline{\underline{105.5\ \%}}$$

9AIR201.08 (1/76)

ORSAT ANALYSIS DATA

Name of source Worthington Corp Date Nov 4, 1976

Addressof source Roberts Ave., Buffalo

Description of equipment Cupola Scrubber Stack

Tested by NYSDEC R-9 Sample No. 5

Remarks Burell Orsat

Pass No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% N_2
1	17.7	17.7	20.6	2.9	20.9	0.3	79.1
2	17.7	17.7	21.0	3.3	21.2	0.2	78.8
3	17.5	17.5	21.0	3.5	21.4	0.4	78.6
Avg		17.6		3.2		0.3	78.9

76-00-93 (7/76)

ANALYTICAL DATA

Plant Worthington Corp
Source Cupola Scrubber Stack
Date Nov 4, 1976 Run No. 5

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

134.0 mg = 137.3 mg - (345 ml X .0097 mg/ml)

Impinger Wash

9.1 mg = 11.6 mg - (260 ml X .0097 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s) 9-246 9-247			858.7 852.5 mg
2 Probe, Cyclone & Flask Wash			134.0 mg
TOTAL			1845.2 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	9.1 mg
3 Impinger Condensate Suspended Solids	— mg
3 Impinger Condensate Evaporated Solids	9.5 mg
TOTAL WET CATCH	18.6 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	526 ml	200 ml	326 ml	
3 Impinger #2 & #3	684 ml	200 ml	484 ml	
4 Silica Gel	848.8 g	820.7 g	28.1 g*	28.1 ml
TOTAL CONDENSATE VOLUME				838.1 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1\ \text{g./ml}} = \text{Volume Water ml.}$$

9AIR 224.1 (10/74)

AIR-224 (3/74)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

Pg 1 of 2

STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	Run No.
11/5/76	Worthington	Roberts Ave	6

Description of Installation: Cupola Scrubber

Tested by: N.Y.S.D.E.C. R9

Sample Box No.	Meter Box No.	Meter ΔH in. Hg	C factor	Ambient Temp. °F	Bar. Pres. in. Hg	Assumed Moisture, %
R9	R9	1.84	K=1.3947	42	29.15	42

Meter Box Setting, °F	Probe Length, ft.	Nozzle Diameter, in.	Probe Heater Setting, °F	OTHER
250	3 o 5	.250	6 amps	Probe 2-4 Glass

FILTER NOS.: 9-248

CONDENSATE; milliliters			SILICA GEL
Impinger	No. 1	No. 2	
Final	494	473	823.1
Initial	200	200	802.6
Difference	294	273	20.5

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	~~Stack~~ STATIC Pressure in. Hg	Stack Gas Velocity fps
	12.51	0	150.175	START		OF	TEST						
NE-10		5	152.64	.58	.81	41	40	171	2	240	48	-.43	
9		10	154.99	.54	.75	44	40	174	2	250	48	-.35	
8		15	157.17	.46	.64	46	41	171	3	240	43	-.37	
7		20	159.13	.38	.53	46	41	173	3	275	47	-.35	
6	1:16	25	161.168	.38	.53	46	41	173	4	270	47	-.34	
SE-5	1:20	30	163.33	.44	.62	42	41	176	5	255	42	-.35	
4		35	165.50	.45	.63	44	41	175	7	285	41	-.35	
3		40	167.635	.43	.60	46	42	176	8	245	41	-.39	
2		45	169.90	.50	.70	46	42	173	9	230	40	-.38	
1		50	172.184	.52	.72	47	42	177	11	230	41	-.41	

AIR-224 (3/74)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	FILTER NOS.	CONDENSATE; milliliters			SILICA GEL
1-5-7[illegible]	[illegible]			Impinger	No. 1	No. 2	
Description of Installation	Tested by	Run No. 6		Final			
Sample Box No.	Meter Box No.	Meter ΔH in. Hg	C factor	Ambient Temp. °F	Bar. Pres. in. Hg	Assumed Moisture, %	
				Initial			
Meter Box Setting, °F	Probe Length, ft.	Nozzle Diameter, in.	Probe Heater Setting, °F	OTHER			
				Difference			

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	~~Stack~~ static Pressure in. Hg	Stack Gas Velocity fps
5	1:56	50	170.154	.69	.96	43	42	175	13	255	44	-.29	
NE 1		55	174.[illegible]	.86	1.20	47	42	176	19	275	46	-.46	
2	2:06	60	177.520	Stop		Change	Filter	+ Imp.		Leak Check			
									Leak check OK.				
	2:21	60	177.875	← New		Volume							
3		65	180.78	.88	1.20	43	41	177	1	275	47	-.50	
4		70	183.63	.86	1.20	47	42	176	3	250	47	-.55	
5		75	186.316	.75	1.05	48	42	175	6	280	43	-.50	
SE 1	2:42	80	188.78	.60	.84	46	43	172	6	275	43	-.26	
2		85	191.36	.66	.92	51	43	170	8	260	44	-.31	
3		90	193.87	.62	.86	55	45	170	9	300	46	-.35	
4		95	196.38	.62	.86	57	46	170	11	250	48	-.39	
5		100	198.863	.58	.81	57	47	170	12	290	50	-.39	
			-.355	Volume adjustment for leak check									

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp Test Date 11-5-76

Source: Cupola Scrubber Stack Run No. 6

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 48.333 c.f.

θ = 100 min.

P_{bar} = 29.15 in. Hg

P_s = 29.12 in. Hg

T_s = 174 °F + 460 = 634 °R

T_m = 45 °F + 460 = 505 °R

Ave$\sqrt{\Delta p}$ = 0.762 in. H_2O

ΔH = 0.822 in. H_2O

V_{lc} = 587.5 mL

A_n = .00034 Sq. ft.

M_n = 1466.3 mg

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-5-76

Source: Cupola Scrubber Stack Run No. 6

Dry Gas Volume (Standard Conditions) (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 48.333 (17.71) \left[\frac{29.15 + \frac{.822}{13.6}}{505} \right]$$

$$= \underline{\underline{49.512 \text{ SCF}}}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{l_c} (0.0474)$$

$$= 587.5 (.0474)$$

$$= \underline{\underline{27.848 \text{ SCF}}}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Worthington Corp. Test Date 11-5-76

Source: Cupola Scrubber Stack Run No. 6

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{27.848}{27.848 + 49.512}$$

$$= .360 = 36.0\ \%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44(14.0) + .32(6.9) + .28(0 + 79.1)$$

$$= 30.52\ \text{lb/lb-mole}$$

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp Test Date 11-5-76

Source: Cupola Scrubber Stack Run No. 6

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.52(1-.360) + 18(.360)$$

$$= \underline{\underline{26.01 \text{ lb/lb-mole}}}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p}) \text{ Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= (85.48)(.836)(.762)\sqrt{\frac{634}{(29.12)(26.01)}}$$

$$= \underline{\underline{49.820 \text{ fps}}}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-5-76

Source Cupola Scrubber Stack Run No. 6

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\left[\frac{3.1416\ (48)^2}{4}\right]}{144}$$

$$= \underline{\underline{12.566 \text{ sq. ft.}}}$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600\ (V_s)\ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= (3600)(49.820)(12.566)\left(\frac{530}{634}\right)\left(\frac{29.12}{29.92}\right)$$

$$= \underline{\underline{1{,}833{,}663 \text{ SCF/hr}}}$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-5-76

Source Cupola Scrubber Stack Run No. 6

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154 \left(\frac{M_n}{V_{m_{std}}} \right)$$

$$= .0154 \left(\frac{1466.3}{49.512} \right)$$

$$= \underline{\underline{0.4561 \text{ gr/scf}}}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 49.512 + 27.848$$

$$= \underline{\underline{77.360 \text{ SCF}}}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Worthington Corp. Test Date 11-5-76

Source: Cupola Scrubber Stack Run No. 6

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q's$$

$$= \left[\frac{(1/454{,}000)\ 1466.3}{77.360}\right] 1{,}833{,}663$$

$$= \underline{\underline{76.55 \text{ lb/hr}}}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(77.360)(634)}{(.00034)(49.820)(29.12)(100)}\right]\left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= \underline{\underline{93.6\ \%}}$$

9AIR201.08 (1/76)

ORSAT ANALYSIS DATA

Name of source Worthington Corp Date Nov 5, 1976

Addressof source Roberts Ave, Buffalo

Description of equipment Cupola Scrubber Stack

Tested by NYSDEC R-9 Sample No. 6

Remarks Burell Orsat

Pass No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% N_2
1	14.0	14.0	20.9	6.9	20.9	0.0	79.1
2	14.0	14.0	20.9	6.9	20.9	0.0	79.1
3	14.0	14.0	21.0	7.0	21.0	0.0	79.0
Avg		14.0		6.9		0.0	79.1

Plant Worthington Corp
Source Cupola Scrubber Stack
Date Nov 5, 1976 Run No. 6

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

82.4 mg = 85.5 mg - (322 ml X .0097 mg/ml)

Impinger Wash

5.6 mg = 7.6 mg - (205 ml X .0097 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s) 9-248 9-249			744.9 639.0 mg
2 Probe, Cyclone & Flask Wash			82.4 mg
TOTAL			1466.3 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	5.6 mg
3 Impinger Condensate Suspended Solids	— mg
3 Impinger Condensate Evaporated Solids	9.5 mg
TOTAL WET CATCH	15.1 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	494 ml	200 ml	294 ml	
3 Impinger #2 & #3	473 ml	200 ml	273 ml	
4 Silica Gel	823.1 g	802.6 g	20.5 g*	20.5 ml
TOTAL CONDENSATE VOLUME				587.5 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1 \text{ g./ml}} = \text{Volume Water ml.}$$

9AIR 224.1 (10/74)

New York State Department of Environmental Conservation

Ogden Reid,
Commissioner

Operating Schedule of Cupola During Testing

	Run # 3 10/22	Run # 5 11/4	Run # 6 11/5
Light Up	10:12 Am	10:20 Am	10:20 Am
Intermittant Wind	10:14	10:25	10:25
Off Wind + Start Charge	10:39	10:50	10:50
Preheat	10:50	11:20	11:20
Wind On	11:40	11:40	11:55
Tap Out	12:00 Pm	12:00 Pm	12:15 Pm
Last Charge	2:50	3:05	—
Stop Tap	3:25	3:35	3:30
Drop Bottom	3:30	3:45	3:32
Melt Time *	3 hrs 25 min (3.42 hrs)	3 hrs 35 min (3.58 hrs)	3 hrs 15 min (3.25 hrs)

* As defined by 6 NYCRR 213.2 (d) "Melt Time. The time in which the metal is melting and available at the spout or Tap hole ..."

PROCESS WEIGHT TABULATION

Date: 10-22-76

Cupola Preparation

Sand	3,000
Blastpatch	2,400
Subtotal	5,400 lbs.

Bed

Coke	5,500
Stone	150
Flux and Carbide	16
Wood	1,500
Fuel Oil (5 gallons)	32
Subtotal	7,198 lbs.

Charges

Grade	Charge Weight	Flux, Stone and Coke	Total Charge	Number	Total Weight
V E	2000	444	2444	3	7,332
Duct	2000	444	2444	35	85,540
II E	2000	294	2294	6	13,764
VI E	2000	444	2444	15	36,660
				Subtotal	143,294 lbs.

Total Weight 155,894

Hours of Operation 3.42

Process Weight (Pounds/hour) 45,583

NO. #12

HT. NO. 3683

CUPOLA CHARGE REPORT

DATE 10-22-76

CUP. NO. W

DE	STEEL 2 BARML.	STEEL AUTO	MN (SPGL).	Si 50%	Si BRIQ	PIG IRON	IRON BRIQ	PURCH. IRON SCRAP	IRON RETURNS IE	IRON RETURNS VE	TOTAL CHARGE WT.	NO. CHGS.	FLUX	STONE	COKE
E	1915			75	10 (2)						2000	(3)	4	40	400
CT	500					TAC 1000	SOREL 500				2000	(35)	4	40	400
E		1000	20 (6)		6 (1)				980 975		2000	(6)	4	40	250
E										2000	2000	(15)	4	40	400

KE MFG. SOLVAY

KE SIZE 5X7

OKE-BED 5500

TONE-BED 150

LUX-BED 16

PIG IRON

% Si 2.15 3.12

% Mn .07 .98

Innoculant K-60

NO.	MATERIAL	Si	MG	Ni	Ca	Ce	Al	LADLE #1 LBS.	LADLE #1 %	LADLE #2 LBS.	LADLE #2 %			
	Si-MG-CE													
	Ni-MG #1													
	Ni-MG #2													
	75% CA-FE-Si		27	.3	12	.3		21	.3	80	.5	26	.3	12	.3
	K-59C		225	260	100	260		175	260	450	260	213	260	100	260
	100-FLUX														
	~~CRYOLITE~~		9	01	4	01		7	01	18	01	9	01	4	01
	~~CALCIUM CARBIDE~~														
	~~Na_2CO_3 BRIQ~~		180	20	80	20		140	20	360	20	170	20	80	20
	IRON		9000		4000			7000		18000		8500		4000	
								30	.5	27	.3				
								150	250	225	250				
								6	01	9	01				
								120	20	180	20				
								6000		9000					

CE70

PROCESS WEIGHT TABULATION

Date: 11-4-76

Cupola Preparation

Sand	3,000
Blastpatch	2,400
Subtotal	5,400 lbs

Bed

Coke	5500
Stone	150
Flux and Carbide	16
Wood	1500
Fuel Oil (4 gallons)	32
Subtotal	7,198 lbs.

Charges

Grade	Charge Weight	Flux, Stone and Coke	Total Charge	Number	Total Weight
V E	2000	444	2444	3	7,332
Duct	2000	444	2444	40	97,760
II E	2000	294	2294	19	43,586
V E	2000	444	2444	4	9,776
			Subtotal		158,454

Total Weight 171,052

~~Hrs. of~~ Hours of Operation 3.58

Process Weight (Pounds/hour) 47,780

T. NO. #3

CT. HT. NO. 3690

CUPOLA CHARGE REPORT

DATE 11-4-76

CUP. NO. E

RADE	STEEL 2 BARML.	STEEL AUTO	MN (SPGL).	SI 50%	SI BRIQ	PIG IRON	IRON BRIQ	PURCH. IRON SCRAP	IRON RETURNS IIE	IRON RETURNS IVE	TOTAL CHARGE WT.	NO. CHGS.	FLUX	STONE	COKE
LE	1915			75	10 (2)						2000	(3)	4	40	400
						TAC	SOCEL								
UCT	~~[illegible]~~				~~[illegible]~~	~~[illegible]~~	~~[illegible]~~				2000	(40)	4	40	400
	600				5 (1)	1000	395								
E		1000	20 (6)		5 (1)				975		2000	(19)	4	40	250
												(14)			
E										2000	2000	(X)	4	40	400

OKE MFG. SOLVAY

OKE SIZE 5X7

COKE-BED 5500

STONE-BED 150

FLUX-BED 16

PIG IRON

% Si	2.15	3.12
% Mn	.07	.98

Innoculant K60

66 TONS

T NO.	MATERIAL	SI	MG	NI	CA	CE	AL	LADLE #1 LBS.	LADLE #1 %	LADLE #2 LBS.	LADLE #2 %				
	SI-MG-CE														
	NI-MG #1														
	NI-MG #2														
	45% CA-FE-SI		30	.3	23	.3		54	.3	29	.3	12	.3	30	.5
	K69C		250	250	188	250		450	250	238	250	100	250	150	250
	~~SF100 FLUX~~														
	~~CRYOLITE~~		10	01	8	0.1		18	01	10	01	4	0.1	6	01
	~~CALCIUM CARBIDE~~		200	20	150	2.0		360	20	190	2.0	80	2.0	120	2.0
	~~Na2CO3 BRIQ~~														
	IRON		10000		7500			18000		9500		4000		6000	
								23	.3	12	.3	21	.3		
								188	250	100	250	175	250		
								8	01	4	01	7	01		
								150	2.0	80	2.0	140	2.0		
								7500		4000		7000			

CE70

PROCESS WEIGHT TABULATION

Date: 11-5-76

Cupola Preparation

Sand	3000
Blastpatch	2400
Subtotal	5400 lbs

Bed

Coke	5500
Stone	150
Flux and Carbide	16
Wood	1500
Fuel Oil (4 gallons)	32
Subtotal	7,198 lbs.

Charges

Grade	Charge Weight	Flux, Stone and Coke	Total Charge	Number	Total Weight
V E	2000	444	2444	3	7,332
Duct	2000	444	2444	27	65,988
II E	2000	294	2294	13	29,822
V E	2000	444	2444	9	21,996
			Subtotal		125,138 lbs.

Total Weight 137,736 lbs.

Hours of Operation 3.25 hrs.

Process Weight (pounds / hour) 42,380

NO. #4

HT. NO. 3691

CUPOLA CHARGE REPORT

11/5/76

DATE 11 5 76

CUP. NO. W

E	STEEL 2 BARML.	STEEL AUTO	MN (SPGL).	Si 50%	Si BRIQ	PIG IRON	IRON BRIQ	PURCH. IRON SCRAP	IRON RETURNS IF	IRON RETURNS VE	TOTAL CHARGE WT.	NO. CHGS.	FLUX	STONE	COKE
	1915			75	10 (2)						2000	(3)	4	40	400
	600				5 (1)	TAC 1000	SOREL 395				2000	(27)	4	40	400
		1000	20 (6)		5 (1)				975		2000	(13)	4	40	250
										2000	2000	(9)	4	40	400

E MFG. SOLVAY

E SIZE 5X7

KE-BED 5500

ONE-BED 150

JX-BED 16

wood

fuel oil

PIG IRON 1 1 Totals

% Si 215 312

% Mn 07 .98

52 TONS

Innoculant K60

NO.	MATERIAL	Si	MG	Ni	Ca	Ce	Al	LADLE #1 LBS.	LADLE #1 %	LADLE #2 LBS.	LADLE #2 %				
	SI-MG-CE														
	NI-MG #1														
	NI-MG #2														
	85% CA-FE-Si		30	.3	20	.3	48	.3	9	.3	27	.3	20	.3
	K5/C		250	250	163	250	400	250	75	250	225	250	163	250
	100 FLUX ~~CRYOLITE~~		10	01	7	01	16	01	3	01	9	01	7	01
	~~CALCIUM CARBIDE~~ ~~Na_2CO_3 BRIQ~~		200	20	130	20	320	20	60	20	180	20	130	20
	IRON		10000		6500		16000		3000		9000		6500	

CE70

STATE OF NEW YORK
DEPARTMENT OF HEALTH

COMMISSIONER
Robert P. Whalen, M.D.

DIVISION OF LABORATORIES
AND RESEARCH

CENTRAL NEW YORK LABORATORY
677 SOUTH SALINA STREET
SYRACUSE, N. Y. 13202

November 30, 1976

File

Mr. Roger McCabe
N.Y.S. Dept. of Environmental Conservation
Region 9
584 Delaware Avenue
Buffalo, N.Y. 14202

Dear Mr. McCabe:

Attached are analytic results of samples collected 10/22 - 11/5/76 from Worthington Cupola Scrubber, Buffalo, N.Y.

Yours truly,

Arthur M. Hanson

Arthur M. Hanson
Associate Chemist

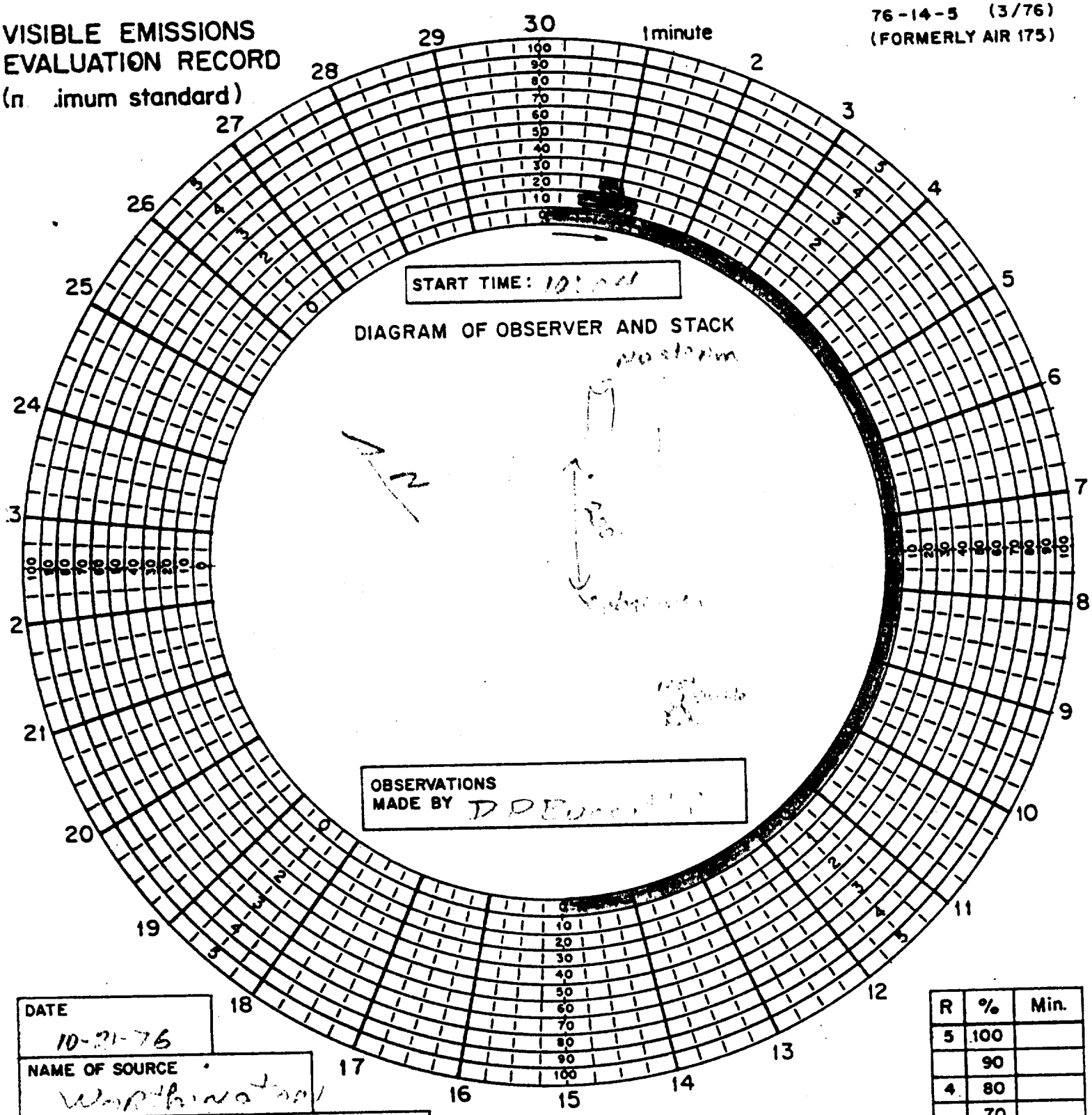
Test Number	Filter Number	Sample Weight (milligrams)	Condensate Volume (ml.)	Evap'd Solids (milligrams)	Notes
3,5,6			287	2.8	Acetone blank
3	9-241	759.7			
3	9-242	528.1			
3			400	37.2	Probe wash
3			275	8.4	Impinger wash
3			1020	4.4	Impinger conden., evapd. solids
3					
5	9-246	858.7			
5	9-247	852.5			
5			345	137.3	Probe wash
5			260	11.6	Impinger wash
5			1200	9.5	Impinger conden., evapd. solids
5					
6	9-248	744.9			
6	9-249	639.0			
6			322	85.5	Probe wash
6			205	7.6	Impinger wash
6			1070	16.3	Impinger conden., evapd. solids
6					

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

76-14-5 (3/76)
(FORMERLY AIR 175)

VISIBLE EMISSIONS EVALUATION RECORD
(m .imum standard)



DATE	
10-21-76	
NAME OF SOURCE	
Worthington	
ADDRESS	
Roberts	
STACK DESCRIPTION	
[illegible]	
WEATHER CONDITIONS	WIND SPEED
Cold & overcast	[illegible]
PLUME COLOR, MOVEMENT	BACKGROUND COLOR
Grey	SKY-CLOUDY [illegible]

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	.25
	10	.50
0	0	14.25
	Total	15.0

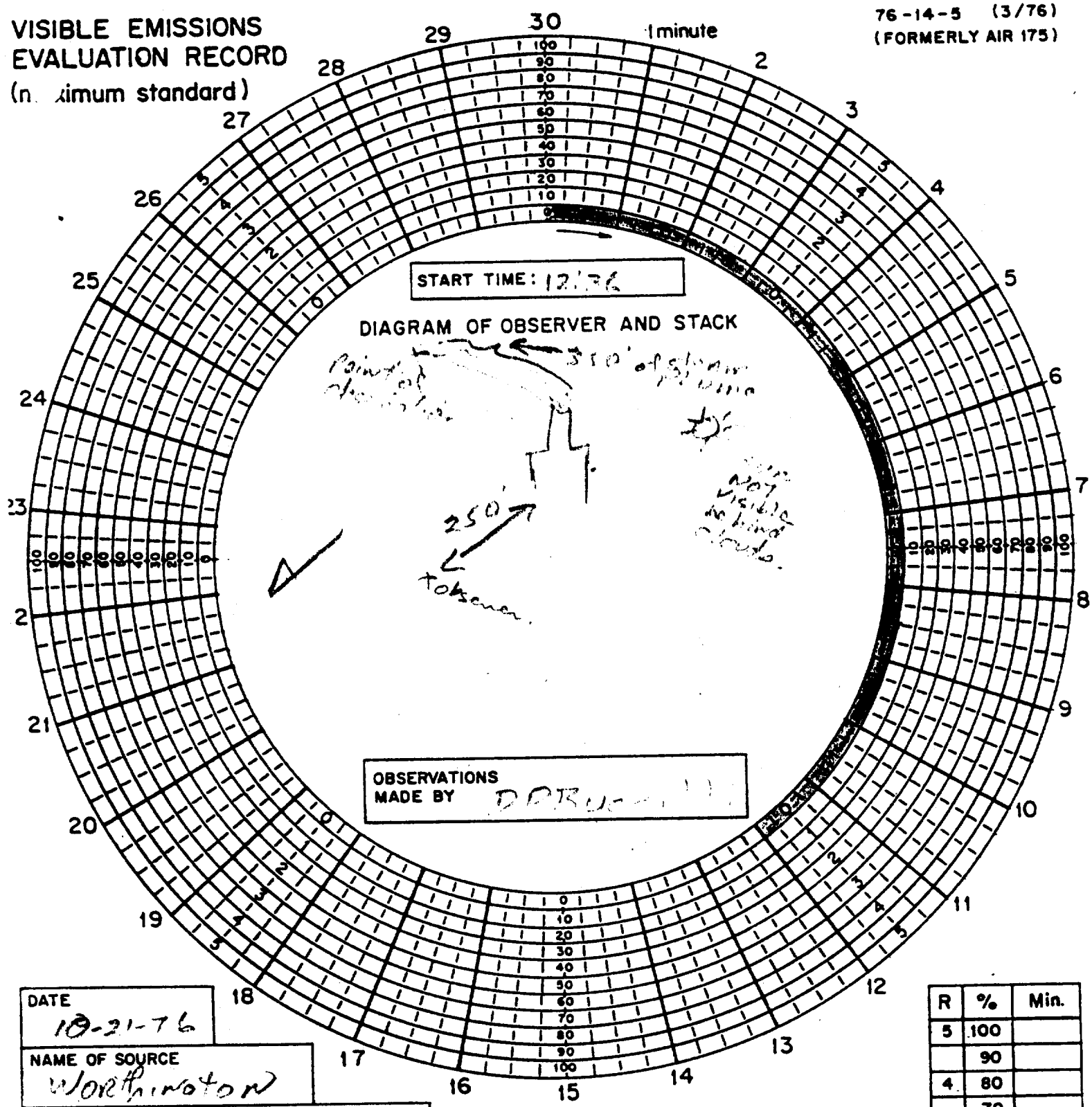
(Use other side for additional data & diagrams)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

76-14-5 (3/76)
(FORMERLY AIR 175)

VISIBLE EMISSIONS EVALUATION RECORD
(n. ximum standard)



DATE	10-21-76
NAME OF SOURCE	Worthington
ADDRESS	Cohoes
STACK DESCRIPTION	Stainless steel
WEATHER CONDITIONS	Sun-cloudy
WIND SPEED	30 mph
PLUME COLOR, MOVEMENT	white yellowish
BACKGROUND COLOR	Sky-blue white

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	12
X	Total	12

(Use other side for additional data & diagrams)

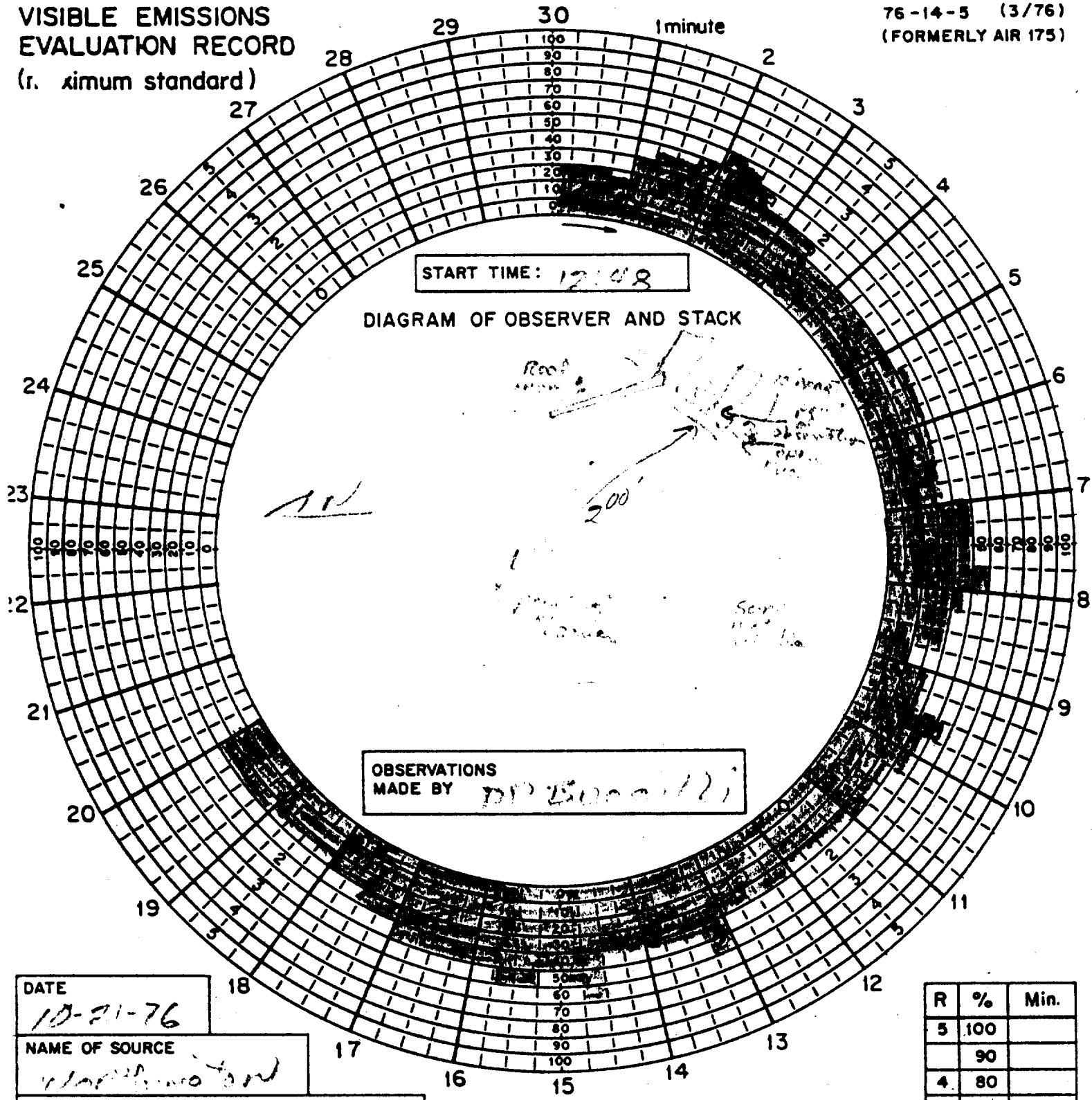
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(r. ximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	10-21-76
NAME OF SOURCE	[illegible]
ADDRESS	[illegible]
STACK DESCRIPTION	[illegible]
WEATHER CONDITIONS	[illegible]
WIND SPEED	[illegible]
PLUME COLOR, MOVEMENT	[illegible]
BACKGROUND COLOR	[illegible]

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	.25
	50	1.50
2	40	3.25
	30	5.75
1	20	7.75
	10	1.50
0	0	
X	Total	20.00

(Use other side for additional data & diagrams)

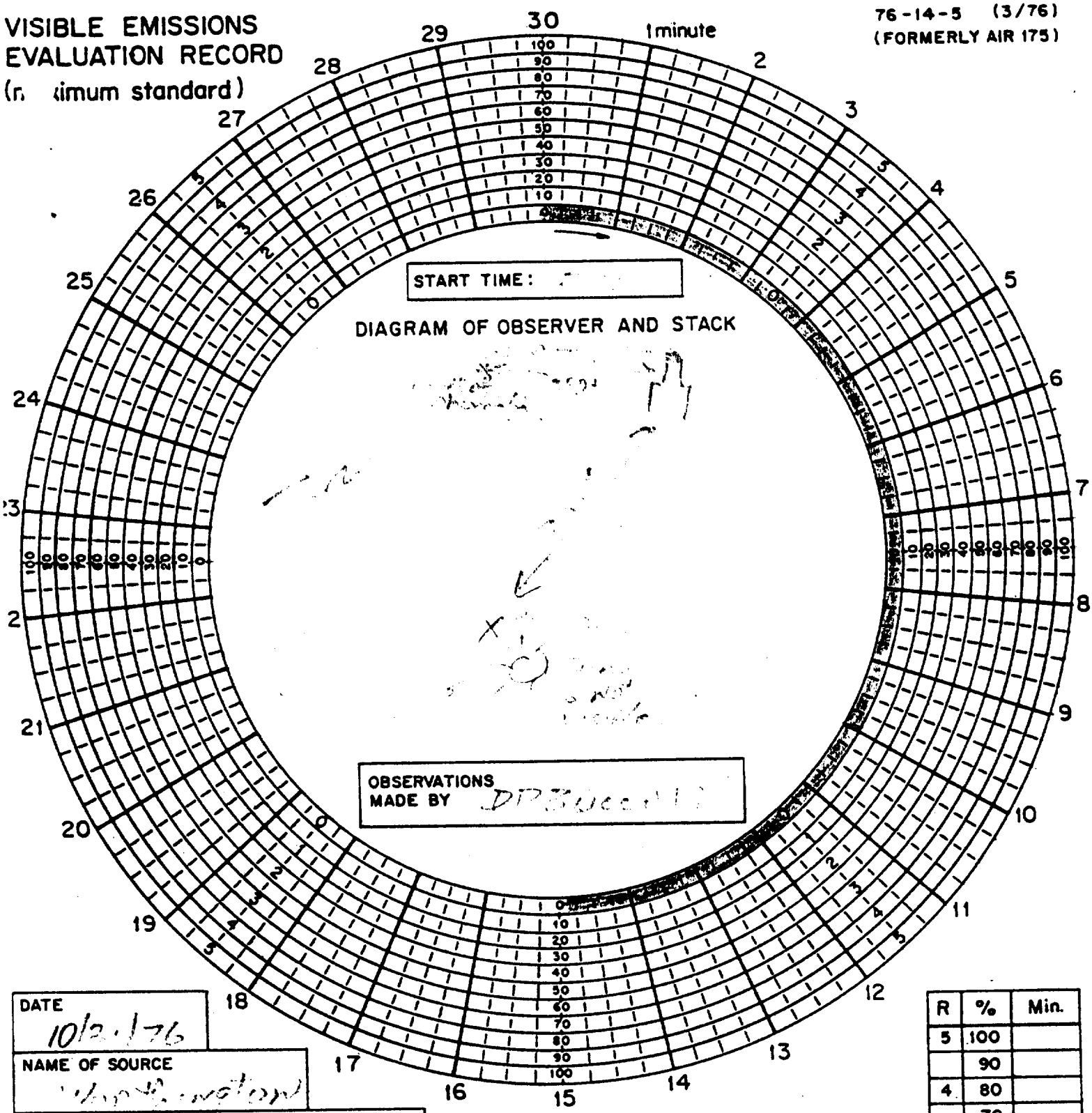
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(maximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	10/2/76
NAME OF SOURCE	Worthington
ADDRESS	Roberts
STACK DESCRIPTION	Spillway [illegible]
WEATHER CONDITIONS	[illegible]
WIND SPEED	35 mph
PLUME COLOR, MOVEMENT	[illegible]
BACKGROUND COLOR	[illegible]

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	15
X	Total	15

(Use other side for additional data & diagrams)

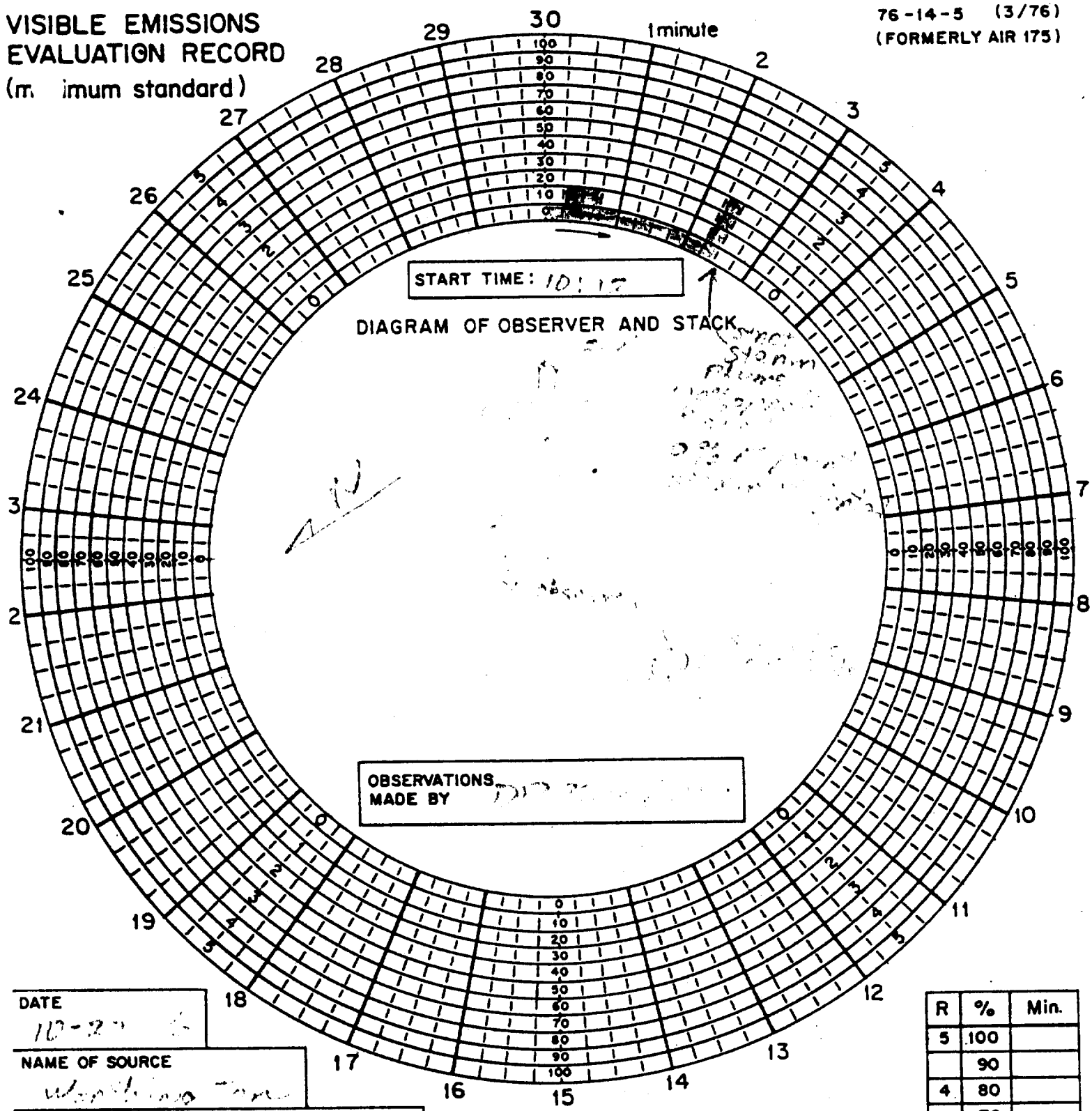
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(m imum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	10-2[illegible]
NAME OF SOURCE	[illegible]
ADDRESS	[illegible]
STACK DESCRIPTION	Stainless Steel
WEATHER CONDITIONS	Cloudy [illegible]
WIND SPEED	[illegible]
PLUME COLOR, MOVEMENT	Grey
BACKGROUND COLOR	[illegible]

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	.25
1	20	
	10	.50
0	0	1.75
X	Total	2.50

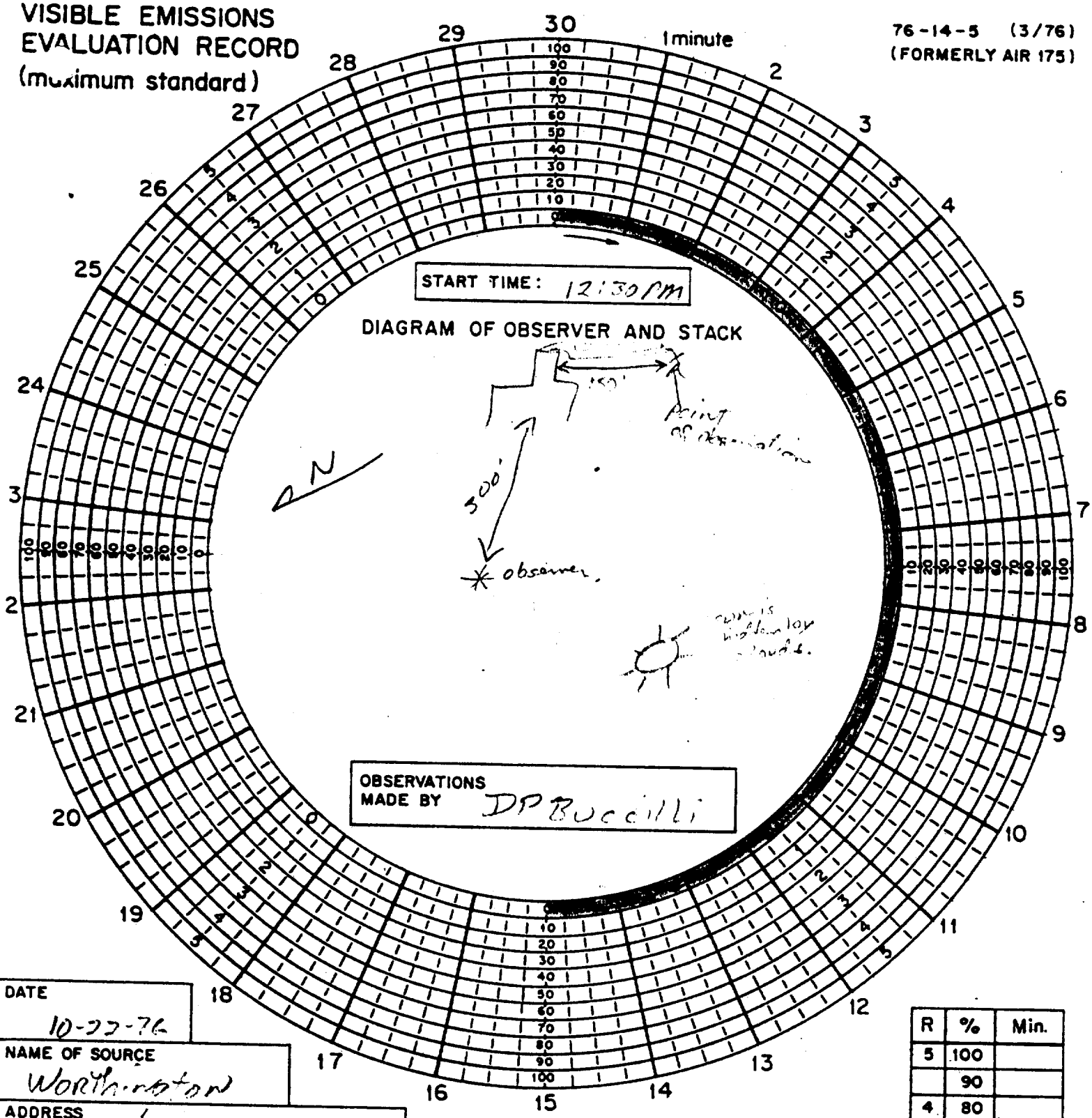
(Use other side for additional data & diagrams)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD
(maximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	15
X	Total	15

DATE: 10-22-76

NAME OF SOURCE: Worthington

ADDRESS: Robert Ave

STACK DESCRIPTION: Stainless Steel

WEATHER CONDITIONS: Cold Cloudy

WIND SPEED: [illegible] mph

PLUME COLOR, MOVEMENT: Grey white

BACKGROUND COLOR: Grey Bluish white sky

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

(Use other side for additional data & diagrams)

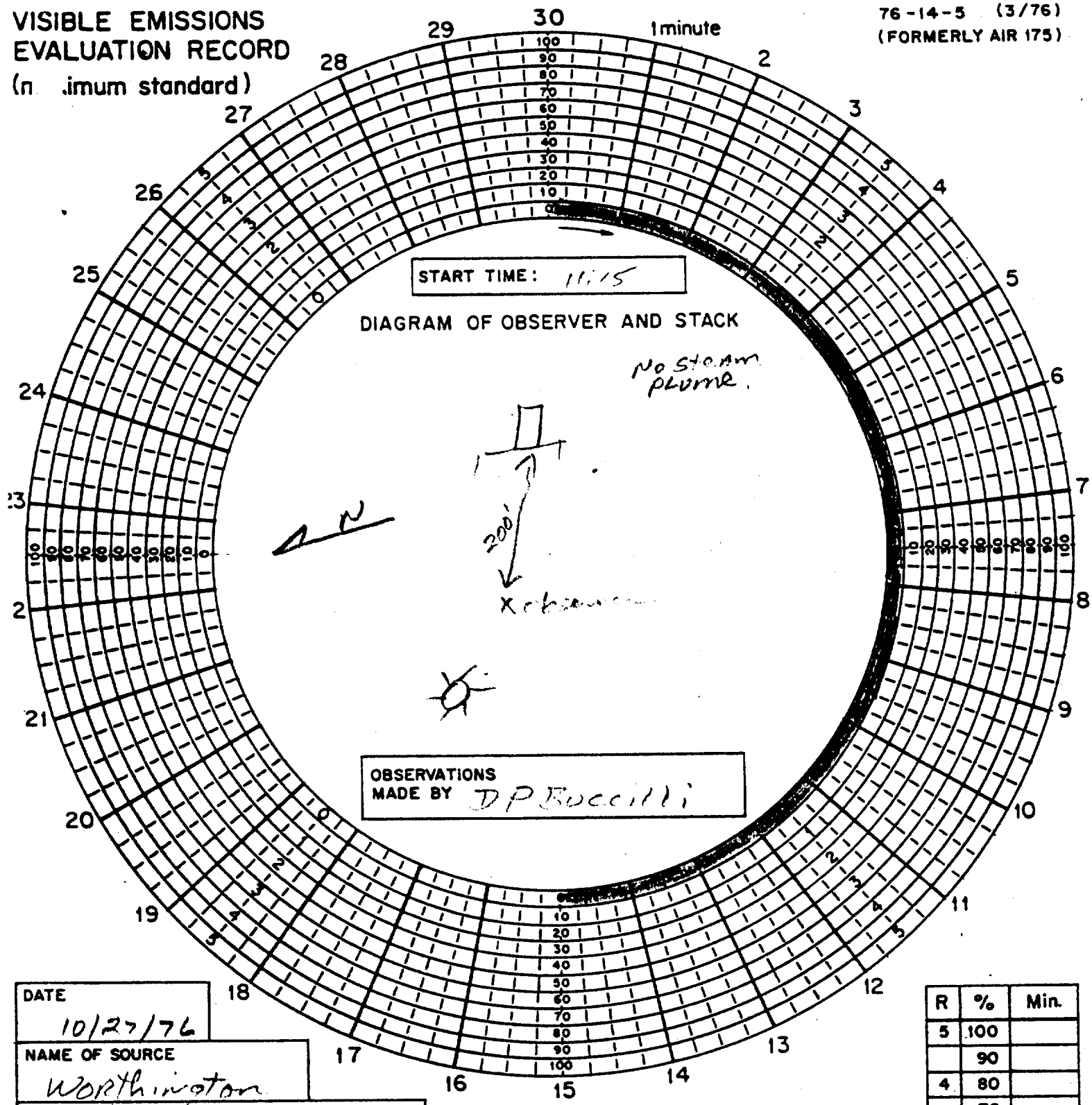
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(n .imum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	10/27/76
NAME OF SOURCE	Worthington
ADDRESS	Robert Ave.
STACK DESCRIPTION	stainless steel
WEATHER CONDITIONS	Cold & Cloudy
WIND SPEED	35 mph
PLUME COLOR, MOVEMENT	
BACKGROUND COLOR	Cloudy Sky

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	15
X	Total	15

(Use other side for additional data & diagrams)

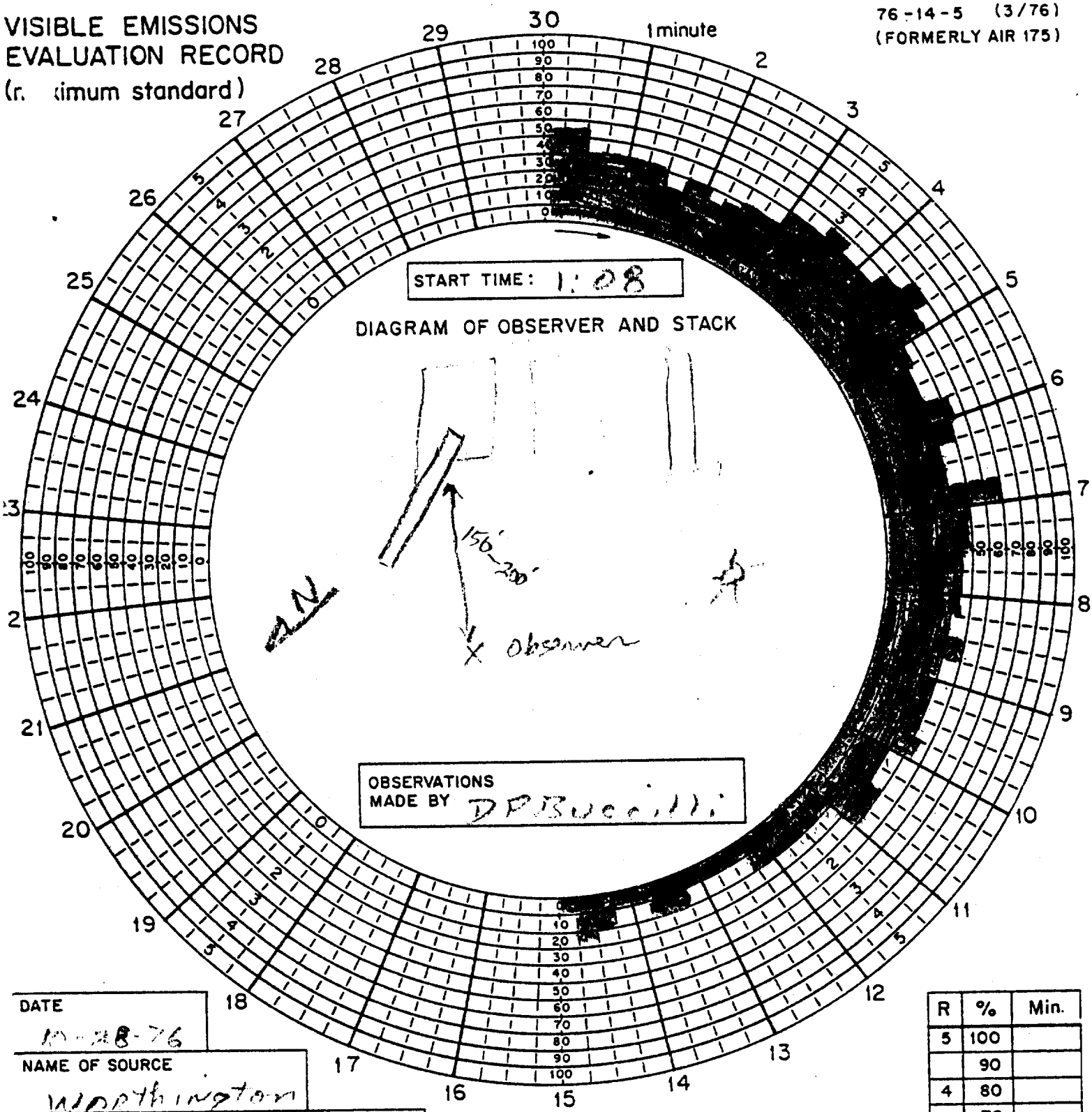
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(r. ximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	10-28-76
NAME OF SOURCE	Worthington
ADDRESS	Roberts Ave
STACK DESCRIPTION	Roof monitor
WEATHER CONDITIONS	Cold-cloudy
WIND SPEED	25 mph
PLUME COLOR, MOVEMENT	Bluish
BACKGROUND COLOR	Rust Brown (paint weather wall)

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	.50
	50	.50
2	40	2.75
	30	6.00
1	20	1.25
	10	2.25
0	0	1.75
X	Total	15.0

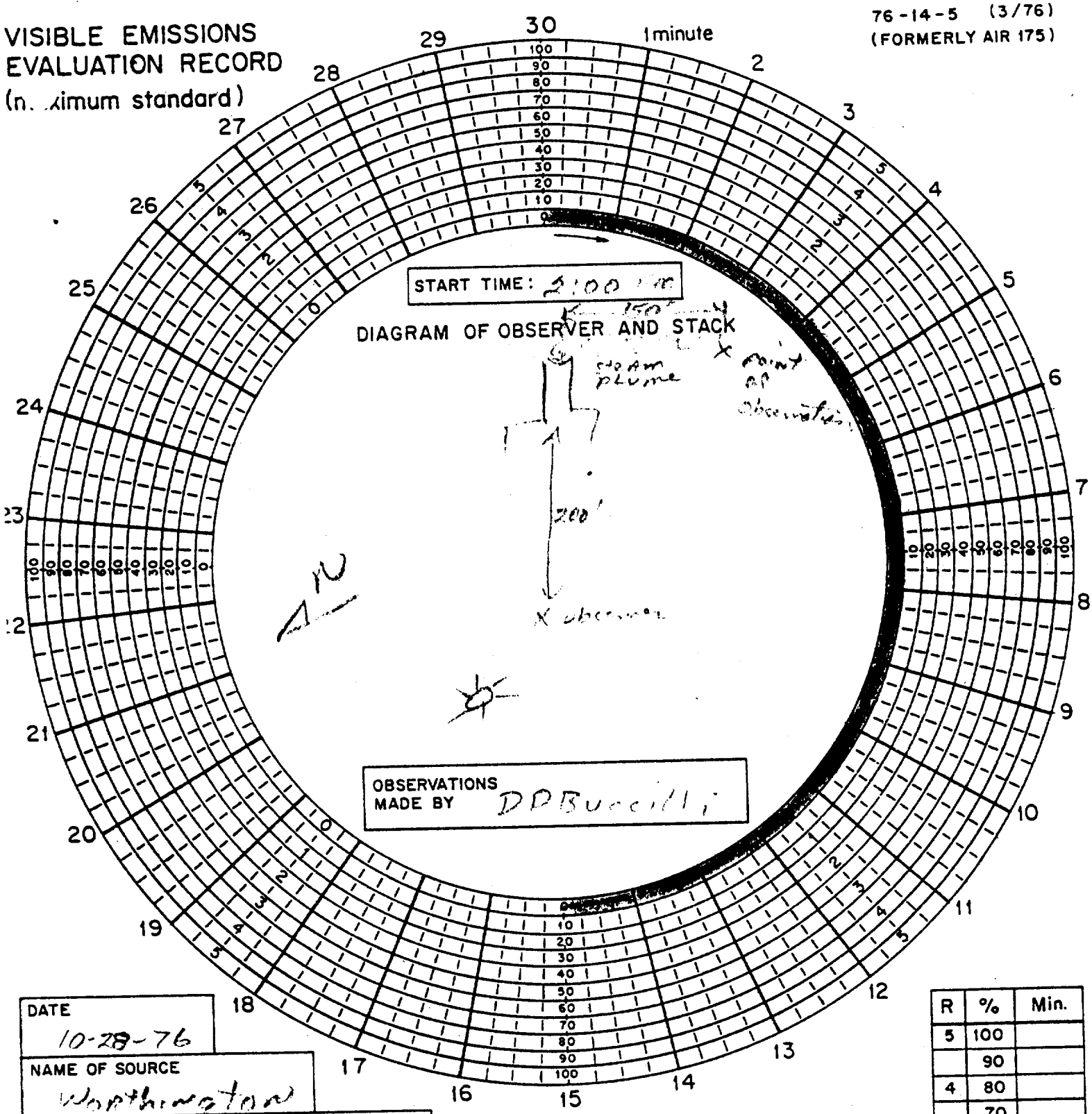
(Use other side for additional data & diagrams)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

76-14-5 (3/76)
(FORMERLY AIR 175)

VISIBLE EMISSIONS EVALUATION RECORD
(maximum standard)



DATE	10-28-76
NAME OF SOURCE	Worthington
ADDRESS	Roland
STACK DESCRIPTION	painted steel stack
WEATHER CONDITIONS	cold partly cloudy
WIND SPEED	35 mph
PLUME COLOR, MOVEMENT	white steam plume
BACKGROUND COLOR	cloudy sky

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	15
X	Total	15

(Use other side for additional data & diagrams)

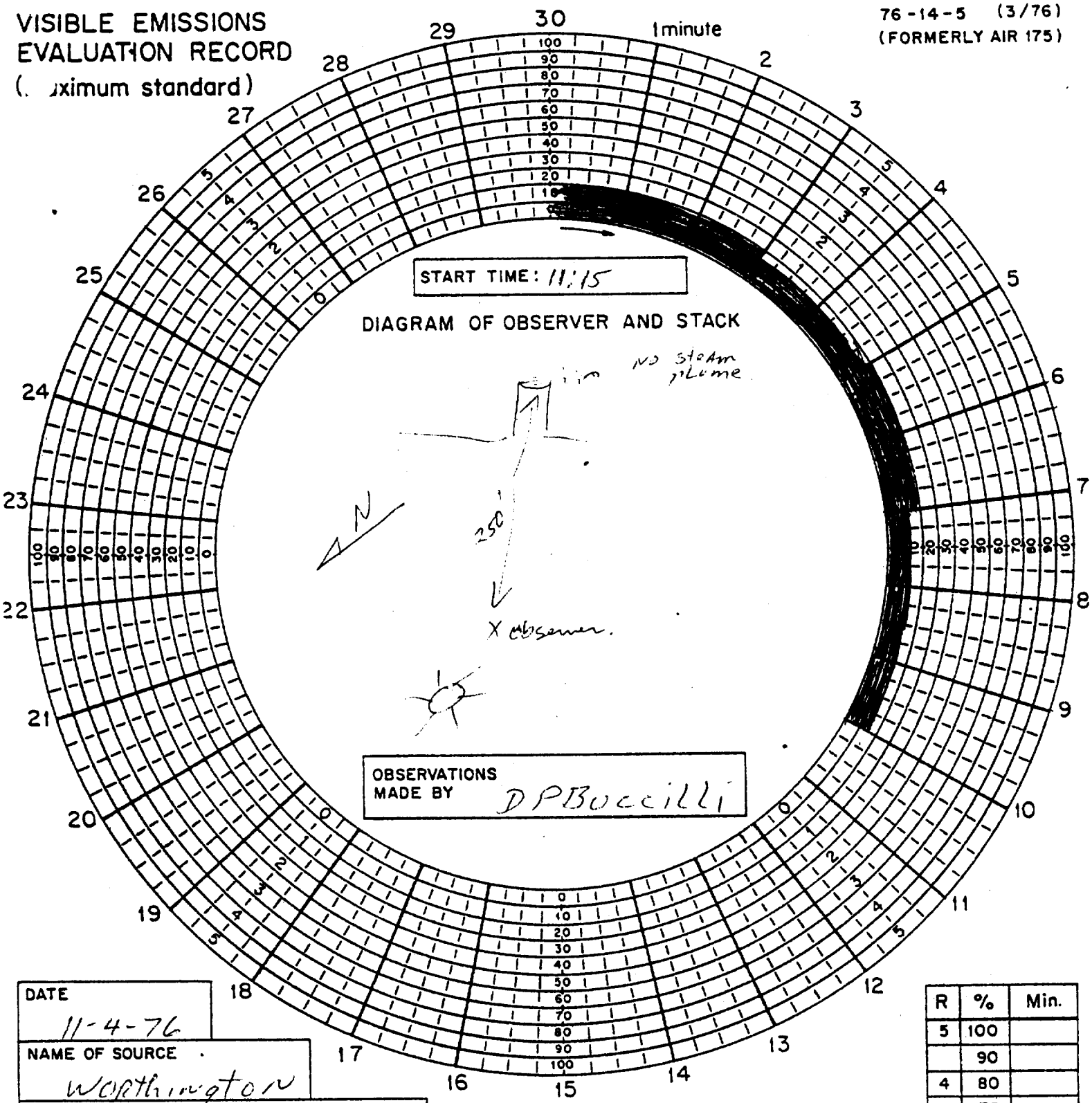
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(. ɹximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)



DATE	11-4-76
NAME OF SOURCE	Worthington
ADDRESS	Robert Rd.
STACK DESCRIPTION	Stainless Steel Stack
WEATHER CONDITIONS	Clear Skys.
WIND SPEED	10 mph.
PLUME COLOR, MOVEMENT	Grey.
BACKGROUND COLOR	Sky. Blue & clear

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	5.0
0	0	5.0
X	Total	10.0

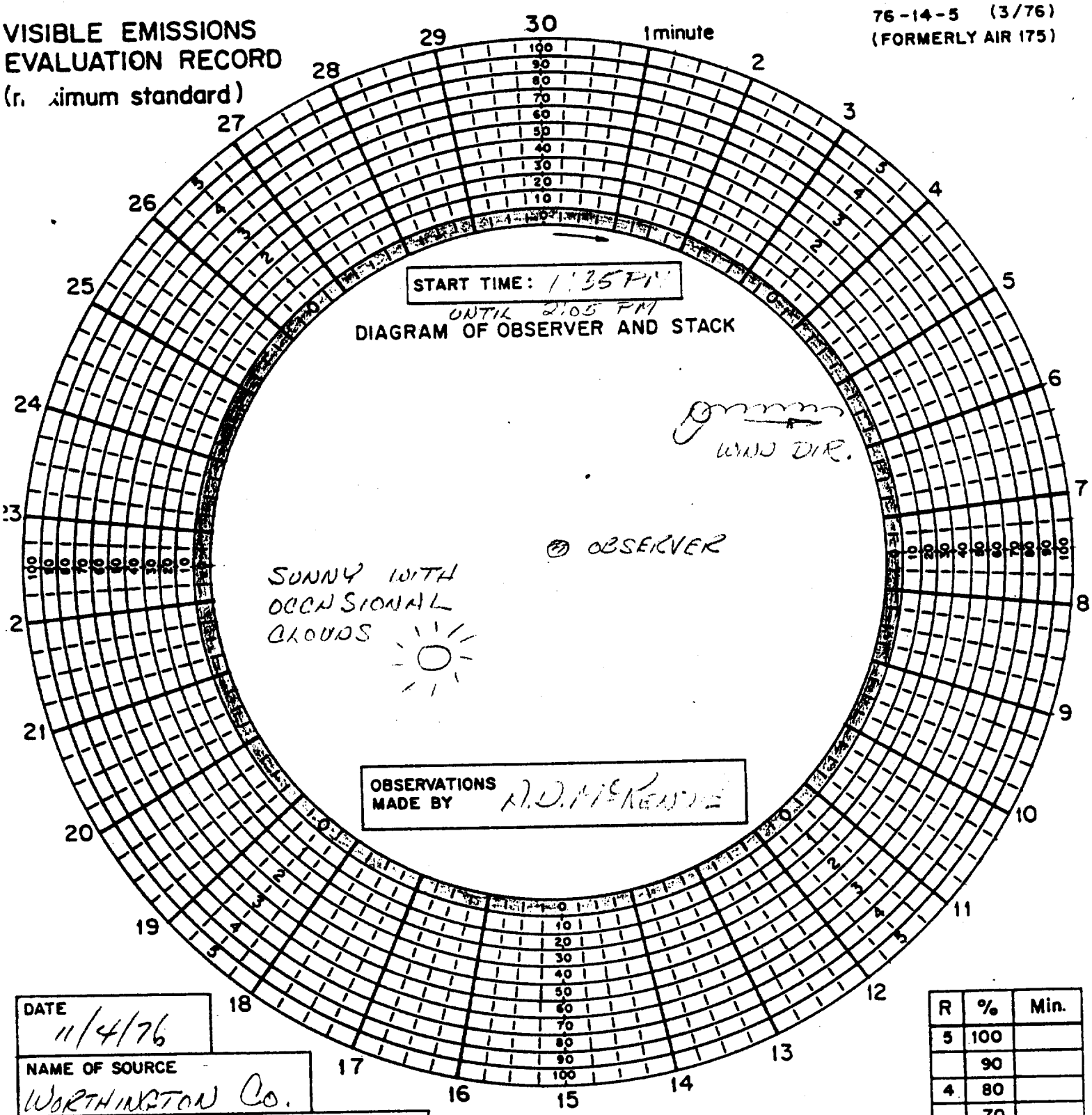
(Use other side for additional data & diagrams)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR POLLUTION CONTROL PROGRAM

76-14-5 (3/76)
(FORMERLY AIR 175)

VISIBLE EMISSIONS EVALUATION RECORD
(r. ximum standard)



DATE	11/4/76
NAME OF SOURCE	WORTHINGTON Co.
ADDRESS	ROBERTS ST., BUFFALO
STACK DESCRIPTION	
WEATHER CONDITIONS	SUNNY
WIND SPEED	10 MPH
PLUME COLOR, MOVEMENT	HEAVY STEAM PLUME WITH SLIGHT TAN COLOR IN CENTER
BACKGROUND COLOR	BLUE SKY

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	30
0	0	
X	Total	30

(Use other side for additional data & diagrams)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

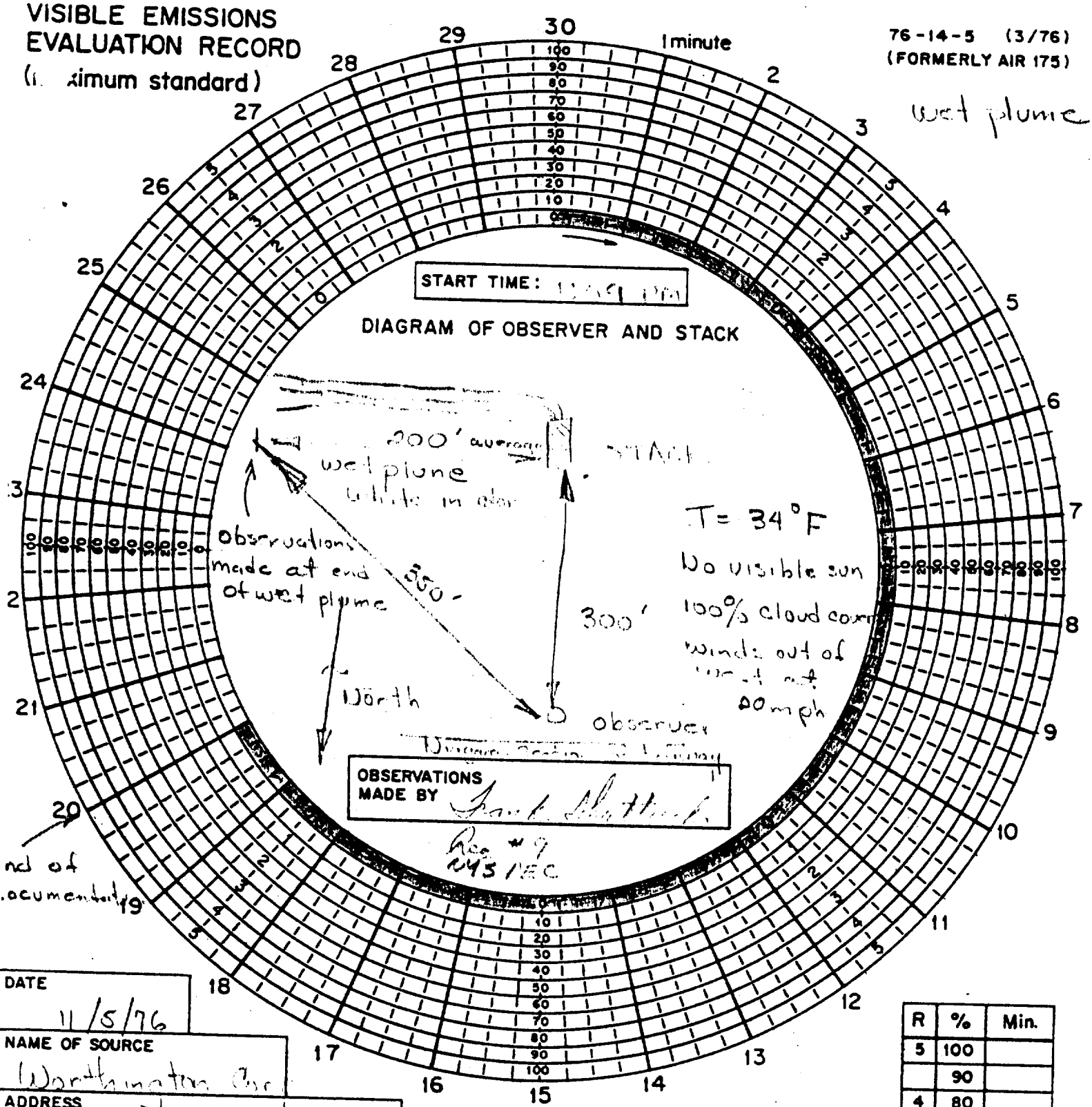
AIR POLLUTION CONTROL PROGRAM

VISIBLE EMISSIONS EVALUATION RECORD

(maximum standard)

76-14-5 (3/76)
(FORMERLY AIR 175)

wet plume



DATE: 11/5/76

NAME OF SOURCE: Worthington Corp

ADDRESS: Roberts Ave Buffalo

STACK DESCRIPTION: [illegible] metal stack [illegible]

WEATHER CONDITIONS: light rain [illegible]

WIND SPEED: 20 mph

PLUME COLOR, MOVEMENT: no visible plume after [illegible]

BACKGROUND COLOR: [illegible]

[illegible] steam dissipates, [illegible] (Use other side for additional data & diagrams)

INSTRUCTIONS

IN ABOVE DIAGRAM INDICATE LOCATION OF OBSERVER, STACK AND SUN. SHOW DISTANCE FROM OBSERVER TO STACK AND DIRECTION OF PLUME. INCLUDE ELEVATION SKETCH AND IDENTIFY ALL STACKS (BY EMISSION POINT NUMBER, WHERE POSSIBLE) INDICATE NORTH BY ARROW.

R	%	Min.
5	100	
	90	
4	80	
	70	
3	60	
	50	
2	40	
	30	
1	20	
	10	
0	0	20
	Total	20