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MOLECULAR SIEVE TESTS FOR CONTROL OF SULFURIC ACID PLANT EMISSIONS

Industrial Environmental Research Laboratory
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Research Triangle Park, North Carolina 27711

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MOLECULAR SIEVE TESTS FOR CONTROL OF SULFURIC ACID PLANT EMISSIONS

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ABSTRACT

A molecular sieve control system for sulfur dioxide from sulfuric acid plant tail gas was tested by York Research Corporation. The system, the PuraSiv S, was developed by Union Carbide Corporation, Linde Division, and is currently operating at the Coulton Chemical Corporation in Oregon, Ohio. The PuraSiv S utilizes a molecular sieve adsorbent material which releases SO_2 upon the application of heat. The SO_2 is then recycled for an additional 2 to 3 percent production of acid.

This report is an evaluation of the PuraSiv S based upon data gathered during a 4-week test program. Sulfur dioxide concentrations were continuously measured and recorded by a DuPont 460/1 photometric gas analyzer at both the inlet and outlet gas streams. Average removal efficiency was 98.0 percent. Average SO_2 emissions from adsorbers during testing was less than 100 ppm.

This report was submitted in fulfillment of contract number 68-02-1401, Task Number 2 by York Research Corporation under the sponsorship of the Environmental Protection Agency. Work was completed as of March 4, 1975.

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ACKNOWLEDGMENT

York Research would like to express its appreciation to the staff of Coulton Chemical Corporation for the courtesy extended during the performance of this test series. Particular thanks are extended to Messrs. Dave Lovell, Leonard Stonestreet and Connelly Neal for the technical knowledge and assistance both in the preparation of test sites and during the actual testing.

We would also like to thank Messrs. Lou Fornoff of Union Carbide and Ed Wooldridge of the Environmental Protection Agency for their invaluable assistance throughout the project.

I. INTRODUCTION

York Research Corporation, under contract to the Environmental Protection Agency, Office of Research and Development, Industrial Environmental Research Laboratory, tested a sulfur dioxide control system designed and manufactured by the Union Carbide Corporation, Linde Division, and installed at the Coulton Chemical Corporation in Oregon, Ohio. Designated the PuraSiv S* process, the unit utilizes a molecular sieve adsorbent material which has an affinity for polar compounds. It is being used to remove sulfur dioxide from the tail gas stream of a contact sulfuric acid plant.

The PursaSiv S utilizes two adsorbing beds, one of which is "on-line" and one of which is being "regenerated" at any particular time. Normal cycle time is 4 hours; however, the cycle time can be increased or decreased from the norm as conditions dictate. The system has been operating at Coulton Chemical Corporation's B-Plant since February 4, 1973, although the adsorbing beds were replaced in November of that year. A second-generation, more durable sieve material was installed at that time. Actual usage of the new beds was about 11 months, since the plant experienced several shutdowns.

The B-Plant was rated at 200 tons of sulfuric acid per day; however, operational problems had reduced the production rate to 160 tons per day. The plant operators successfully increased the SO_2 loading to the PuraSiv S in excess of maximum design loading for the test.

The specific task assignment entailed the continuous measurement of sulfur dioxide in order to perform a technical evaluation of the tail gas control system. Sampling sites were at the outlet of the adsorption bed prior to the inlet to the stack and at the inlet of the adsorbers following the Brink demister. A total of 118 cycles, 59 for each adsorber, were monitored between February 4, 1975 and March 4, 1975. Instrumentation used was a DuPont 460/1 photometric gas analyzer with a two-point sampling system and dual range capability. In order to determine baseline tail gas component concentrations, wet tests were performed for the following: sulfuric acid mist, total acid, nitrogen oxides, hydrocarbons, chloride, sulfides, carbon dioxide, oxygen, and moisture.

*Union Carbide trade name.

II. SUMMARY

Sulfur dioxide concentrations were measured at the outlet and inlet of the PuraSiv S unit at the Coulton Chemical Corporation in Oregon, Ohio. The plant is a typical contact sulfuric acid plant with a rated capacity of 200 tons per day. The PuraSiv S has a maximum design loading of 2800 ppm SO_2 at 10,500 SCFM.

The objectives of the test program were (a) to establish SO_2 emission levels at maximum design loadings, (b) to document SO_2 emission levels when a process upset caused inlet concentrations to go out of control, and (c) to determine the effect of tail gas impurities on the performance of the sieve. Objectives (a) and (b) were successfully obtained and can be found in detail in Section V of this report. Objective (c) was not obtained since the test program was far too short to complete a definitive study on tail gas impurities. However, baseline determinations of the following tail gas components were obtained and can be found in Section V: sulfuric acid mist, total acid, nitrogen oxides, hydrocarbons, chloride, sulfides, carbon dioxide, oxygen, and moisture.

Due to an operational difficulty with the plant during the test period, production rate was down to 160 tons per day with an accompanying drop in tail gas flow rate to 7500 SCFM. The plant operators, however, were able to increase the SO_2 loading to the PuraSiv S without endangering the equilibrium balance of the plant. This was accomplished by routing the recycled SO_2 directly to the combustion air inlet from the regenerating adsorber and bypassing the primary stripper.

The PuraSiv S unit is comprised of two adsorbing vessels which alternate functions at 4- or 5-hour intervals - i.e., at any particular time one vessel is adsorbing and the other is regenerating. During regeneration the desorbed SO_2 is piped to the combustion air inlet and recycled through the plant for an additional 2 to 3 percent production of sulfuric acid. The major portion (75 percent) of the stream leaving the adsorber is exhausted through the main tail gas stack, while a slipstream is taken from the outlet duct and used to regenerate the air dryer beds.

The SO_2 concentrations were measured at the adsorber inlet and in the outlet duct just prior to entering the main stack. Sulfur dioxide concentrations were printed on a strip chart, permitting instantaneous results and documentation of trends and patterns. Inlet values averaged from 2335 to 4800 ppm over individual cycles of operation. When inlet concentration is plotted versus time for a single cycle, the curve is characterized by a constant value during the first hour. The next 1½ hours give a rise of 500 ppm above the concentration seen during the first hour, followed by a drop to 100 ppm below the concentration seen the

first hour. The last hour is characterized by a return to the same value experienced during the first hour. The rise is caused by a "slug" of desorbed SO_2 from the regenerating adsorber which has been recycled through the plant. Since the desorption is followed by a flush of clean air through the bed, the slug of SO_2 is followed by a slug of clean air, accounting for a dilution of tail gas that shows up as a drop in inlet SO_2 concentration.

The pattern of outlet concentrations over a single cycle typically started at 15 to 50 ppm during the first hour, rising to 80 to 100 ppm during the second hour and continuing to a maximum of 120 to 180 ppm at the end of the cycle. Several process upsets were documented and two shutdowns were experienced; however, at no time was "breakthrough" noted. (Breakthrough is the point at which emissions increase sharply due to bed saturation.) The emissions exceeded the EPA limit of 4 pounds SO_2 per ton of acid (300 ppm) only during startup. The average emissions from A2 were 0.804 pounds SO_2 per ton of acid as measured over the entire range of test conditions.

Sixty percent of the test period saw loadings to the PuraSiv S in the range of 75 percent of maximum. Emissions, when averaged over separate cycles, were 62 ppm for adsorber A2 and 73 ppm for adsorber A1. At 100 percent of maximum design loading, which was experienced over 35 percent of the test period, emissions averaged 82 ppm for adsorber A2 and 111 ppm for adsorber A1. Five percent of the test period saw loadings of 100 percent of maximum design. Emissions during these cycles averaged 99 ppm for adsorber A2 and 107 ppm for adsorber A1. A short time before the test program, a problem with adsorber A1 was discovered. The bed support had broken and an unknown quantity of molecular sieve had been lost. The problem had not yet been corrected at the time of testing and, therefore, slightly lower efficiency was experienced from that unit.

The emissions from adsorber A2 were below 100 ppm, as emissions were averaged over several cycles. When averaged over individual cycles, however, emissions were as high as 118 ppm. Union Carbide has claimed that the emissions from the PuraSiv S average less than 100 ppm* per cycle, and this level was exceeded in 13 percent of the total number of cycles measured.

Average efficiency of SO_2 removal by adsorber A2 was 98.05 percent for SO_2 loadings up to 100 percent of design, while efficiency was 97.9 percent for loadings up to 110 percent of design.

*Union Carbide Corporation, "PuraSiv S Systems for Sulfuric Acid Plants - Technical Fact Sheet."

III. PROCESS DESCRIPTION AND OPERATION

The PuraSiv S system has been in operation at the B-Plant of Coulton Chemical Corporation since February 4, 1973. In November of that year the molecular sieve adsorbent material in the beds was replaced with a more durable second-generation sieve packing. The new adsorbent was claimed to have a useful life in excess of 3 years. At the onset of testing, the age of the new sieve was 15 months, although the actual usage had been approximately 11 months.

The B-Plant was designed to produce 200 tons per day of concentrated sulfuric acid. However, problems had been experienced with an electrical transformer on the electrostatic precipitator. This problem forced the use of a smaller standby transformer, which restricted the daily production to 160 tons.

The plant is a single adsorption contact plant, where combustion of sulfur-bearing feed produces a gas stream high in SO_2, which is then exposed to several sequential processes before the final product of sulfuric acid is realized. The feed is composed of molten sulfur, H_2S off-gas, and spent sulfuric acid waste from a nearby petroleum refinery. The tail gas from the adsorption process is the major source of emissions at the plant. Other emission sources include fuel combustion units for air heating. The tail gas flow rate fluctuates with production rate and ranges up to 10,500 SCFM, with an average SO_2 concentration ranging between 2500 and 5000 ppm. At design loading to the PuraSiv S, 1300 $\pm$ 100 pounds of SO_2 are adsorbed over a 4-hour period.

Although the plant was operating at reduced capacity, a condition was induced during the test period whereby the weight of SO_2 adsorbed on the PuraSiv S beds equalled or exceeded the design loading. The regeneration gas returning to the plant was piped directly to the combustion air inlet, bypassing the SO_2 stripper, and increasing the SO_2 concentration in the gas stream through the plant. Combined with the lengthening of the adsorption cycle beyond 4 hours, the resulting effect was to increase the loading to as much as 1560 pounds of SO_2 absorbed per cycle.

Figure 1 is a schematic diagram which shows the basic flow pattern of the B-Plant. Two combustion chambers are utilized for the production of SO_2; one of which is fed molten sulfur, and the other hydrogen sulfide and alkylation spent acid supplied by the petroleum refinery. The combustion takes place at a high enough temperature to dissociate the spent acid and hydrogen sulfide into SO_2 and water vapor. The gas stream is humidified prior to the removal of dust and SO_3/acid mist in a lead-lined electrostatic precipitator. During normal equilibrium conditions virtually no SO_3/acid mist is formed at this stage of the process. However, during startup and shutdown procedures, and any other process imbalance which results in temperature fluctuations,

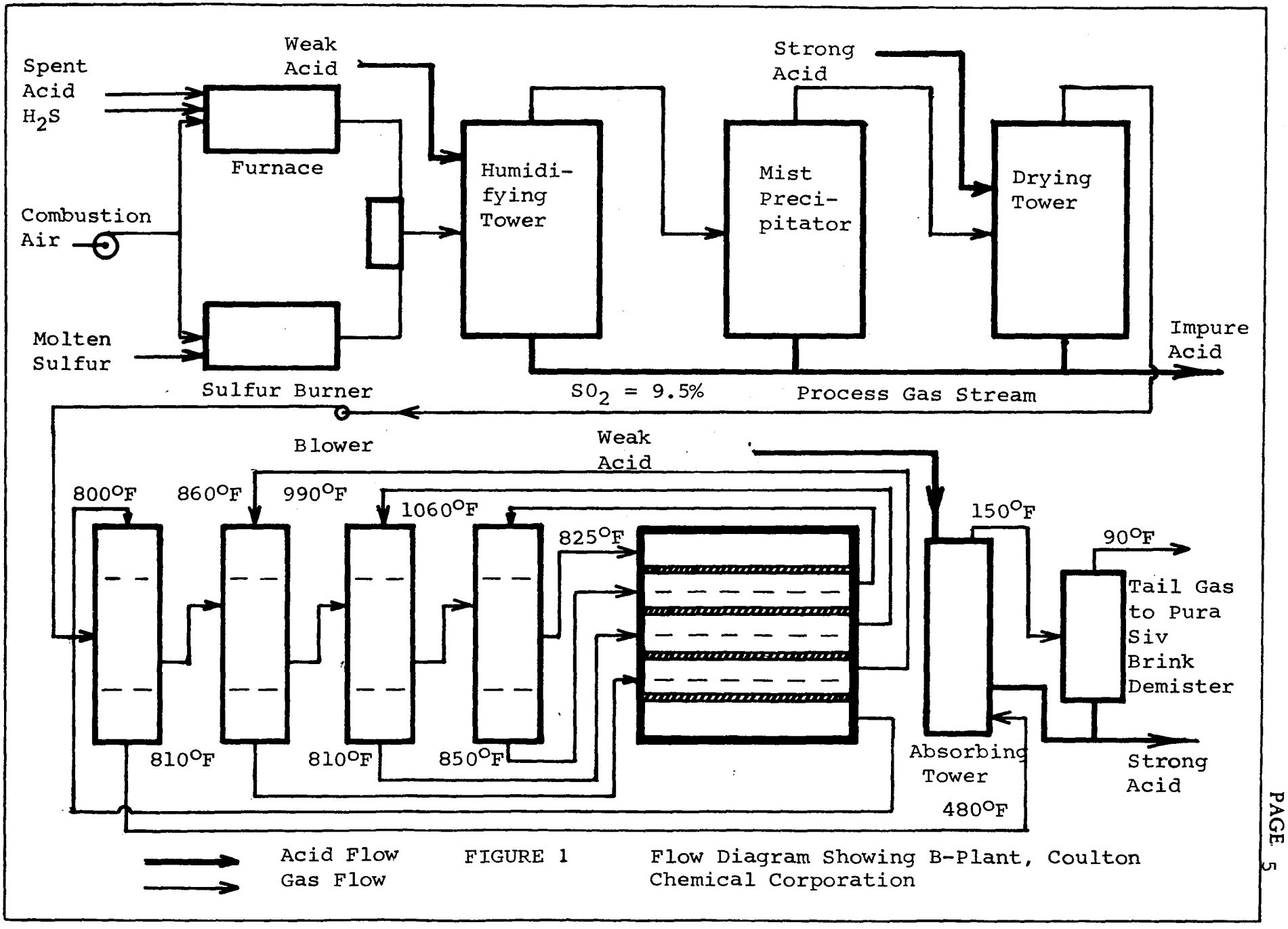


FIGURE 1 Flow Diagram Showing B-Plant, Coulton Chemical Corporation

SO_3 and acid mist may form in considerable quantities.

The next stage of the process involves the removal of water vapor from the stream in order to prevent acid formation in the piping. This is accomplished by exposing the stream to circulating concentrated sulfuric acid in a drying tower. The temperature of the stream is then reduced to approximately 825° F in a heat-exchange system prior to entering the first stage of the four-stage converter. At this point in the system the gas stream contains 9 to 10 percent SO_2 with smaller amounts of CO_2 and O_2; the balance being nitrogen. The SO_2 oxidation reaction is exothermic; thus, the temperature of the gas stream rises appreciably when passing through the converter. Heat exchangers are utilized between stages to cool the gas stream back to approximately 825°F before it enters the next stage of the converter. The practical upper limit of conversion for single absorption plants is about 98 percent. This appears to be the level at which the SO_2 is in an equilibrium state with SO_3 and although oxygen is available for the reaction, further oxidation will not take place unless partial removal of SO_3 takes place. The remaining SO_3 passes through the system unchanged.

The process stream leaves the conversion area at about 800°F but is cooled to 480°F prior to absorption. The absorption tower is similar in construction and operation to the drying tower. The gas is exposed to a circulating stream of 98 to 99 percent sulfuric acid, where the sulfur trioxide combines with the water in the acid and increases the strength to between 99.1 and 99.3 percent. Virtually 100 percent of the SO_2 is absorbed while the unconverted SO_3 (0.2 to 0.5 percent) passes through unabsorbed. A Brink demister is utilized at the tail end of the base plant to remove any acid mist carry-over from the absorber. Temperature at this point is about 90°F.

The tail gas stream is piped via a 24-inch diameter steel duct to the PuraSiv S unit where it is routed to one of two adsorbing vessels. The system is flexible in that cycle time can be increased or decreased from the 4-hour standard, depending on the SO_2 load from the plant. During any particular cycle, one vessel is adsorbing and one vessel is being regenerated, thus returning the desorbed SO_2 to the combustion air inlet.

The first hour of regeneration is spent flushing the bed with hot, dry air in order to bring the bed up to an optimum temperature. The bulk of SO_2 desorption takes place during the second hour after the bed has reached the desired temperature. The increase of SO_2 in the process gas stream during the second hour of regeneration is demonstrated by a 500 ppm increase in the SO_2 concentration in the tail gas and by a boost of acid strength in the absorber amounting to 0.002 percent. The last 2 hours of the regeneration cycle consist of bringing the bed

back to operating temperature by purging it with dry, ambient air.

The adsorbent in the PuraSiv S has a strong affinity for polar compounds, and since water is highly polar, water vapor will actually displace SO_2 from the bed. This causes no problem with plant tail gas as moisture is removed from the stream prior to conversion. The concentration of moisture in the PuraSiv S inlet stream was only 20 ppm.

Since ambient air is used for regeneration, it is imperative to remove moisture from the regeneration air, and this is accomplished with the use of two similar (although smaller) adsorption beds. These air dryers normally operate on 4-hour cycles. Adsorber regeneration air is drawn by fan F-1 through one air dryer at a constant 4625 SCFM and heated prior to introducing it into the regenerating adsorbers. The heater exhaust gases do not mix with the regeneration air. At the end of the initial 2 hours of the cycle, the heater cuts off and fan F-1 continues to flush the bed with dry air. Simultaneously, the alternate dryer is being regenerated with a slipstream of treated tail gas. Fan F-2 pulls this slipstream at a constant 2000 SCFM. Two hours of heating and 2 hours of cooling are required for regeneration of the air dryers. This process of adsorption/regeneration is illustrated schematically in Figure 2, which shows adsorber A1 adsorbing and adsorber A2 regenerating while air dryer A4 is drying and A3 is regenerating.

It is obvious from Figure 2 that there are two SO_2 emission points from the PuraSiv S: the main tail gas stack and the air dryer stack. The concentration of SO_2 in the main stack is equal to the SO_2 concentration of the gas entering the air dryer. Some SO_2 may adsorb on the air dryer bed during the last 2 hours of regeneration; however, this SO_2 will desorb upon the application of heat during the following regeneration cycle. Therefore, the weight rate of SO_2 leaving the adsorber will equal the weight rate of SO_2 emitted to the atmosphere from both stacks when averaged over an 8-hour period. For calculating the outlet SO_2 weight rate, the PuraSiv S was treated as a single emission source, using SO_2 concentration at the base of the stack and flow rate at the inlet to the adsorber.

An attempt was made to measure the inlet flow rate by traversing the duct with an S-type pitot tube, but the attempt had to be aborted before completion due to hazardous working conditions. The high SO_2 concentration and high internal duct pressure (2 inches of mercury) made it impossible to work without a sealed test port. A standard-type, fixed-point pitot tube had been installed at the inlet site for a previous test. Since the duct was sufficiently large in diameter for the unmeasured areas to have a significant effect upon the calculation of flow rate,

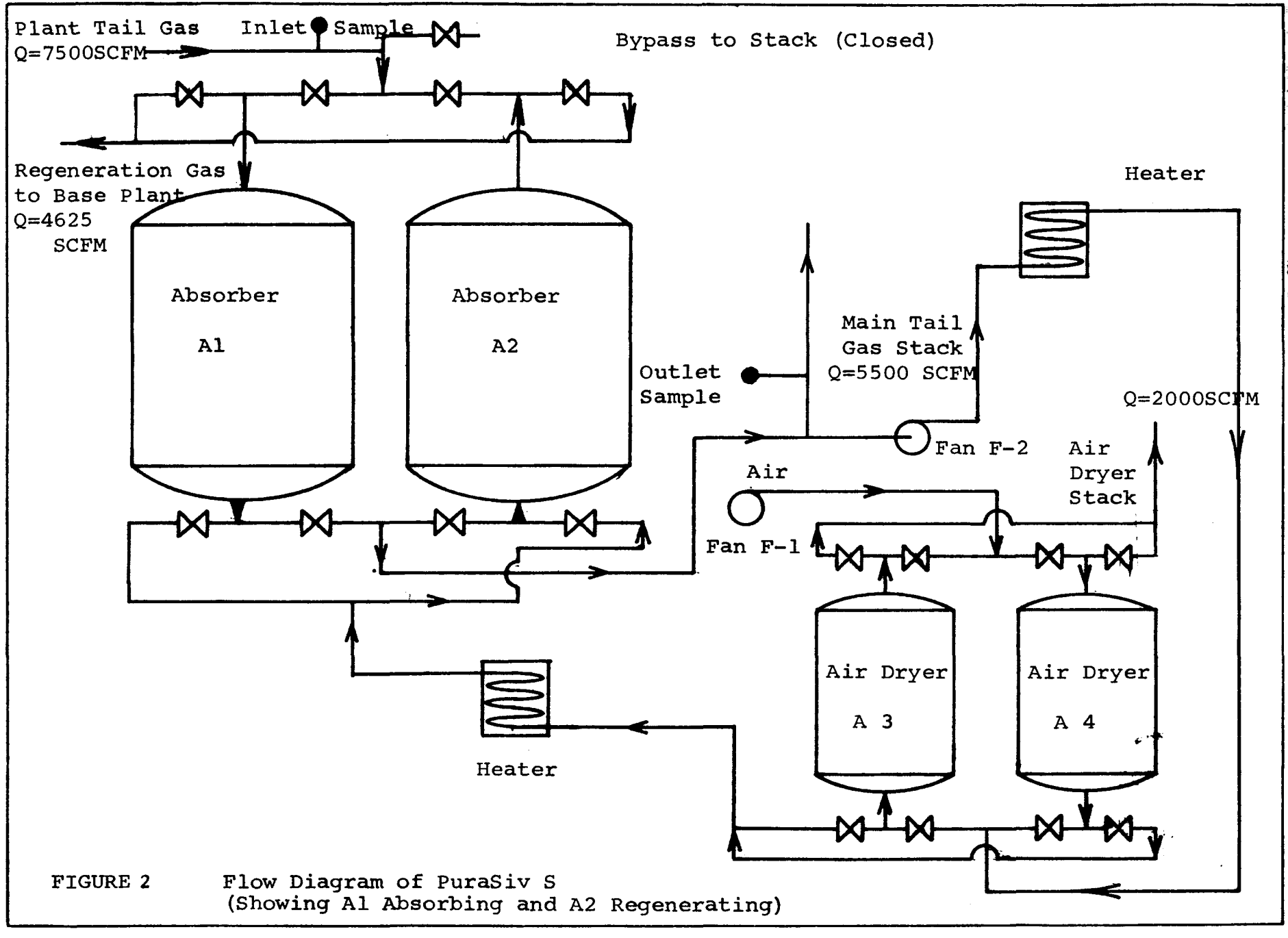


FIGURE 2 Flow Diagram of PuraSiv S
(Showing A1 Absorbing and A2 Regenerating)

the pitot reading was used only to monitor fluctuations. Flow rate was measured periodically by Coulton personnel. A determination was made by traversing the blower inlet and calculating a sulfur balance on the entire plant. During the test period, flow rate ranged from 7440 to 7670 SCFM, while the acid production rate, measured simultaneously with flow rate, remained constant at 160 tons per day.

IV. SAMPLING AND ANALYTICAL PROCEDURES

At the initial coordination meeting between the representatives of Coulton Chemical, Union Carbide, the Environmental Protection Agency, and York Research Corporation, York Research proposed to perform a continuous monitoring study of the PuraSiv S process. The Environmental Protection Agency agreed to sponsor the study, provided that wet tests were performed using an acceptable method to verify the results of the gas analyzer. Following a long preparation period, during which several types of analyzers were discussed, the decision was made to use a DuPont 460/1 photometric gas analyzer equipped with a two-point sampling system. This instrument has a precision of 2 percent.*

Teflon sample lines with a ¼-inch outside diameter were connected to the inlet and outlet of the absorber. A compressed air line was also connected to the instrument from the plant compressor station. The DuPont 460/1 utilizes a switching system powered by pneumatic valves and an air-powered arrangement is used to move the sample. The dual sample-point arrangement consists of twin aspirators and switching capability to operate the instrument in any one of four sampling modes. The first mode is a flush of instrument air through the sampling interface, through the sample handling system, and through one of the sample lines to the probe. During this flush of clean air, the instrument automatically sets the readout at zero. The second mode is a sample mode, during which some stack gas is extracted and concentration is measured at the sampling interface. The next step is a flush of clean air through the sampling system and back down the second sample line. Following this is a sample extraction and measurement from the second sampling location. Each step is automatically and sequentially controlled by a control station that can be programmed. In addition, a manual override is included so that any particular sample mode can be eliminated or held for an indefinite period of time. Normal cycle times are 30 seconds for each flush sequence and 90 seconds for each sample sequence.

Since the instrument had only one sampling interface, the calibration and range adjustment could not be made separately for each sample location. A high SO_2 removal efficiency characteristic of the PuraSiv S necessitated that a modification be made to the instrument that would permit an independent range and calibration adjustment for each sample location. This was accomplished by the inclusion of a separate 20 K potentiometer and solenoid switching arrangement that was actuated automatically whenever the sample position switched. The result was a separate calibration and range adjustment that showed no appreciable drift.

*As claimed by the manufacturer.

A. Location of Sampling Ports

The inlet sampling location was chosen by the existence of a maintenance platform and sample port utilized by plant personnel for taking their own samples. The inlet duct was approximately 25 feet above grade, circular (with a 24-inch diameter), and ran horizontally from the demister outlet to the PuraSiv S inlet. The sample port was located 30 feet downstream of the demister outlet and 8 feet upstream of the adsorber inlet. This port location is schematically illustrated in Figure 3. The instrument probe consisted of a piece of stainless steel tubing fitted through a tee, as illustrated in the lower right area of Figure 3. One leg of the tee was fitted with another length of tubing, which was connected to a sample line running to the plant control room. The sample probes were arranged so that the backflush of air from the DuPont instrument would not affect the sample taken by the control room personnel.

A special port coupling was designed so that the high SO_2 concentration and high internal duct pressure would not pose a hazard to the test crew when the wet tests were performed. The coupling is shown at the lower left of Figure 3. It was designed so that the probe could be sealed in place for testing but could be removed for cleanup. The major component was a 4-inch gate valve capped with a reducer down to 1-inch pipe thread. A 1-inch Swagelok fitting was threaded into the reducer and was used to seal the probe in place. The probe was glass heated by nichrome windings and sheathed in stainless steel.

It was originally intended to extract the PuraSiv S outlet sample from a port in the main tail gas stack approximately 25 feet above grade. This location, however, was immediately above the adsorber bypass inlet and a small amount of leakage around the closed bypass valve caused erroneous readings. The sample probe was then moved to an existing sample tap located in the outlet duct between the fan F-2 take-off and the inlet to the stack. This sample location, which was accessible at ground level, is schematically illustrated in Figure 4. The duct was horizontal and had a 36-inch diameter. The analyzer probe consisted of a piece of stainless steel tubing fitted into a 1-inch pipe coupling with a Swagelok reducing fitting. A 3-inch pipe coupling welded onto the duct at 90^{o} to the analyzer probe served as the wet test sample port.

B. Sampling Procedures

Wet tests were performed at the inlet and outlet of the PuraSiv S for sulfuric acid mist, sulfur dioxide, sulfur trioxide, total acid, chloride, sulfides, oxides of nitrogen, hydrocarbons, oxygen, and carbon dioxide. With the exception of the acid mist tests, which were performed isokinetically using a button-hook-type nozzle on the probe, all wet tests were performed at a proportional sample rate with a plain probe.

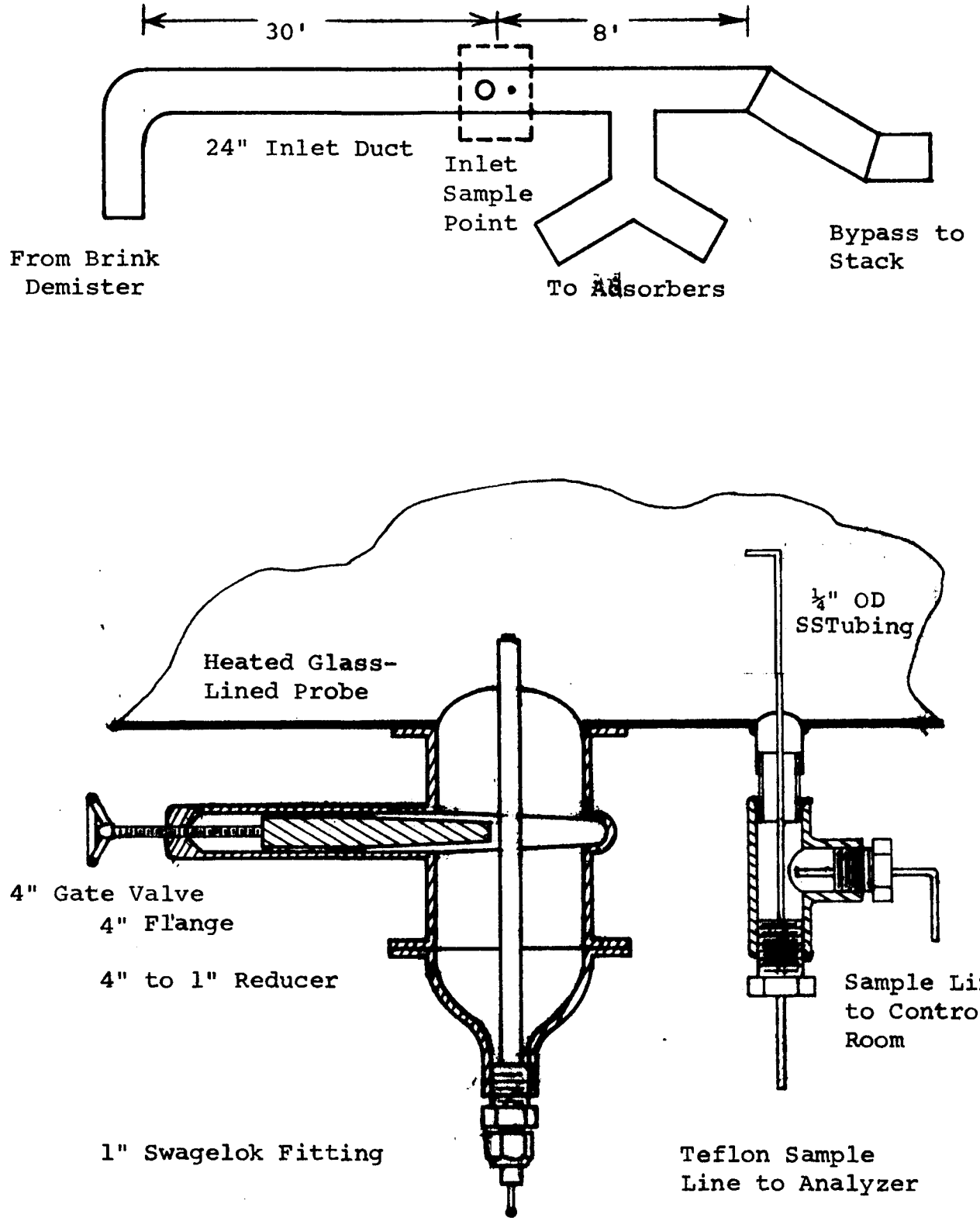
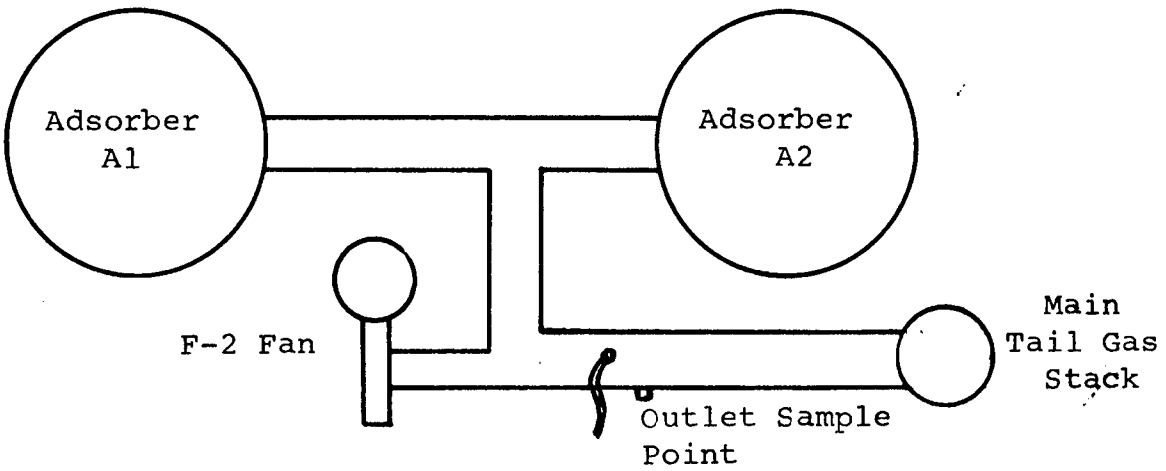
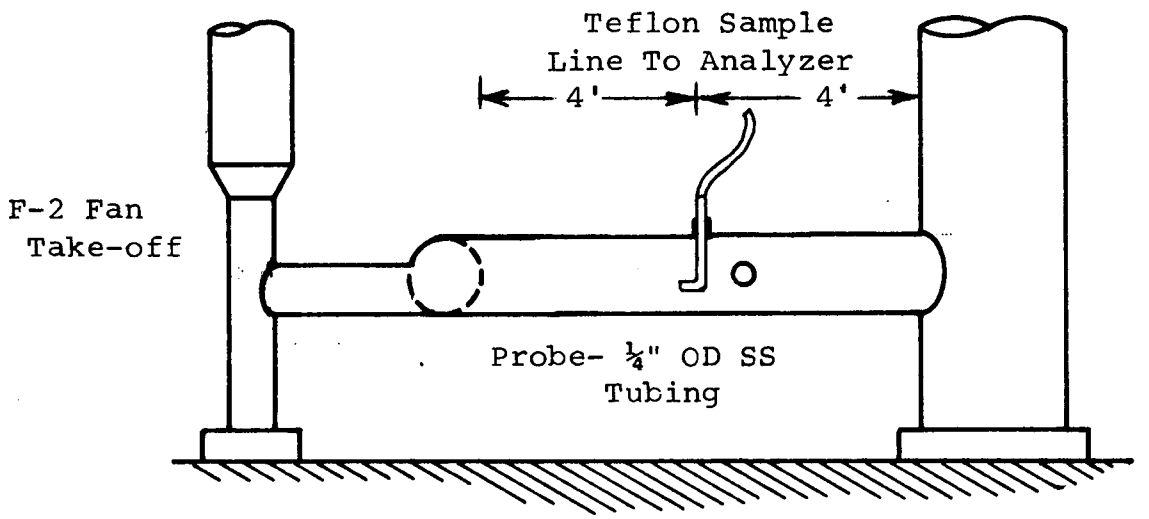


FIGURE 3 Location of Inlet Sample Point and Detail of Probe
Not to scale



Top View



Front View

Figure 4 Location of Outlet Sample Point

The acid mist tests were performed isokinetically at a single point just before the center line of the duct, using a modification of EPA Method 8. The single-point test was justified by the fact that acid mist particles leaving a demister are believed to be less than 5 microns in size,* and in this range particles tend to be evenly dispersed throughout the duct. Velocity measurements at the inlet were made with a standard-type pitot tube, and at the outlet they were made with an S-type pitot tube. The detailed test method can be found in Appendix C.

The mist tests were performed during the first week of the test period. However, the purge of the train had been accomplished without the filter in place. Since the SO_2 which was absorbed by the filter was not removed during the purge, the results were erroneously high and are not presented in this report. The tests were repeated later in the test program.

The tests for nitrogen oxides, using EPA Method 7, were performed during the first and last week of the test period. Total acid/chloride tests were also performed during the first and last week of the test period. The sample gas was bubbled through Greenburg-Smith-type impingers containing 100 ml each of distilled water. Sample aliquots were then analyzed for total acid and chloride. Hydrocarbon sampling was performed during the first week, whereas the testing had to be aborted during the last week when the heating element used to heat the grab flasks malfunctioned. Sulfides were analyzed from the sample catch in the iospropyl alcohol bubbler which is incorporated into the SO_2 and sulfuric acid mist sample trains. These tests were performed in the period between the first and last weeks of testing. Oxygen and carbon dioxide samples were taken during the first and last weeks of the test program and analysis was performed on-site using an Orsat analyzer. Moisture content of the inlet and outlet gas streams was determined during the middle of the program using the instrumentation method detailed in Appendix C.

Sample recovery and train preparation were undertaken in an enclosed trailer parked at the plant site in close proximity to the sampling locations. The sample recovery consisted of probe and glassware rinses with either distilled water or isopropyl alcohol. In the case of sulfuric acid mist tests, the filters were removed and placed in plastic petri dishes and sealed in plastic bags. With the exception of Orsat analysis and the SO_2 samples, which were analyzed on-site, all samples were transported in sealed containers to York Research Corporation's laboratory in Stamford, Connecticut, for final analysis.

*U.S. Environmental Protection Agency "Compilation of Air Pollutant Emission Factors," February 1972.

C. Analytical Procedures

Sulfur dioxide samples were analyzed on-site in a section of the plant laboratory. The samples were stored in Nalgene 4-ounce plastic sample bottles prior to analysis. Each sample was transferred to a 250-ml volumetric flask and diluted to that volume with distilled water. An aliquot was taken from this flask and placed in a 250-ml Erlenmeyer flask. The aliquot volume of straight isopropyl alcohol was added four times and the aliquot was then diluted to 80 ml with 80 percent isopropyl alcohol. A few drops of thorin indicator were added and the solution titrated to a pink end point with a standardized solution of 0.01 N barium chloride. Agitation was provided by a magnetic stirrer. Blanks of all solutions were analyzed on-site.

The acid mist samples were collected on Fiberglas filter discs, placed in plastic petri dishes, and sealed in plastic bags for transportation to York Research's laboratory. The first step in the analytical procedure was to macerate the filters individually in an aqueous medium in order to remove all sulfuric acid from each filter. The acid solution was then combined with an excess of sodium carbonate to form sodium sulfate in an alkaline medium. The solution was treated with barium chloride in order to precipitate barium sulfate out of solution; however, because this reaction takes place more readily in an acid medium, a quantity of hydrochloric acid was added prior to the addition of barium chloride. The resulting solution of sodium chloride with a barium sulfate precipitate has a turbidity which is proportional to the concentration of the sulfate. This turbidity was measured with a visible spectrophotometer at 450 nm and sulfate concentration was obtained from a standard curve.

Sulfur trioxide samples were stored in 4-ounce plastic sample bottles and transported to York Research's laboratory for analysis by titration with barium chloride. The samples were transferred to a 100-ml volumetric flask and diluted to that volume with distilled water. An aliquot was taken and transferred to a 250-ml Erlenmeyer flask prior to the addition of four times the aliquot volume of straight isopropyl alcohol.

A few drops of thorin indicator were added and the solution was titrated to a pink end point with a 0.01 N solution of barium chloride.

Determinations of total acid were performed in order to demonstrate the existence of other acids in addition to sulfuric acid. The samples were placed in glass jars and transported to York Research Corporation's laboratory for analysis. An aliquot of the sample was taken and placed in a 250-ml Erlenmeyer flask. The flask was placed on a magnetic stirrer and titrated with a standardized solution of sodium hydroxide to a phenolphthalein end point. The resulting volume of base necessary to neutralize the sample was then converted to milliequivalents of total acid.

Chloride analysis was performed on an aliquot from the same sample which was analyzed for total acids. A chloride selection ion electrode combined with a Corning Model 610 research pH meter was used to measure chloride concentration in the aliquot. The concentration multiplied by total volume of the sample resulted in chloride content of the sample.

Sulfide samples were obtained in solutions of 80 percent isopropyl alcohol and sealed in Nalgene 4-ounce plastic sample bottles for transportation to the Stamford laboratory. A sufficient amount of ammonium hydroxide was added to the samples to make the solution alkaline, after which the sulfide was combined with lead acetate in order to form a lead/sulfide precipitate. The amount of lead sulfide was determined colorimetrically by matching the color of the precipitate visually to known concentration standards.

Hydrocarbon samples were obtained in 500-ml glass grab flasks and transported to the Stamford laboratory in a foam-lined wooden packing crate. The samples were displaced from the flasks by injection of liquid mercury, thereby causing the sample to flow out of the flask and into a Perkin-Elmer Model 881 gas chromatograph (GC) utilizing a flame ionization detector. The GC was standardized with a known mixture of hexane and nitrogen, and an empty column was used so that separation of hydrocarbons did not occur. The chromatograms were then read as total hydrocarbons.

Analysis of nitrogen oxide samples was performed in the Stamford laboratory using a phenoldisulfonic acid method. The samples, which contained 0.1 normal sulfuric acid and absorbed nitrogen oxides, were transported to the laboratory in Nalgene 4-ounce plastic sample bottles. The acid was neutralized with sodium hydroxide and the solution was evaporated to dryness over moderate heat to avoid spattering. The residue was dissolved in 2 ml of phenoldisulfonic acid with constant stirring. Twenty milliliters of water were added to complete the dissolution of undissolved salts. Upon the addition of 10 ml of concentrated ammonia, a trialkali salt of 6 nitro-1-phenol-2-4 disulfonic acid was formed, with a distinct yellow color which is proportional to the concentration. The color was read with a Bausch & Lomb Spectronic-20 visible spectrophotometer at 420 nm wave length, and the NO_2 concentration was obtained from a calibration curve made specifically for that purpose.

Analysis of carbon dioxide and oxygen was performed on-site using an Orsat analyzer. This is a standard apparatus which volumetrically measures gaseous components by absorption into a specific fluid. The samples were taken simultaneously at the inlet and outlet using leveling bottles with a solution of dilute sulfuric acid and methyl red.

V. DISCUSSION OF TEST RESULTS

In order to assess the efficiency of the PuraSiv S process, a 1-month source sampling and continuous monitoring program was undertaken. During this period 118 absorption cycles and a variety of transient conditions were measured. Thus, the test data obtained allowed for a complete mapping of system performance.

Copies of the original recorded strip charts can be found in Appendix C. Listings of SO_2 mass emission rate for each cycle are tabulated in Appendices E and F. Typical cycles for adsorbers A1 and A2 are shown in Graphs 1 and 2, respectively; Graphs 4 through 10 depict various process unbalances and upsets.

The results of the continuous monitoring study were recorded on a parts per million by a volume basis. The analyzer utilizes a dual-range capability which permits the recorder to switch from the 0 to 5000 ppm inlet scale to the outlet 0 to 300 ppm scale. Example calculations demonstrating the technique used to arrive at the SO_2 mass emission rates are shown in Appendix B. The tail gas flow rate was calculated by Coulton Chemical personnel and then corrected to standard conditions (70°F and 29.92 inches Hg). In determining the outlet mass emission rates, the inlet flow rate was used. This results in an average emission rate equal to the total of the main stack SO_2 emission rate plus the air dryer stack emission rate, thus showing the PuraSiv S system to be the single source of SO_2 emissions at the Coulton B-Plant. This is justified by the fact that both the Federal and state of Ohio Environmental Protection Agencies limit total emissions of acid plant tail gas rather than emissions from individual points within the plant.

A. Normal Operation

An unusually wide range of SO_2 inlet concentrations to the PuraSiv S were experienced over the 4-week period, varying from a minimum average of 2335 ppm to a maximum of 4800 ppm per cycle, with peaks exceeding 5000 ppm during the recycle stages. The lower readings were recorded during the first 2 days of testing and were due in part to an improperly marked high-range calibration gas cylinder. The cylinder was recalibrated using the procedure outlined in the September 11, 1974 Federal Register.

After recalibration of the cylinders, correlation with wet tests was within 5 percent. The readings obtained during the first 2 days are listed in the mass emission tables in Appendix B, but they have been omitted from the summaries in Tables 1 and 2.

Since the plant was operating under the restriction of an undersized electrical transformer, neither acid production nor tail gas flow rate could be altered without imposing a serious equilibrium im-

balance on the plant. However, a simulation of variations in loadings to the PuraSiv S was performed by increasing the time of adsorption cycle and the SO_2 concentration to the adsorber. Thus, we were able to exceed the maximum design loading conditions to the PuraSiv unit. These results are tabulated by categorization of:

(a) adsorber vessel.
(b) inlet concentration.
(c) length of cycle.

In addition, Table 1 summarizes the results of average mass emission rates as a function of each of the above.

Inlet concentrations averaged less than 4000 ppm during 60 percent of the test period, while the outlet emissions averaged 62 ppm from adsorber A2 and 73 ppm from adsorber A1. The discrepancy is due to a problem with an adsorbent bed support in adsorber A1. The range of inlet concentrations, which represents maximum capacity of the beds at a flow rate of 7500 SCFM, is 4000 to 4500 ppm. These inlet concentrations were experienced over 35 percent of the test period, while the outlet of adsorber A2 averaged 82 ppm and adsorber A1 111 ppm. For the remaining periods (approximately 5 percent) the inlet concentrations of SO_2 to the PuraSiv exceeded 4500 ppm. At this time the concentration leaving adsorber A1 averaged 107 ppm and 99 ppm for A2.

Adsorbing vessels A1 and A2 were designed to be identical in function and performance. Prior to testing, A1 was found to have a defective bed support, which caused a quantity of molecular sieve to be lost from the system. As well as reducing the capacity of that bed, the loss of some adsorbent altered the flow distribution through the vessel, which resulted in slightly less efficiency for that unit.

Union Carbide Corporation guarantees that the PuraSiv S system is capable of reducing the average SO_2 emission level to less than 100 ppm* over a single cycle. A realistic evaluation, taking the bed support problem of A1 into consideration, shows that the PuraSiv S emissions exceed this level in 13 percent of the total number of cycles measured. The highest SO_2 emission level from A2, averaged over a single cycle, was 118 ppm.

Graphs 1 and 2 represent typical cycles of normal operation for adsorbers A1 and A2, respectively. The adsorbers have similar curves with the exception of slightly higher emission concentration

*Union Carbide Corporation "PuraSiv S Systems for Sulfuric Acid Plants - Technical Fact Sheet."

TABLE 1. SO_2 TEST SUMMARY

Cycle Length	Unit	No. of Cycles	Avg. Inlet ppm	Avg. Inlet lb/hr	Avg. Inlet kg/hr	Avg. Outlet ppm	Avg. Outlet lb/hr	Avg. Outlet kg/hr	Efficiency
4:00-4:20	A1	6	3672	276.6	125.59	92	6.91	3.14	97.5
4:21-4:40	A1	24	3164	235.0	111.54	65	4.84	2.20	97.9
>4:41	A1	2	3013	223.3	101.38	113	8.38	3.81	96.3
4:00-4:20	A1	6	4193	316.5	143.67	129	9.72	4.42	96.9
4:21-4:40	A1	12	4206	314.8	142.90	99	7.63	3.35	97.6
4:40-4:21	A1	2	4673	352.7	160.13	107	8.04	3.65	97.8
4:00-4:20	A2	2	3270	245.1	111.26	62	4.64	2.11	98.1
4:21-4:40	A2	23	3211	238.3	108.28	55	4.08	2.36	98.3
>4:41	A2	5	3060	227.9	103.68	91	6.73	3.06	96.9
4:00-4:20	A2	9	4196	316.7	143.42	86	6.52	2.99	97.9
4:21-4:40	A2	8	4246	318.7	144.70	77	5.75	2.61	98.2
4:00-4:20	A2	4	4619	348.7	158.50	100	7.51	3.41	97.9
>4:41	A2	1	4620	341.6	155.09	98	7.25	3.29	97.9

TABLE 2. LIST OF SO_2 TEST CYCLES

Avg. Inlet ppm	Avg. Inlet lb/hr	Avg. Inlet kg/hr	Avg. Outlet ppm	Avg. Outlet lb/hr	Avg. Outlet kg/hr	Efficiency
CYCLE LENGTH: 4:00-4:20 UNIT: A1 INLET CONDITIONS: <4000 ppm						
2600	192.8	87.5	76	5.63	2.56	97.1
3870	292.1	132.6	81	6.11	2.77	97.9
3930	296.6	134.7	101	7.62	3.46	97.4
3765	284.2	129.0	99	7.47	3.39	97.4
3965	299.3	135.9	103	7.77	3.53	97.4
3905	294.7	133.8	91	6.87	3.12	97.7
CYCLE LENGTH: 4:21-4:40 UNIT: A1 INLET CONDITIONS: <4000 ppm						
2795	207.2	94.1	85	6.30	2.86	97.0
2495	185.0	84.0	57	4.23	1.92	97.7
2610	193.0	87.9	76	5.63	2.56	97.1
3330	249.9	113.5	80	5.93	2.69	97.6
3290	243.9	110.7	76	5.63	2.56	97.7
3060	226.9	103.0	63	4.67	2.12	97.9
2590	192.0	87.2	67	4.97	2.26	97.4
3090	229.1	104.0	49	3.63	1.65	98.4
3460	256.5	116.5	77	5.71	2.59	97.8
2745	203.5	92.4	38	2.82	1.28	98.6
2780	205.5	93.3	46	3.40	1.54	98.3
3065	226.6	102.9	53	3.92	1.78	98.3
2960	218.9	99.4	51	3.77	1.71	98.3
3250	240.3	109.1	63	4.66	2.10	98.1
3335	246.6	112.0	64	4.73	2.15	98.1
3545	262.1	119.0	82	6.06	2.75	97.7
3195	236.2	107.2	62	4.58	2.08	98.1
3120	230.7	104.7	56	4.14	1.88	98.2
3385	250.3	113.6	67	4.95	2.25	98.1
2495	217.7	98.8	55	4.07	1.85	98.1
3510	259.5	117.8	64	4.73	2.15	98.2
3750	283.0	128.5	72	5.43	2.47	98.1
3645	275.1	124.9	75	5.66	2.57	97.9
3980	300.4	136.4	87	6.57	2.98	97.8
CYCLE LENGTH: 4:41 UNIT: A1 INLET CONDITIONS: <4000 ppm						
3045	225.7	102.5	123	9.12	4.14	96.0
2980	220.9	100.3	103	7.64	3.47	96.5

LIST OF SO_2 TEST CYCLES (CONTD.)

CYCLE LENGTH: 4:00-4:20 UNIT: A1 INLET CONDITIONS: 4000-4500 ppm

Avg. Inlet ppm	Avg. Inlet lb/hr	Avg. Inlet kg/hr	Avg. Outlet ppm	Avg. Outlet lb/hr	Avg. Outlet kg/hr	Efficiency
4020	303.4	137.7	107	8.08	3.67	97.3
4075	307.6	139.7	103	7.77	3.53	97.5
4420	333.6	151.5	141	10.64	4.83	96.8
4275	322.7	146.5	136	10.27	4.66	96.8
4100	309.5	140.4	134	10.11	4.59	96.7
4265	321.9	146.1	152	11.47	5.21	96.4

CYCLE LENGTH: 4:21-4:40 UNIT: A1 INLET CONDITIONS: 4000-4500 ppm

4080	301.7	137.0	94	6.95	3.16	97.7
4130	305.4	138.7	97	7.17	3.26	97.6
4495	332.0	150.7	113	8.36	3.80	97.5
4490	332.0	150.7	110	8.13	3.69	97.6
4245	313.9	142.5	97	7.17	3.26	97.7
4065	306.8	139.3	89	6.72	3.05	97.8
4205	317.4	144.1	112	8.45	3.84	97.3
4005	302.3	137.2	97	7.32	3.32	97.6
4250	320.8	145.6	109	8.23	3.74	97.4
4255	321.7	146.0	91	6.87	3.12	97.9
4105	309.8	140.7	99	7.47	3.39	97.6
4150	313.2	142.2	75	8.76	2.57	98.2

CYCLE LENGTH: 4:00-4:21 UNIT: A1 INLET CONDITIONS: >4500 ppm

4700	354.8	161.1	114	8.60	3.90	97.6
4645	350.6	159.2	99	7.47	3.39	97.9

LIST OF SO_2 TEST CYCLES (CONTD.)

CYCLE LENGTH: 4:00-4:20 UNIT: A2 INLET CONDITIONS: <4000 ppm

Avg. Inlet ppm	Avg. Inlet lb/hr	Avg. Inlet kg/hr	Avg. Outlet ppm	Avg. Outlet lb/hr	Avg. Outlet kg/hr	Efficiency
2605	193.1	87.7	54	4.00	1.82	97.9
3935	297.0	134.8	70	5.28	2.40	98.2

CYCLE LENGTH: 4:21-4:40 UNIT: A2 INLET CONDITIONS: <4000 ppm

2755	204.2	92.7	74	5.49	2.49	97.3
2805	208.0	94.4	61	4.52	2.05	97.8
3440	255.0	115.8	81	6.01	2.73	97.6
3080	228.3	103.7	63	4.60	2.09	98.0
2750	203.9	92.6	68	5.04	2.29	97.5
2885	213.9	97.1	40	2.97	1.35	98.6
3230	239.5	108.7	50	3.71	1.68	98.5
2945	218.3	99.1	45	3.34	1.52	98.5
2740	203.1	92.2	28	2.07	.94	99.0
2990	221.1	100.4	33	2.33	1.11	98.9
3235	239.2	108.6	49	3.62	1.64	98.5
2920	215.9	98.0	40	2.96	1.34	98.6
3305	244.4	111.0	52	3.84	1.74	98.4
3635	268.8	122.0	62	4.58	2.08	98.3
3460	255.8	116.1	71	5.25	2.38	98.0
3300	244.0	110.8	53	3.92	1.78	98.4
3360	248.4	112.8	54	3.99	1.81	98.4
3145	232.5	105.6	50	3.70	1.68	98.4
2810	207.8	94.3	51	3.77	1.71	98.2
3550	264.5	120.1	54	3.99	1.81	98.5
3980	300.4	136.4	64	4.83	2.19	98.4
3700	279.3	126.8	59	4.45	2.02	98.4
3830	289.1	131.3	64	4.83	2.19	98.3

CYCLE LENGTH: 4:41 UNIT: A2 INLET CONDITIONS: <4000 ppm

3065	227.2	103.2	111	8.23	3.74	96.4
3230	239.5	108.7	107	7.93	3.60	96.7
2715	201.3	91.4	66	4.89	2.22	97.6
2375	176.1	80.0	102	7.56	3.43	95.7
3915	295.5	134.2	67	5.06	2.30	98.3

LIST OF SO_2 TEST CYCLES (CONTD.)

CYCLE LENGTH: 4:00-4:20 UNIT: A2 INLET CONDITIONS: 4000-4500 ppm

Avg. Inlet ppm	Avg. Inlet lb/hr	Avg. Inlet kg/hr	Avg. Outlet ppm	Avg. Outlet lb/hr	Avg. Outlet kg/hr	Efficiency
4500	339.7	151.1	72	5.43	2.92	98.1
4000	301.9	137.1	77	5.81	2.40	98.2
4290	323.8	147.0	86	6.49	2.95	98.0
4150	313.2	142.2	75	5.66	2.57	98.2
4040	304.9	138.4	101	7.62	3.46	97.5
4225	318.9	144.8	106	8.00	3.63	97.5
4365	329.5	149.6	118	8.91	4.05	97.3
4090	308.7	140.2	75	5.66	2.57	98.2
4100	309.5	140.5	68	5.13	2.33	98.3

CYCLE LENGTH: 4:21-4:40 UNIT: A2 INLET CONDITIONS: 4000-4500 ppm

4445	328.7	149.2	84	6.21	2.82	98.1
4500	332.7	151.1	87	6.43	2.92	98.1
4215	318.1	144.4	75	5.66	2.56	98.2
4000	301.9	137.1	70	5.28	2.40	98.2
4270	322.3	146.3	80	6.04	2.74	98.1
4170	314.7	142.9	70	5.28	2.40	98.3
4165	314.4	142.7	73	5.51	2.50	98.2
4200	317.0	143.9	74	5.59	2.54	98.2

CYCLE LENGTH: 4:00-4:20 UNIT: A2 INLET CONDITIONS: >4500 ppm

4540	342.7	155.6	91	6.87	3.12	98.0
4800	362.7	164.7	87	6.57	2.98	98.2
4520	341.2	154.9	110	8.30	3.77	97.6
4615	348.3	158.1	110	8.30	3.77	97.6

CYCLE LENGTH: 4:41 UNIT: A2 INLET CONDITIONS: >4500 ppm

4620	341.6	155.1	98	7.25	3.29	97.9

from A1. The typical curve of plant tail gas concentration has a period of higher SO_2, beginning at the start of the second hour in the PuraSiv cycle and continuing for 1½ to 2 hours. This is caused by the desorbed SO_2 being released from the regenerating bed and recycled through the plant. Following the recycle period is a light lowering of SO_2 concentration, caused by a dilution of plant tail gas from the flush of cool air through the bed at the end of the regenerative cycle.

Efficiency of the PuraSiv S is represented by:

$$\frac{\text{Inlet-Outlet}}{\text{Inlet}}$$

Graph 3 shows efficiency of adsorbers A1 and A2 using the emission data from Graph 1 and Graph 2. Efficiency for each adsorber decreases with time and is relatively unaffected by inlet concentration. This is demonstrated by the fact that no discontinuities are shown where inlet concentration changes in the second and third hours of the cycle. Upon extrapolation of the curves, we would experience breakthrough. However, since we have no supporting mathematical data as to the limits involved, this phenomenon has not been predicted. The curves do show, however, that breakthrough would occur on A1 before A2.

B. Transient Conditions

The analyzer, operating continuously, has documented emissions during several minor process upsets as well as recorded two plant shutdowns and startups. The delicate nature of the equilibrium balance of a contact sulfuric acid plant is responsible for drastic changes in SO_2 tail gas concentrations. Low SO_2 caused by a high converter temperature is responsible for the upset shown in Graph 4. As inlet concentration drops, so does emission level. The average emission level over the cycle, however, does not vary appreciably from normal operation.

Erratic converter temperature caused by a malfunction in a condenser controller is responsible for the upset represented in Graph 5. Again, the PuraSiv average emission does not vary appreciably from the emission found under normal conditions. The upset represented in Graph 6 is different in nature from the previous ones in that inlet concentration is excessively higher than normal (greater than 5000 ppm). The emission level rises rapidly during this period but drops when inlet concentration drops. It is obvious, however, that if the inlet concentration had continued at the high level for a longer period of time, then the emission would have reached 300 ppm (maximum scale) before the end of the cycle. This upset occurred when a sulfur plug in the burner feed line was dislodged, and a slug of sulfur was dumped into the burner.

Graph 7 and Graph 8 represent emissions recorded during two separate plant shutdowns. Graph 7 was a plant shutdown taking place on

February 9, 1975 due to a freezeup in the absorbing tower. During this shutdown the PuraSiv was taken off-line and tail gas was bypassed and vented to the atmosphere. Graph 8 depicts a shutdown which took place on February 13, 1975 in order to make repairs on an acid pump. During this shutdown the PuraSiv was left on-line with the obvious characteristic of low emission levels throughout.

Graph 9 and Graph 10 show the SO_2 concentrations experienced during two separate plant startups. Concentrations in excess of maximum scale on the instrument were experienced at both inlet and outlet locations. After the first two PuraSiv cycles, however, normal conditions were re-established.

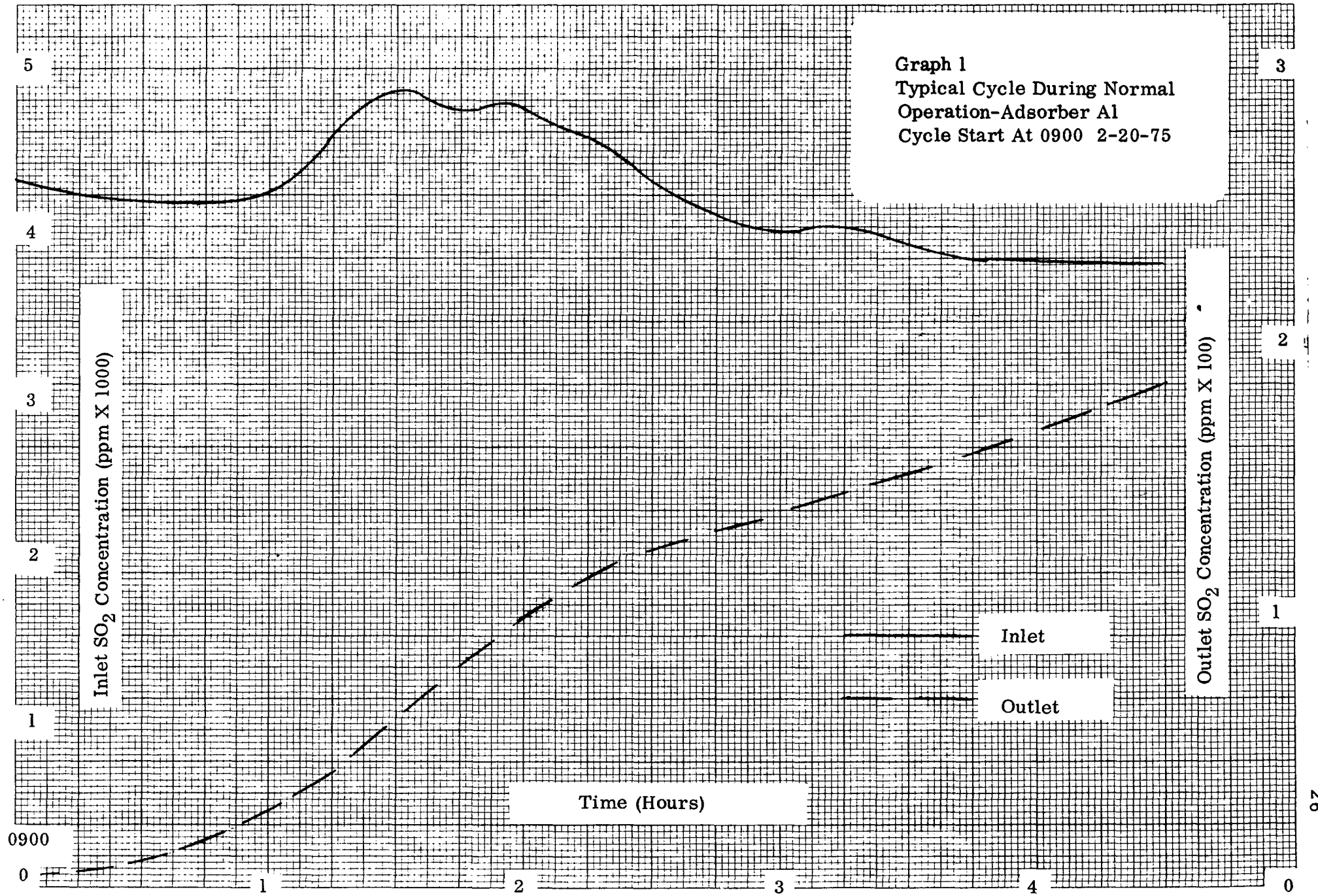
C. Wet Tests

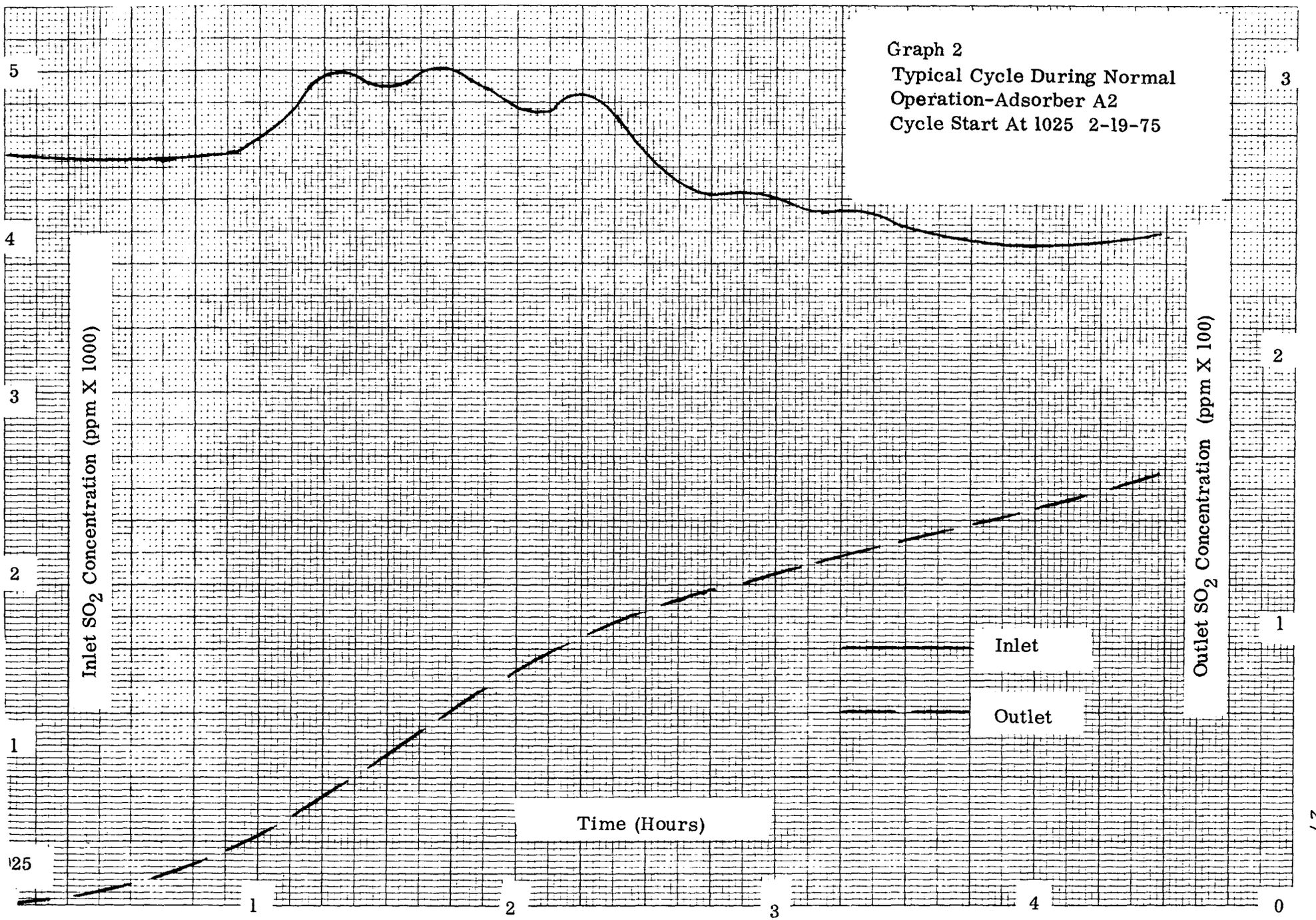
The results of the wet tests are shown in Tables 3 through 11 and define the location, date, and time of the tests. Results are in terms of averages plus or minus the 95 percent confidence limit. Sulfur trioxide results are not reported due to erroneously high values obtained. It is believed that incorrect purging of the sample train was responsible for the high results.

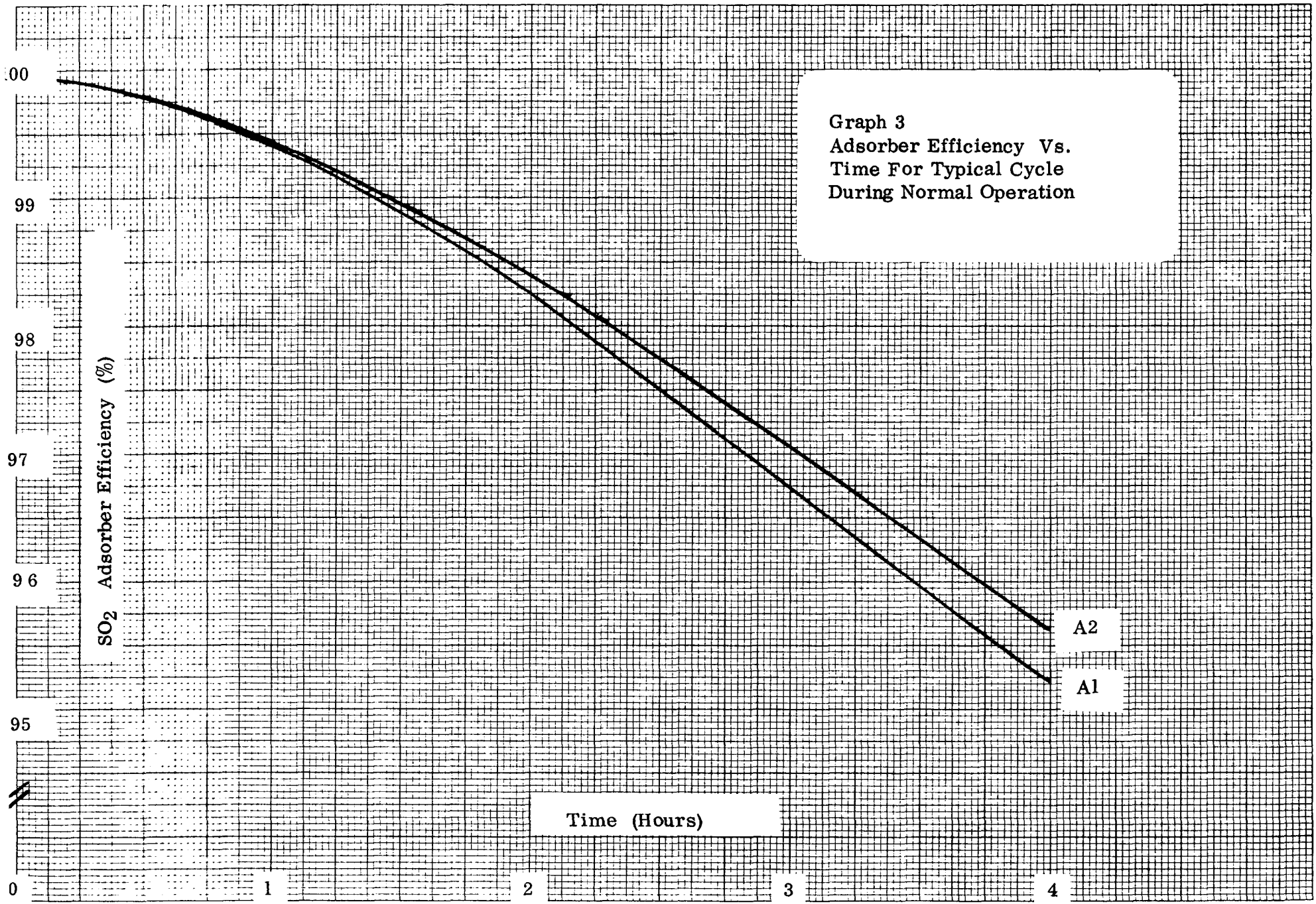
One of the original objectives of the test period was to define any change in performance of the adsorber over a period of 4 weeks and to correlate the change with the presence of tail gas impurities. The delicate nature of the acid plant equilibirum was responsible for constantly changing conditions: e.g., composition of feed, temperature of converter, and fluctuating of SO_2 by recycle. Daily performance change was documented; however, a performance change over 4 weeks would be unnoticeable because of the drastic changes mentioned above. In order to obtain documentation of performance versus time, a program with a time span of at least 6 months would be necessary.

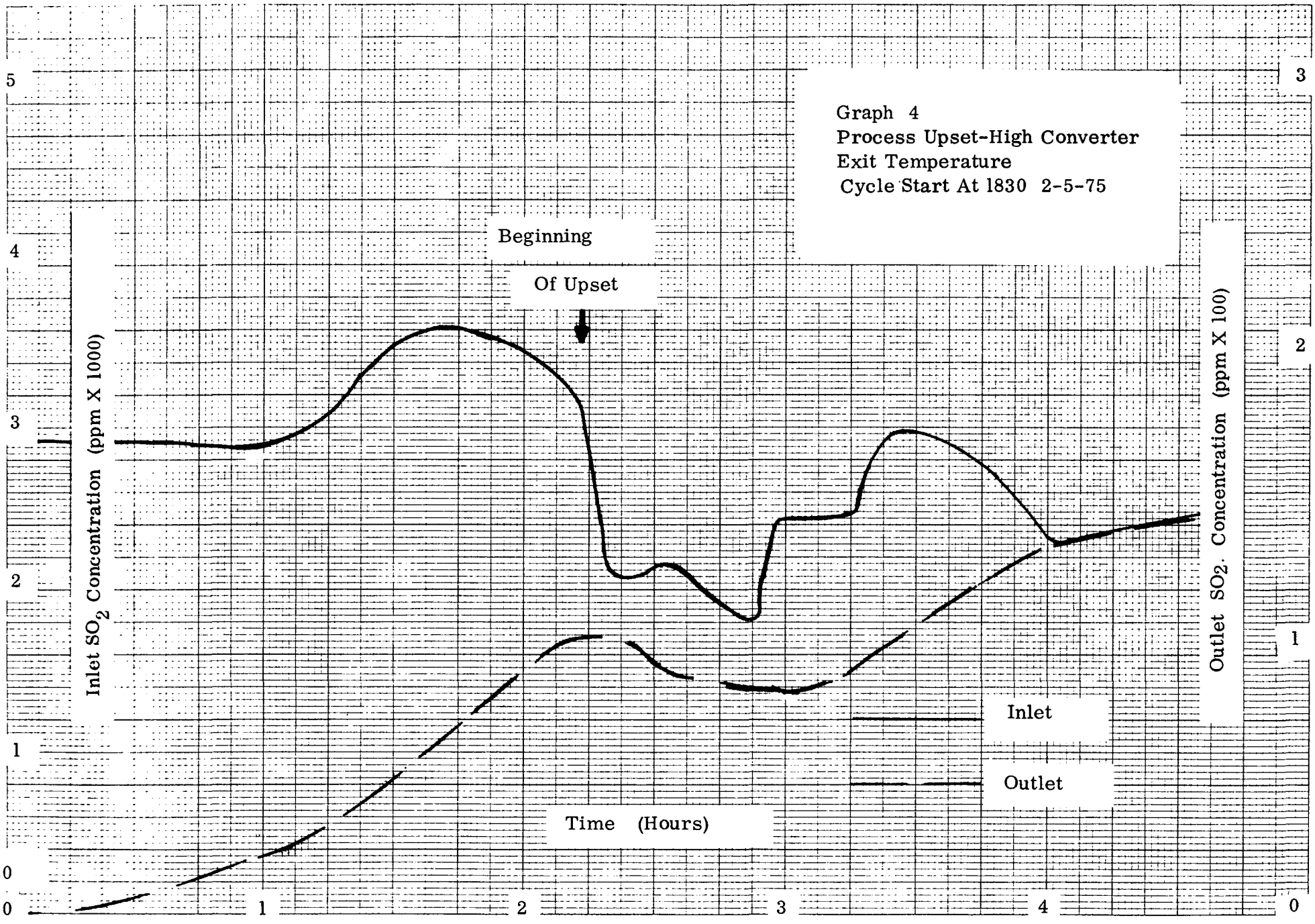
The results of the tests for certain tail gas impurities - e.g., sulfide, chloride, and total acid - was dependent primarily upon composition of furnace feed. Due to their variable nature, these results are considered as base-line data.

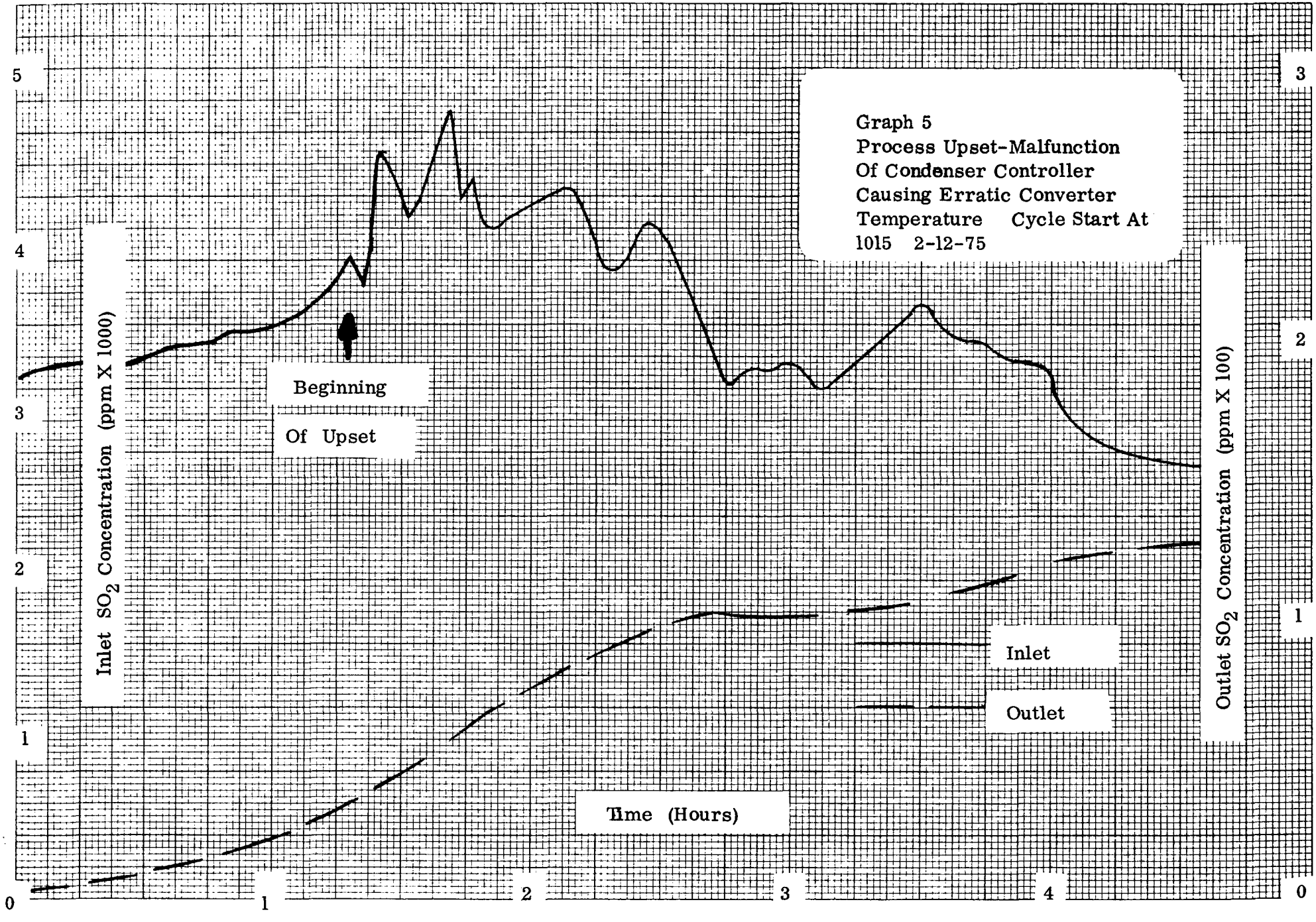
It was noted that these compounds were adsorbed on the PuraSiv beds in varying degrees since the outlet wet tests yielded results which were generally lower than the inlet results. The effect of these compounds on the performance of the sieve material on both efficiency and life is unknown since wet tests were not performed on the desorbed gas returning to the plant.

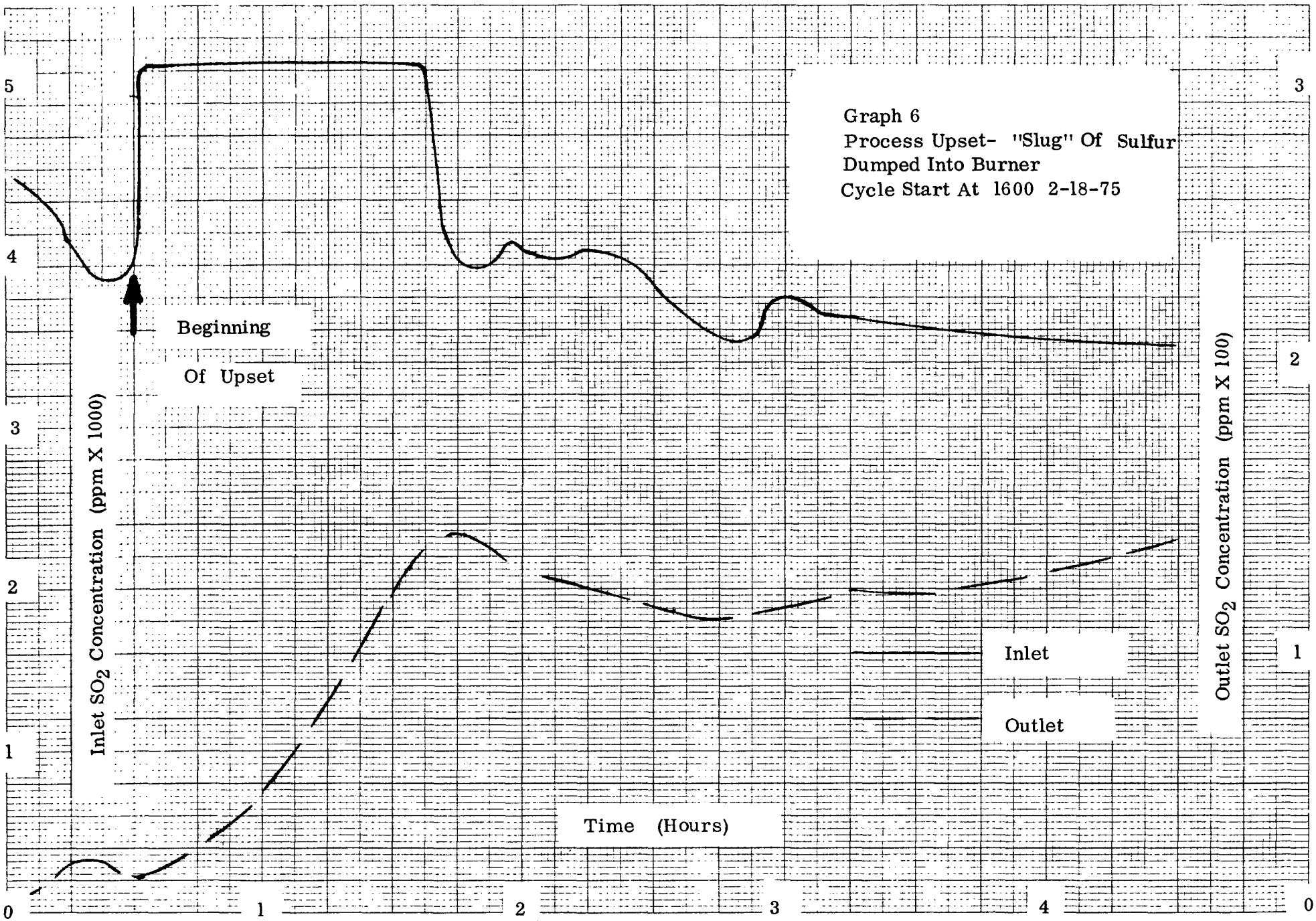


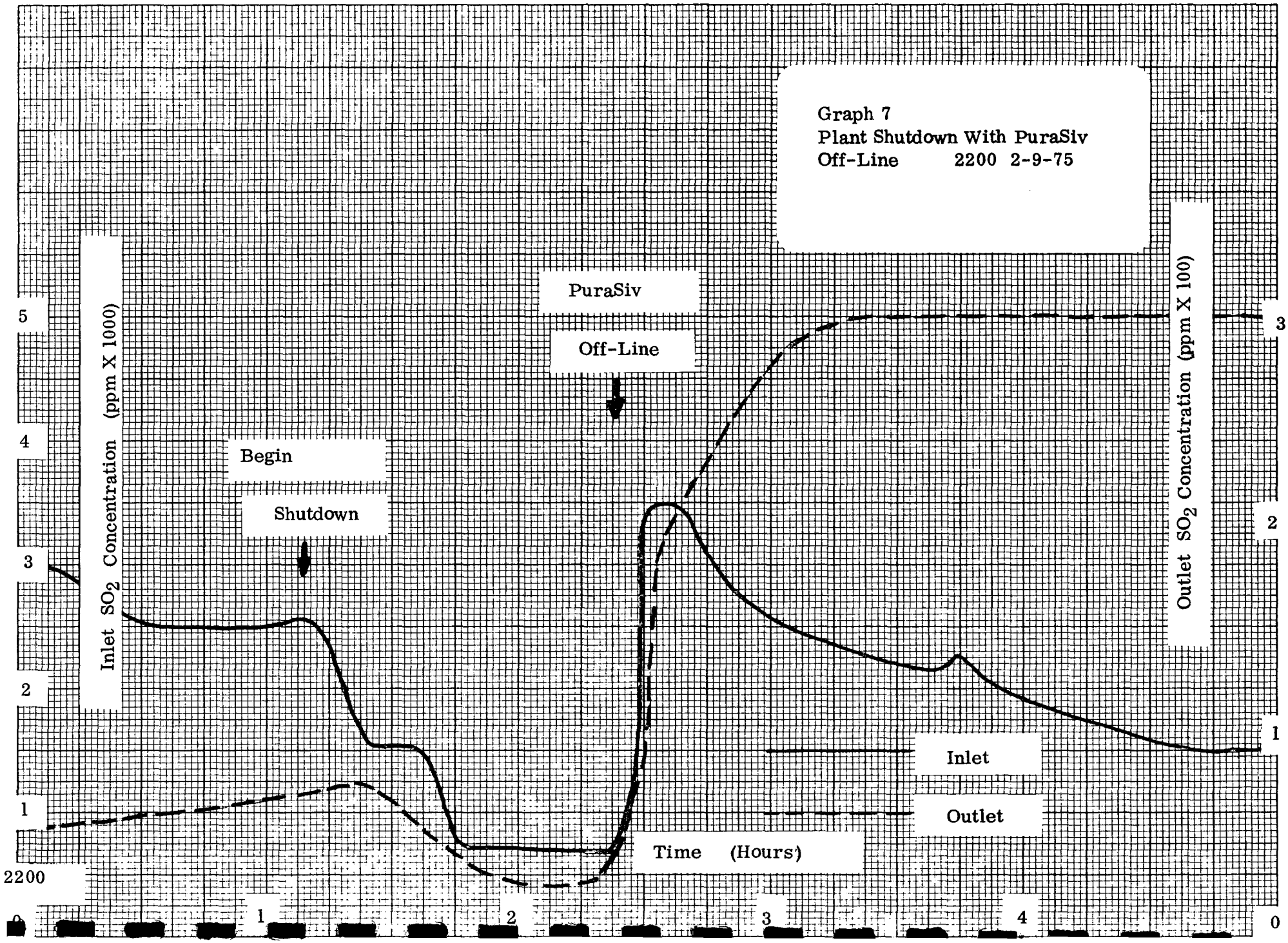


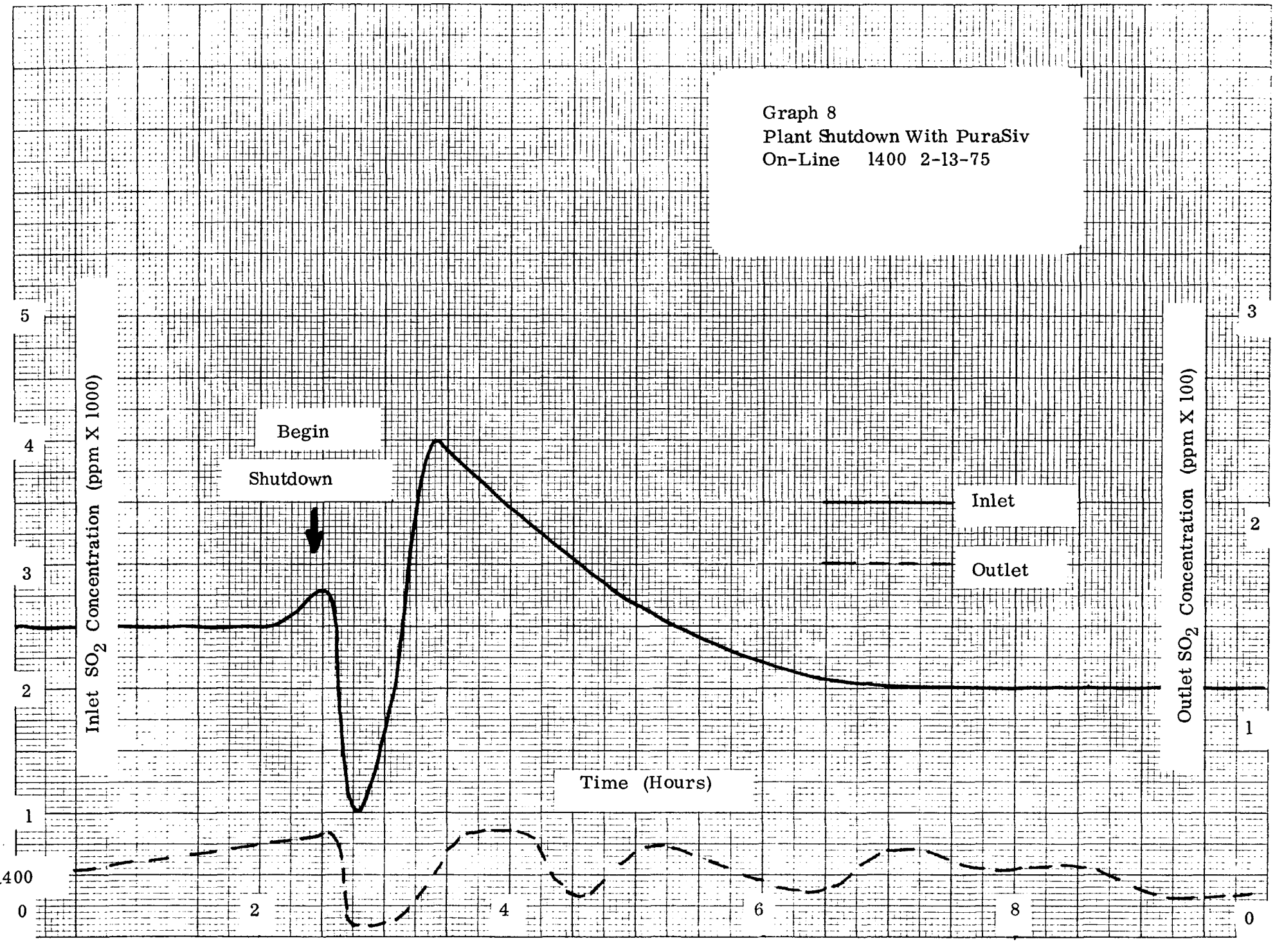


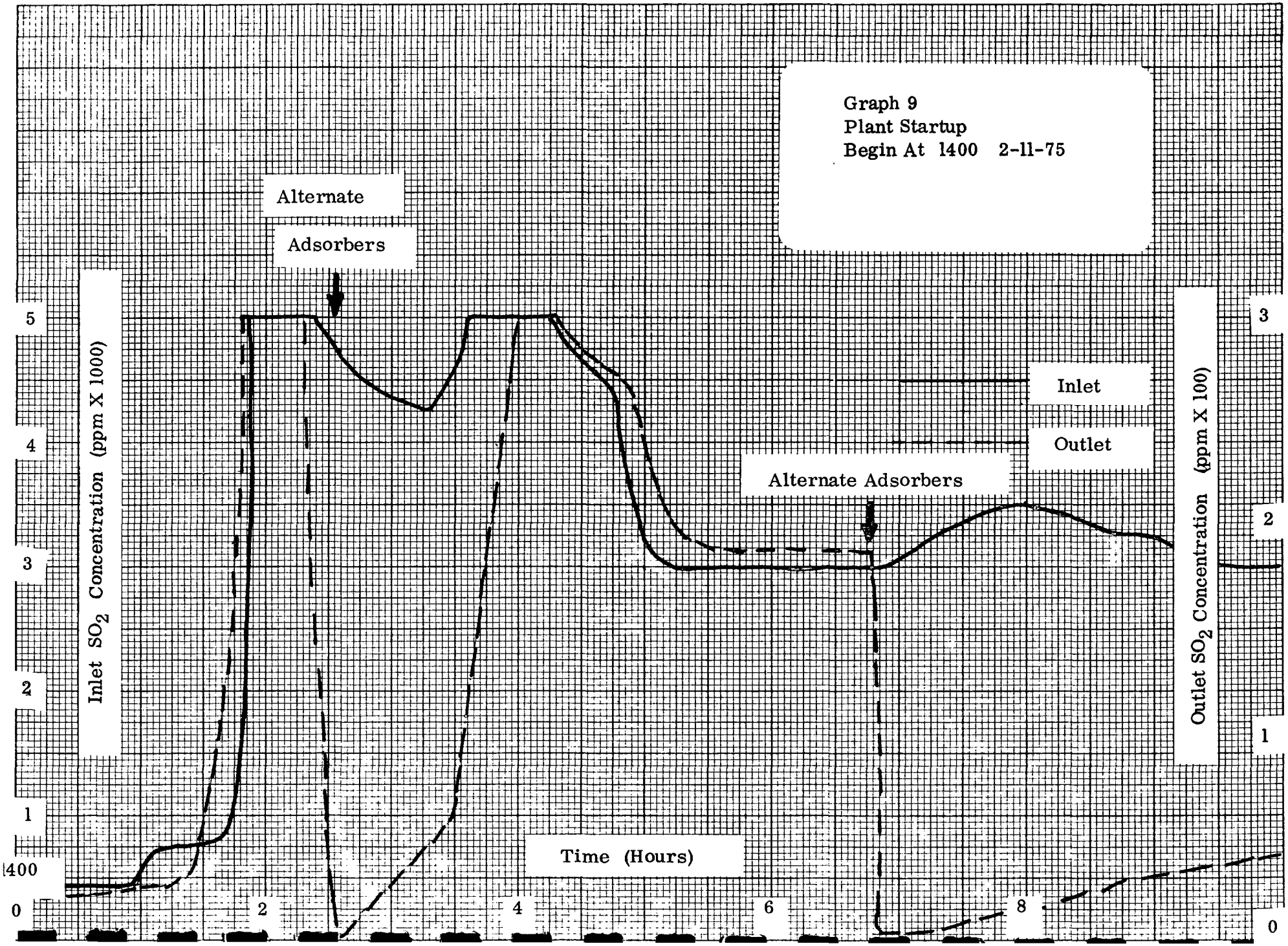

Graph 4
Process Upset-High Converter
Exit Temperature
Cycle Start At 1830 2-5-75
Beginning
Of Upset
Inlet SO_2 Concentration (ppm X 1000)
Outlet SO_2. Concentration (ppm X 100)
Inlet
Outlet
Time (Hours)
1830
0
1
2
3
4
5




Graph 6
Process Upset- "Slug" Of Sulfur Dumped Into Burner
Cycle Start At 1600 2-18-75
Beginning
Of Upset
Inlet
Outlet
Inlet SO_2 Concentration (ppm X 1000)
Outlet SO_2 Concentration (ppm X 100)
Time (Hours)
0
1
2
3
4
5




Graph 8
Plant Shutdown With PuraSiv
On-Line 1400 2-13-75
Begin
Shutdown
Inlet
Outlet
Inlet SO_2 Concentration (ppm X 1000)
Outlet SO_2 Concentration (ppm X 100)
Time (Hours)
5
4
3
2
1
0
3
2
1
0
1400
2
4
6
8



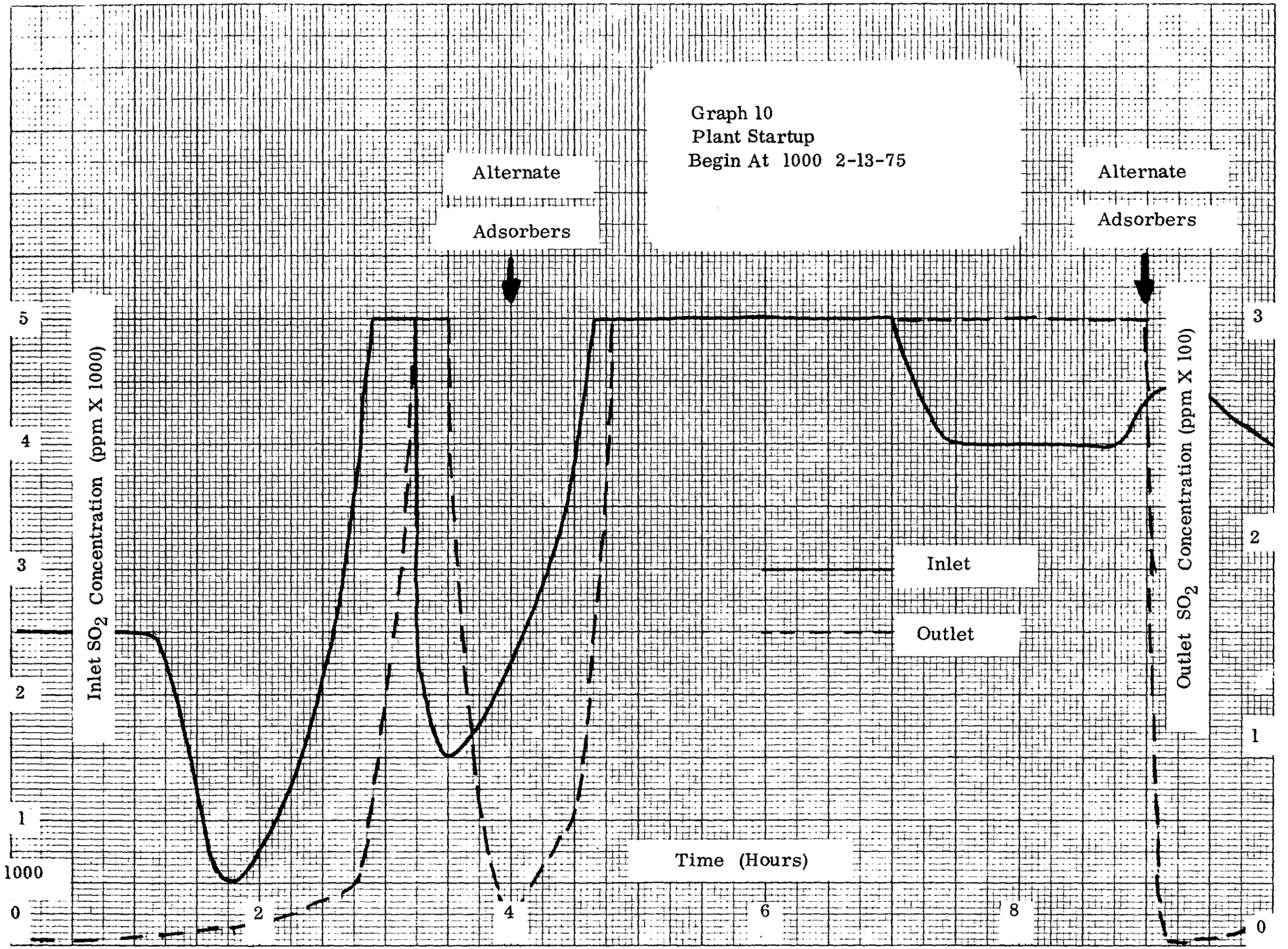

Graph 10
Plant Startup
Begin At 1000 2-13-75
Alternate
Adsorbers
Alternate
Adsorbers
Inlet
Outlet
Inlet SO_2 Concentration (ppm X 1000)
Outlet SO_2 Concentration (ppm X 100)
Time (Hours)
1000
0
2
4
6
8
1
2
3
4
5
0
1
2
3

TABLE 3. DUPONT SO_2 ACCURACY CALCULATIONS

Date	Time	Test No.	Location	Method 6 ppm/v	DuPont ppm/v	X Difference	(X^2)
2/12	1035	1	Inlet	3322	3300	22	484
2/12	1147	2	Outlet	72.3	73	0.7	.49
2/12	1555	3	Inlet	3359	3385	26	676
2/14	0924	4A	Inlet	3176	3217	41	1681
2/14	0925	4B	Inlet	3022	3217	195	38025
2/14	1134	5	Oulet	115	102	13	169
2/14	1224	6	Outlet	15.1	7.5	7.6	57.76
2/17	1133	7	Inlet	2615	2500	115	13225
2/17	1135	8	Outlet	88.3	84	4.3	18.49
2/17	1320	9	Inlet	2749	2525	224	50176
2/17	1340	10	Outlet	16.2	10.5	5.7	32.5
2/17	1435	11	Outlet	45.7	39	6.7	44.9
2/18	1116	12	Outlet	120.6	135	14.4	207.4
2/18	1110	13	Inlet	3354	3400	46	2116

$$\bar{x} = \frac{1}{n_i}\sum_{1}^{n} x_i = 51.5$$

$$\text{C.I. } 95 = \frac{t.975}{n\sqrt{n-1}} \{ n (\Sigma x_i^2) = (\Sigma x_i)^2 \}^{\frac{1}{2}}$$

$$\text{C.I. } 95 = \frac{2160}{14\sqrt{13}} \{14 (106913.5) = (520418)\}^{\frac{1}{2}}$$

$$\text{Accuracy} = \{\frac{51.5 + 42.28}{1576.4}\} \times 100 = 5.95\%$$

TABLE 4. SULFURIC ACID MIST EMISSION RESULTS

Date	Time	Location	ppm/V	mg/SCM	kg/hr	kg/metric ton	mg/SCF	gr/SCF	lb/hr	lb/ton
2/20	1105	Inlet	1.04	4.27	.0540	.0095	.121	.0019	.119	.019
2/20	1230	Inlet	3.66	14.97	.1891	.034	.424	.0065	.417	.068
2/20	1420	Inlet	*							
2/21	1022	Outlet	.22	.883	.0113	.002	.025	.0004	.025	.004
2/21	1128	Outlet	.13	.530	.0068	.001	.015	.0002	.015	.002
2/21	1225	Outlet	.21	.883	.0109	.002	.025	.0004	.024	.004
2/26	1117	Inlet	1.47	5.90	.0762	.012	.167	.0026	.168	.025
2/26	1120	Outlet	1.06	4.27	.0549	.009	.121	.0019	.121	.018
2/26	1315	Inlet	1.89	7.27	.0975	.016	.206	.0032	.215	.032
2/26	1315	Outlet	1.24	4.98	.0639	.0105	.141	.0022	.141	.021
2/27	1032	Inlet	1.40	5.58	.0721	.012	.158	.0024	.159	.024
2/27	1030	Outlet	.87	3.50	.0449	.0075	.099	.0015	.099	.015
AVERAGE		Inlet	1.89	7.60	.0978	.017	.215	.0033	.216	±.025
AVERAGE		Outlet	.62	2.51	.0321	.0065	.071	.0011	.071	±.009

*Loss of sample during transportation.

TABLE 5. TOTAL ACID EMISSION RESULTS

Date	Time	Location	Meq/SCF*	Meq/SCM*
2/6	0927	Inlet	.143	5.050
2/6	0915	Outlet	.0189	.667
2/6	1030	Inlet	.135	4.767
2/6	1010	Outlet	.0225	.795
2/6	1110	Inlet	.131	4.626
2/6	1058	Outlet	.0262	.925
2/24	1452	Inlet	.122	4.308
2/24	1452	Outlet	.0179	.632
2/24	1040	Inlet	.0778	2.747
2/24	1040	Outlet	.0140	.494
2/25	1150	Inlet	.0605	2.136
2/25	1153	Outlet	.0193	.682
AVERAGE		Inlet	.111	$\pm$1.259
AVERAGE		Outlet	.0198	$\pm$ .146

*Emissions are reported as milliequivalents of total acid, including H_2SO_4.

TABLE 6. CHLORIDE EMISSION RESULTS*

Date	Time	Location	ppm/V	mg/SCM	kg/hr	mg/SCF	gr/SCF	lb/hr
2/6	0927	Inlet	.911	2.871	.0471	.0813	.00125	.104
2/6	0915	Outlet	.025	.0777	.0013	.0022	.00003	.003
2/6	1030	Inlet	4.11	12.716	.2125	.36	.00555	.469
2/6	1010	Outlet	.010	.0330	.0005	.0009	.00001	.001
2/6	1110	Inlet	1.494	4.718	.0772	.133	.0205	.170
2/6	1058	Outlet	.026	.0836	.0013	.0024	.00004	.003
2/24	1452	Inlet	.370	1.166	.0191	.0330	.00051	.042
2/24	1452	Outlet	.009	.0285	.0004	.0008	.00001	.001
2/24	1040	Inlet	.201	.6362	.0104	.0180	.00028	.023
2/24	1040	Outlet	.019	.0617	.0010	.0017	.00003	.002
2/25	1150	Inlet	.578	1.818	.0299	.0515	.00079	.066
2/25	1153	Outlet	.009	.0279	.0004	.0008	.00001	.001
AVERAGE		Inlet	1.277	3.988	.0660	.1128	.00481	±.105
AVERAGE		Outlet	.016	.0521	.00082	.0015	.000022	±.001

*Reported as Cl^-.

TABLE 7. SULFIDE EMISSION RESULTS

Date	Time	Location	ppm/V	mg/SCM	kg/hr	mg/SCF	gr/SCF	lb/hr
2/14	0924	Inlet	<.5[t]	<2	-	<.05	-	-
2/14	0925	Inlet	<.5	<2	-	<.05	-	-
2/14	1134	Outlet	6.87	21.68	.871	.614	.0095	1.92
2/14	1224	Outlet	6.18	19.49	.248	.552	.0085	.546
2/17	1133	Inlet	<.5	<2	-	<.05	-	-
2/17	1320	Inlet	12.0	37.80	.481	1.07	.016	1.06
2/20	1105	Inlet	14.4	45.20	.576	1.28	.020	1.27
2/20	1230	Inlet	13.1	41.32	1.656	1.17	.018	3.65
2/20	1420	Inlet	<.5	<2	-	<.05	-	-
2/21	1022	Outlet	<.5	<2	-	<.05	-	-
2/21	1128	Outlet	<.5	<2	-	<.05	-	-
2/21	1225	Outlet	19.0	59.68	.762	1.69	.026	1.68
AVERAGE		Inlet	5.93	18.90	-	.53	-	-
AVERAGE		Outlet	6.61	20.97	-	.59	-	-

*Reported as CS_2.
[t]Indicates that concentration is below the detectable limit of the analysis method.

TABLE 8. HYDROCARBON EMISSION RESULTS*

Date	Time	Location	ppm/V	kg/hr	lb/hr
2/7	0840	Inlet	20.1	.911	2.01
2/7	0850	Inlet	71.9	3.26	7.19
2/7	0900	Inlet	t		
2/7	0910	Inlet	70.1	3.18	7.01
2/7	0920	Inlet	38.5	1.75	3.85
2/7	0930	Inlet	23.3	1.06	2.33
2/7	0940	Inlet	41.3	1.87	4.13
2/7	0950	Inlet	18.4	.834	1.84
2/7	1000	Inlet	58.9	2.67	5.89
2/7	1010	Inlet	29.9	1.36	2.99
2/7	1055	Outlet	5.3	.240	0.53
2/7	1105	Outlet	10.9	.494	1.09
2/7	1115	Outlet	8.2	.372	0.82
2/7	1125	Outlet	18.6	.844	1.86
2/7	1135	Outlet	11.5	.522	1.15
2/7	1145	Outlet	35.9	1.63	3.59
2/7	1155	Outlet	79.3	3.60	7.93
2/7	1205	Outlet	t		
2/7	1215	Outlet	51.3	2.33	5.13
2/7	1225	Outlet	35.6	1.61	3.56
AVERAGE		Inlet	41.38	1.88	±1.61
AVERAGE		Outlet	28.51	1.29	±1.89

*Reported as Hexane.
tLoss of sample due to flask leakage.

TABLE 9. OXIDES OF NITROGEN EMISSION RESULTS

Date	Time	Location	ppm/V	mg/SCM	kg/hr	mg/SCF	gr/SCF x 10^{-5}	lb/hr
2/6	1105	Inlet	13.2	.0293	.32	.00083	1.28	.70
2/6	1105	Outlet	7.9	.0164	.19	.00046	.71	.42
2/6	1110	Inlet	19.5	.0391	.43	.00111	1.71	.94
2/6	1110	Outlet	9.2	.0198	.22	.00056	.86	.48
2/6	1115	Inlet	11.1	.0222	.27	.00063	.97	.59
2/6	1115	Outlet	*					
2/6	1120	Inlet	16.7	.0361	.40	.00102	1.58	.89
2/6	1120	Outlet	13.5	.0292	.33	.00083	1.28	.72
2/6	1125	Inlet	9.1	.0192	.22	.00054	.84	.49
2/6	1125	Outlet	9.8	.0206	.24	.00058	.90	.52
2/6	1130	Inlet	14.8	.0310	.35	.00088	1.35	.78
2/6	1130	Outlet	11.4	.0243	.28	.00069	1.06	.61
2/25	1400	Inlet	*					
2/25	1400	Outlet	21.5	.0403	.53	.00114	1.76	1.16
2/25	1405	Inlet	15.3	.0285	.38	.00081	1.24	.83
2/25	1405	Outlet	11.8	.0233	.29	.00066	1.02	.64
2/25	1410	Inlet	23.1	.0428	.57	.00121	1.87	1.25
2/25	1410	Outlet	11.2	.0236	.28	.00067	1.03	.61
2/25	1415	Inlet	18.6	.0365	.46	.00103	1.59	1.01
2/25	1415	Outlet	19.9	.0378	.49	.00107	1.65	1.08
2/25	1420	Inlet	21.0	.0379	.52	.00107	1.66	1.14
2/25	1420	Outlet	18.3	.0335	.45	.00095	1.46	.99
2/25	1425	Inlet	22.8	.0448	.56	.00127	1.96	1.23
2/25	1425	Outlet	11.4	.0216	.28	.00061	.94	.62
AVERAGE		Inlet	16.84	.0334	.41	.00095	1.46	$\pm$.17
AVERAGE		Outlet	13.26	.0264	.33	.00075	1.15	$\pm$.17

*Loss of sample due to flask leakage.

TABLE 10. MOISTURE RESULTS

Date	Time	Location	ppm	mg/SCM	mg/SCF	gr/SCF
2/12	0930	Inlet	18	13.42	.380	.0058
2/12	1105	Outlet	5	3.71	.105	.0016
2/14	1450	Inlet	20	14.90	.422	.0065
2/14	1535	Outlet	4	2.97	.084	.0013
2/15	1005	Inlet	15	11.19	.317	.0049
2/15	1120	Outlet	3	2.22	.063	.0010
2/16	0915	Inlet	22	16.38	.464	.0072
2/16	1055	Outlet	5	3.71	.105	.0016
2/17	1325	Inlet	18	13.42	.380	.0058
2/17	1445	Outlet	4	2.97	.084	.0013
2/18	1520	Inlet	18	13.42	.380	.0058
2/18	1645	Outlet	4	2.97	.084	.0013
2/19	0830	Inlet	18	13.42	.380	.0058
2/19	1000	Outlet	4	2.97	.084	.0013
2/20	0925	Inlet	17	12.68	.359	.0055
2/20	1050	Outlet	4	2.97	.084	.0013
2/21	0820	Inlet	18	13.42	.380	.0058
2/21	0955	Outlet	5	3.71	.105	.0016
AVERAGE		Inlet	18.2 $\pm$ 1.5	13.58	.385	.0059
AVERAGE		Outlet	4.2 $\pm$ .5	3.13	.089	.0014

TABLE 11. ORSAT READINGS

Date	Time	Location	% CO_2	% O_2	% CO
2/3	1530	Inlet	3.5	7.8	0.0
2/3	1530	Outlet	2.9	6.0	0.0
2/6	1100	Inlet	2.7	5.2	0.0
2/6	1100	Outlet	2.8	5.2	0.0
2/6	1200	Inlet	2.2	5.6	0.0
2/6	1200	Outlet	2.2	7.2	0.0
2/24	1030	Inlet	4.7	5.3	0.0
2/24	1030	Outlet	4.8	5.6	0.0
2/24	1120	Inlet	4.8	5.8	0.0
2/24	1120	Outlet	4.3	5.7	0.0
2/27	1300	Inlet	3.8	4.4	0.0
2/27	1300	Outlet	3.9	4.5	0.0
AVERAGE		Inlet	3.6	5.7	0.0
AVERAGE		Outlet	3.5	5.7	0.0

APPENDIX A

INSTALLATION AND OPERATION OF CONTINUOUS MONITORING SYSTEM

Description of Equipment

The DuPont 460/1 operates on the principle that specific gases absorb radiant energy at specific wave lengths in proportion to their concentrations. The sample gas passes through a No. 316 stainless steel sample cell which is a tube with a quartz window covering each end. An ultraviolet light source projects a beam through the cell that is picked up by a photometric detection system. The detector consists of a series of optical filters that permit only the light of certain wave lengths to pass through. A prism splits the selected light beam in two and transmits each beam to a separate phototube. One measures the energy at 280 nm (measuring band) and the other the energy at 578 nm (the reference band). The difference between these resultants is equivalent to the amount of energy absorbed by the sample gas, which is then proportional to the pollutant concentration. The detector output is amplified and transmitted to the recorder, which provides an analog instrument output. Precision of this instrument is claimed by DuPont to be ± 2 percent.

The DuPont 460/1 was included with the capability of measuring gaseous concentrations at two separate sampling locations. An integral programmer determines which mode the analyzer is operating in at any given time. Since the instrument has only one sampling interface, it cannot sample two locations simultaneously; instead, it samples one location and backflushes the system with clean air before it samples the other location. Normal operation is to sample one location for 90 seconds and backflush for 30 seconds and to sample a second location for 90 seconds and backflush again for 30 seconds to complete one full cycle. The instrument also has the capability to measure NO_x; however, a measurement at either location increases the total cycle time by 12 minutes per reading. Since this would drastically reduce the number of SO_2 readings, it was decided that the NO_x analysis mode would not be used so that trends and patterns of SO_2 emissions could be more clearly defined.

The recorder used with the DuPont 460/1 was a Leeds & Northrup Speedomax H multipoint unit. A modified Leeds & Northrup Flexelect B programmer is an integral part of the recorder; it provides programmable, sequential sample-point selection and automatic zero control.

Installation

The entire DuPont system was permanently mounted in a 12-foot steel trailer and was complete with a sample-handling system and calibration input manifold, valves, and switches. Once at the site the necessary hookups were made, including:

(1) electrical power (110 v).
(2) compressed air (50 psig).
(3) sample lines (2¼-inch od Teflon).
(4) calibration standards (zero air and three ranges of SO_2).

After the instrument was set up, it became apparent that a single range for both sampling points would be ineffective since the inlet concentrations ranged from 2500 to 4000 ppm, while the outlet concentrations ranged from 0 to 150 ppm. A dual range capability was adapted to the instrument which allowed an inlet span of 0 to 5000 ppm and an outlet span of 0 to 300 ppm. The adaptation consisted of a relay and an extra 20 K potentiometer wired into the Flexelect; each sampling mode was transferred through a separate potentiometer, thus permitting independent calibration of each mode.

Operation

Normal operation of the plant is 24 hours per day. The analyzer also operated 24 hours per day and was left running even during shutdowns. Normal procedure was to calibrate with standard gases once per day per channel. Zero adjustment is automatic on the DuPont.

The sample cell windows were cleaned once per week. This insured that no build-up of foreign material interfered with the photometer.

APPENDIX B

CALCULATION OF SO_2 MASS EMISSION RATE

(1) SO_2 Mass Rate to PuraSiv S Inlet

$$\text{lb/hr inlet} = (Q) \times (\text{ppm inlet}) \times \frac{64.1 \text{ lb}}{\text{mole}} \times \frac{\text{mole}}{387 \text{ cu ft}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{10^{-6}}{\text{ppm}}$$

where: Q = inlet flow rate as calculated by plant personnel - (SCFM)

ppm = SO_2 concentration as measured by photometric analyzer.

(2) SO_2 Mass Emission Rate

$$\text{lb/hr outlet} = (Q) \times (\text{ppm outlet}) \times \frac{64.1 \text{ lb}}{\text{mole}} \times \frac{\text{mole}}{387 \text{ cu ft}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{10^{-6}}{\text{ppm}}$$

where: Q = inlet flow rate as calculated by plant personnel - (SCFM)

ppm outlet = SO_2 concentration as measured by photometric analyzer.

(3) SO_2 Mass Collected by PuraSiv S per Cycle

$$\frac{\text{lb } SO_2}{\text{cycle}} = \text{lb/hr inlet} - \text{lb/hr outlet} \times (t)$$

where: t = length of cycle in hours

(4) SO_2 Mass Emission on a Daily Basis:

$$\frac{\text{lb } SO_2}{\text{day}} = \frac{\sum_{i=1}^{N} \text{lb/hr outlet}}{n} \times 24 \text{ hr/day}$$

where: n = number of cycles in a 24-hour period

(5) SO_2 Mass Emission Rate per Ton of Acid Produced:

$$\text{lb/ton } SO_2 = \frac{\text{lb/day } SO_2}{\text{daily production rate}}$$

(6) Efficiency of SO_2 Removal:

$$\text{Efficiency} = 100 \times \frac{\text{lb/hr inlet} - \text{lb/hr outlet}}{\text{lb/hr inlet}}$$

APPENDIX C

WET CHEMICAL TEST METHODS

Sulfur Dioxide

The test method followed in the collection of sulfur dioxide samples was a modified version of EPA Method 6, "Determination of Sulfur Dioxide Emissions from Stationary Sources."* The modification consisted of saving the catch from the isopropyl alcohol bubbler and analyzing the contents for sulfur trioxide and/or sulfides.

A glass probe, wound with nichrome wire and sheathed with stainless steel, was used to extract the sulfur dioxide samples. A glass wool prefilter in the end of the probe inhibited acid mist entrainment into the sample stream. The probe was attached to the sample train by means of a three-way stopcock tee utilizing ground-glass ball and socket joints. At the inlet sample location, where postive internal duct pressures were encountered, the pump was bypassed and the sample stream allowed to be pushed through the train and gas meter by the duct pressure. Adjustment of the sample flow rate was accomplished by turning the stopcock tee.

The midget impinger train included a midget bubbler containing 15 ml of 80 percent isopropyl alcohol initially, followed by two midget impingers in series with each containing 15 ml of 3 percent hydrogen peroxide initially. A final midget impinger was left blank in order to collect any carry-over from the previous impingers. Incorporated into the sample line between the final impinger and the pump (the gas meter at the inlet) was a drying tube filled with silica gel. The gas measured total sample volume and a rotameter measured sample flow rate (see Figure A1).

Sulfuric acid is soluble in isopropyl alcohol; therefore, any acid mist or sulfur trioxide will be scrubbed out in the midget bubbler, while sulfur dioxide will pass through. Available oxygen from the hydrogen peroxide in the second and third impingers combines with sulfur dioxide, forming the reactive trioxide, which is then readily absorbed in the water. A small amount of sulfur dioxide will remain in the isopropyl alcohol and must be removed prior to cleanup of the train. This is accomplished by pulling clean, sulfur-free air through the train, entraining the sulfur dioxide, and allowing the second and third impingers to scrub it out. The hydrogen peroxide impingers have a collection

*Federal Register, Vol. 36, No. 247, Thursday, December 23, 1971.

SO_2 SAMPLING TRAIN

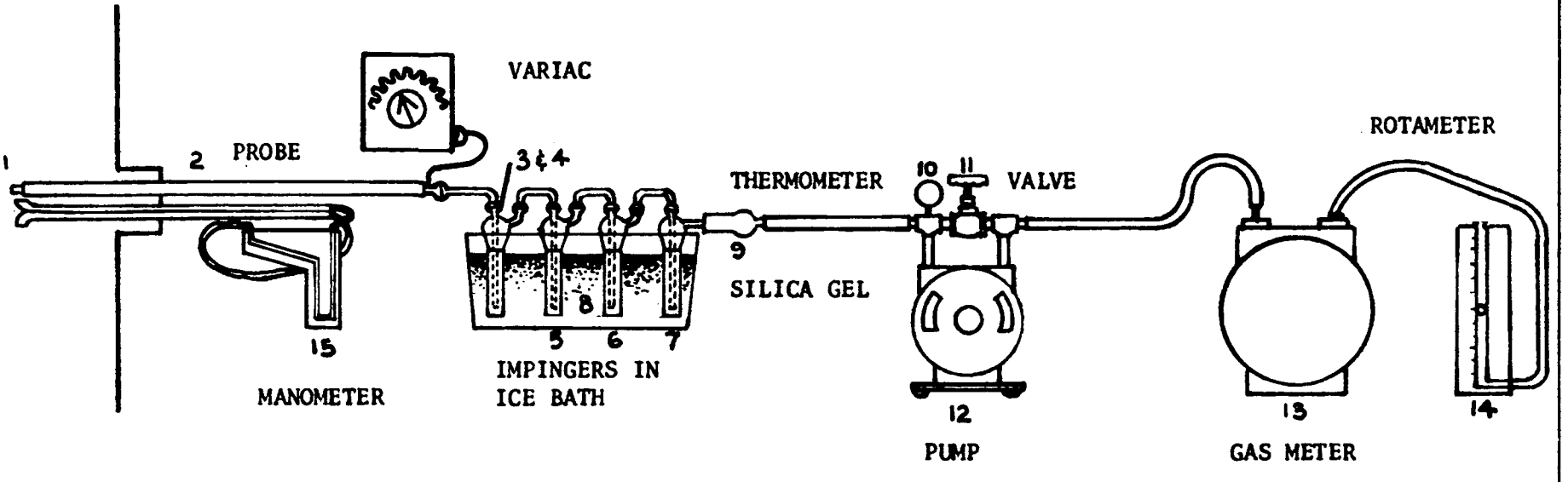


FIGURE A1

efficiency of 90 percent for SO_2, thereby providing a combined collection efficiency of 99 percent. The analysis has an accuracy of 1.53 standard error.

The cleanup was accomplished by transferring the contents of the first midget impinger to a 4-ounce plastic sample bottle and adding the alcohol rinse. The contents of the second, third, and fourth impingers were transferred to a second bottle and the distilled water rinse was added.

Sulfuric Acid Mist

Sulfuric acid is a liquid that forms droplets with extremely small diameters at temperatures less than 640°F. In order to catch these small particles, the sample gas was pulled through a high-efficiency Fiberglas filter contained in a stainless steel holder. These filters have a collection efficiency of 99.9 percent of particles greater than 0.3 microns as measured by the DOP test, and have an over-all efficiency of 98 percent of all particles greater than 0.05 microns. Prevention of water condensation on the filter, and hence the loss of the catch by leaching, was provided by enclosing the filter holder in an insulated box with a heating element and controller set to a temperature of 250°F. At this temperature, no condensation of water occurs, although sulfuric acid will remain in the liquid state (see Figure A2).

The filter was connected to the heated glass probe on the inlet side and to the three-way stopcock tee on the outlet side through ground glass to stainless steel ball and socket joints. The tee serves as connector between the filter holder and the inlet to the series of four sequential midget impingers. The first midget impinger is used to collect any sulfur trioxide that may have passed through the filter and contains 15 ml of 80 percent isopropyl alcohol. The second and third impingers in the series each contain 15 ml of hydrogen peroxide, collecting the sulfur dioxide from the sample stream. A fourth remains empty in order to collect any carry-over.

At the inlet, sulfuric acid mist tests were performed by the same method used for sulfur dioxide but without using the pump. The gas meter was used to measure total sample volume, while a rotameter measured sample flow rate. Gas velocity in the duct was measured with the use of a pitot tube (standard-type at inlet, S-type at outlet), and sample flow rate was adjusted to isokinetic conditions through the use of a needle valve inserted in the sample line prior to the gas meter.

The cleanup included removing the filter and carefully placing it in a sealed plastic container for storage until analysis. The contents of the first midget impinger and the alcohol rinse of the impinger and stopcock tee were transferred to a Nalgene 4-ounce plastic sample bottle. The contents of the second, third,

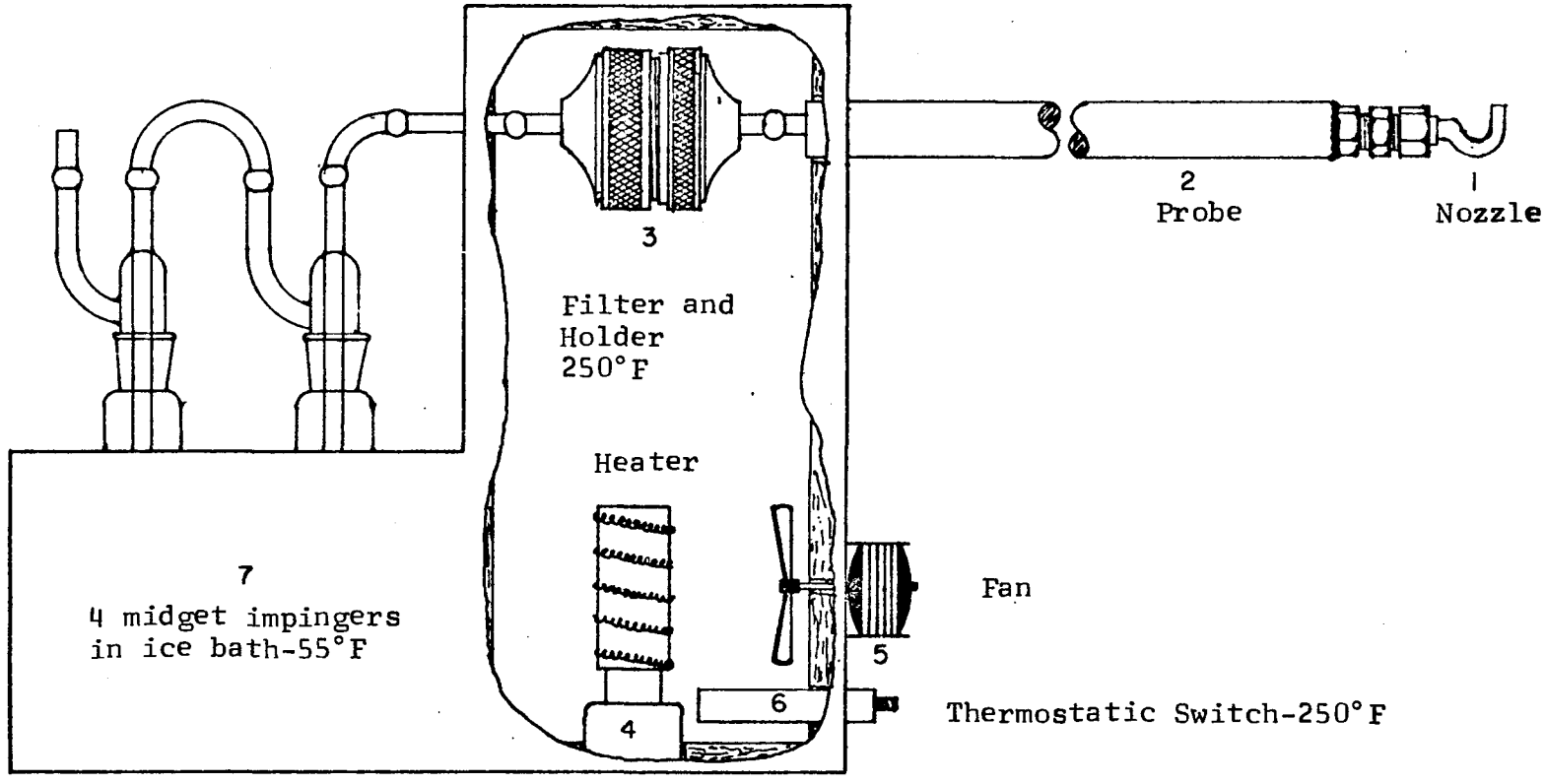


DIAGRAM OF A HEATED MIDGET SAMPLE TRAIN & PROBE

FIGURE A2

and fourth impingers were transferred to a separate 4-ounce plastic sample bottle, and a distilled water rinse was added to it. The collection efficiency of the train is 99.9 percent.

Sulfur Trioxide and Sulfides

Samples for these tests were obtained by drawing sample gas through a heated glass-lined probe and bubbling the gas through a series of four impingers, as described on page C1. The first impinger contained 15 ml of 80 percent isopropyl alcohol, while the second and third contained 15 ml of 3 percent hydrogen peroxide, and the fourth remained empty. Sulfur trioxide forms sulfuric acid with the water in the isopropyl alcohol, while sulfur dioxide passes through the hydrogen peroxide upon purging of the train. A sample prefilter was used to prevent sulfuric acid from entering the probe. The collection efficiency is 95 percent.

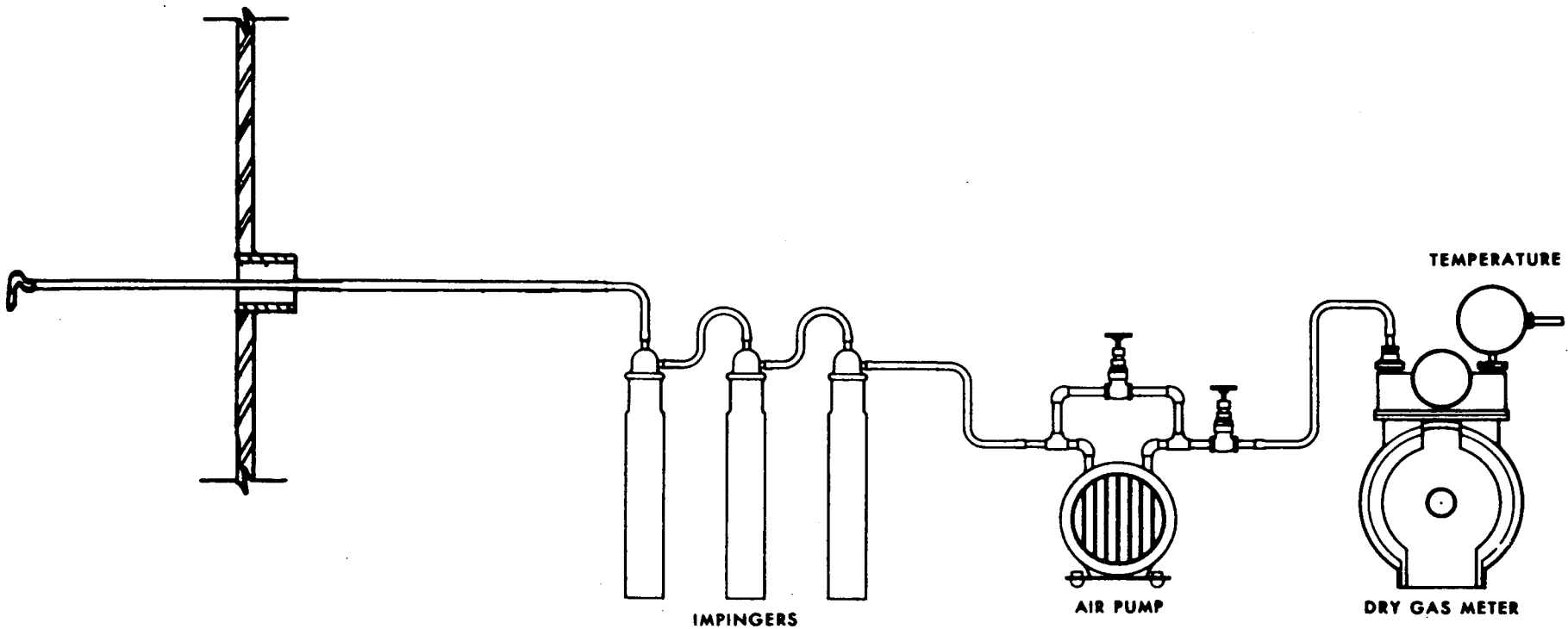
The impingers were connected with glass U-connectors with ground-glass ball and socket joints. A silica gel drying tube was used between the exit of the last impinger and the entrance to the pump in order to prevent water vapor from entering the pump. A gas meter was used to measure total gas sample volume on a dry basis. As with sulfur dioxide and sulfuric acid mist tests, no sample pump was used at the inlet location where internal duct pressure was allowed to push the sample through the train. Sample flow rate was adjusted by partially closing the stopcock tee.

Cleanup was accomplished by collecting the contents of the first impinger and the alcohol rinses of the impinger and the probe into a 4-ounce plastic sample bottle.

Total Acids and Chloride

The equipment for these tests included a stainless steel probe, large-diameter rubber tubing, and three impingers of the Greenburg-Smith design. 100 milliliters of distilled water were placed in each of the first and second impingers, while the third was modified by replacing the tip with an open tube extending to within ½ inch of the bottom. Three hundred grams of silica gel in the third impinger prevented water from entering the gas pump and gas meter. The impingers were linked using large-diameter rubber tubing; at the inlet location the precaution of taping the impinger to the bottle in order to prevent separation under pressure was taken. A sliding vane pump was used to pull the sample, while a standard gas meter was used to measure total sample volume. Sample flow rate was measured by timing the revolutions of the meter face, while adjustment of sample flow rate was maintained with a gate valve across the pump connections (see Figure A3).

The water samples were transferred to glass jars with Teflon lids and to this was added the distilled water rinse of probe, hoses,



SAMPLING TRAIN

FIGURE A3

and impingers. Collection efficiencies for both parameters above are 99 percent.

Hydrocarbons

Hydrocarbon samples were obtained in 500-ml glass grab flasks which are cylindrically shaped and have an opening at each end with a ground-glass stopcock. One end was connected to the heated glass-lined probe from which the sample was extracted, while the other end was attached to a sliding vane vacuum pump with large-diameter rubber tubing. Each flask was conditioned by wrapping it with a heating tape. Each was heated to approximately 130°F, being simultaneously purged with stack gas. After approximately 5 minutes of conditioning the flask, the sample was enclosed by shutting both valves. The flasks were transported to the Stamford laboratory in a foam-packed case for analysis by gas chromatography (see Figure A4). Collection efficiencies are 99.9 percent and analysis accuracy ±0.5 percent of full-scale deflection.

Nitrogen Oxides

Nitrogen oxides were sampled using EPA Method 7, "Determination of Nitrogen Oxide Emissions from Stationary Sources."* The samples were obtained in 2-l glass boiling flasks, encased in styrofoam and equipped with a three-way glass stopcock tee utilizing ground-glass ball and socket joints. Twenty-five milliliters of a dilute sulfuric acid/hydrogen peroxide absorbing solution were placed in each flask prior to sampling. A sliding vane vacuum pump capable of producing 26 inches of Hg negative pressure was connected to the back of the tee via high-vacuum gum rubber, while the front of the tee was connected to the heated, glass-lined stack probe. The vacuum induced by the pump was monitored with a mercury manometer, one leg of which was tied into the pump vacuum while the other leg was open to the atmosphere. After evacuating the flask, the pump inlet was pinched in order to see if a leak were present; if not, the three-way stopcock was positioned so that the flask was sealed and the probe open for purging. After purging, the sample was taken by turning the three-way stopcock very slowly, allowing the sample to enter the flask at a rate whereby the pressures were equalized after about 15 seconds (see Figure A5).

In order to ensure complete absorption of nitrogen oxides into the solution of dilute sulfuric acid/hydrogen peroxide, each flask was shaken vigorously for a period of 5 minutes. After a period of 16 hours, during which the solution and the sample gas come to an equilibrium state, the flasks were shaken again and a final pressure was obtained from the mercury manometer. The contents

*Federal Register, Vol. 36, No. 247, Thursday, December 23, 1971.

HYDROCARBON SAMPLING

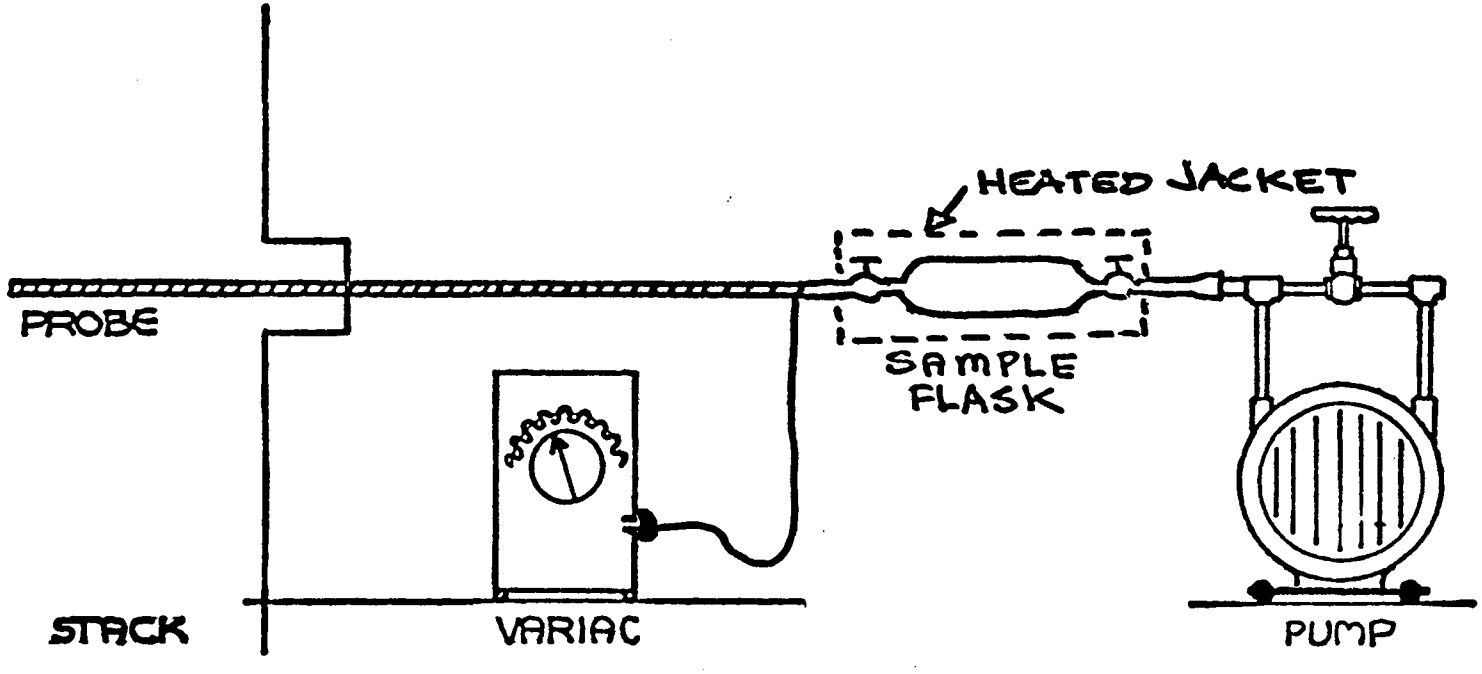


FIGURE A4

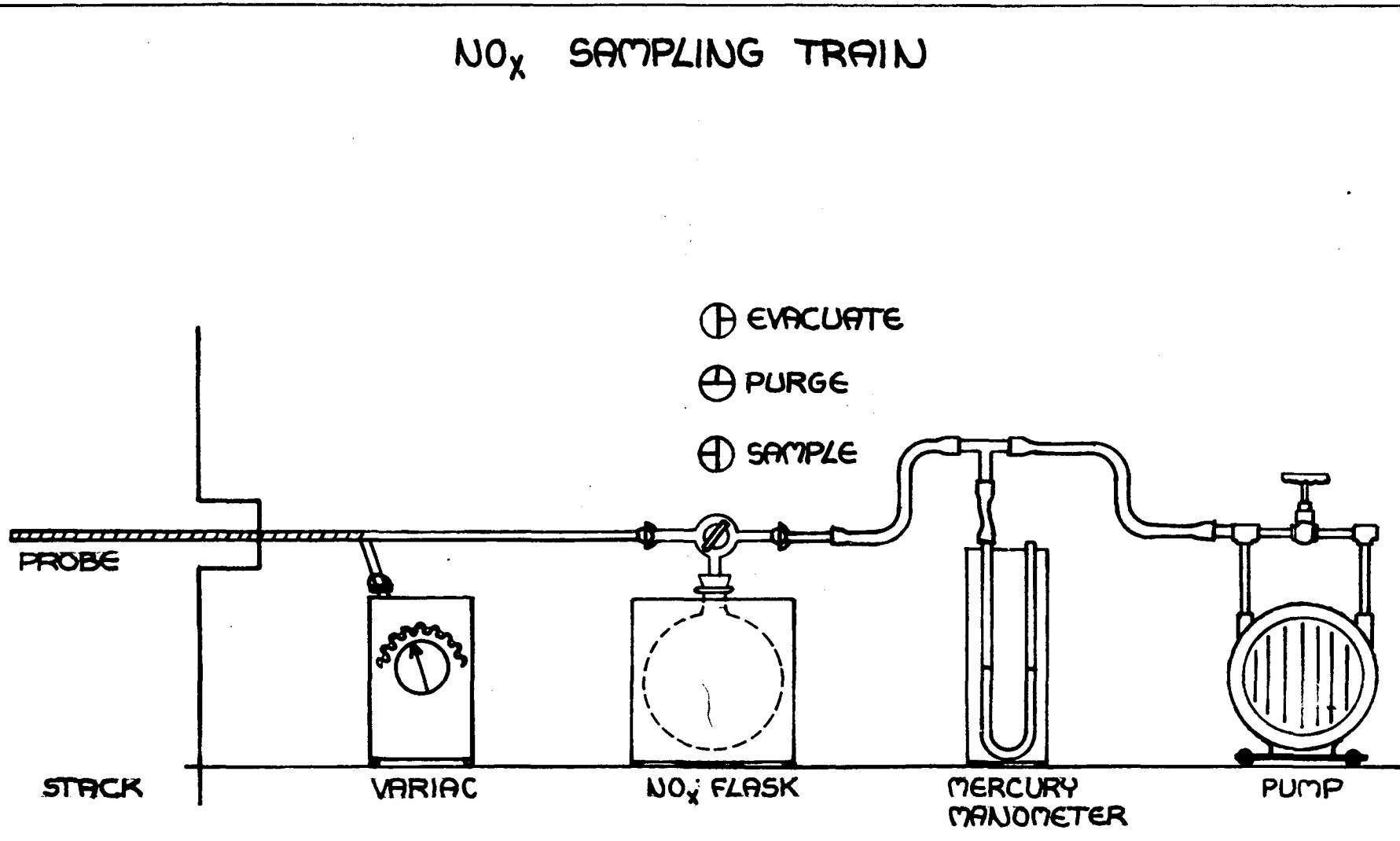

NOx SAMPLING TRAIN
EVACUATE
PURGE
SAMPLE
PROBE
STACK
VARIAC
NOx FLASK
MERCURY MANOMETER
PUMP

FIGURE A5

of the flasks were transferred to 4-ounce plastic sample bottles; each flask and tee was rinsed twice with distilled water and the rinse added to the sample bottle. The collection efficiency was above 98 percent, and the precision was ± 5 percent.

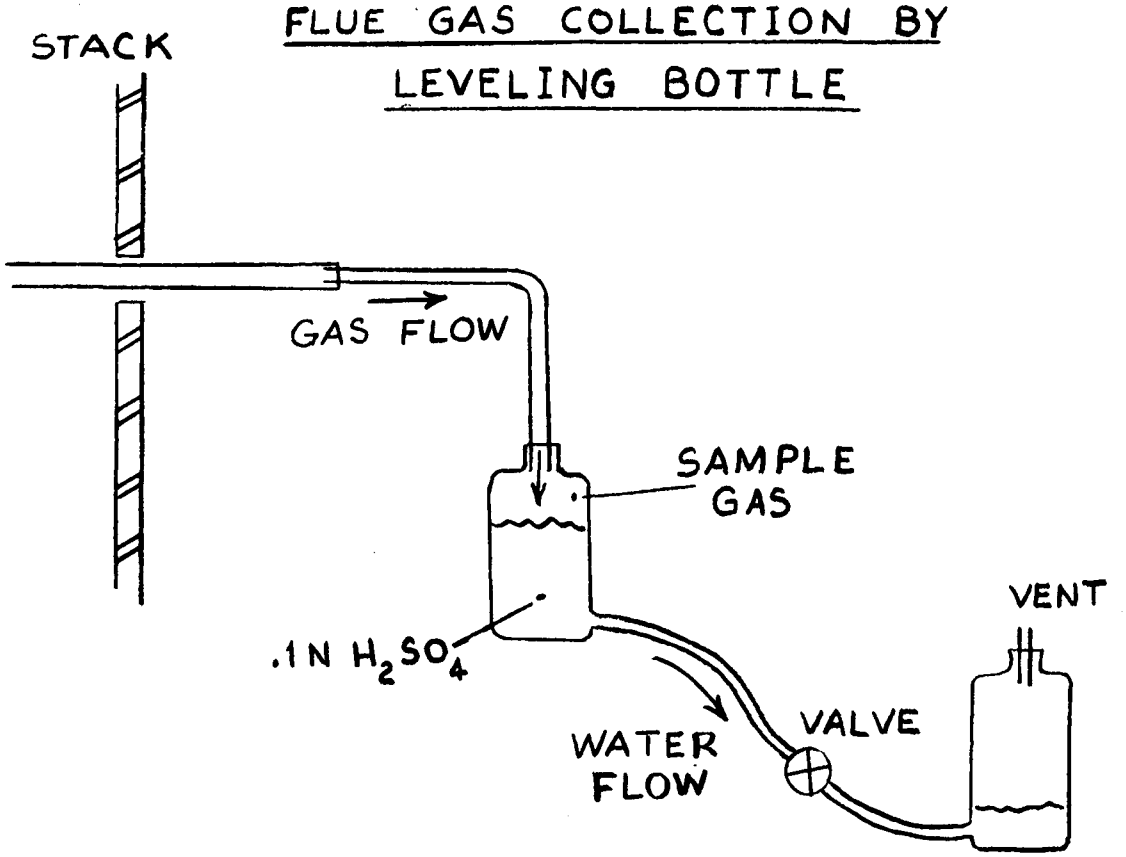
Moisture

Moisture tests were performed through the use of a Panametrics Model 2000 hygrometer. The hygrometer is a sensitive instrument for measurement of water vapor pressure that utilizes an aluminum oxide probe placed inside a stainless case through which a continuous stream of sample gas is pulled. Each probe is individually calibrated and comes with a curve of dew point versus meter reading. Computation of moisture concentration is performed by measuring gauge pressure of the gas stream and application toward a nomograph. The accuracy is within 1 percent absolute error.

At the inlet location the positive pressure of the gas stream pushed a sample through the probe holder, while a vacuum pump was utilized at the outlet. A 1-hour conditioning period for each test at each location assured that readings were not affected by residual moisture in the holder.

Orsat

Orsat analyses were performed on-site. Samples were obtained with two plastic 5-gallon leveling bottles. The bottles were set at unequal levels with the higher filled with a dilute solution of sulfuric acid/methyl red indicator while the lower bottle remained empty. With a rubber tube from a stainless steel probe inserted into the stack to the top of the higher bottle, the solution was allowed to flow to the lower bottle. After a suitable period of time, the tube ends were sealed and the sample analyzed (see Figure A6).


FLUE GAS COLLECTION BY
LEVELING BOTTLE
STACK
GAS FLOW
SAMPLE
GAS
VENT
.1 N H_2SO_4
WATER
FLOW
VALVE

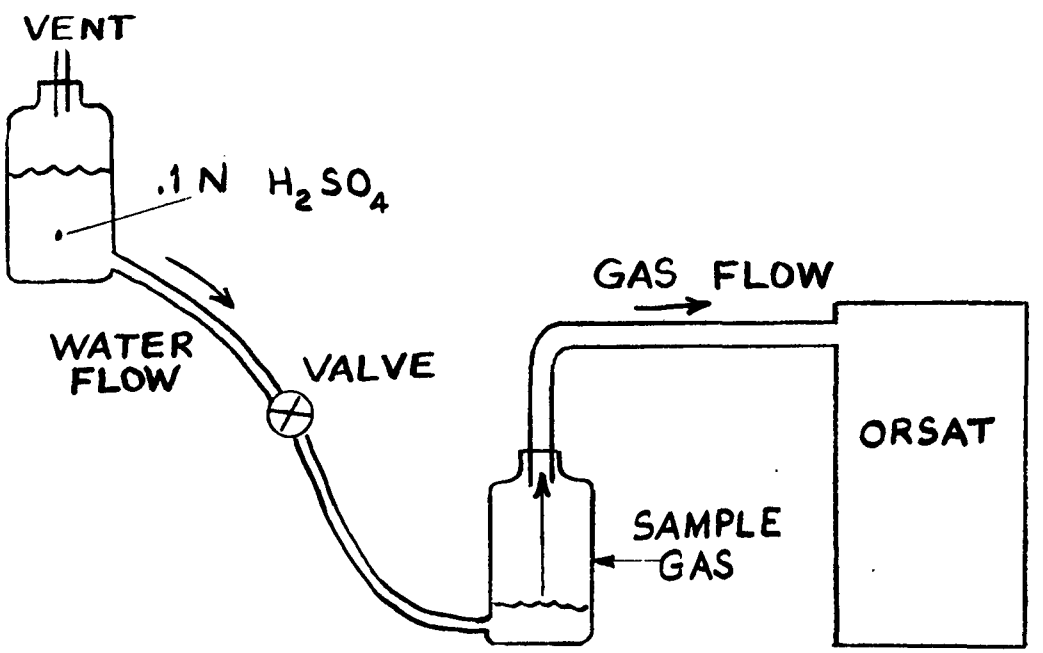

ORSAT SAMPLE ANALYSIS
VENT
.1 N H_2SO_4
GAS FLOW
WATER
FLOW
VALVE
ORSAT
SAMPLE
GAS

FIGURE # A6

APPENDIX D

EXAMPLE CALCULATIONS FOR WET TESTS

(1) Weight of Component Found in Sample:

$$\text{mg in sample} = \frac{\text{microliters of comp.}}{\text{liters of liquid sample}} \times \text{liters of liquid sample} \times \text{specific gravity of component}$$

(2) Parts per Million by Volume in Stack Gas:

$$\text{ppm/V} = \frac{\text{mg in sample}}{\text{std. cu ft dry gas sampled}} \times \frac{387 \text{ cu ft}}{\text{mole}} \times \frac{1 \text{ mole}}{\text{MW}} \times \frac{1 \text{ lb}}{454{,}000 \text{ mg}} \times \frac{1}{10^{-6}}$$

(3) Pounds per Hour in Stack Gas:

$$\text{lb/hr} = \frac{\text{mg in sample}}{\text{std. cu ft dry gas sampled}} \times Q \times \frac{60 \text{ min}}{1 \text{ hr}} \quad \frac{1 \text{ lb}}{454{,}000 \text{ mg}}$$

where: Q = inlet flow rate as calculated by plant personnel

APPENDIX E

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO_2 ton acid
2/4	A2	1915	4:30	2655	202.4	83	6.33	147	882.3		
2/4	A1	2345	4:45	2335	178.0	83	6.33	144	815.4		
2/5	A2	0430	5:00	2495	190.2	75	5.72	132	922.4	127.00	.79
2/5	A1	0930	4:20	2400	182.9	67	5.11	111	800.1		
2/5	A2	1350	5:05	2810	208.3	71	5.26	138	1015.2		
2/5	A1	1855	4:15	2535	187.9	76	5.63	144	774.6		
2/5	A2	2310	4:35	2720	201.7	64	4.74	126	886.3		
2/6	A1	0345	4:35	2795	207.2	85	6.30	165	920.8	188.26	1.18
2/6	A2	0820	5:10	3065	227.2	111	8.23	183	1131.3		
2/6	A1	1330	5:00	3045	225.7	123	9.12	207	1082.9		
2/6	A2	1830	5:00	3230	239.5	107	7.93	195	1157.9		
2/6	A1	2330	5:00	2980	220.9	103	7.64	192	1066.3		
2/7	A2	0430	5:00	2715	201.3	66	4.89	129	982.1	133.44	.83
2/7	A1	0930	3:30	2600	192.8	76	5.63	135	655.1		
2/7	A2	1300	5:30	2375	176.1	102	7.56	120	927.0		
2/7	A1	1830	4:30	2495	185.0	57	4.23	123	813.5		
2/7	A2	2300	4:30	2755	204.2	74	5.49	141	894.2		
2/8	A1	0330	4:40	2610	193.5	76	5.63	153	876.1	133.06	.83
2/8	A2	0810	4:30	2805	208.0	61	4.52	144	915.7		
2/8	A1	1240	4:35	3330	249.9	80	5.93	162	1118.2		
2/8	A2	1715	4:30	3440	255.0	81	6.01	138	1120.5		
2/8	A1	2145	4:30	3290	243.9	76	5.63	135	1072.2		

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO2 ton acid
2/9	A2	0215	4:30	3080	228.3	62	4.60	111	1006.7	111.74	.70
2/9	A1	0645	4:30	3060	226.9	63	4.67	117	1000.0		
2/9	A2	1115	4:30	2750	203.9	68	5.04	114	894.9		
2/9	A1	1545	4:30	2590	192.0	67	4.97	123	841.6		
2/9	A2	2015	4:05	2605	193.1	54	4.00	96	772.2		
2/11	A2	2045	4:30	2885	213.9	40	2.97	72	949.2		.45
2/12	A1	0115	4:30	3090	229.1	49	3.63	105	1014.6	92.21	.58
2/12	A2	0545	4:30	3230	239.5	50	3.71	111	1061.6		
2/12	A1	1015	4:40	3460	256.5	77	5.71	129	1170.4		
2/12	A2	1455	4:35	2945	218.3	45	3.34	87	985.2		
2/12	A1	1930	4:30	2745	203.5	38	2.82	72	903.1		
2/13	A2	0001	4:30	2740	203.1	28	2.07	57	904.6		
2/13	A1	2245	4:30	2780	205.5	46	3.40	75	909.5		
2/14	A2	0315	4:30	2990	221.1	33	2.44	72	984.0	80.21	.50
2/14	A1	0745	4:30	3065	336.6	53	3.92	123	1002.1		
2/14	A2	1215	4:35	3235	239.2	49	3.62	96	1060.1		
2/14	A1	1650	4:30	2960	218.9	51	3.77	96	968.1		
2/14	A2	2120	4:35	2920	215.9	40	2.96	78	976.0		
2/15	A1	0155	4:30	3250	240.3	63	4.66	126	1060.4	114.58	.72
2/15	A2	0625	4:35	3305	244.4	52	3.84	102	1102.6		
2/15	A1	1100	4:35	3335	246.6	64	4.73	132	1108.6		
2/15	A2	1530	4:30	3635	268.8	62	4.58	129	1189.0		
2/15	A1	2000	4:40	3545	262.1	82	6.06	183	1194.9		

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO_2 ton acid
2/16	A2	0040	4:35	3460	255.8	71	5.25	126	1148.4	107.32	.67
2/16	A1	0515	4:25	3195	236.2	62	-	126	1023.0		
2/16	A2	0940	4:35	3300	244.0	53	3.92	105	1100.4		
2/16	A1	1415	4:30	3120	230.7	56	4.14	117	1019.5		
2/16	A2	1845	4:30	3360	248.4	54	3.99	111	1099.8		
2/16	A1	2315	4:40	3385	250.3	67	4.95	126	1145.0		
2/17	A2	0355	4:25	3145	232.5	50	3.70	78	1010.5	109.30	.68
2/17	A1	0820	4:30	2945	217.7	55	4.07	108	961.3		
2/17	A2	1250	4:40	2810	207.8	51	3.77	144	952.1		
2/17	A1	1730	4:30	-	-	85	6.28	162	-		
2/17	A2	2200	4:30	-	-	67	4.95	126	-		
2/18	A1	0230	4:30	-	-	78	5.76	165	-	139.78	.87
2/18	A2	0700	4:30	-	-	64	4.73	135	-		
2/18	A1	1130	4:30	4080	301.7	94	6.95	192	1326.4		
2/18	A2	1600	4:30	-	-	94	6.95	135	-		
2/18	A1	2030	4:30	3510	259.5	64	4.73	120	1146.5		
2/19	A2	0100	4:40	3550	264.5	54	3.99	117	1215.7	158.30	.99
2/19	A1	0550	4:35	4130	305.4	97	7.17	195	1366.9		
2/19	A2	1025	4:30	4445	328.7	84	6.21	153	1451.2		
2/19	A1	1455	4:35	4495	332.0	113	8.36	213	1483.3		
2/19	A2	1920	4:40	4620	341.6	98	7.25	174	1560.3		
2/20	A1	0001	4:25	4490	332.0	110	8.13	198	1430.4	155.76	.97
2/20	A2	0425	4:35	4500	332.7	87	6.43	162	1495.4		
2/20	A1	0900	4:30	4245	313.9	97	7.17	183	1380.3		

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO_2 ton acid
2/20	A2	1330	4:35	4215	318.1	75	5.66	150	1432.0		
2/20	A1	1805	4:25	4065	306.8	89	6.72	174	1325.4		
2/20	A2	2230	4:35	3980	300.4	64	4.83	126	1354.7		
2/21	A1	0305	4:30	3750	283.0	72	5.43	141	1249.1	131.47	.82
2/21	A2	0735	4:25	3700	279.3	59	4.45	123	1213.9		
2/21	A1	1200	4:40	3645	275.1	75	5.66	159	1257.4		
2/21	A2	1640	4:40	4000	301.9	70	5.28	141	1384.2		
2/21	A1	2110	4:30	3980	300.4	87	6.57	162	1332.2		
2/22	A2	0140	4:50	3915	295.5	67	5.06	129	1403.8	146.35	.91
2/22	A1	0630	4:15	3870	292.1	81	6.11	159	1215.5		
2/22	A2	1045	4:35	3830	389.1	64	4.83	138	1302.9		
2/22	A1	1520	4:30	4205	317.4	112	8.45	186	1390.3		
2/22	A2	1950	4:30	4270	322.3	80	6.04	138	1423.2		
2/23	A1	0020	4:35	4005	302.3	97	7.32	183	1352.0	155.20	.97
2/23	A2	0455	4:35	4170	314.7	70	5.28	174	1418.2		
2/23	A1	0930	4:30	4250	320.8	109	8.23	198	1406.6		
2/23	A1	1400	4:30	4164	314.4	73	5.51	123	1390.0		
2/23	A1	1830	4:35	4255	321.7	91	6.87	181	1443.0		
2/23	A2	2305	4:25	4200	317.0	74	5.59	156	1375.4		
2/24	A1	0330	4:40	4105	309.8	99	7.47	189	1410.9	183.26	1.15
2/24	A2	0810	4:00	4540	342.7	91	6.87	195	1343.3		
2/24	A1	1210	6:05	-	-	130	9.81	204	-		
2/24	A2	1815	4:00	4500	339.7	72	5.43	138	1337.1		
2/24	A1	2215	3:55	4700	354.8	114	8.60	207	1355.9		

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO_2 ton acid
2/25	A2	0210	4:00	4800	362.7	87	6.57	156	1424.5		
2/25	A1	0610	4:00	4645	350.6	99	7.47	174	1372.5		
2/26	A2	1010	4:10	-	-	100	7.55	186	-	199.32	1.25
2/26	A1	1420	4:15	-	-	129	9.74	237	-		
2/26	A2	1835	4:20	-	-	100	7.55	189	-		
2/26	A1	2255	4:10	-	-	111	8.38	195	-		
2/27	A2	0305	4:15	-	-	85	6.42	195	-	188.06	1.18
2/27	A1	0720	4:20	-	-	147	11.10	270	-		
2/27	A2	1140	4?10	4520	341.2	110	8.30	192	1387.1		
2/27	A1	1550	4:20	4020	303.4	107	8.08	171	1279.7		
2/27	A2	2010	4:20	3935	297.0	70	5.28	141	1264.1		
2/28	A1	0020	4:15	3930	296.6	101	7.62	174	1228.2	186.52	1.17
2/28	A2	0435	4:10	4000	301.9	77	5.81	144	1233.7		
2/28	A1	0845	4:15	4075	307.6	103	7.77	213	1274.3		
2/28	A2	1300	4:15	4290	323.8	86	6.49	168	1348.6		
2/28	A1	1715	4:15	4420	333.6	141	10.64	255	1372.6		
2/28	A2	2130	4:15	4615	348.3	110	8.30	237	1445.0		
3/1	A1	0145	4:15	4275	322.7	136	10.27	216	1327.8	196.52	1.23
3/1	A2	0600	4:10	4150	313.2	75	5.66	144	1281.4		
3/1	A1	1010	4:05	4100	309.5	134	10.11	249	1222.5		
3/1	A2	1415	4:15	4040	304.9	101	7.62	177	1263.4		
3/1	A1	1830	4:15	3765	284.2	99	7.47	207	1176.1		
3/1	A2	2245	4:15	4225	318.9	106	8.00	216	1321.3		

SO_2 SUMMARY DATA (ENGLISH UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	lb/hr Avg Inlet	ppm Avg Outlet	lb/hr Avg Outlet	ppm Max Outlet	lb/cycle Adsorbed	lb/day Outlet	lb SO_2 ton acid
3/2	A1	0300	4:15	4265	321.9	152	11.47	282	1319.3	204.34	1.28
3/2	A2	0715	4:15	4365	329.5	118	8.91	234	1362.5		
3/2	A1	1130	4:30	4150	313.2	116	8.76	198	1370.0		
3/2	A2	1600	4:20	4090	308.7	75	5.66	147	1313.2		
3/2	A1	2020	4:05	3965	299.3	103	7.77	171	1190.4		
3/3	A2	0025	4:20	4100	309.5	68	5.13	150	1318.9		
3/3	A1	0445	4:00	3905	294.7	91	6.87	159	1151.3		

APPENDIX F

SO_2 SUMMARY DATA (METRIC UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	$kgSO_2$/ metric ton acid
2/4	A2	1915	4:30	2655	91.98	83	2.87	147	400.6		
2/4	A1	2345	4:45	2335	80.91	83	2.87	144	370.2		
2/5	A2	0430	5:00	2495	86.35	75	2.60	132	418.8	47.66	.40
2/5	A1	0930	4:20	2400	83.04	67	2.32	111	363.2		
2/5	A2	1350	5:05	2810	94.57	71	2.39	138	460.9		
2/5	A1	1855	4:15	2535	85.31	76	2.56	144	351.7		
2/5	A2	2310	4:35	2729	91.57	64	2.15	126	402.4		
2/6	A1	0345	4:35	2795	94.07	85	2.86	165	418.0	85.47	.59
2/6	A2	0820	5:10	3065	103.15	111	3.74	183	513.6		
2/6	A1	1330	5:00	3045	102.47	123	4.14	207	491.6		
2/6	A2	1830	5:00	3230	108.73	107	3.60	195	525.7		
2/6	A1	2330	5:00	2980	100.29	103	3.47	192	484.1		
2/7	A2	0430	5:00	2715	91.39	66	2.22	129	445.9	60.58	.42
2/7	A1	0930	3:30	2600	87.53	76	2.56	135	297.4		
2/7	A2	1400	5:30	2375	79.95	102	3.43	120	420.9		
2/7	A1	1830	4:30	2495	83.99	57	1.92	123	369.3		
2/7	A2	2300	4:30	2755	92.71	74	2.49	141	406.0		
2/8	A1	0330	4:40	2610	87.85	76	2.56	153	398.0	60.41	.42
2/8	A2	0810	4:30	2805	94.43	61	2.05	144	415.7		
2/8	A1	1240	4:35	3330	113.45	80	2.69	162	507.7		
2/8	A2	1715	4:30	3440	115.77	81	2.73	138	508.7		
2/8	A1	2145	4:30	3290	110.73	76	2.56	135	486.8		
2/9	A2	0215	4:30	3080	103.65	62	2.09	111	457.0	50.73	.35

SO_2 SUMMARY DATA (METRIC UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	$kgSO_2$/ metric ton acid
2/9	A1	0645	4:30	3060	103.01	63	2.12	117	454.0		
2/9	A2	1115	4:30	2750	92.57	68	2.29	114	406.3		
2/9	A1	1545	4:30	2590	87.17	67	2.26	123	382.1		
2/9	A2	2015	4:00	2605	87.67	54	1.82	96	350.6		
2/11	A2	2045	4:30	2885	97.11	40	1.35	72	430.9		
2/12	A1	0115	4:30	3090	104.01	49	1.65	105	460.6	41.86	.29
2/12	A2	0545	4:30	3230	108.73	50	1.68	111	482.0		
2/12	A1	1015	4:40	3460	116.45	77	2.59	129	531.4		
2/12	A1	1455	4:35	2945	99.11	45	1.52	87	447.3		
2/12	A1	1930	4:31	2745	92.39	38	1.28	72	410.0		
2/13	A1	0001	4:50	2740	92.21	28	.94	57	410.7		
2/13	A1	2245	4:30	2780	93.30	46	1.54	75	412.9		
2/14	A2	0315	4:30	2990	100.38	33	1.11	72	446.7	36.42	.25
2/14	A1	0745	4:30	3065	102.88	53	1.78	123	455.0		
2/14	A2	1215	4:35	3235	108.60	49	1.64	96	481.3		
2/14	A1	1650	4:30	2960	99.38	51	1.71	96	439.5		
2/14	A2	2120	4:35	2920	98.02	40	1.34	78	443.1		
2/15	A1	0155	4:30	3250	109.10	62	2.12	126	481.4	52.02	.36
2/15	A2	0625	4:35	3305	110.96	52	1.74	102	500.6		
2/15	A1	1100	4:30	3335	111.96	64	2.15	132	503.3		
2/15	A2	1530	4:30	3635	122.04	62	2.08	129	539.8		
2/15	A1	2000	4:40	3545	118.99	82	2.75	183	542.5		

SO_2 SUMMARY DATA (METRIC UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	kgSO_2/ metric ton acid
2/16	A2	0040	4:35	3460	116.13	71	2.38	126	521.4	48.72	.34
2/16	A1	0515	4:25	3195	107.23	62	2.08	126	464.4		
2/16	A2	0940	4:35	3300	110.78	53	1.78	105	490.5		
2/16	A1	1415	4:30	3120	104.74	56	1.88	117	462.19		
2/16	A2	1845	4:30	3360	112.77	54	1.81	111	499.3		
2/16	A1	2315	4:40	3385	113.64	67	2.25	126	519.8		
2/17	A2	0355	4:25	3145	105.56	50	1.68	78	458.8	49.62	.34
2/17	A1	0820	4:30	2945	98.84	55	1.85	108	436.4		
2/17	A2	1250	4:40	2810	94.34	51	1.71	144	432.3		
2/17	A1	1730	4:30	-	-	85	2.85	162	-		
2/17	A2	2200	4:50	-	-	67	2.25	126	-		
2/18	A1	0230	4:30	-	-	78	2.62	165	-	63.46	.44
2/18	A2	0700	4:30	3090	-	64	2.15	135	-		
2/18	A1	1130	4:30	4080	136.97	94	3.16	192	602.2		
1/18	A2	1600	4:30	-	-	94	3.15	135	-		
2/18	A1	2030	4:30	3510	117.81	64	2.15	120	520.5		
2/19	A2	0100	4:50	3550	120.08	54	1.81	117	551.9	71.87	.49
2/19	A1	0550	4:35	4130	138.65	97	3.26	195	620.6		
2/19	A2	1025	4:30	4445	149.23	84	2.82	153	658.8		
2/19	A1	1455	4:25	4495	150.73	113	3.80	213	673.4		
2/19	A2	1920	4:41	4620	155.09	98	3.29	174	708.4		
2/20	A1	0001	4:24	4490	150.73	110	3.69	198	649.4	70.72	.49
2/20	A2	0425	4:35	4500	151.05	87	2.92	162	678.9		
2/20	A1	0900	4:30	4245	142.51	97	3.26	183	626.1		

SO_2 SUMMARY DATA (METRIC UNITS)

Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	$kgSO_2$/ metric ton acid
2/20	A2	1330	4:35	4215	144.42	75	2.56	150	650.1		
2/20	A1	1805	4:25	4065	139.29	89	3.05	174	601.7		
2/20	A2	2230	4:25	3980	136.38	64	2.19	126	615.0		
2/21	A1	0305	4:30	3750	128.48	72	2.47	141	567.1	59.69	.41
2/21	A2	0735	4:25	3700	126.80	59	2.02	123	551.1		
a/a1	A1	1200	4:40	3645	124.90	75	2.57	159	570.9		
2/21	A2	1640	4:30	4000	137.06	70	2.40	141	628.4		
2/21	A1	2110	4:30	3980	136.38	87	2.98	162	604.8		
2/22	A2	0140	4:50	3915	134.16	67	2.30	129	637.3	66.44	.46
2/22	A1	0630	4:15	3870	132.61	81	2.77	159	551.8		
2/22	A2	1045	4:35	3830	131.25	64	2.19	138	591.5		
2/22	A1	1520	4:30	4205	144.10	112	3.84	186	631.2		
2/22	A2	1950	4:30	4270	146.32	80	2.74	138	646.1		
2/23	A1	0020	4:35	4005	137.24	97	3.32	183	613.8	70.46	.49
2/23	A2	0455	4:35	4170	142.87	70	2.40	174	643.9		
2/23	A1	0930	4:30	4250	145.64	109	3.74	198	636.6		
2/23	A2	1400	4:30	4165	142.74	73	2.50	123	631.1		
2/23	A1	1830	4:35	4255	146.05	91	3.12	171	655.1		
2/23	A2	2305	4:25	4200	143.92	74	2.54	156	624.4		
2/24	A1	0330	4:45	4105	140.65	99	3.39	189	640.5	83.20	.57
2/24	A2	0810	4:00	4540	155.59	91	3.12	195	609.9		
2/24	A1	1210	6:05	-	-	130	4.45	204	-		
2/24	A2	1815	4:00	4500	154.22	72	2.47	138	607.0		
2/24	A1	2215	3:55	4600	161.08	114	3.90	207	615.6		

SO_2 SUMMARY DATA (METRIC UNITS)

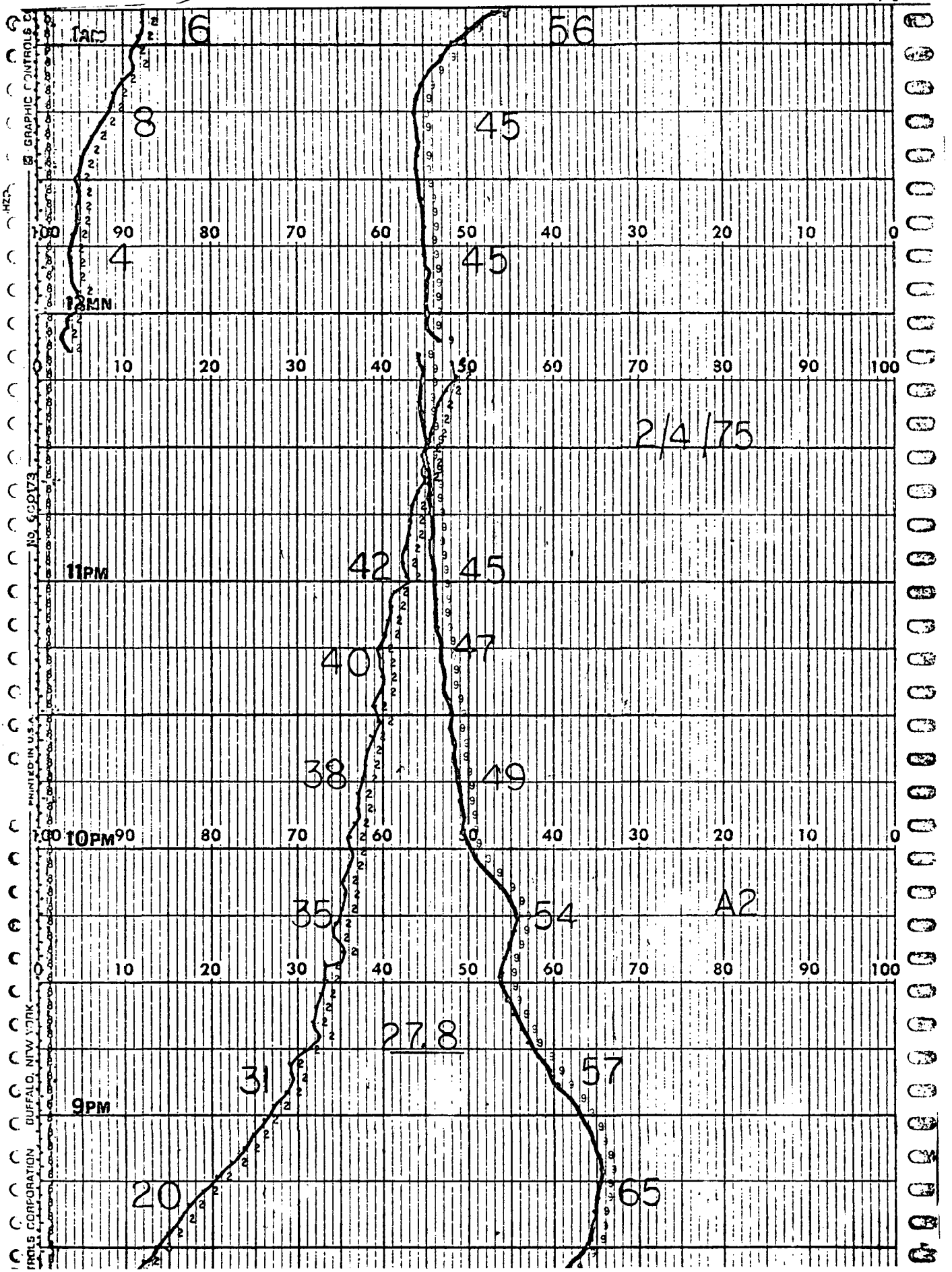
Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	$kgSO_2$/ metric ton acid
2/25	A2	0210	4:00	4800	164.67	87	2.98	156	646.7		
2/25	A1	0610	4:00	4645	159.17	99	3.39	174	623.1		
2/26	A2	1010	4:10	-	-	100	3.43	186	-	90.49	.62
2/26	A1	1420	4:15	-	-	129	4.42	237	-		
2/26	A2	1835	4:20	-	-	100	3.43	189	-		
2/26	A1	2255	4:10	-	-	111	3.80	195	-		
2/27	A2	0305	4:15	-	-	85	2.91	195	-	83.38	.59
2/27	A1	0720	4:20	-	-	147	5.04	270	-		
2/27	A2	1140	4:10	4520	154.90	110	3.77	192	629.7		
2/27	A1	1550	4:20	4020	137.74	107	3.67	171	581.0		
2/27	A2	2010	4:20	3935	134.84	70	2.40	141	573.9		
2/28	A1	0020	4:15	3930	134.66	101	3.46	174	557.7	84.68	.58
2/28	A2	0435	4:10	4000	137.06	77	2.63	144	560.1		
2/28	A1	0845	4:15	4075	139.65	103	3.53	2.13	578.5		
2/28	A2	1300	4:15	4290	146.01	86	2.95	168	612.3		
2/28	A1	1715	4:15	4420	151.45	141	4.83	255	623.2		
2/28	A2	2130	4:15	4615	158.13	110	3.77	237	656.0		
3/1	A1	0145	4:15	4275	146.51	136	4.66	216	602.8	89.22	.61
3/1	A2	0600	4:10	4150	142.19	75	2.57	144	581.8		
3/1	A1	1010	4:05	4100	140.51	134	4.59	249	555.0		
3/1	A2	1415	4:25	4040	138.42	101	3.46	177	573.6		
3/1	A1	1830	4:15	3765	129.03	99	3.39	207	533.9		
3/1	A2	2245	4:15	4225	144.78	106	3.63	216	599.9		

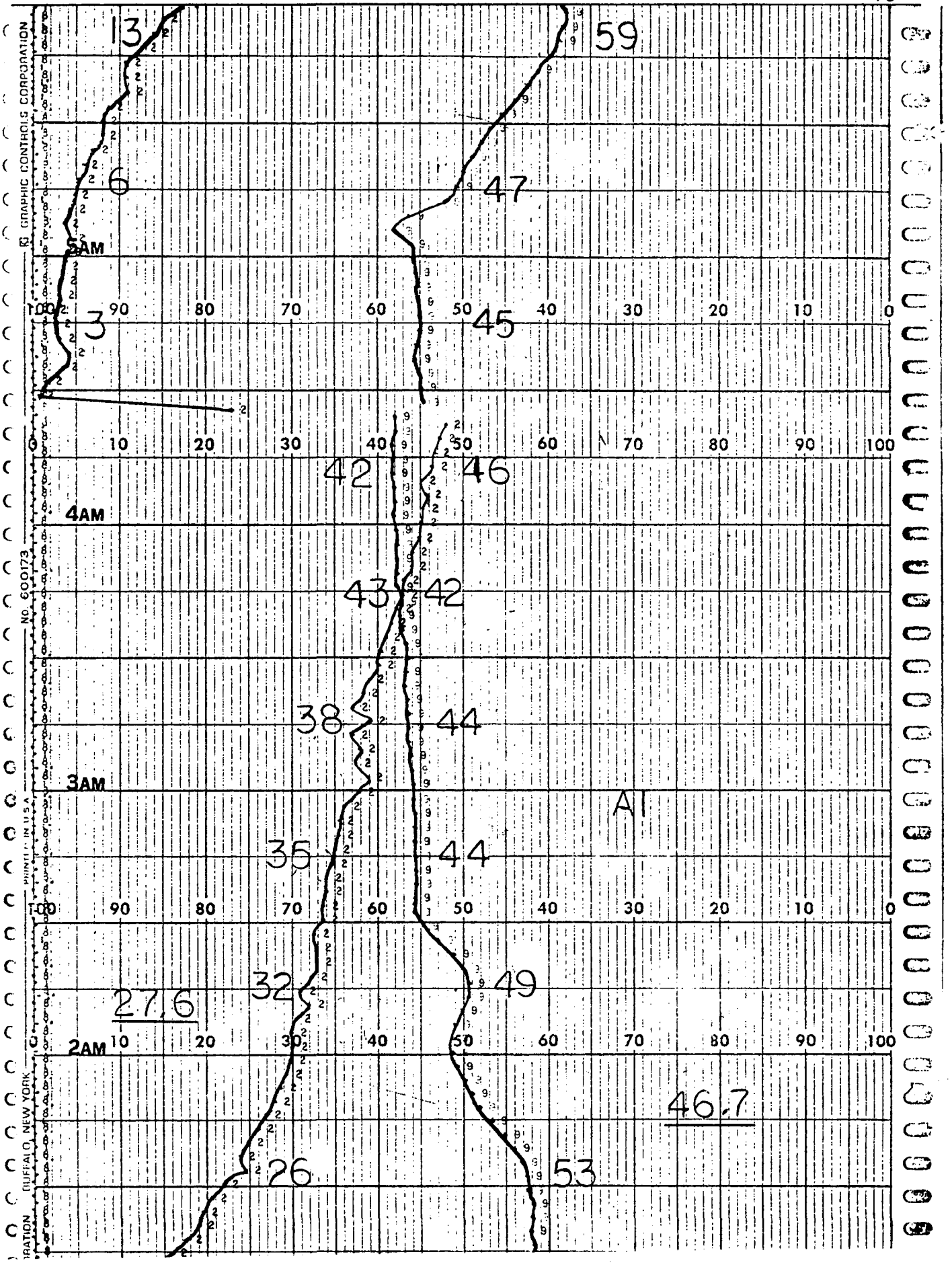
SO_2 SUMMARY DATA (METRIC UNITS)

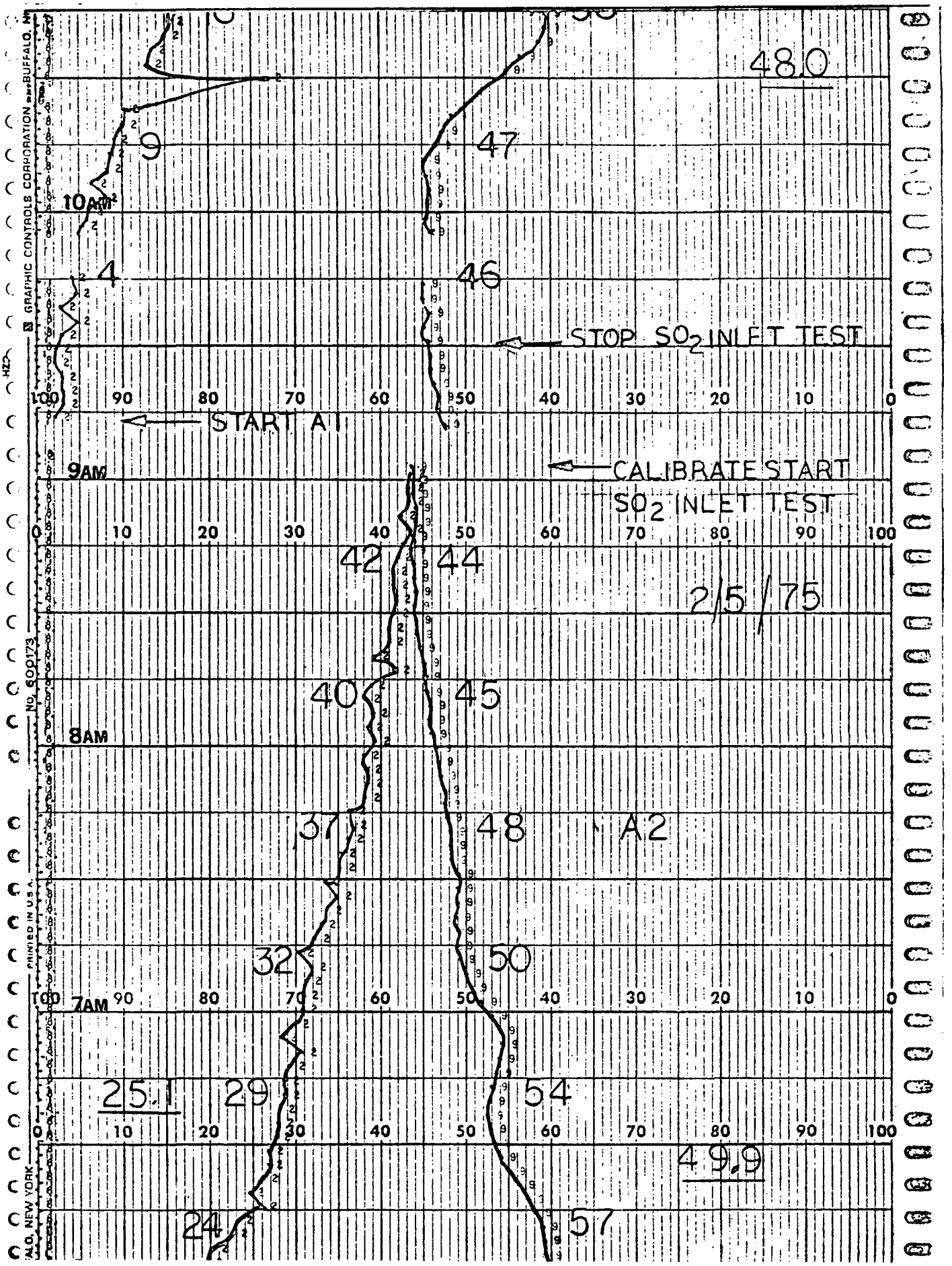
Date	Unit	Time Start	Length of Cycle (hr)	ppm Avg Inlet	kg/hr Avg Inlet	ppm Avg Outlet	kg/hr Avg Outlet	ppm Max Outlet	kg/cycle Adsorbed	kg/day Outlet	$kgSO_2$/ metric ton acid
3/2	A1	0300	4:15	4265	146.14	152	5.21	282	599.0	92.77	.64
3/2	A2	0715	4:15	4365	149.59	118	4.05	234	618.6		
3/2	A1	1130	4:30	4150	142.19	116	3.98	198	622.0		
3/2	A2	1600	4:20	4090	140.15	75	2.57	147	596.2		
3/2	A1	2020	4:05	3965	135.89	103	3.53	171	540.4		
3/3	A2	0025	4:20	4100	140.51	68	2.33	150	598.8		
3/3	A1	0445	4:00	3905	133.79	91	3.12	159	522.7		

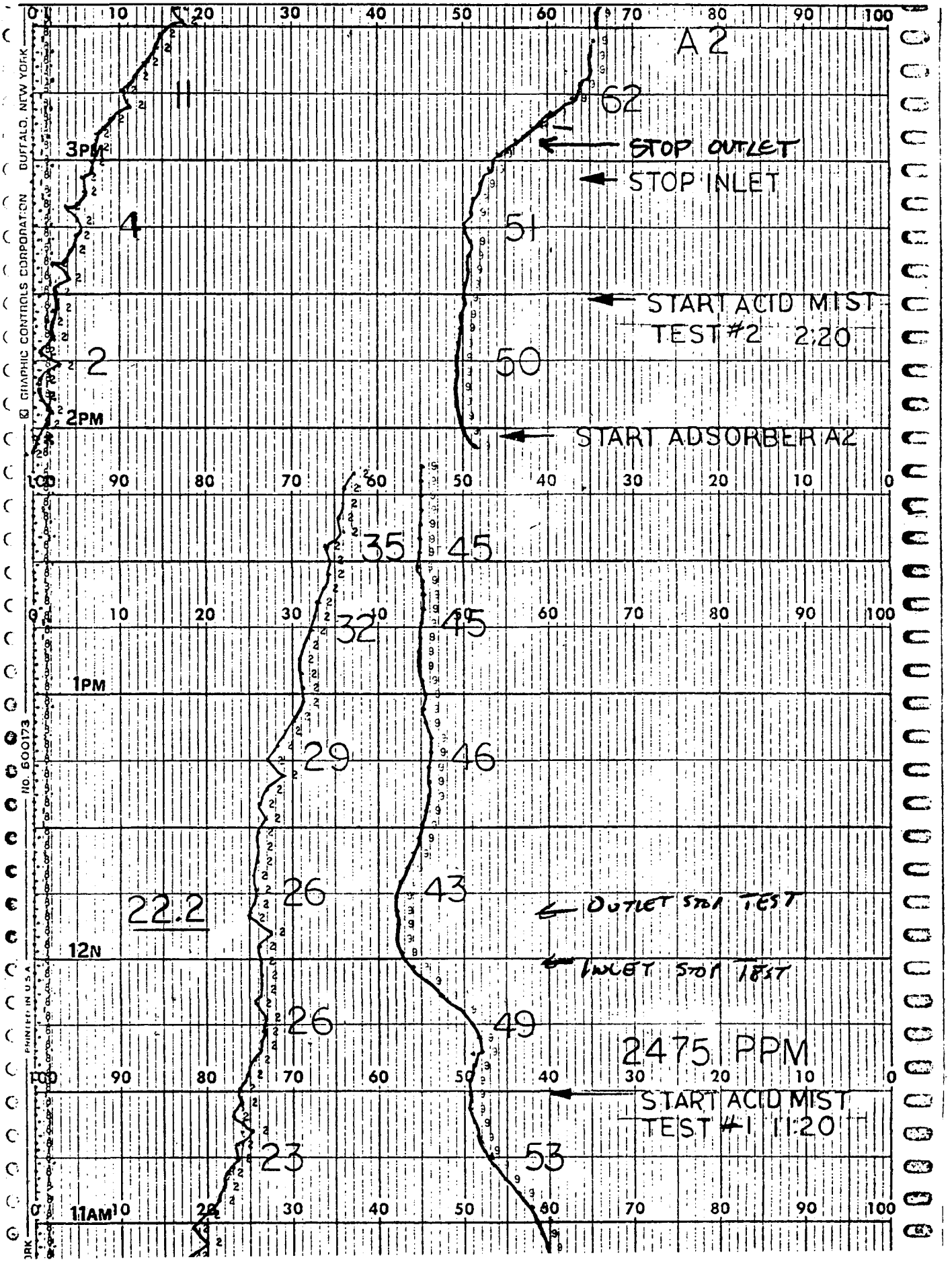
APPENDIX G

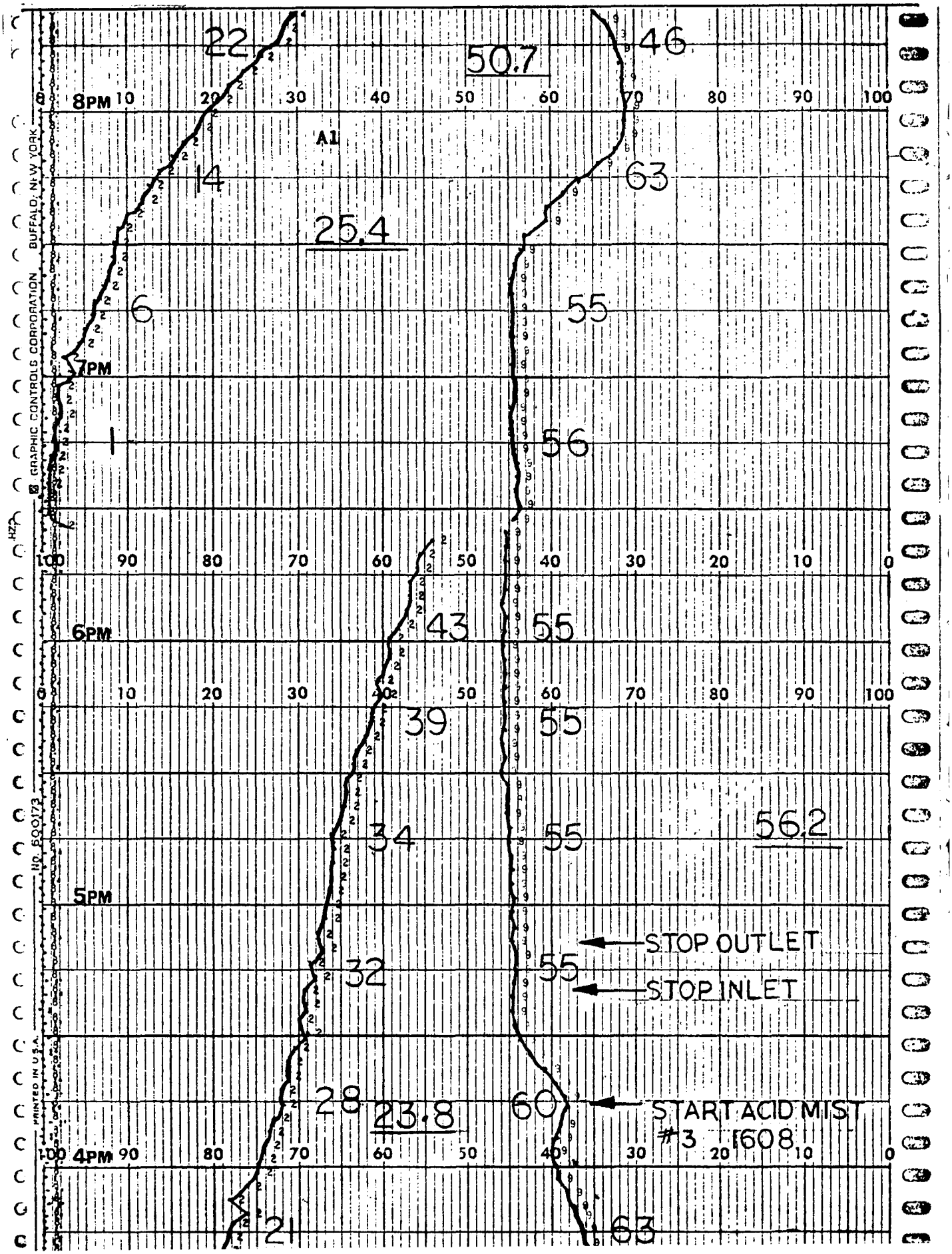
STRIP CHART

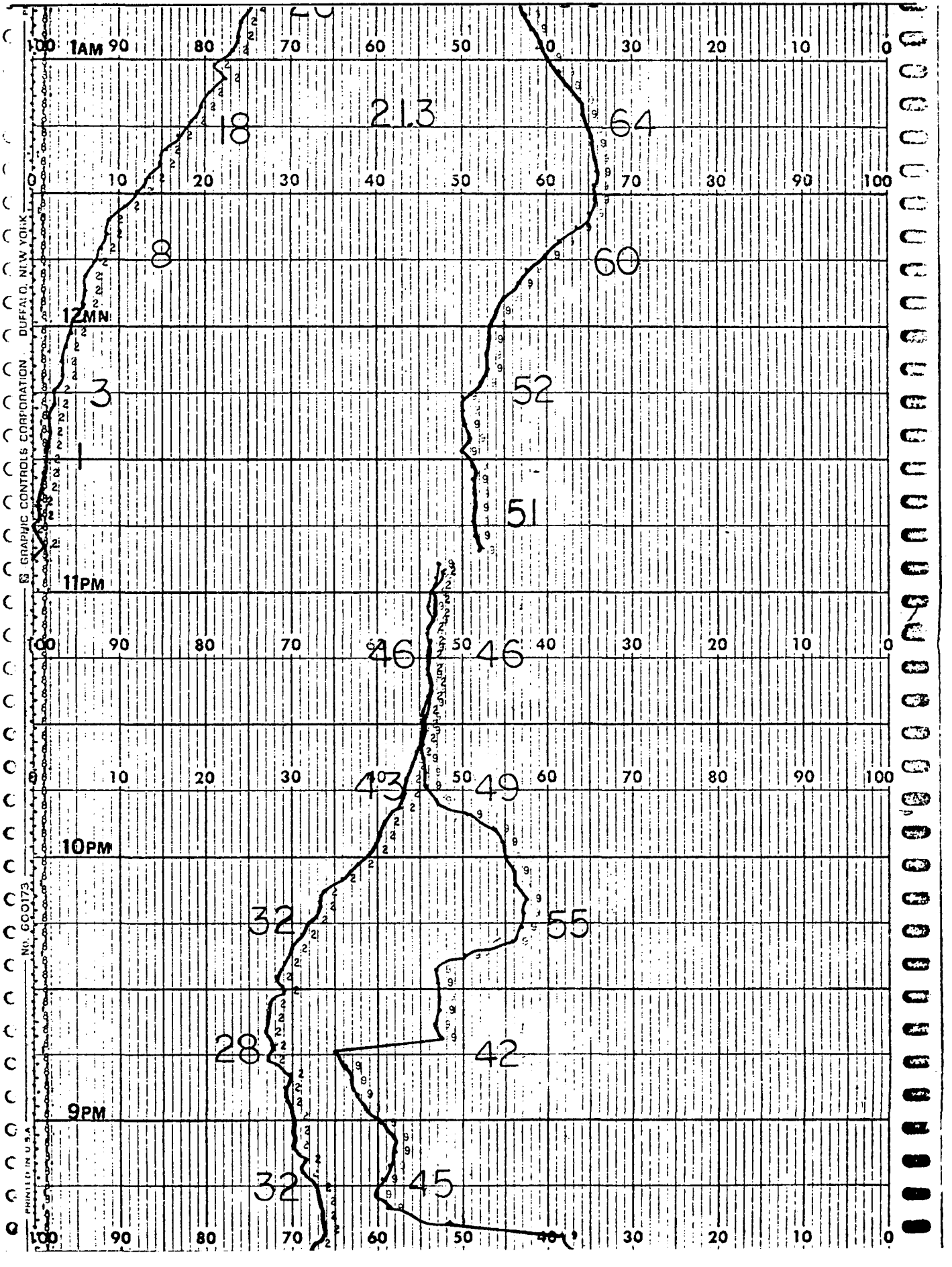

1AM
6
56
8
45
4
45
12MN
2/4/75
11PM
42
45
40
47
38
49
10PM
35
54
A2
27.8
31
57
9PM
20
65
GRAPHIC CONTROLS
BUFFALO, NEW YORK
PRINTED IN U.S.A.

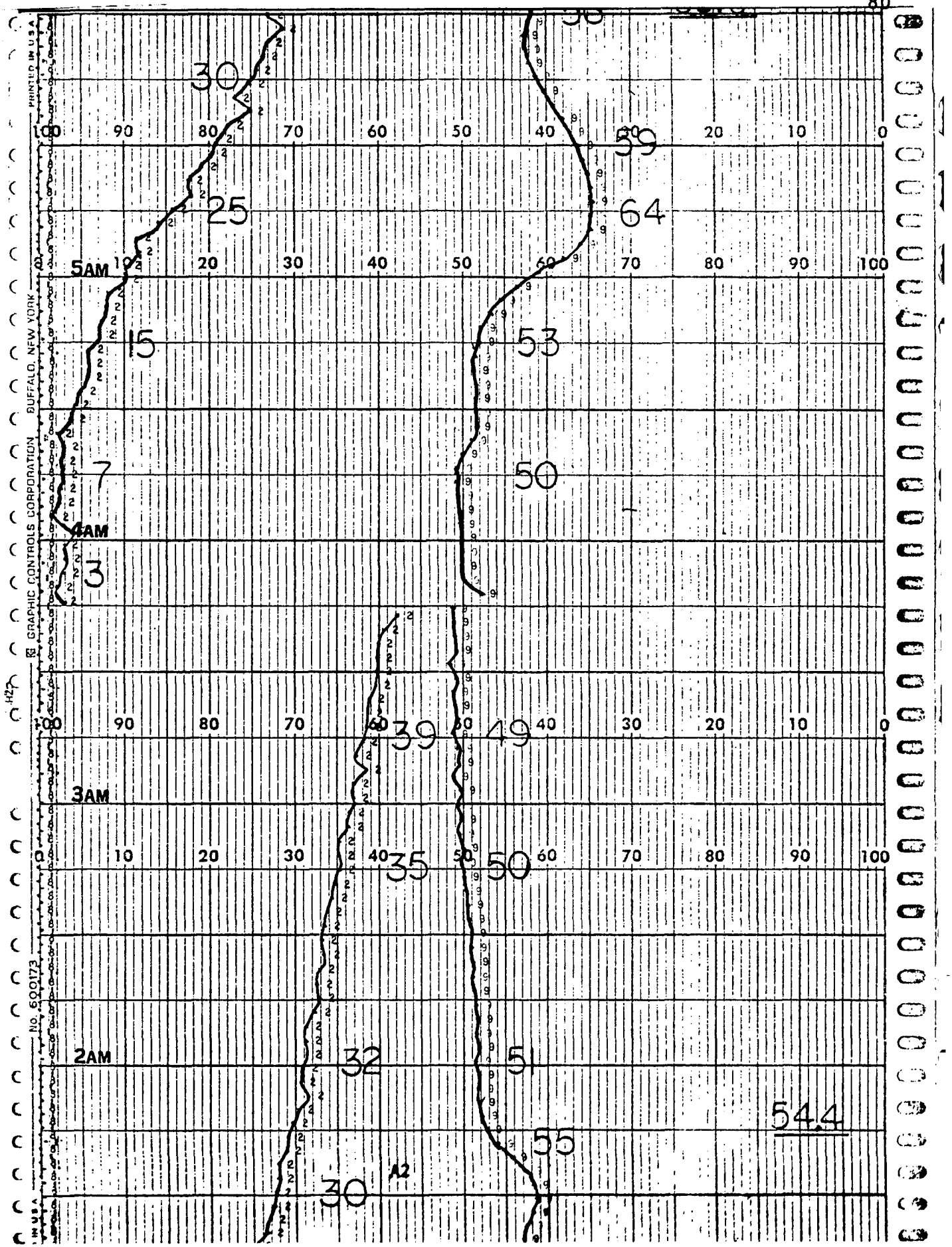

13
59
6
47
5AM
3
45
42
46
4AM
43
42
38
44
3AM
A1
35
44
27.6
32
49
2AM
46.7
26
53
GRAPHIC CONTROLS CORPORATION
NO. 600173
BUFFALO, NEW YORK

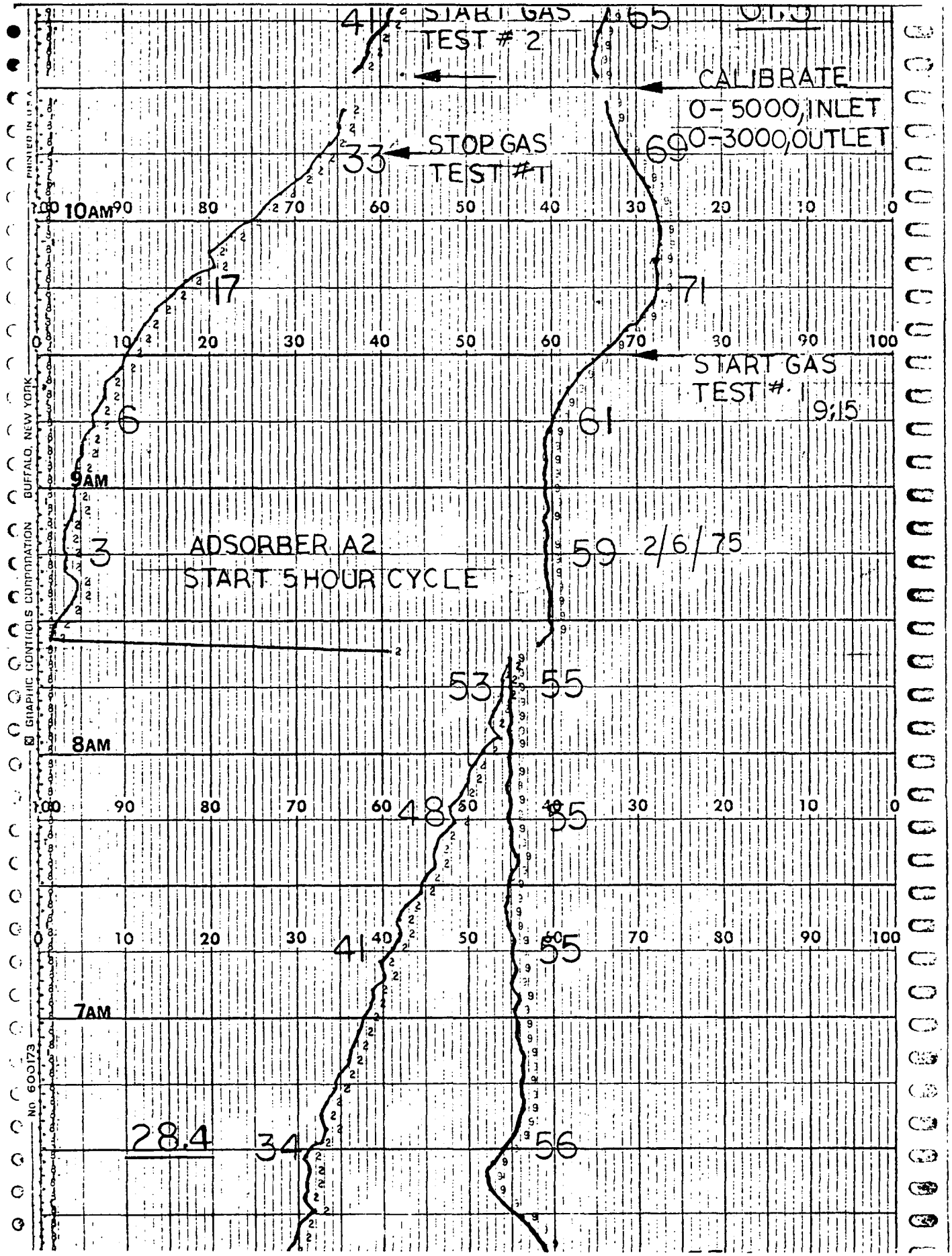

GRAPHIC CONTROLS CORPORATION BUFFALO, NY
NO. 60173
PRINTED IN U.S.A.
NO. NEW YORK
10AM
9AM
8AM
7AM
START A1
STOP SO2 INLET TEST
CALIBRATE START
SO2 INLET TEST
2/5/75
48.0
49.9
25.1
9
4
42
44
40
45
37
48
A2
32
50
29
54
24
57
47
46


A 2
62
STOP OUTLET
STOP INLET
51
START ACID MIST
TEST #2 2:20
50
START ADSORBER A2
35
45
32
45
29
46
26
43
22.2
OUTLET STOP TEST
INLET STOP TEST
26
49
2475 PPM
START ACID MIST
TEST #1 11:20
23
53
3PM
2PM
1PM
12N
11AM
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 60017


8PM
7PM
6PM
5PM
4PM
A1
22
14
6
1
50.7
25.4
46
63
55
56
43
39
34
32
28
23.8
21
55
55
55
55
60
63
56.2
STOP OUTLET
STOP INLET
START ACID MIST
#3 1608
GRAPHIC CONTROLS CORPORATION BUFFALO, N.Y. YORK
NO. 800173
PRINTED IN U.S.A.


1AM
12MN
11PM
10PM
9PM
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
18
213
64
8
60
3
52
1
51
46
46
43
49
32
55
28
42
32
45
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
PRINTED IN U.S.A.


5AM
4AM
3AM
2AM
30
25
15
7
3
39
35
32
30
59
64
53
50
49
50
51
55
54.4
A2
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.


START GAS
TEST # 2
CALIBRATE
0-5000, INLET
0-3000, OUTLET
STOP GAS
TEST #1
START GAS
TEST #1
9:15
ADSORBER A2
START 5 HOUR CYCLE
2/6/75
10AM
9AM
8AM
7AM
28.4
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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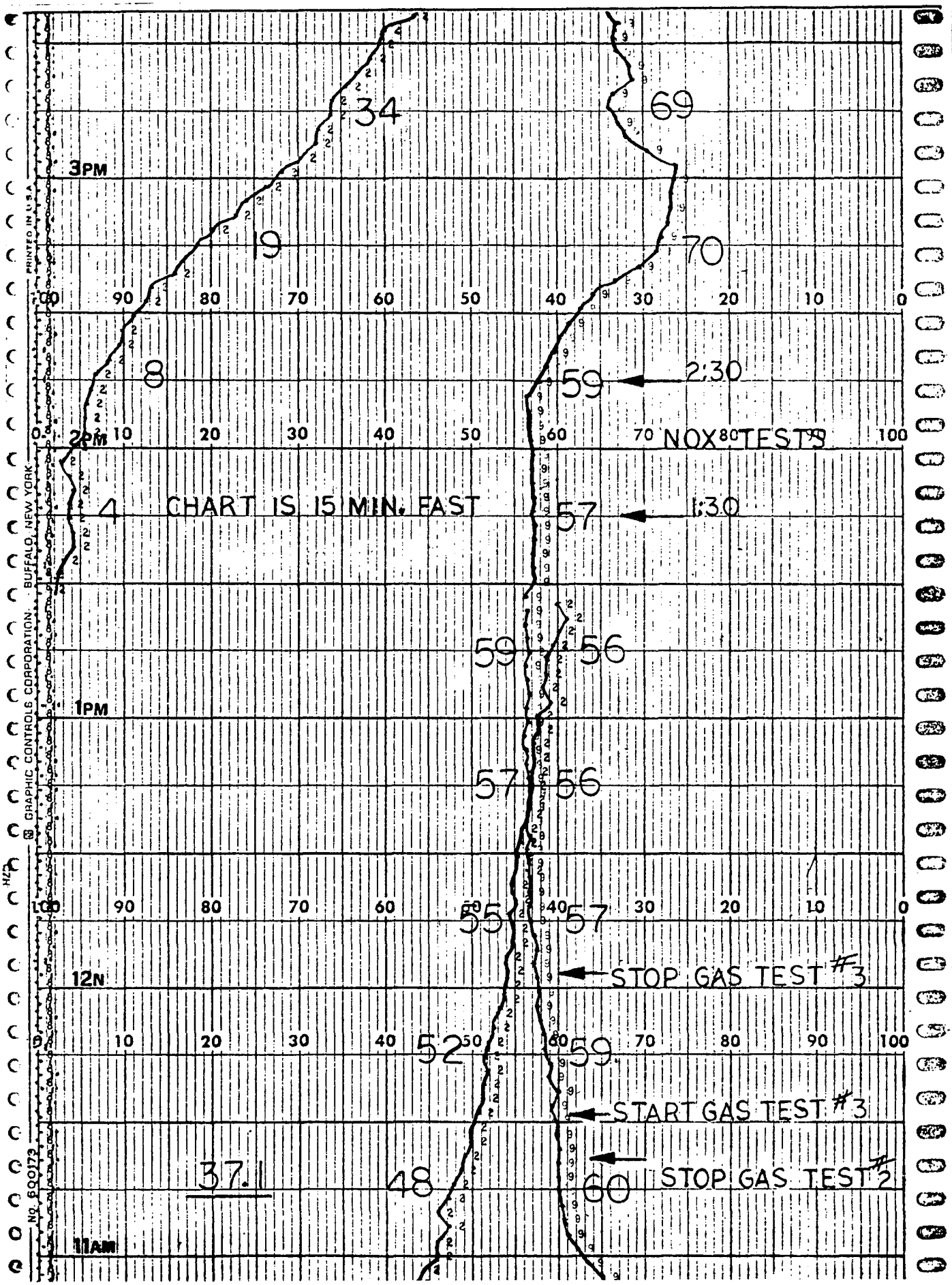
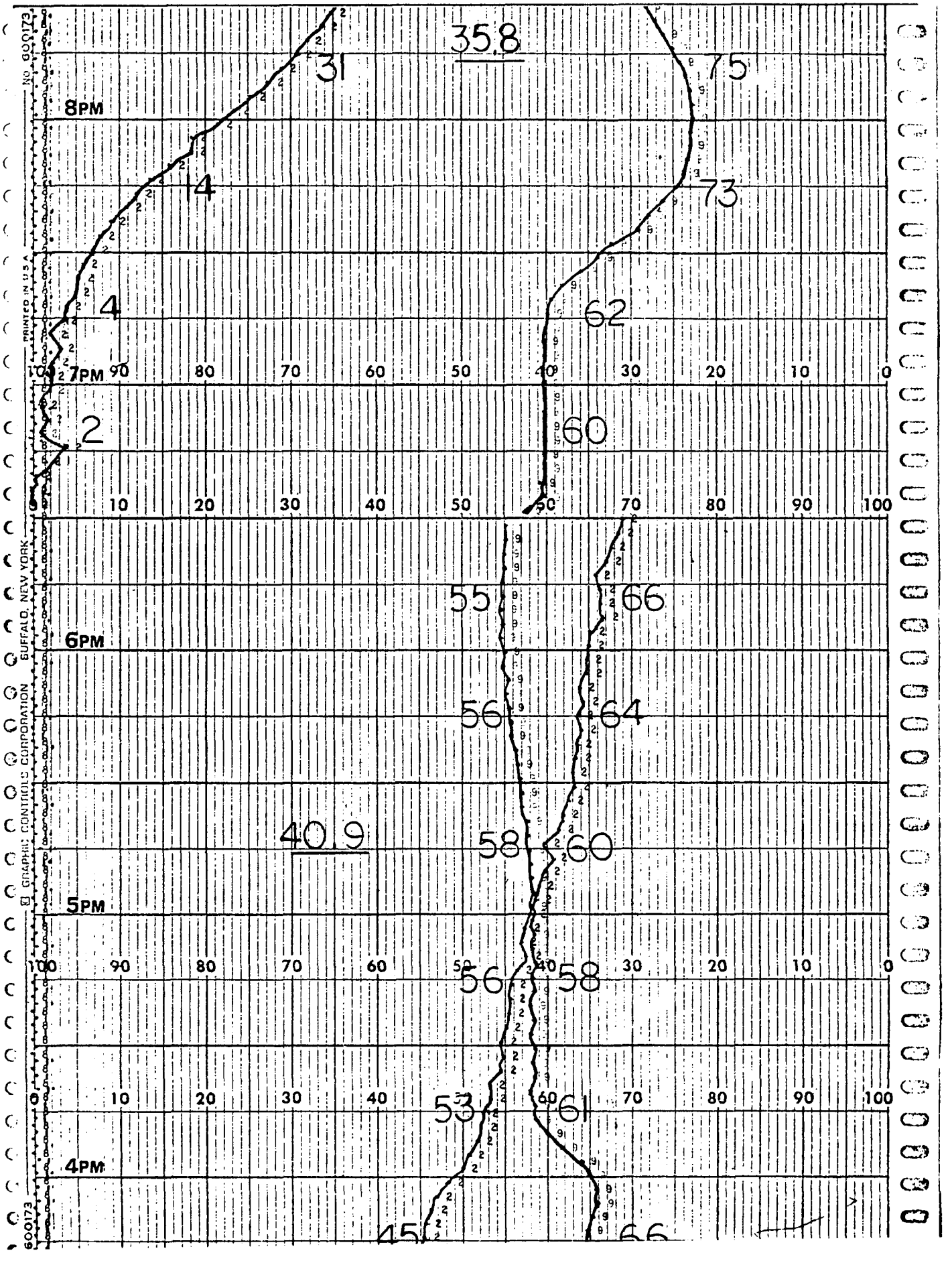
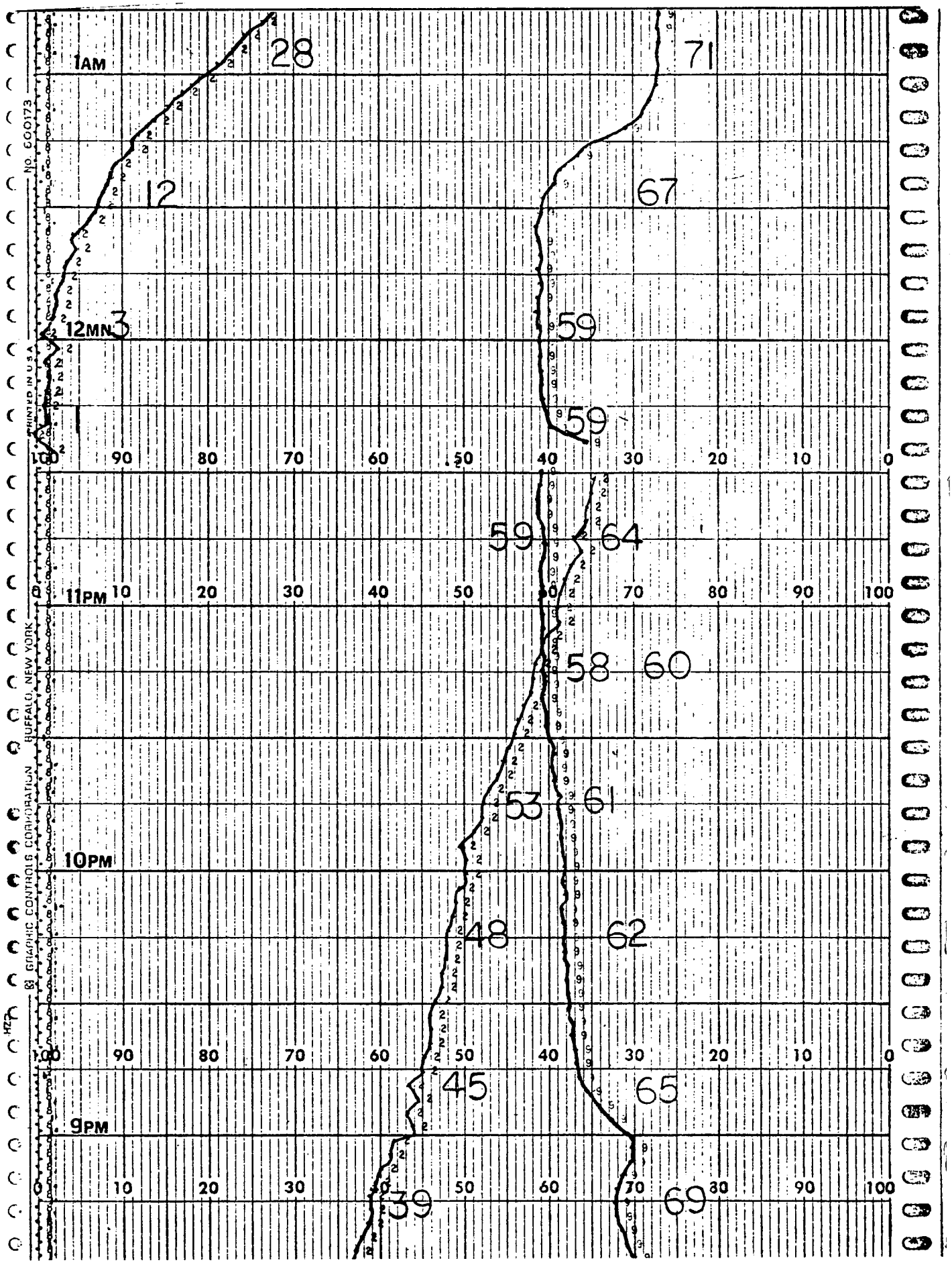
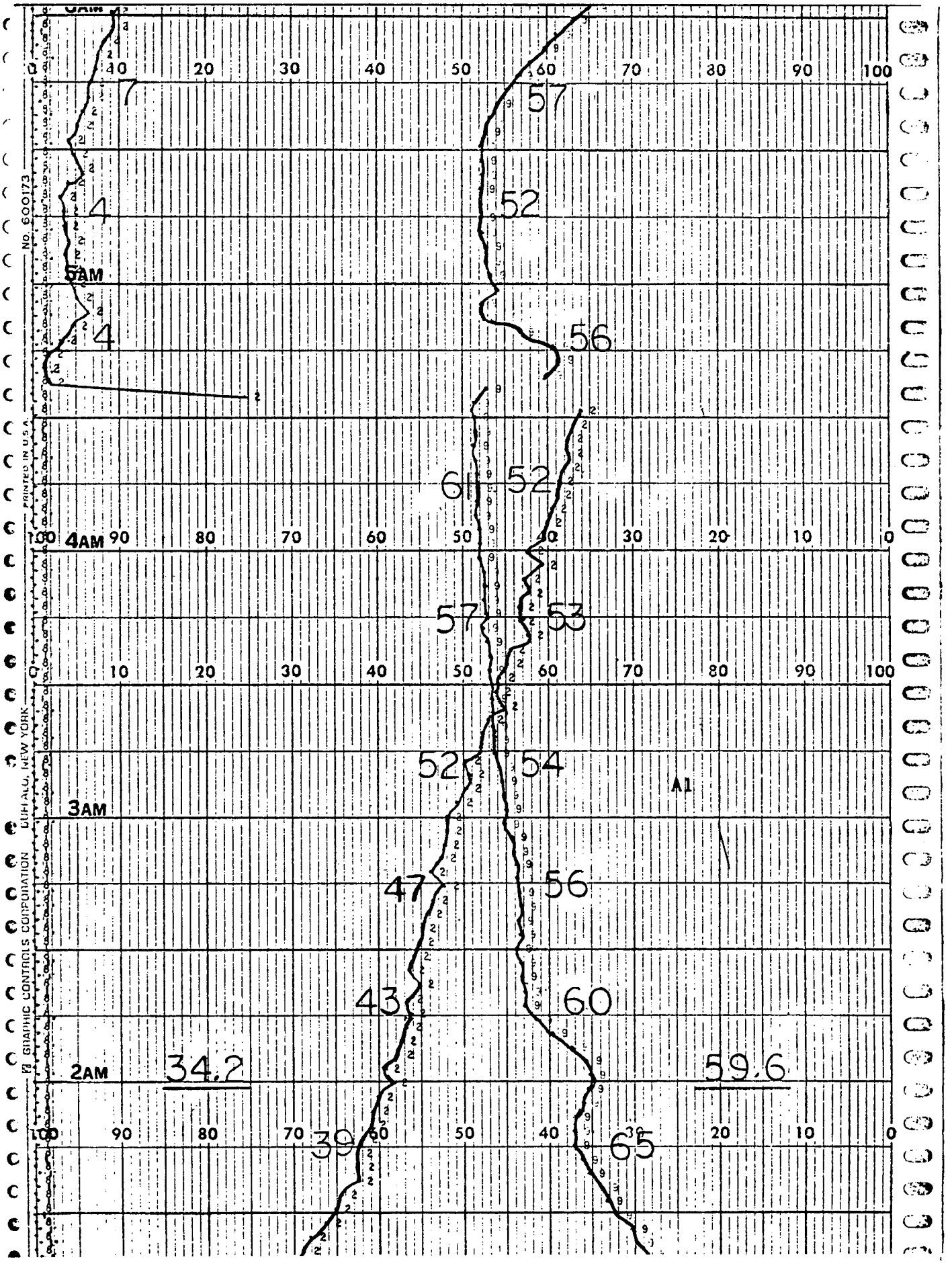
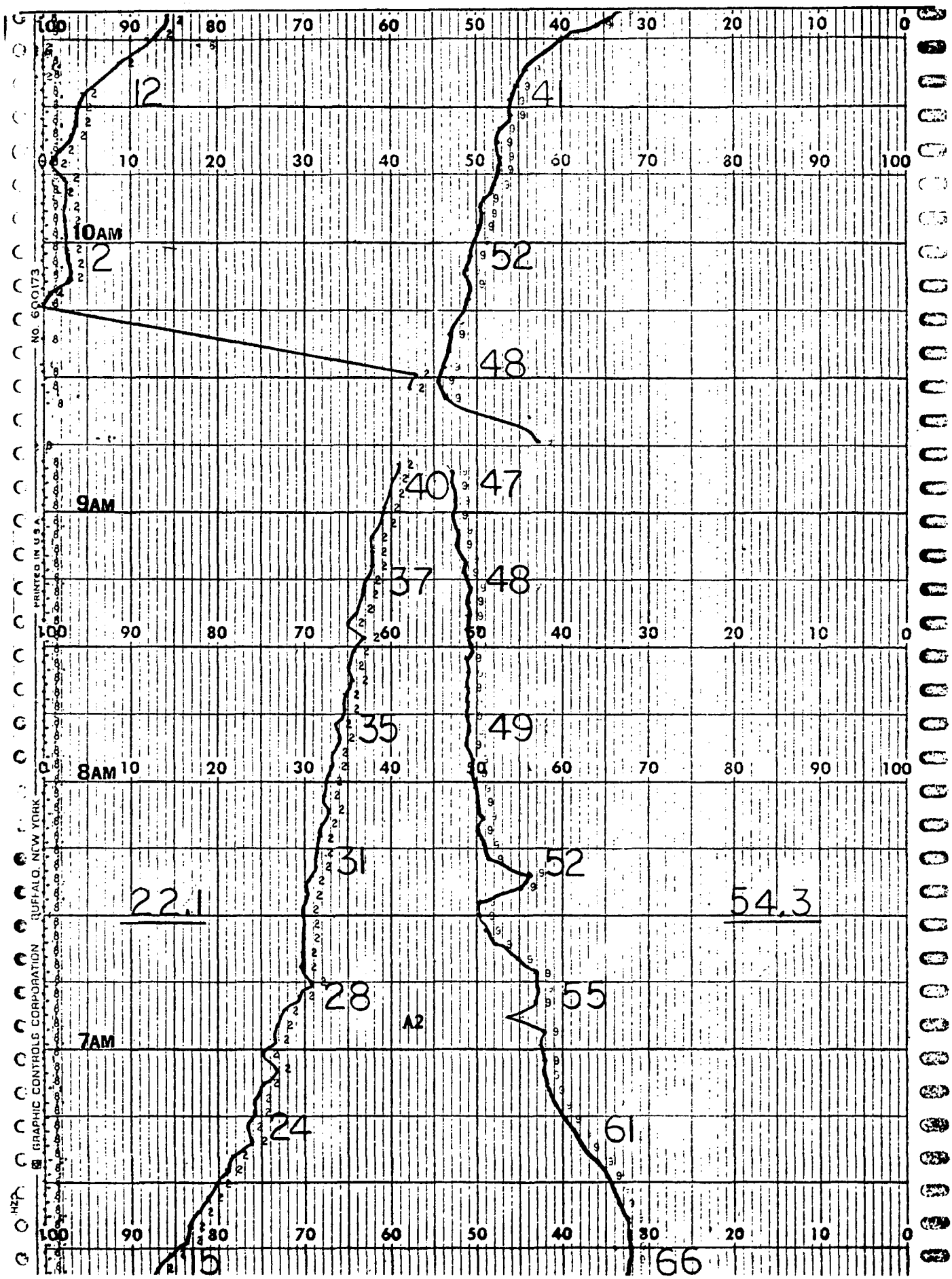
No 60173

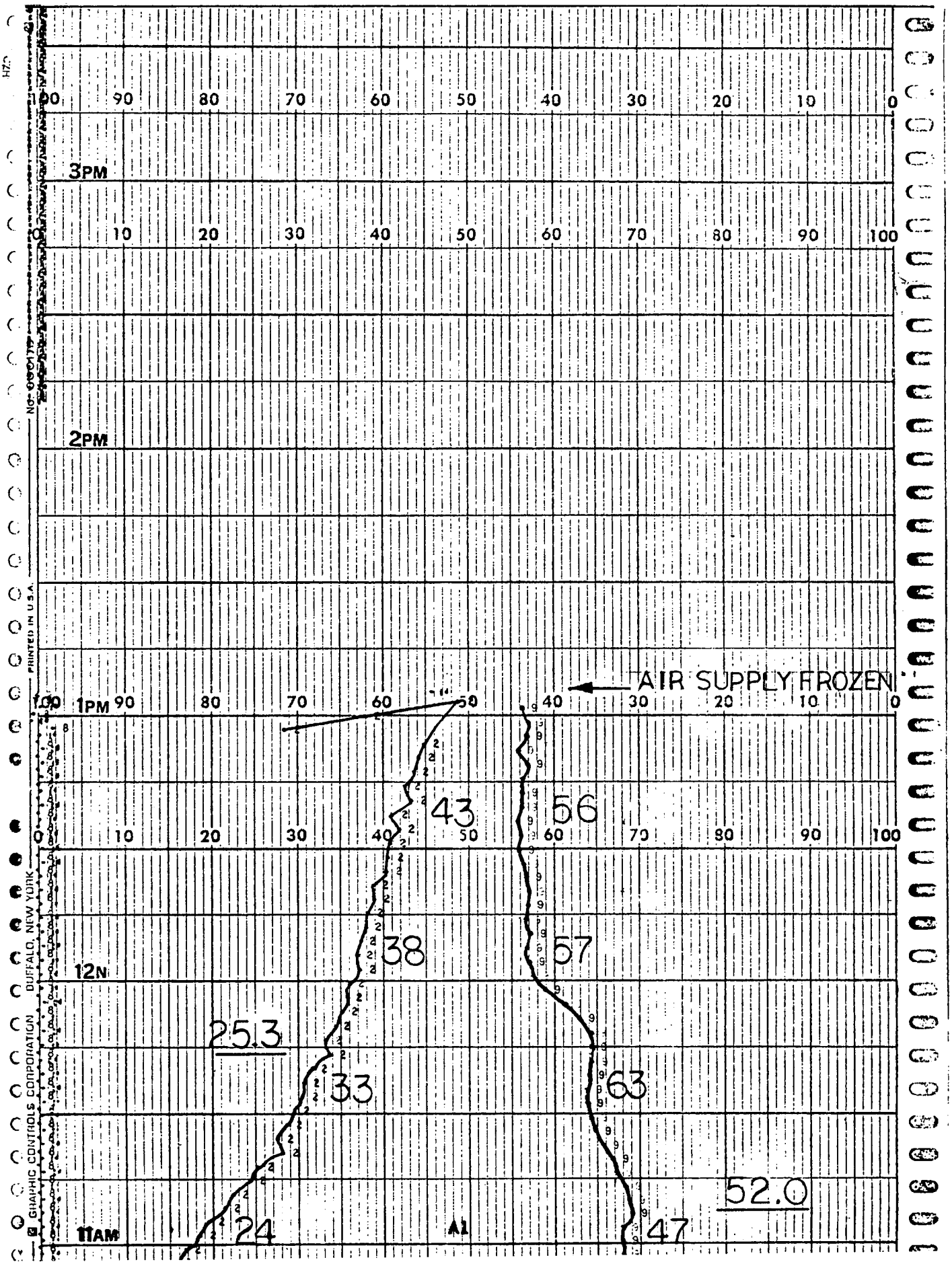

3PM
2PM
1PM
12N
11AM
34
69
19
70
8
59
2:30
NOX TESTS
4
CHART IS 15 MIN. FAST
57
1:30
59
56
57
56
55
57
STOP GAS TEST #3
52
59
START GAS TEST #3
37.1
48
60
STOP GAS TEST #2
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
No. 600172

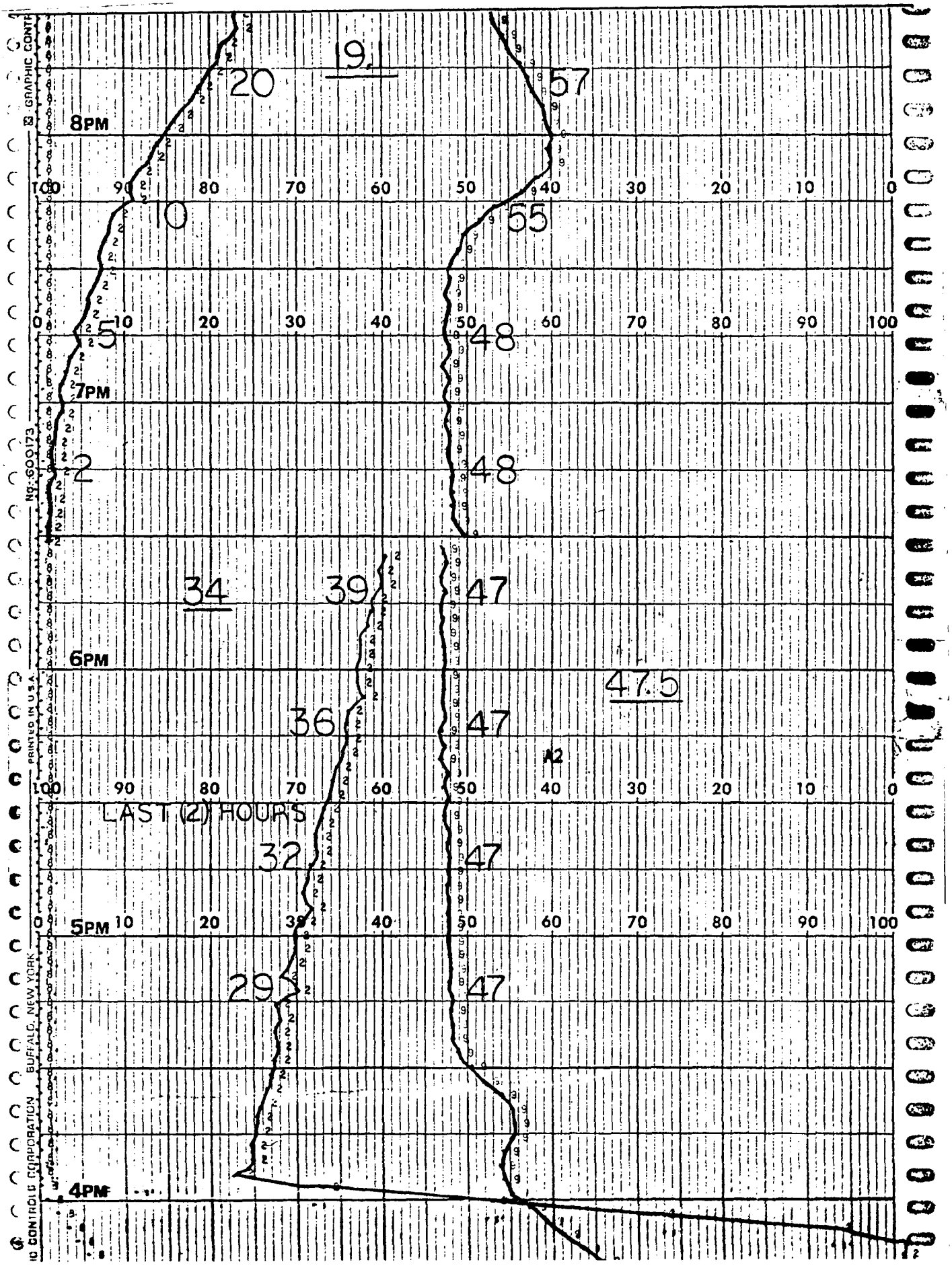

358
31
75
8PM
14
73
4
62
7PM
90
80
70
60
50
40
30
20
10
0
2
60
10
20
30
40
50
60
70
80
90
100
55
66
6PM
56
64
409
58
60
5PM
56
58
53
61
4PM
45
66
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173
600173

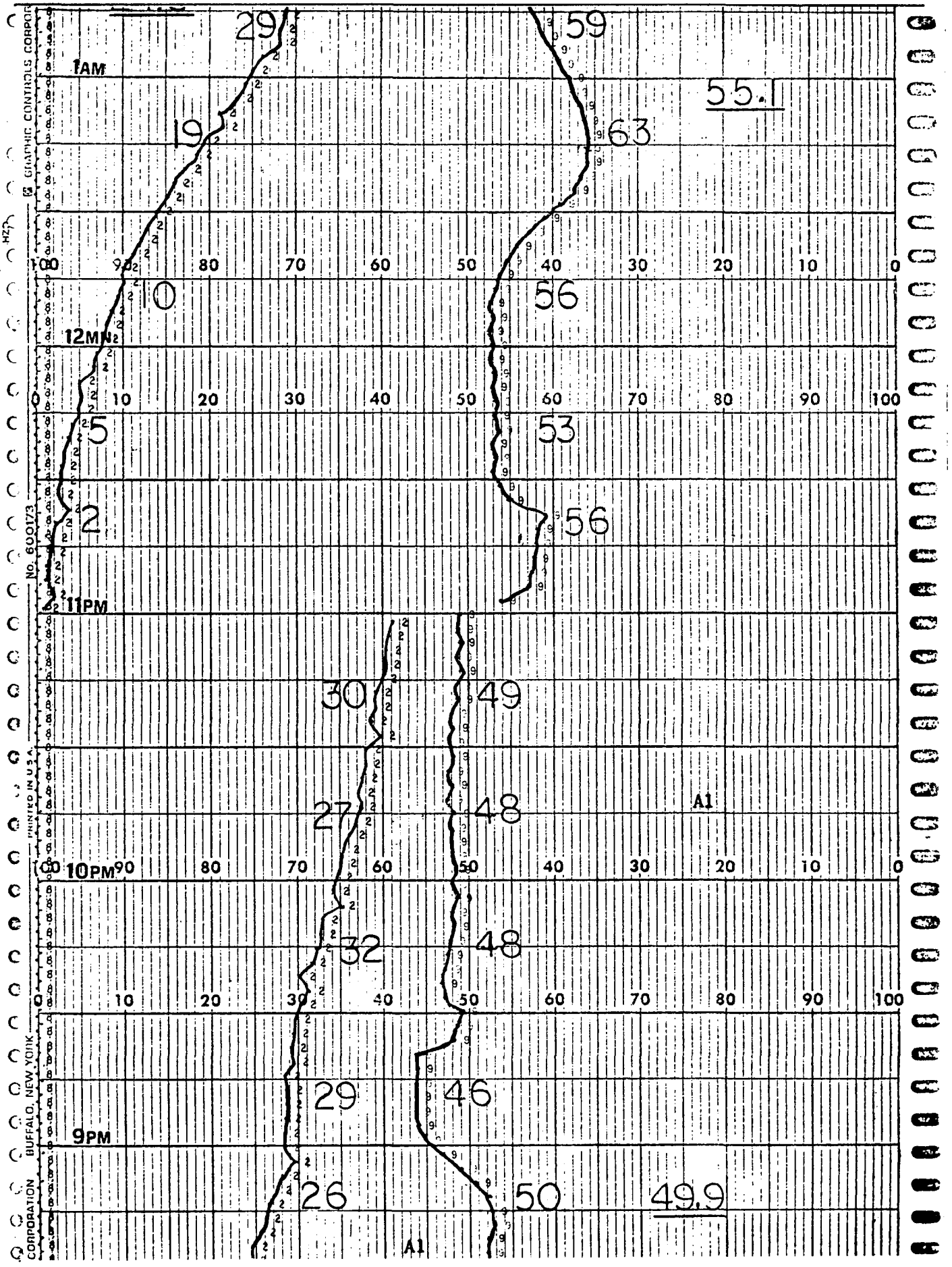

1AM
12MN
11PM
10PM
9PM
28
12
3
1
71
67
59
59
59
64
58
60
53
61
48
62
45
65
39
69
100
90
80
70
60
50
40
30
20
10
0
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173

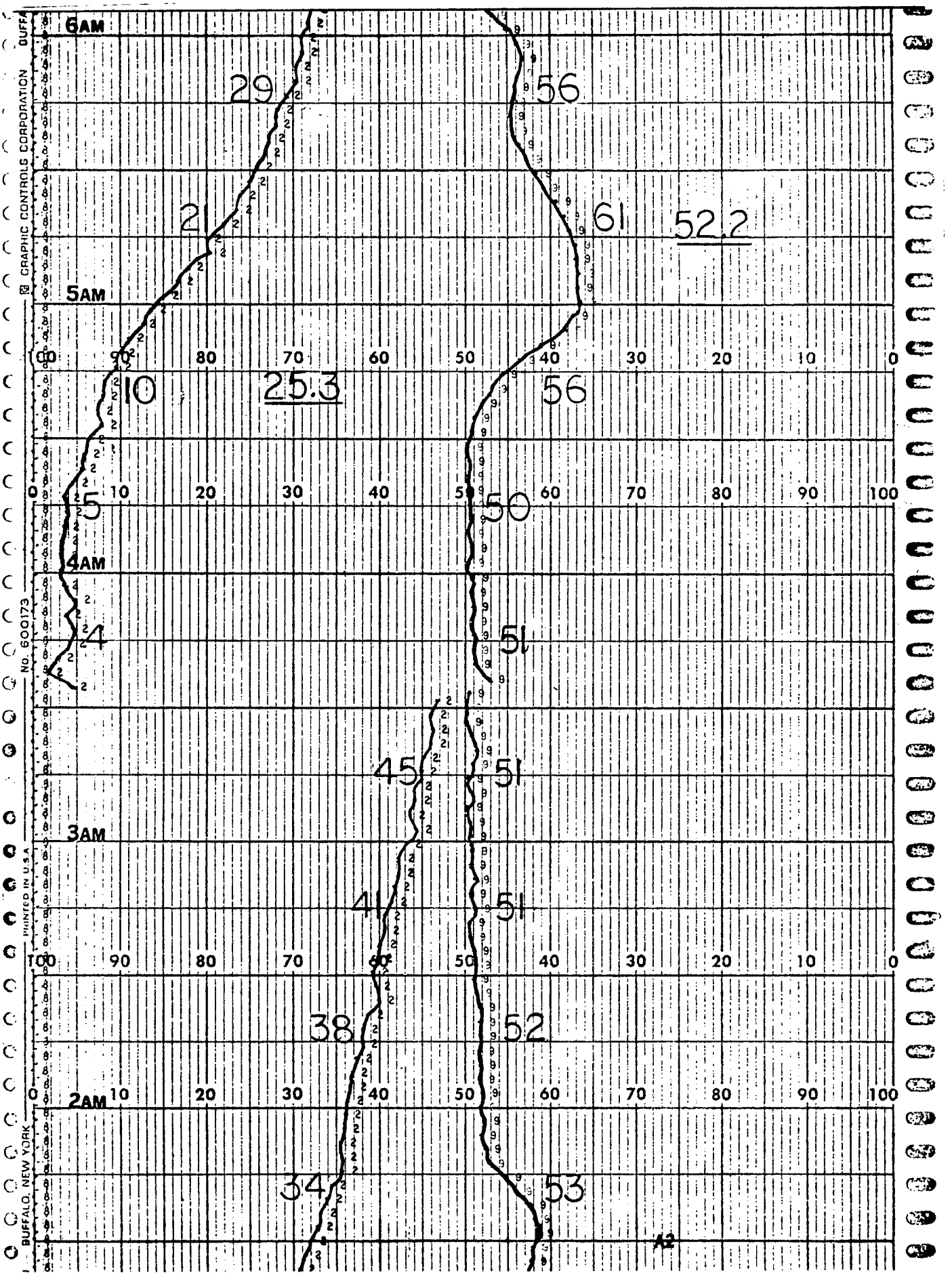

GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173
6AM
5AM
4AM
3AM
2AM
A1
34.2
59.6


100 90 80 70 60 50 40 30 20 10 0
12
4
10AM
2
52
48
9AM
40
47
37
48
35
49
8AM
31
52
22.1
54.3
28
A2
55
7AM
24
61
15
66
NO. 600173
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.
H2


3PM
2PM
1PM
12N
11AM
AIR SUPPLY FROZEN
43
56
38
57
25.3
33
63
24
47
52.0
A1
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.


8PM
7PM
6PM
5PM
4PM
LAST (2) HOURS
20
19
57
10
55
5
48
2
48
34
39
47
47.5
36
47
32
47
29
47
A2
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.


1AM
12MN
11PM
10PM
9PM
29
19
10
5
2
59
55.1
63
56
53
56
30
49
27
48
A1
32
48
29
46
26
50
49.9
A1
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
PRINTED IN U.S.A.


6AM
5AM
4AM
3AM
2AM
29
56
21
61
52.2
10
25.3
56
5
50
4
51
45
51
41
51
38
52
34
53
A2
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
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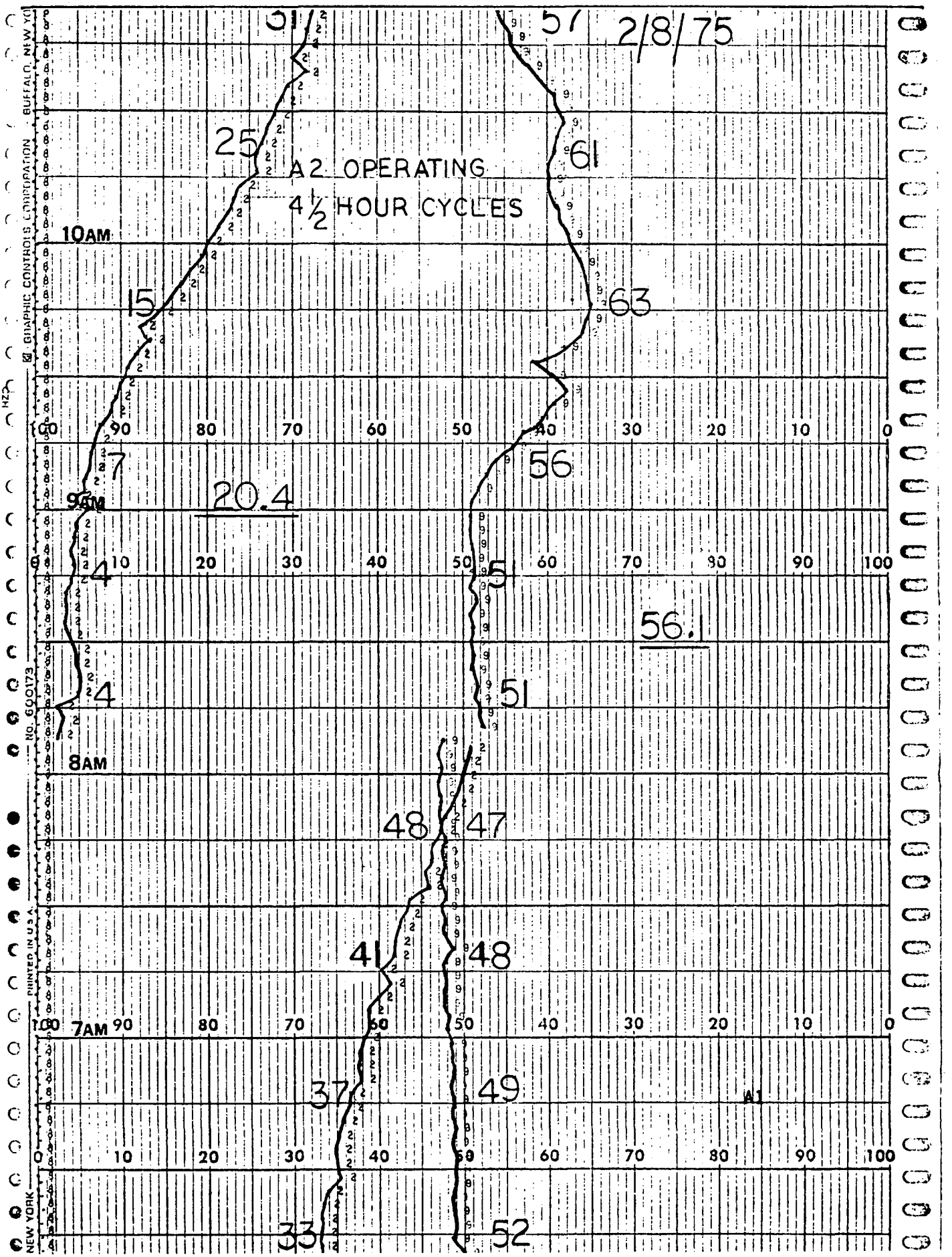
2/8/75
A2 OPERATING
4½ HOUR CYCLES
10AM
9AM
8AM
7AM
20.4
56.1
A1
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 660173
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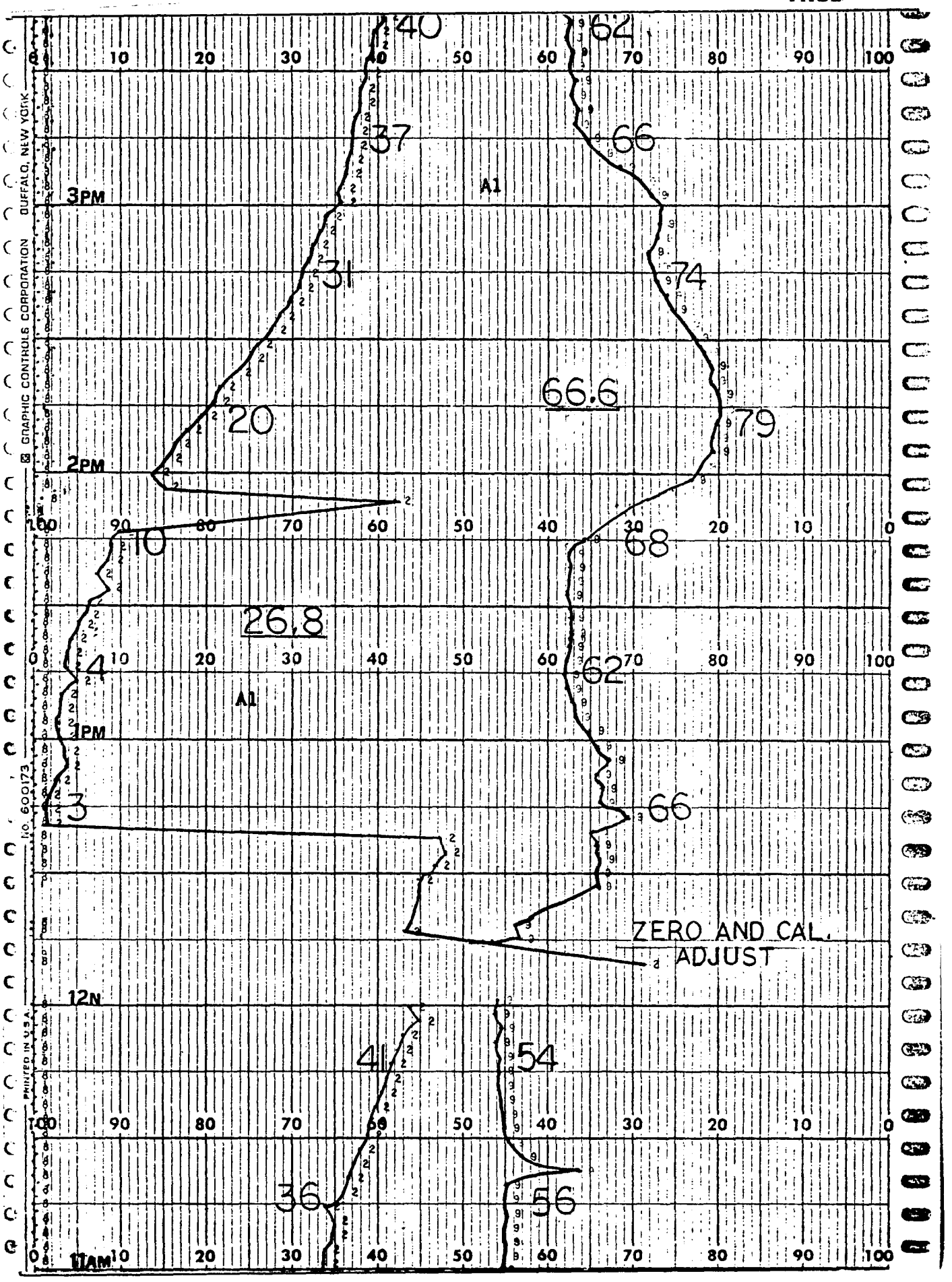
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
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3PM
2PM
1PM
12N
11AM
A1
A1
40
37
31
20
66.6
62
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74
79
68
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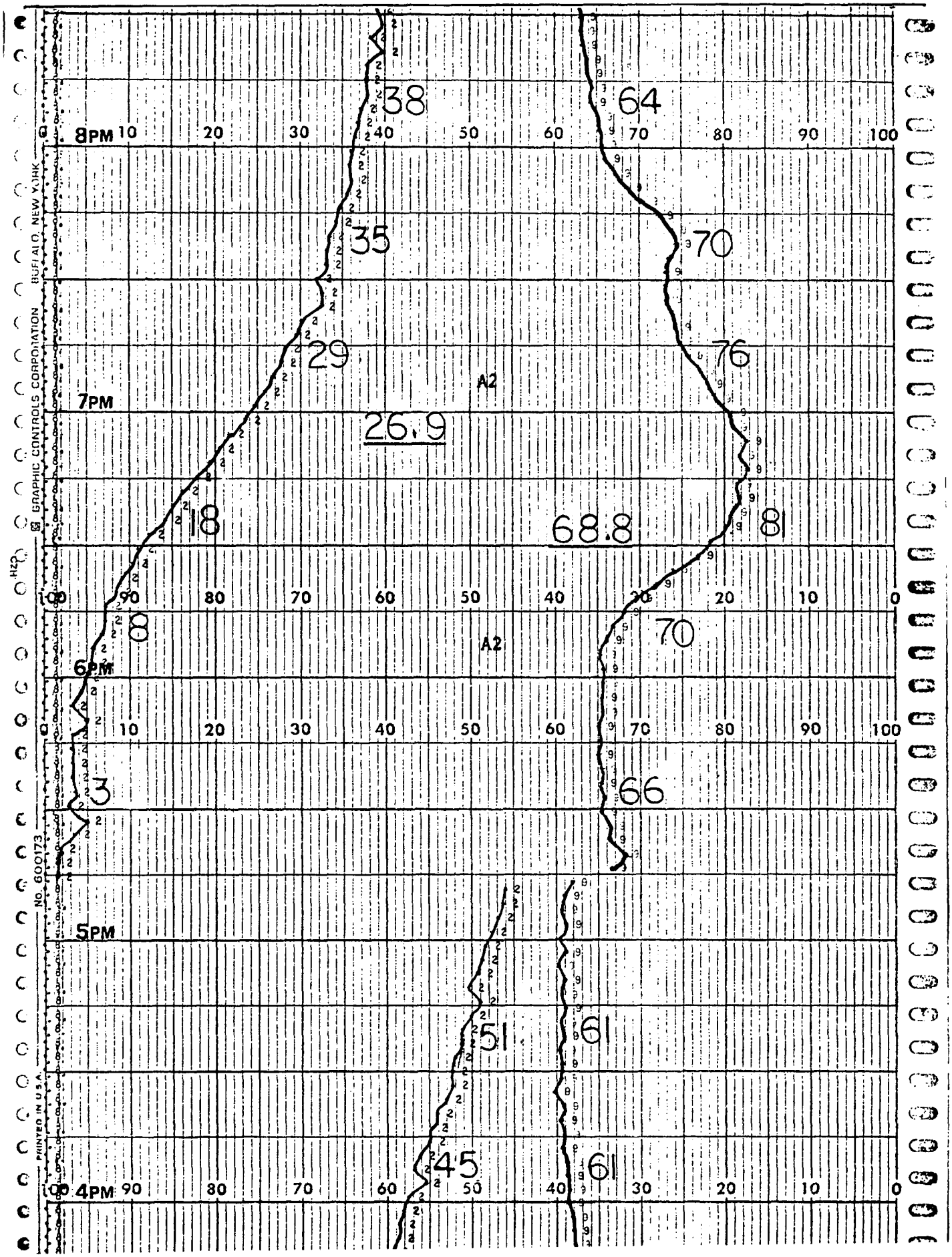
26.8
4
62
66
3
ZERO AND CAL.
ADJUST
41
54
36
56


8PM
7PM
6PM
5PM
4PM
38
64
35
70
29
76
26.9
A2
18
68.8
81
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A2
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51
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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
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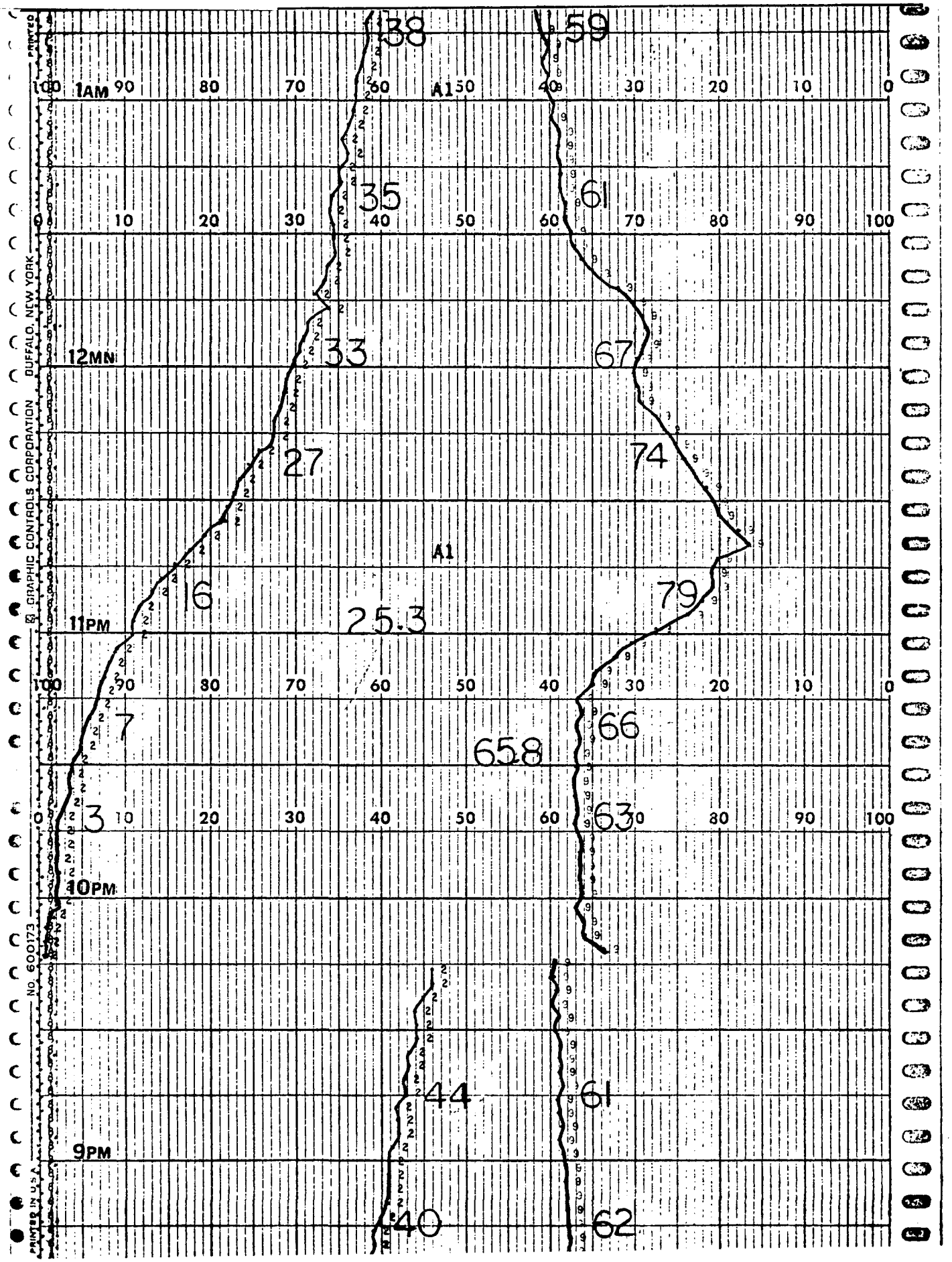
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12MN
11PM
10PM
9PM
A1
A1
138
59
35
61
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25.3
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No. 600173
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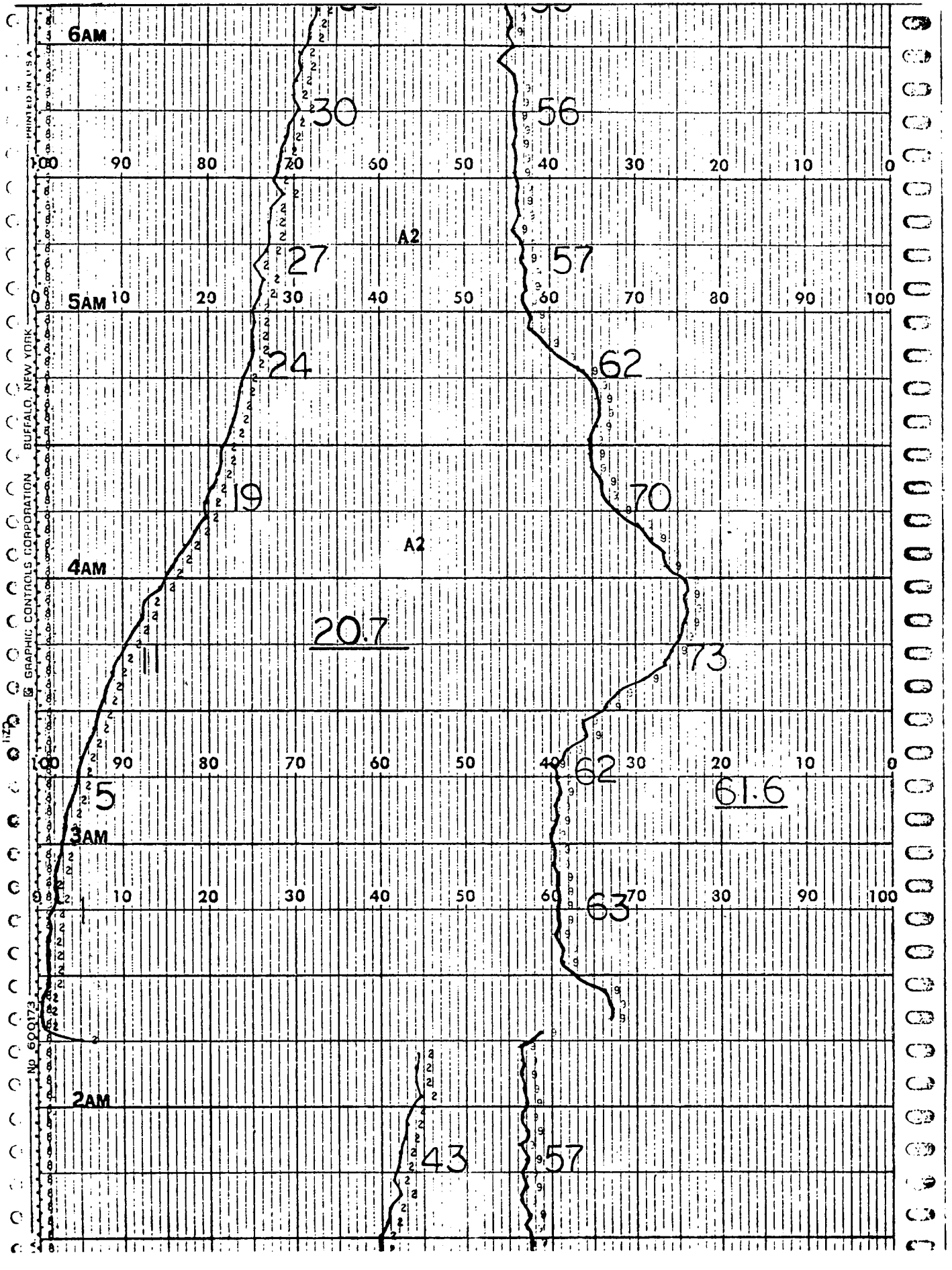
6AM
5AM
4AM
3AM
2AM
A2
A2
30
56
27
57
24
62
19
70
20.7
73
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61.6
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43
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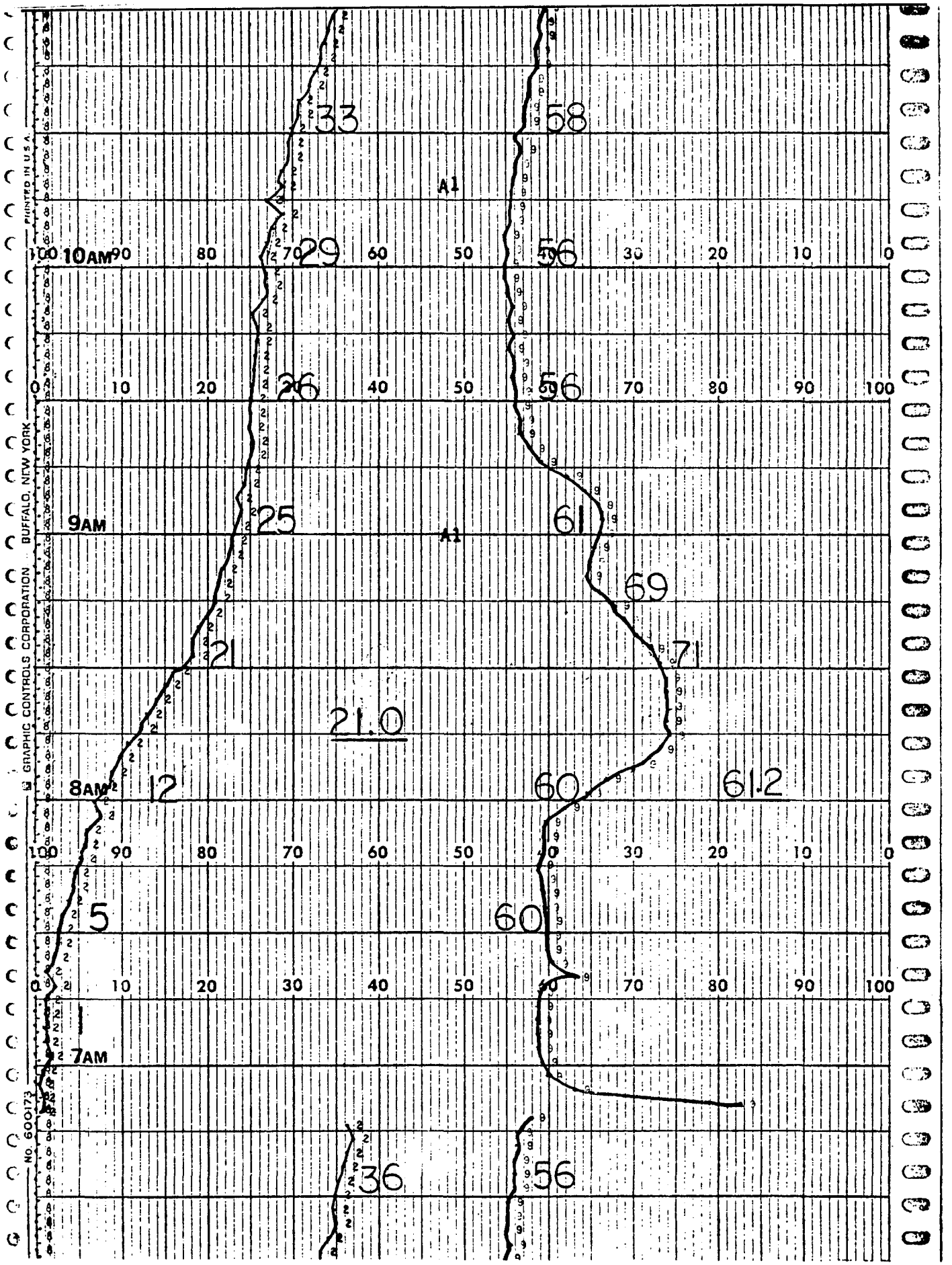
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.
No 620173


PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
10AM
9AM
8AM
7AM
A1
A1
33
29
26
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12
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36
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56
56
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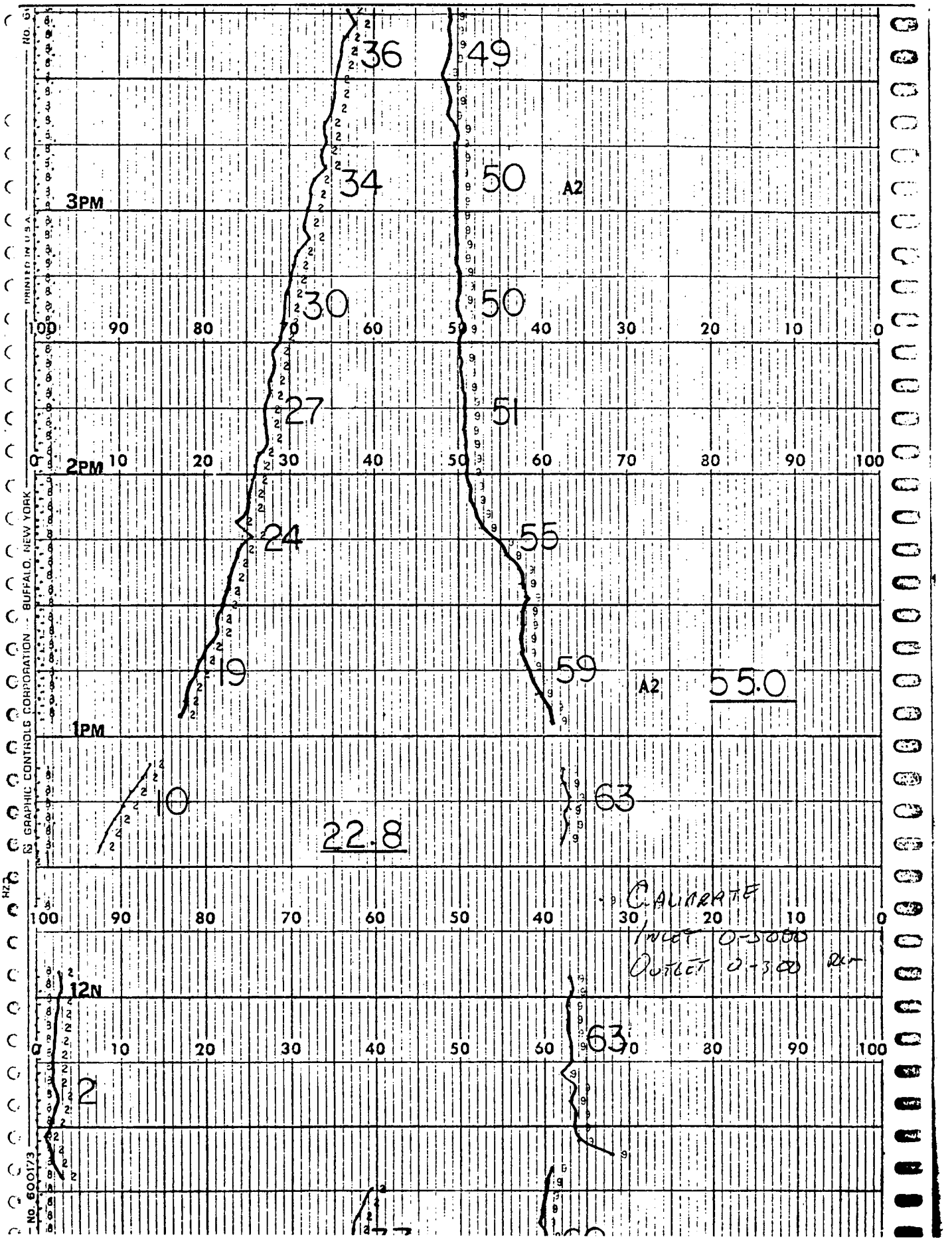
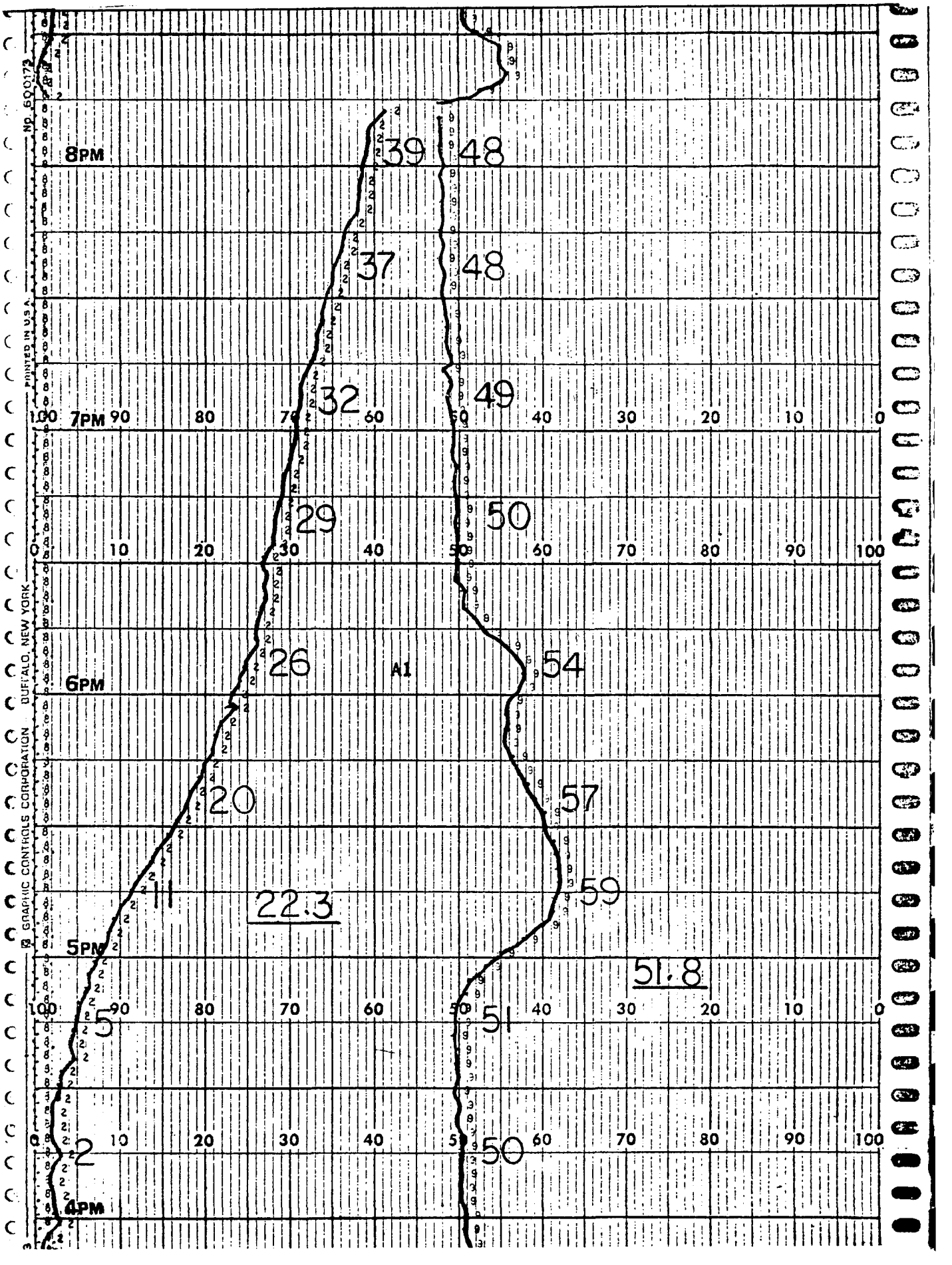
21.0
60
61.2
60
56


36
49
34
50
A2
3PM
30
50
27
51
2PM
24
55
19
59
A2
55.0
1PM
10
63
22.8
CALIBRATE
INLET 0-5000
OUTLET 0-300 Dur
12N
63
2
BUFFALO, NEW YORK — GRAPHIC CONTROLS CORPORATION — PRINTED IN U.S.A. — No. 6001-73


8PM
7PM
6PM
5PM
4PM
39
48
37
48
32
49
29
50
26
A1
54
20
57
59
22.3
51.8
51
5
50
2
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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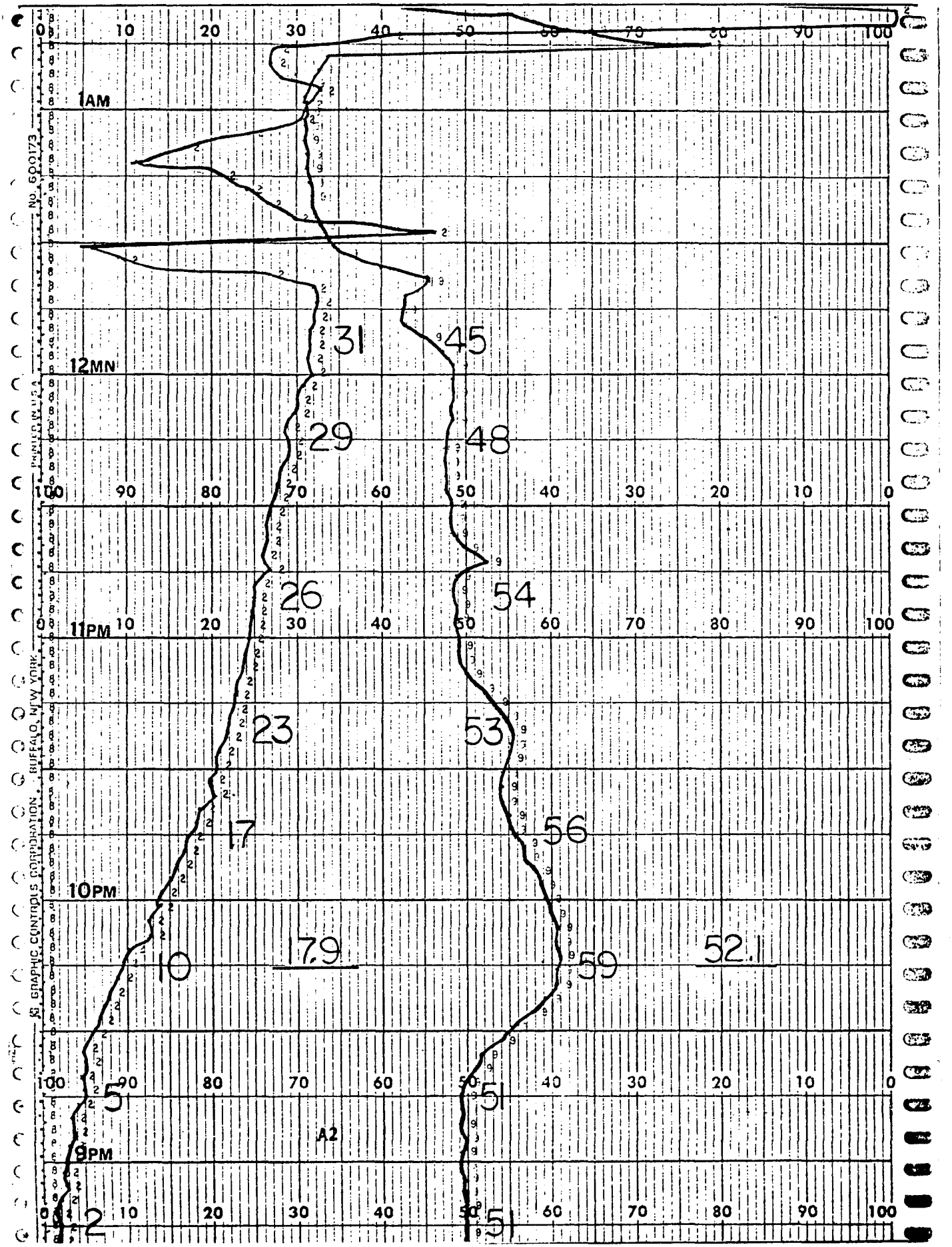
1AM
12MN
11PM
10PM
9PM
31
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48
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54
23
53
17
56
10
17.9
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52.1
5
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2
51
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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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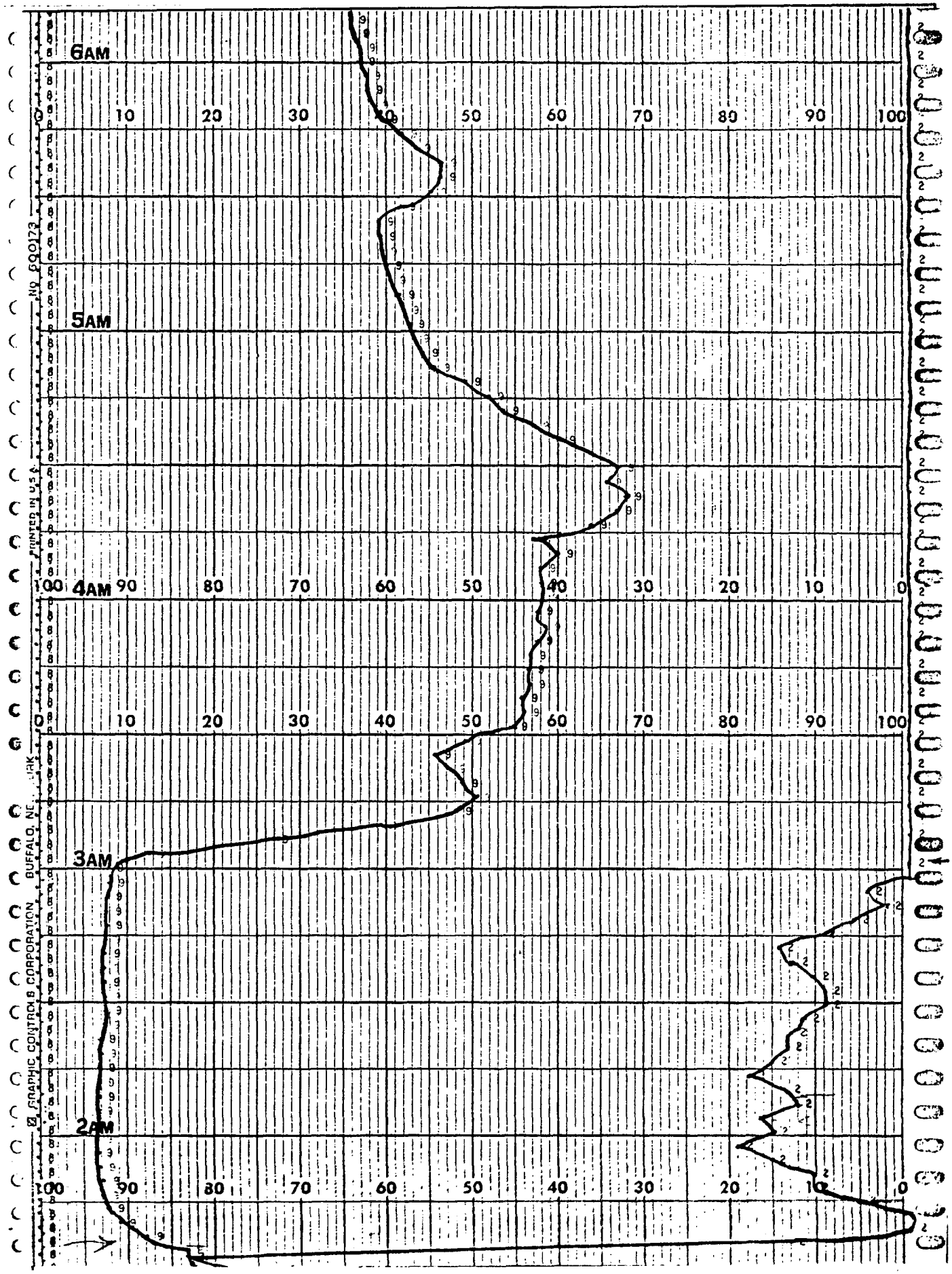
No. 60-0173


6AM
5AM
4AM
3AM
2AM
10
20
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60
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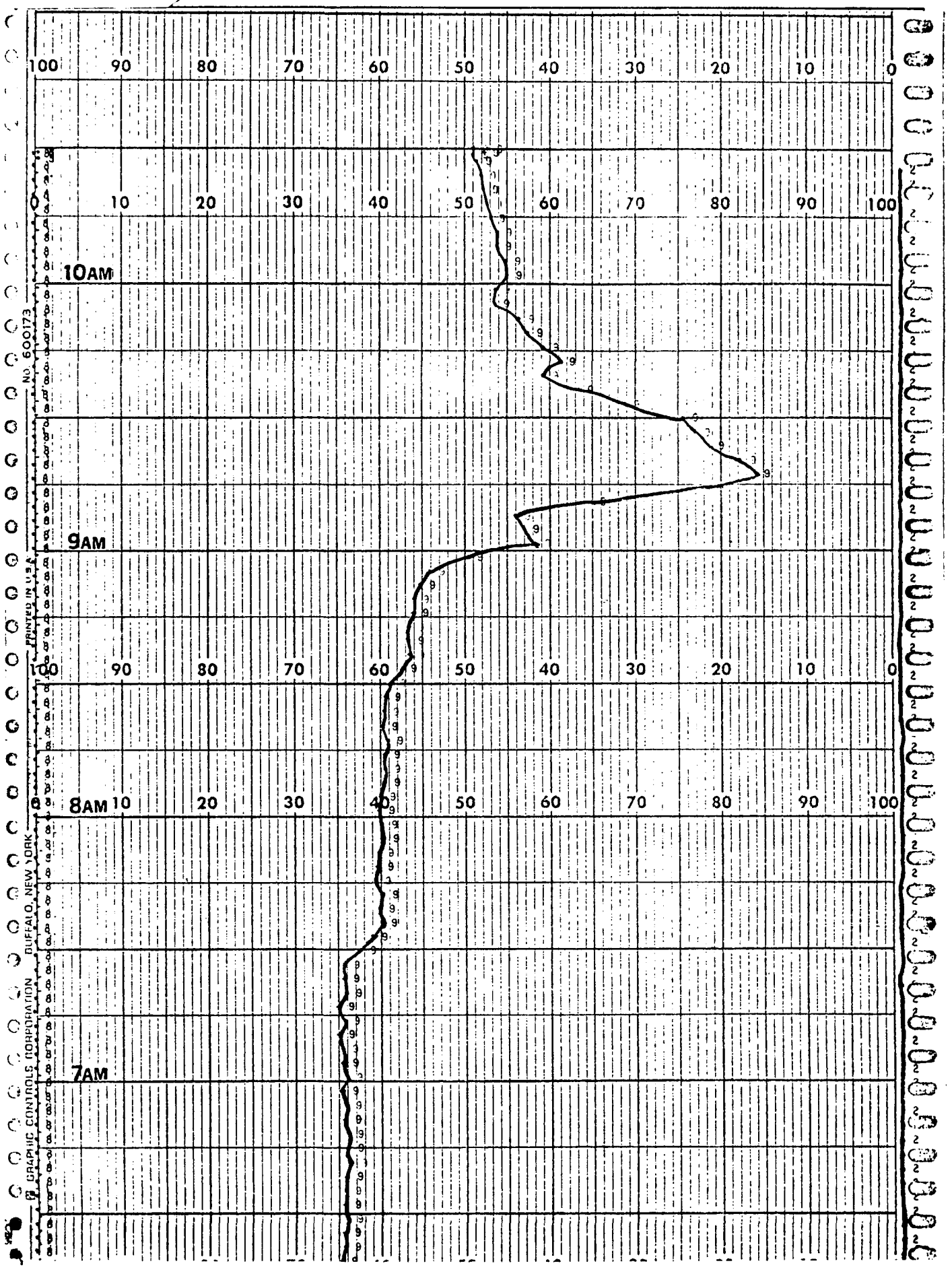
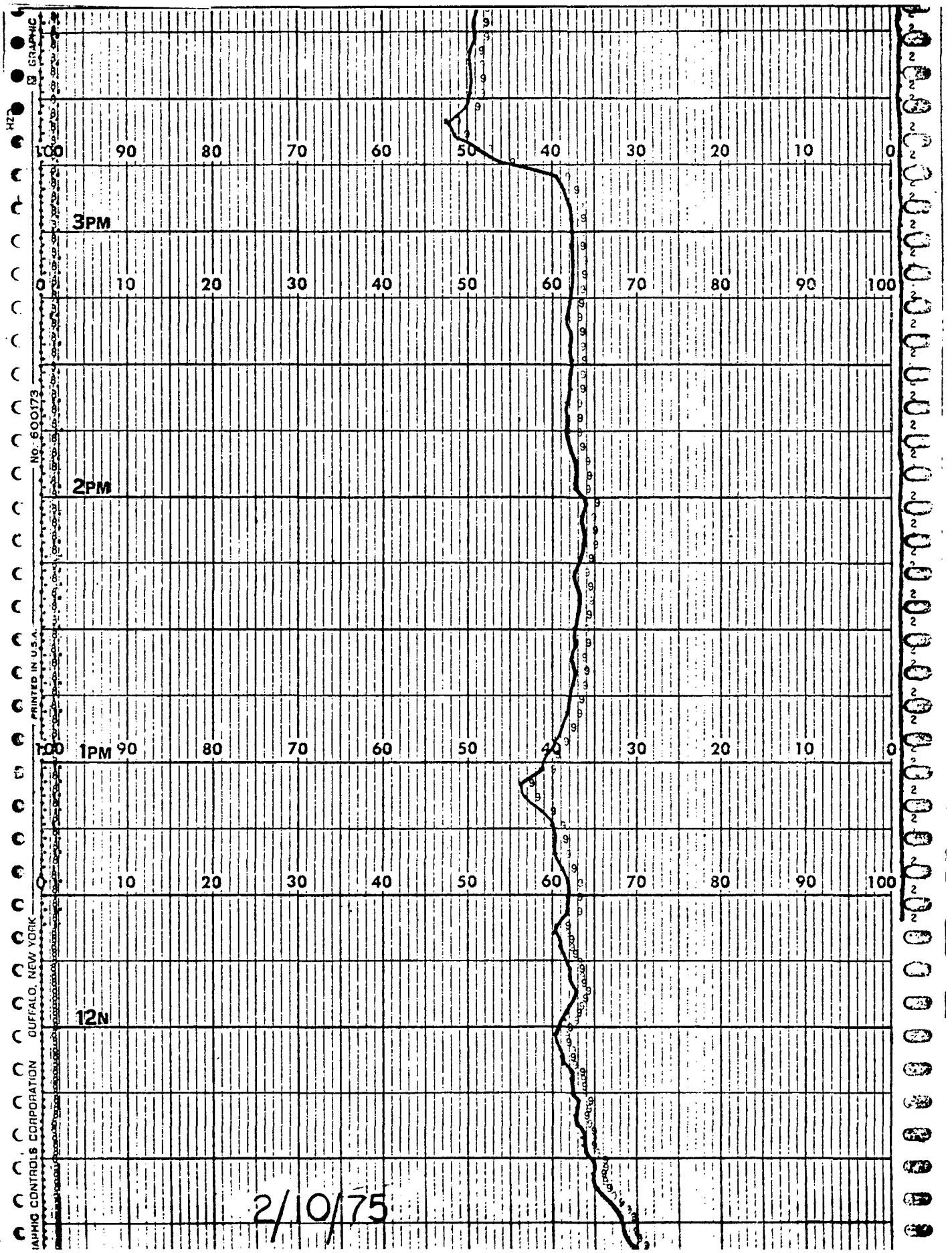
80
90
100
0
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173


100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
10AM
9AM
8AM
7AM
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
No. 600173


GRAPHIC
HZ
100 90 80 70 60 50 40 30 20 10 0
3PM
0 10 20 30 40 50 60 70 80 90 100
2PM
100 1PM 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
12N
No. 600173
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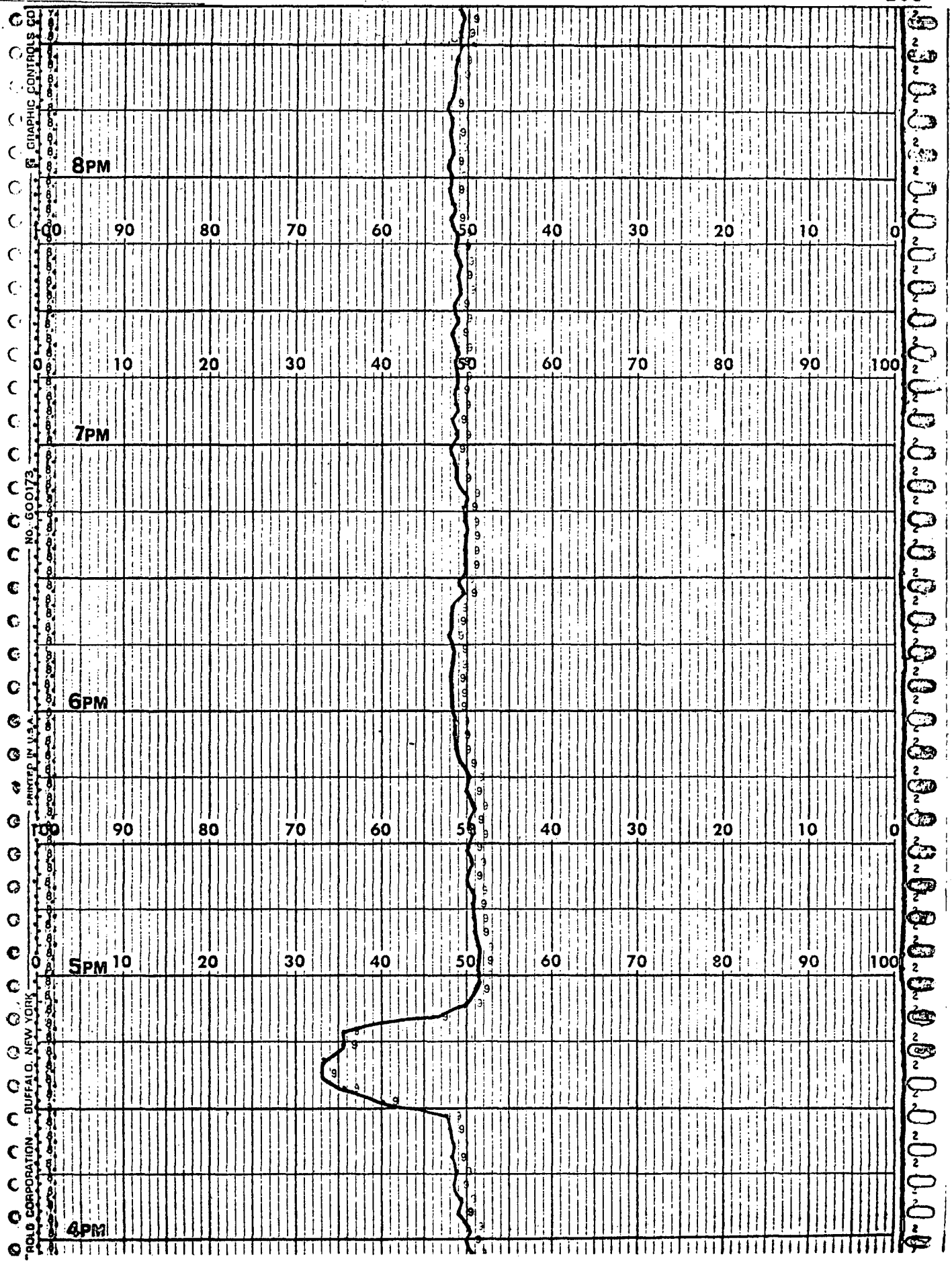
BUFFALO, NEW YORK
2/10/75


8PM
7PM
6PM
5PM
4PM
90
80
70
60
50
40
30
20
10
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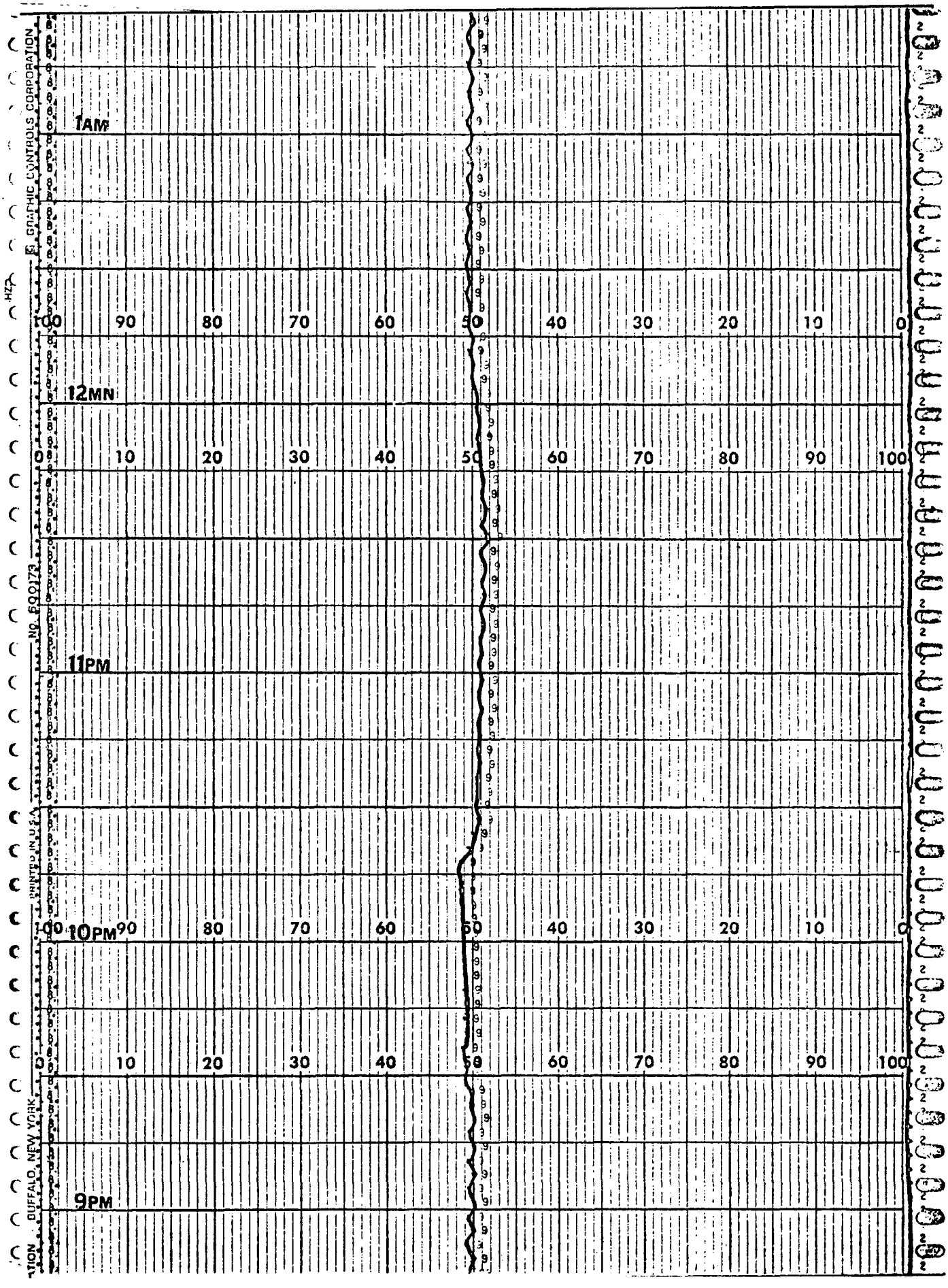
100
GRAPHIC CONTROLS CO.
NO. G00173
PRINTED IN U.S.A.
ROLO CORPORATION BUFFALO, NEW YORK


1AM
12MN
11PM
10PM
9PM
100
90
80
70
60
50
40
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HZ
E. GRAPHIC CONTROLS CORPORATION
NO. 600173
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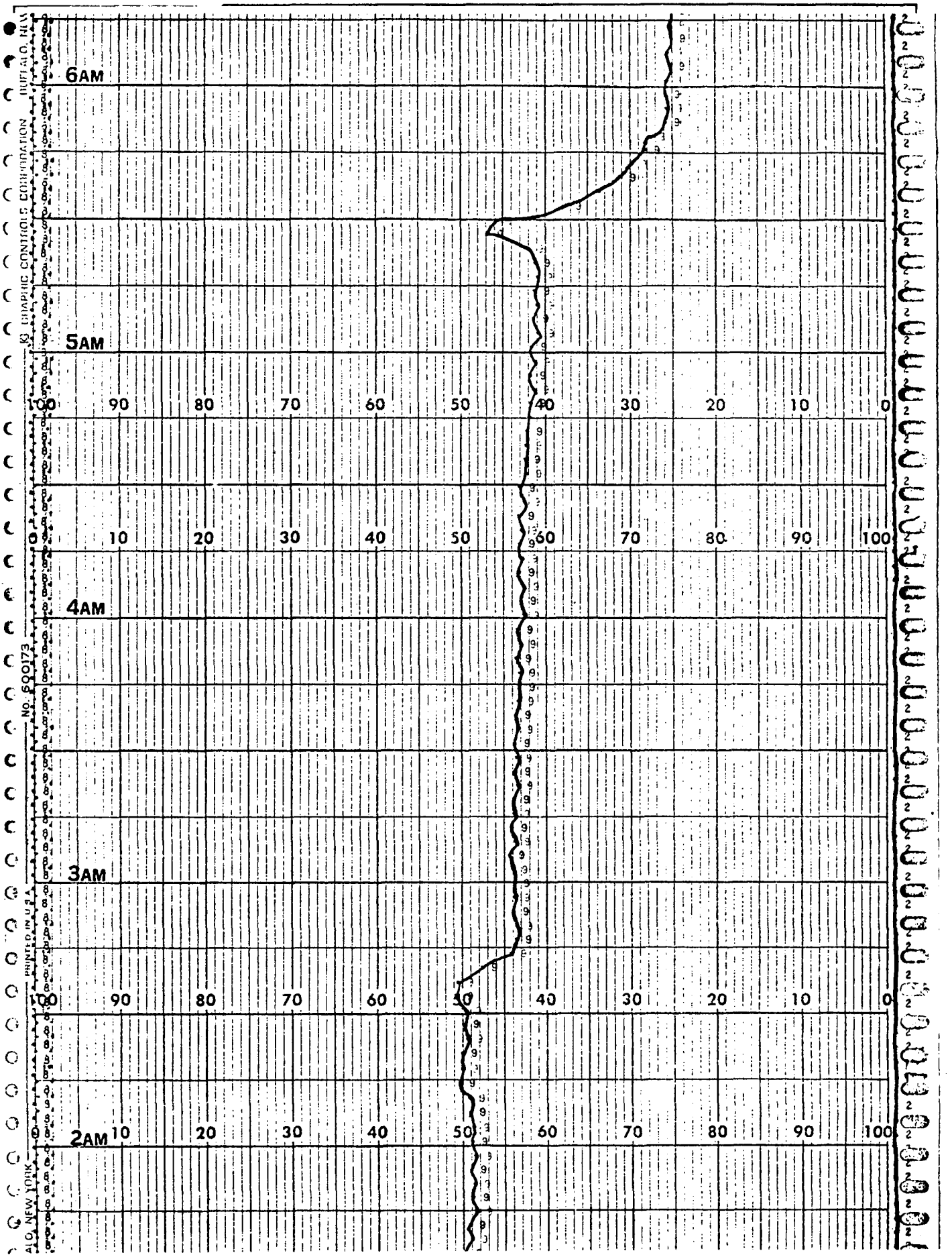
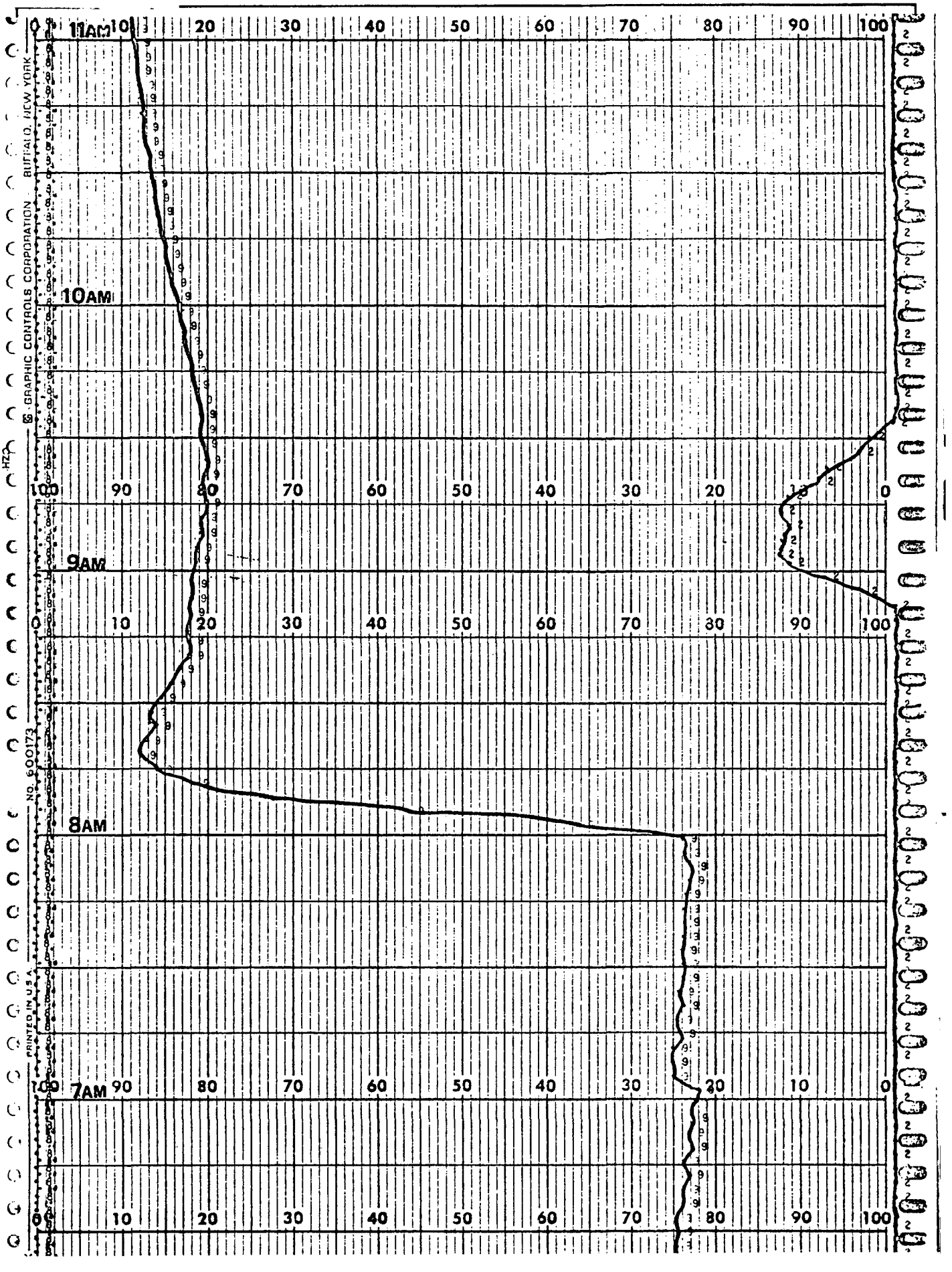
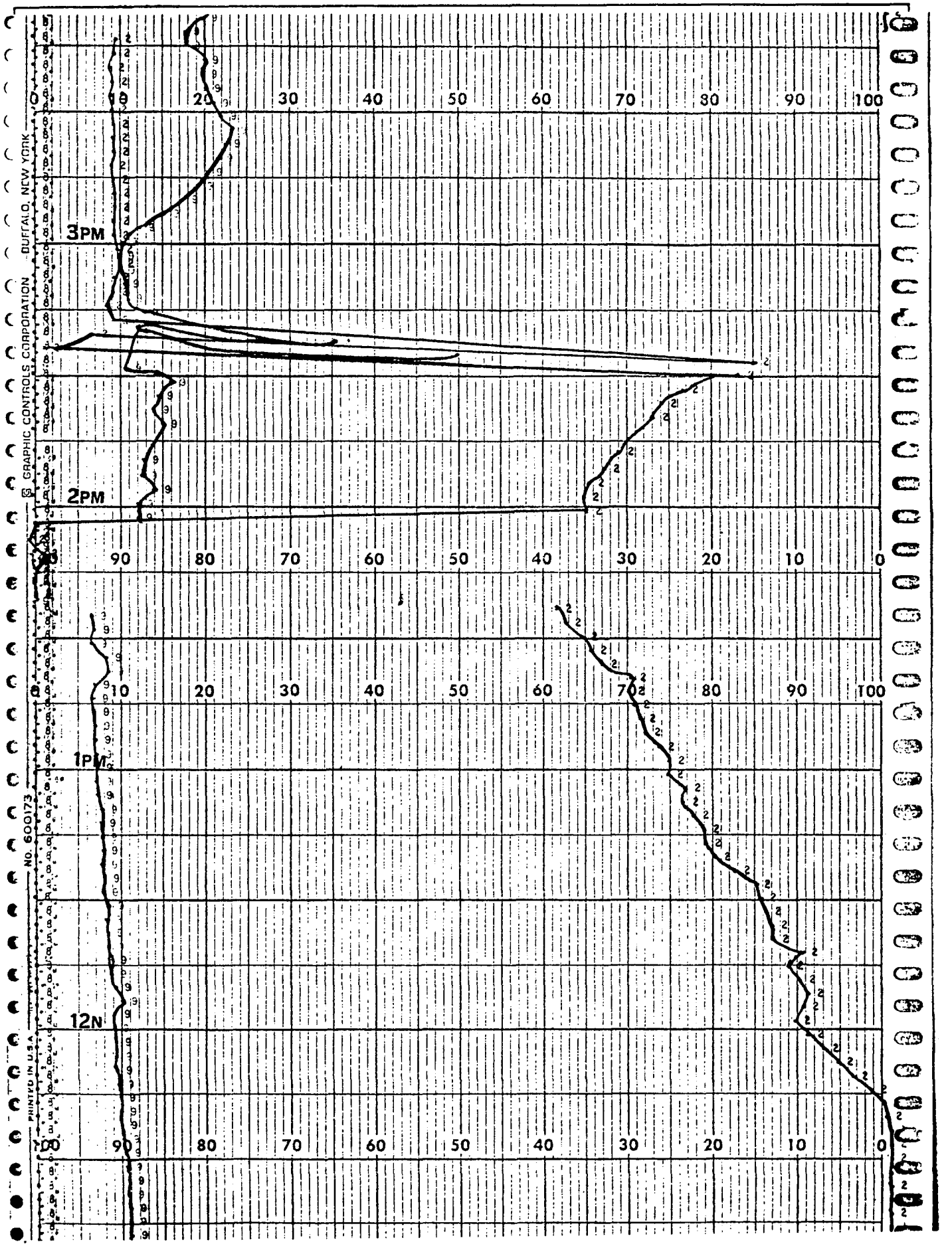
BUFFALO, NEW YORK


6AM
5AM
4AM
3AM
2AM
100 90 80 70 60 50 40 30 20 10 0
10 20 30 40 50 60 70 80 90 100
BUFFALO, NEW
ALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173


11AM
10AM
9AM
8AM
7AM
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
PRINTED IN U.S.A.


3PM
2PM
1PM
12N
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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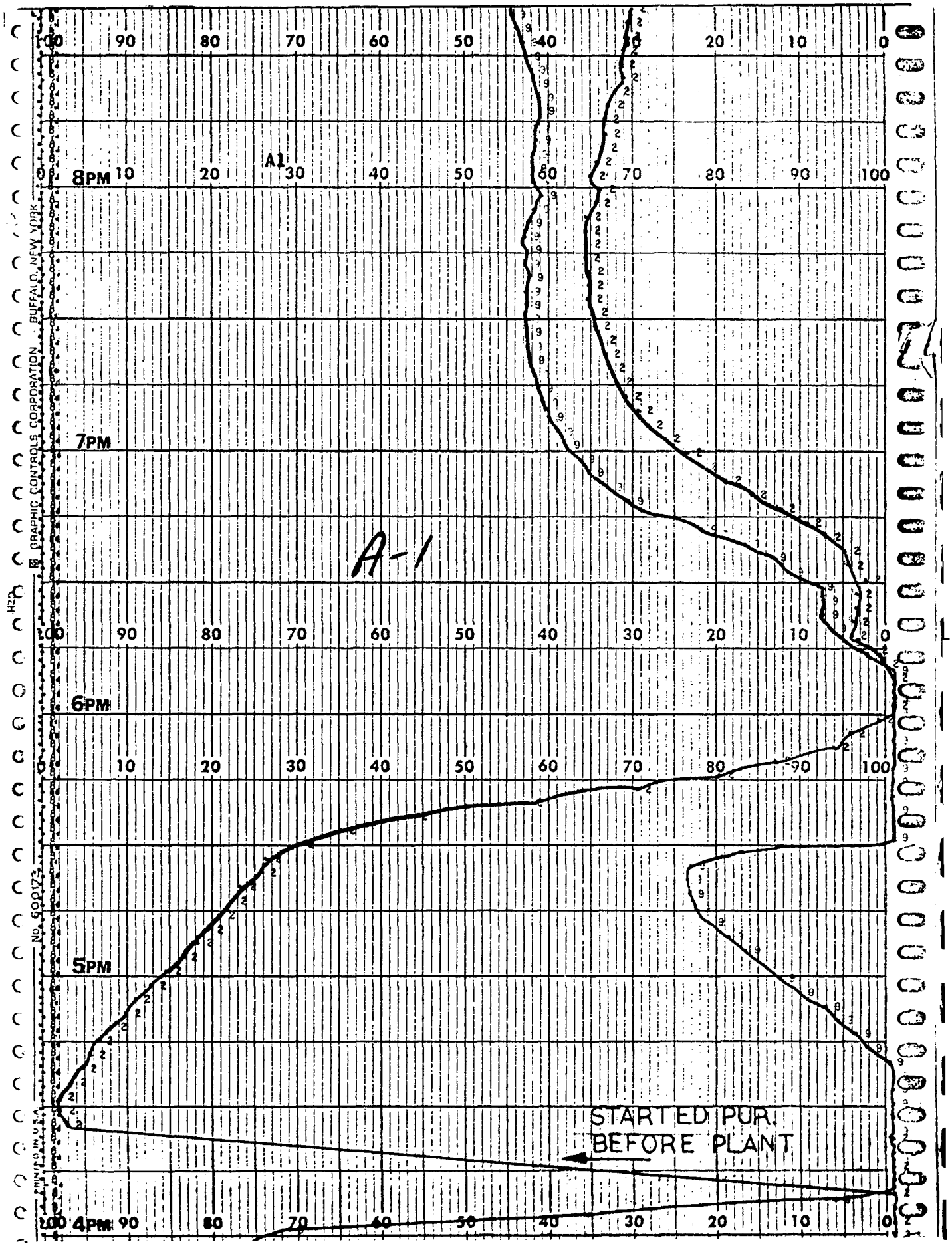
A1
8PM
7PM
6PM
5PM
4PM
A-1
STARTED PUR.
BEFORE PLANT
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No. 50173
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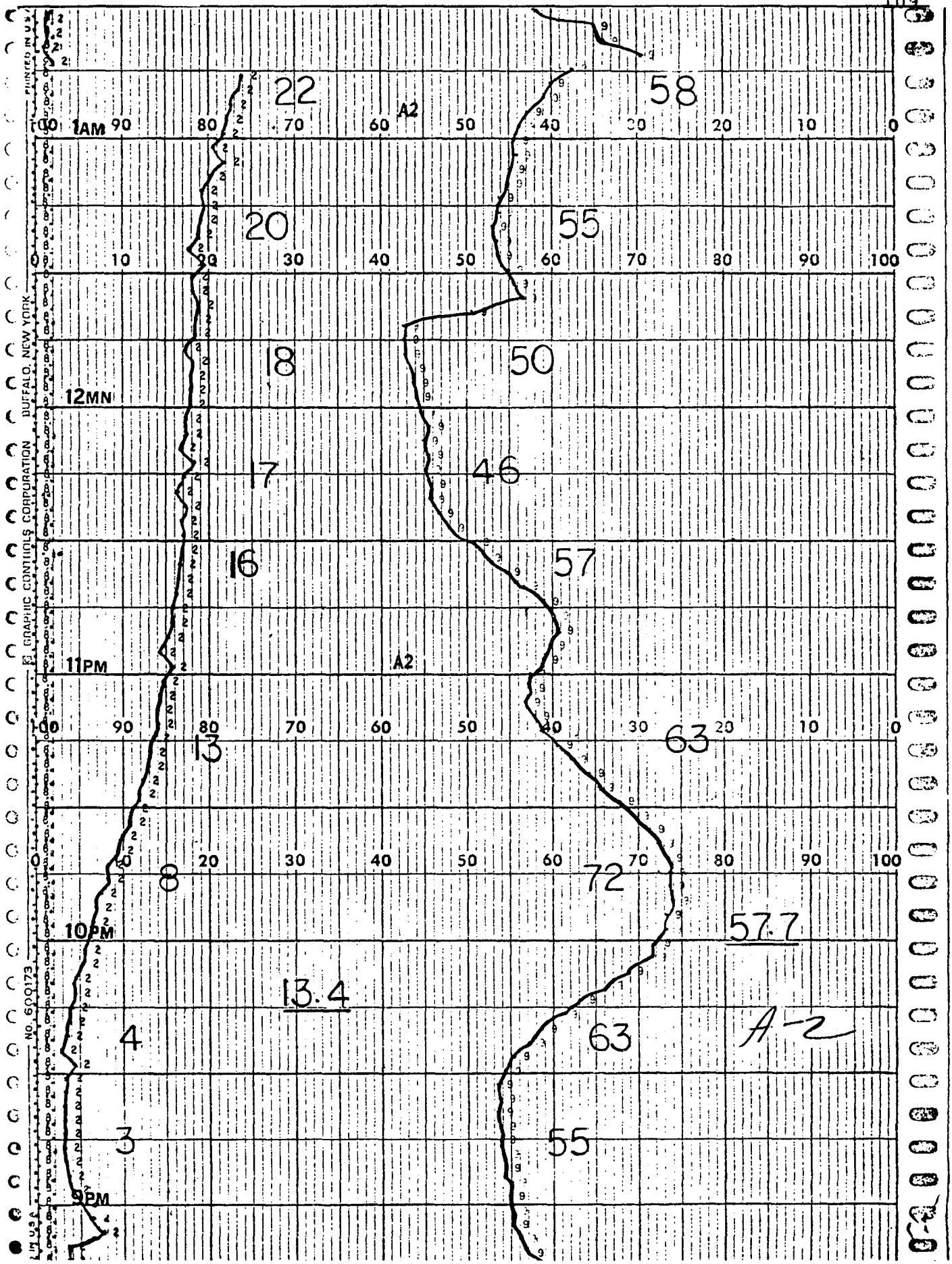
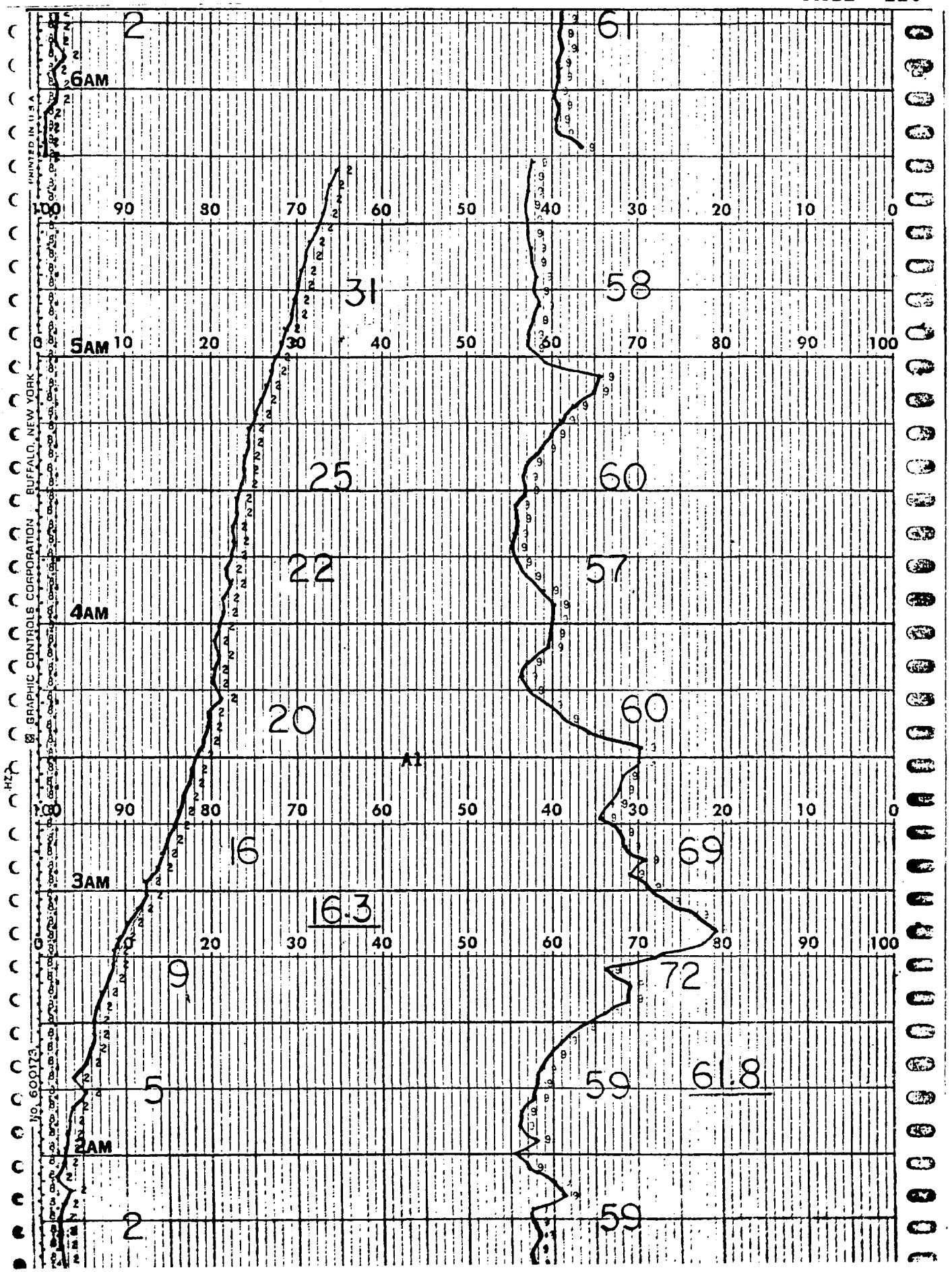

1AM
12MN
11PM
10PM
9PM
A2
22
20
18
17
16
13
8
4
3
58
55
50
46
57
63
72
57.7
13.4
63
55
A-2
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
PRINTED IN U.S.A.


2
6AM
61
100 90 80 70 60 50 40 30 20 10 0
31
58
5AM
10 20 30 40 50 60 70 80 90 100
25
60
22
57
4AM
20
60
A1
100 90 80 70 60 50 40 30 20 10 0
16
69
3AM
16.3
10 20 30 40 50 60 70 80 90 100
9
72
5
59
61.8
2AM
2
59
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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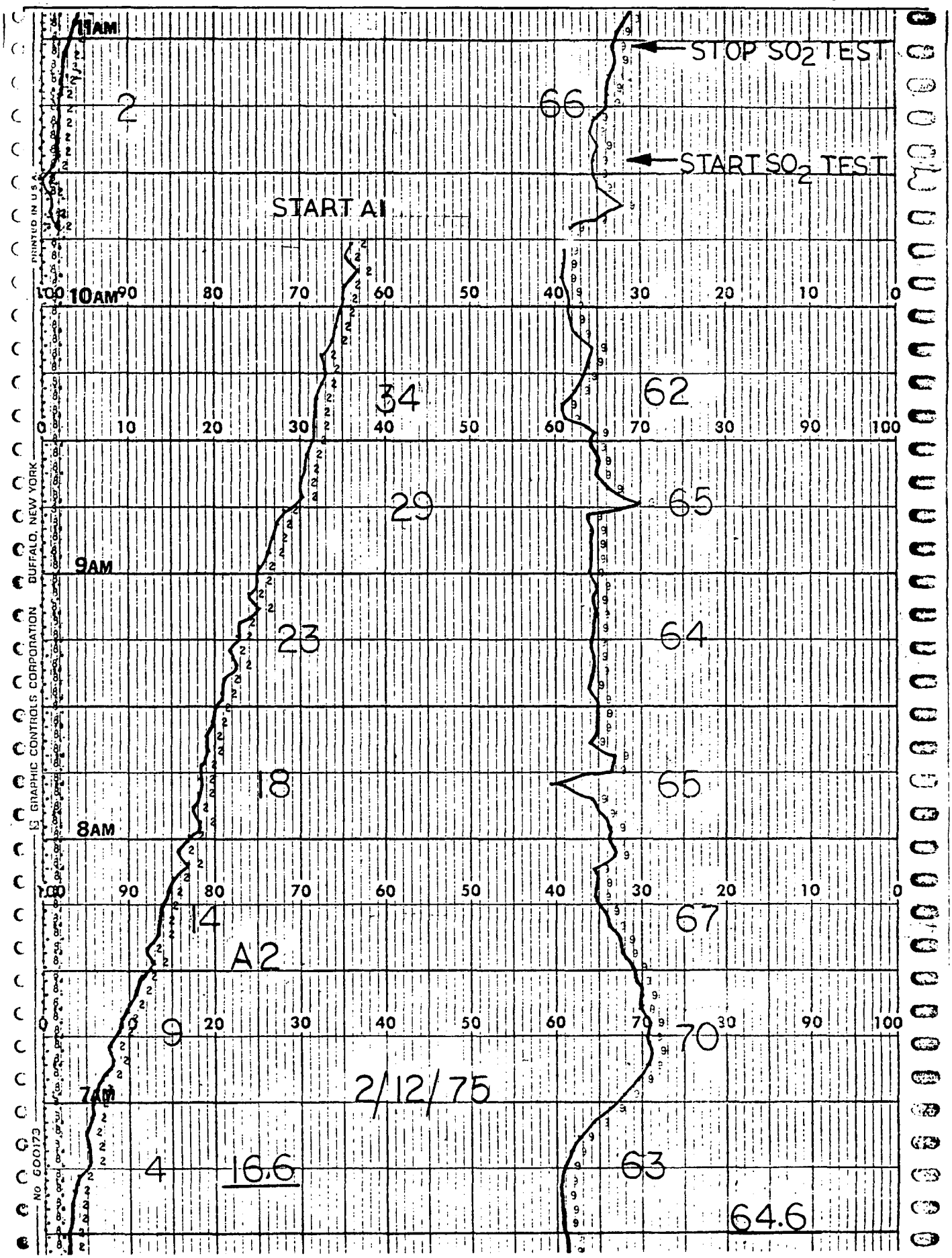
No. 600173
HZ


11AM
STOP SO_2 TEST
START SO_2 TEST
START A1
10AM
9AM
8AM
7AM
2
66
34
62
29
65
23
64
18
65
14
67
A2
9
70
2/12/75
4
16.6
63
64.6
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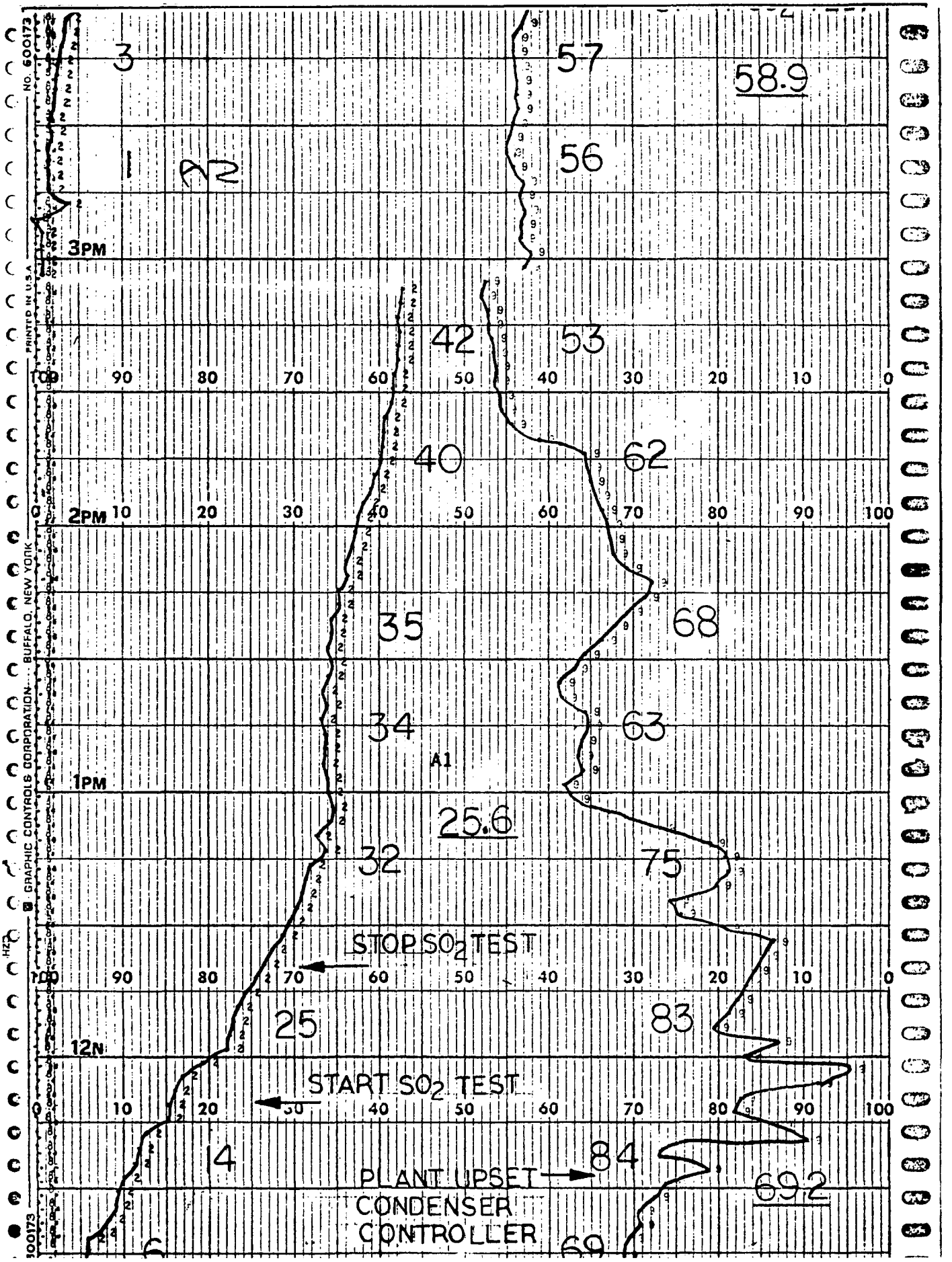
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO 600173


3
57
58.9
82
56
3PM
42
53
40
62
2PM
35
68
34
63
A1
1PM
25.6
32
75
STOP SO2 TEST
25
83
12N
START SO2 TEST
14
84
PLANT UPSET
CONDENSER
CONTROLLER
69
69.2
GRAPHIC CONTROLS CORPORATION — BUFFALO, NEW YORK
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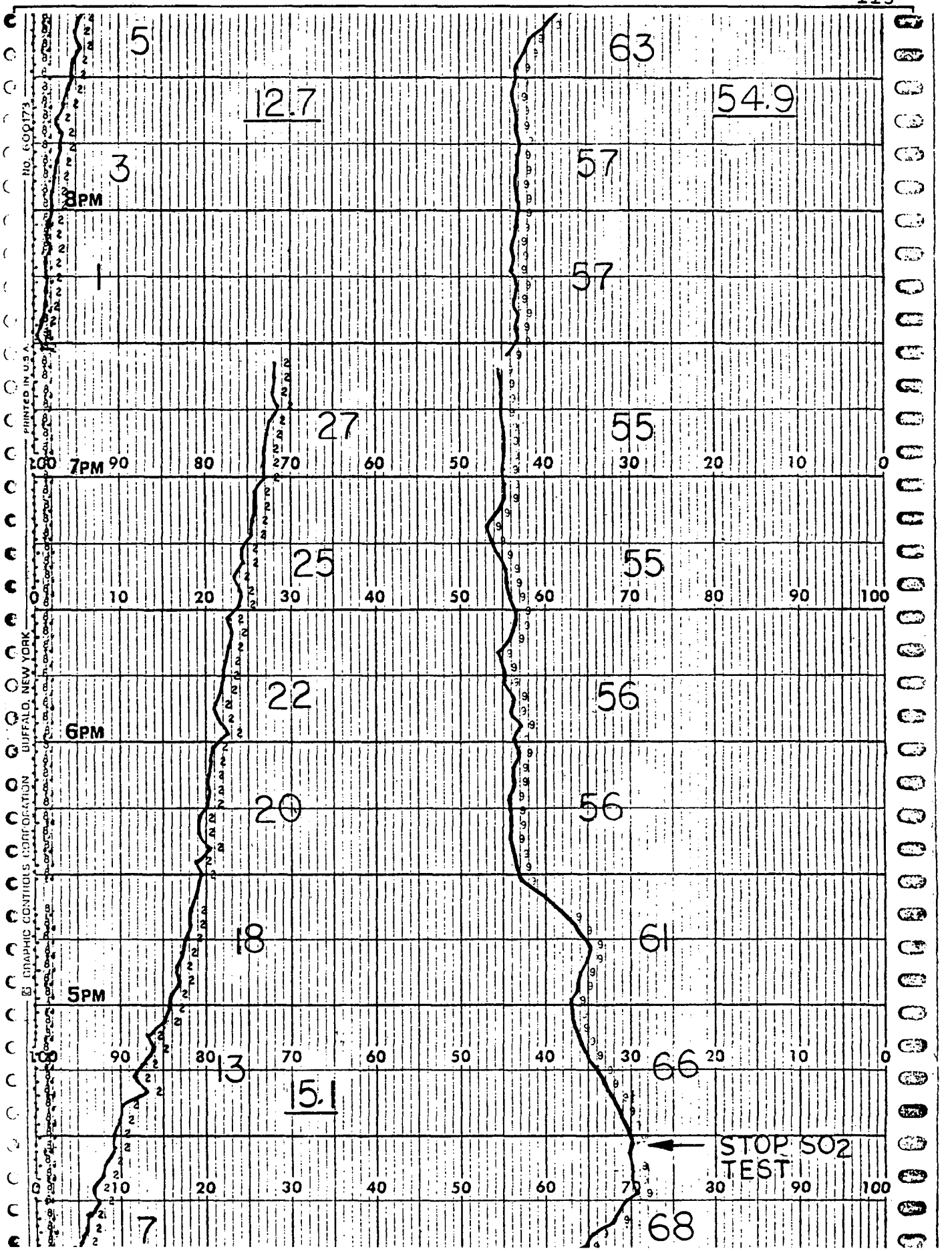
NO. 600173


5
12.7
3
8PM
1
63
54.9
57
57
27
55
7PM
25
55
22
56
6PM
20
56
18
61
5PM
13
15.1
66
STOP SO2 TEST
7
68
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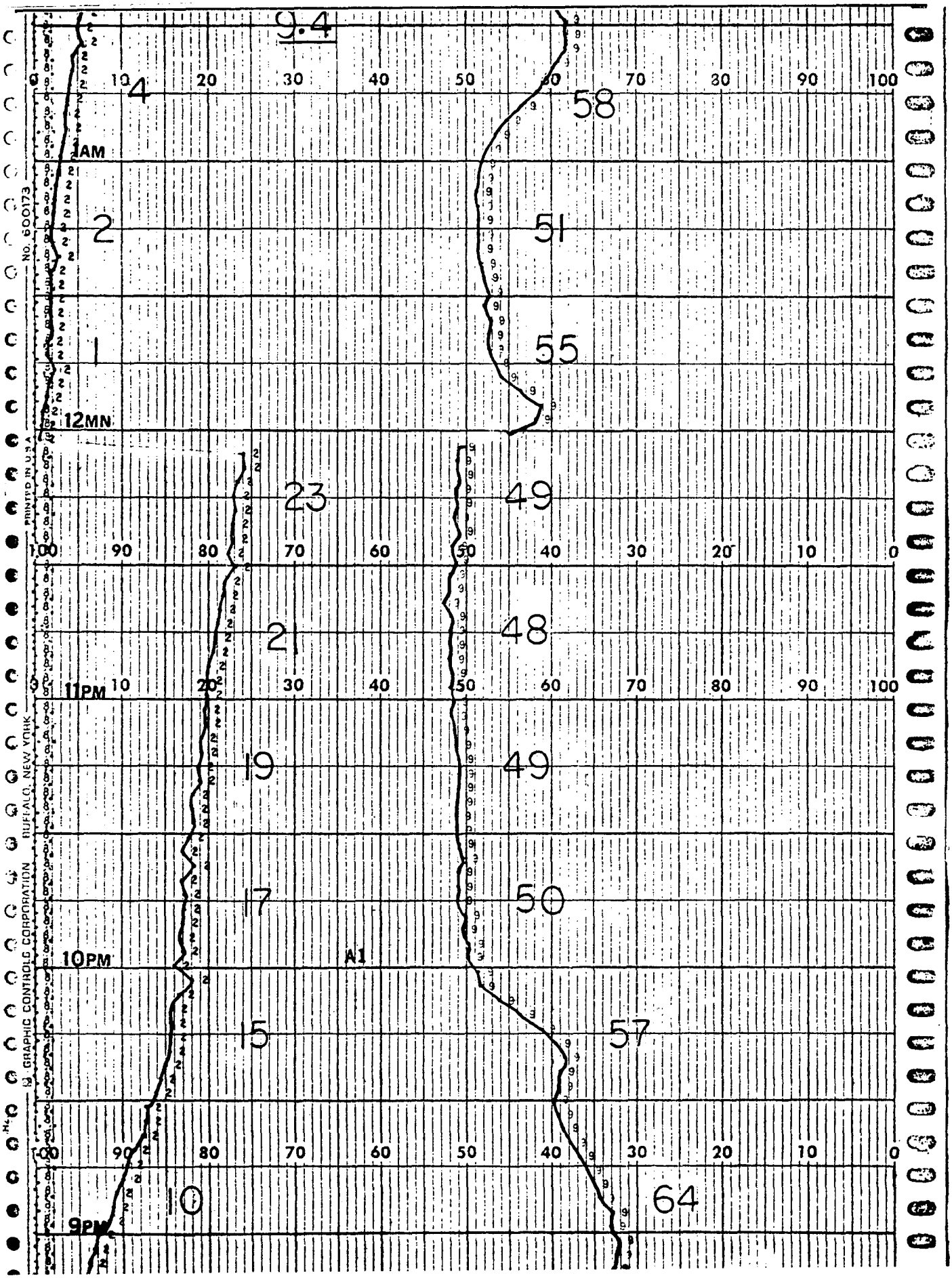
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK


9.4
4
58
1AM
2
51
1
55
12MN
23
49
2
48
11PM
19
49
17
50
10PM
A1
15
57
0
64
9PM
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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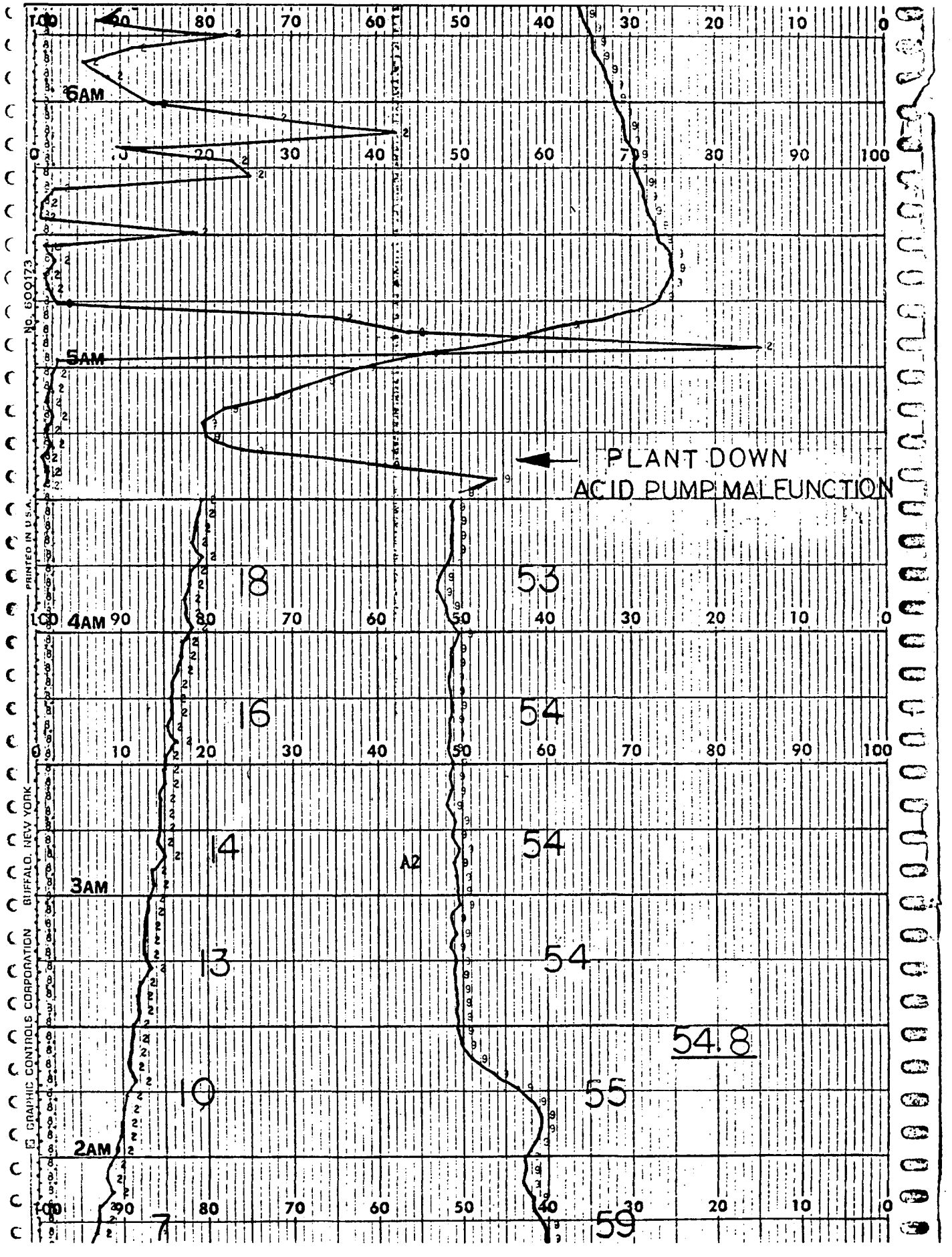
NO. 600173


6AM
5AM
4AM
3AM
2AM
PLANT DOWN
ACID PUMP MALFUNCTION
18
16
14
13
10
7
53
54
54
54.8
55
59
A2
No. 609173
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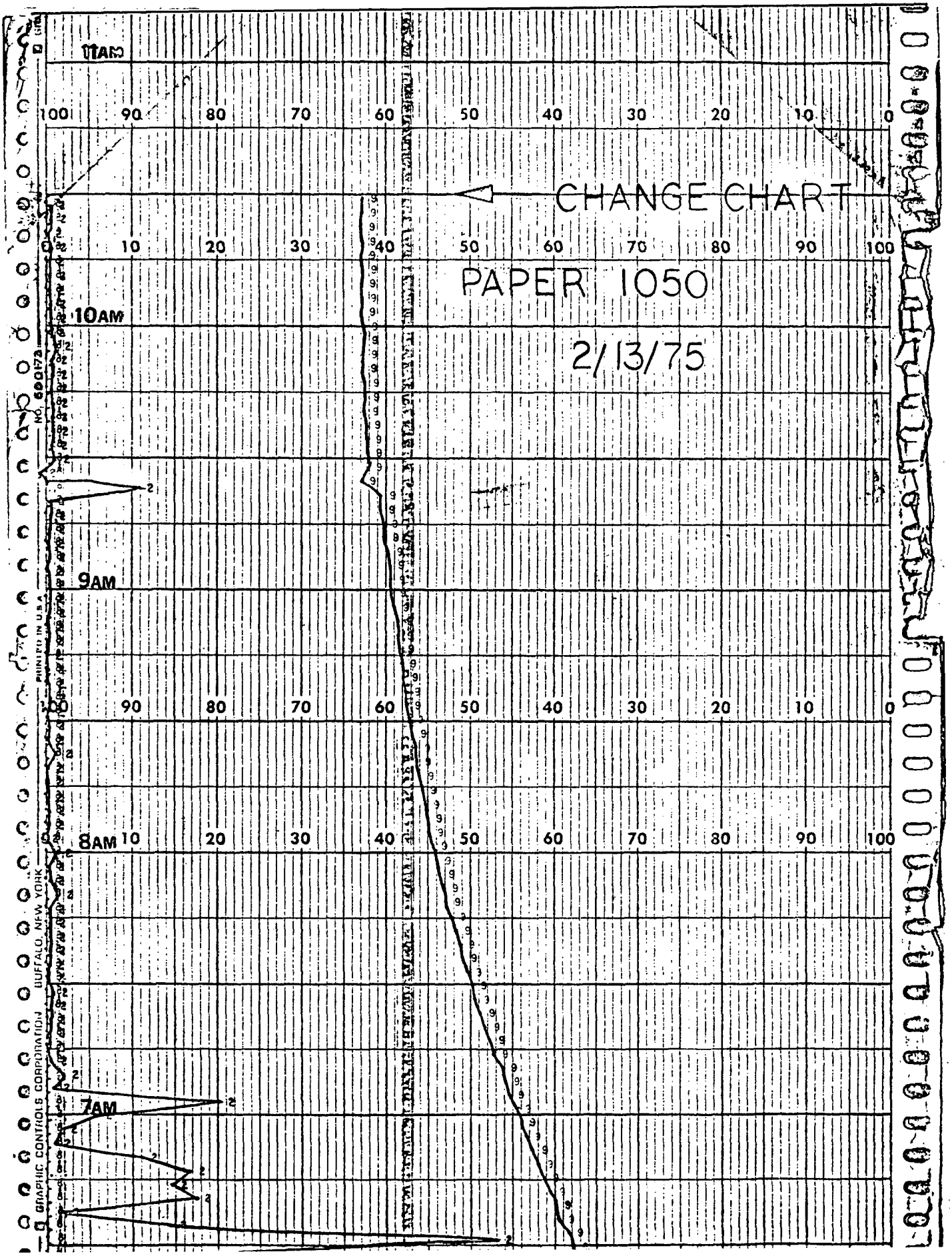
11AM
10AM
9AM
8AM
7AM
CHANGE CHART
PAPER 1050
2/13/75
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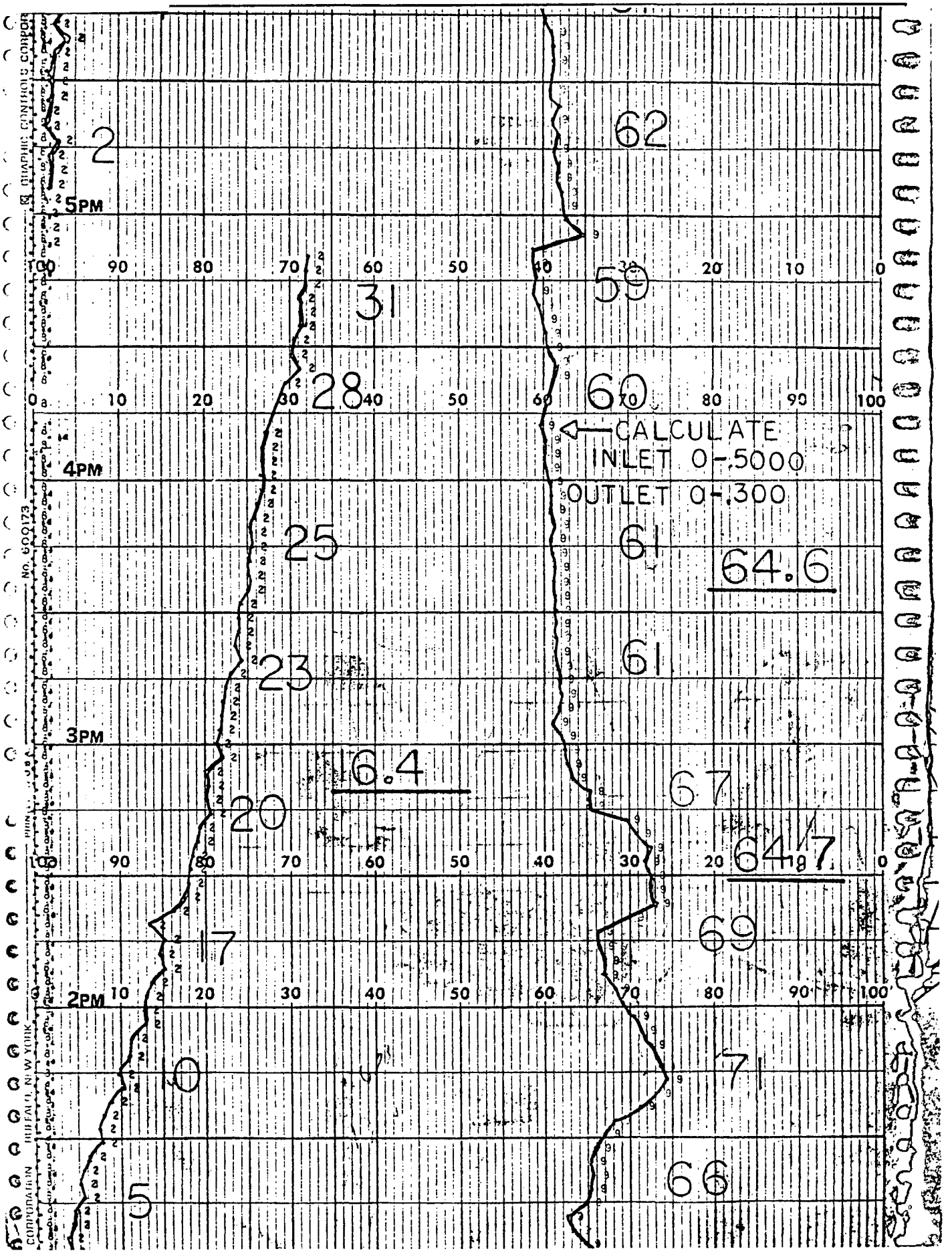
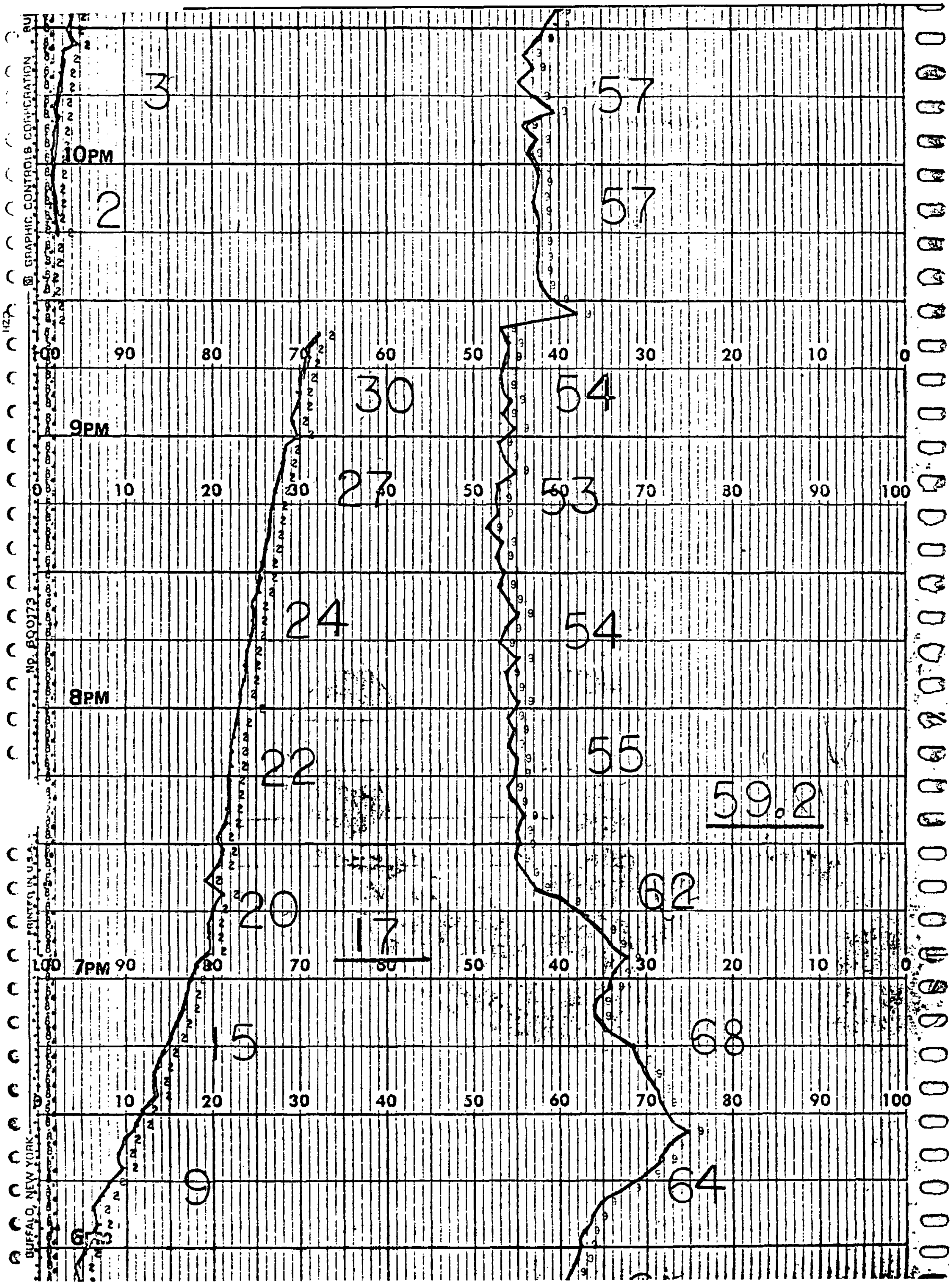

5PM
4PM
3PM
2PM
2
31
28
25
23
20
17
10
5
62
59
60
61
61
67
69
71
66
64.6
64.7
64.4
CALCULATE
INLET 0-.5000
OUTLET 0-.300


GRAPHIC CONTROLS CORPORATION
No. 600173
PRINTED IN U.S.A.
BUFFALO, NEW YORK
10PM
9PM
8PM
7PM
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
3
57
2
57
30
54
27
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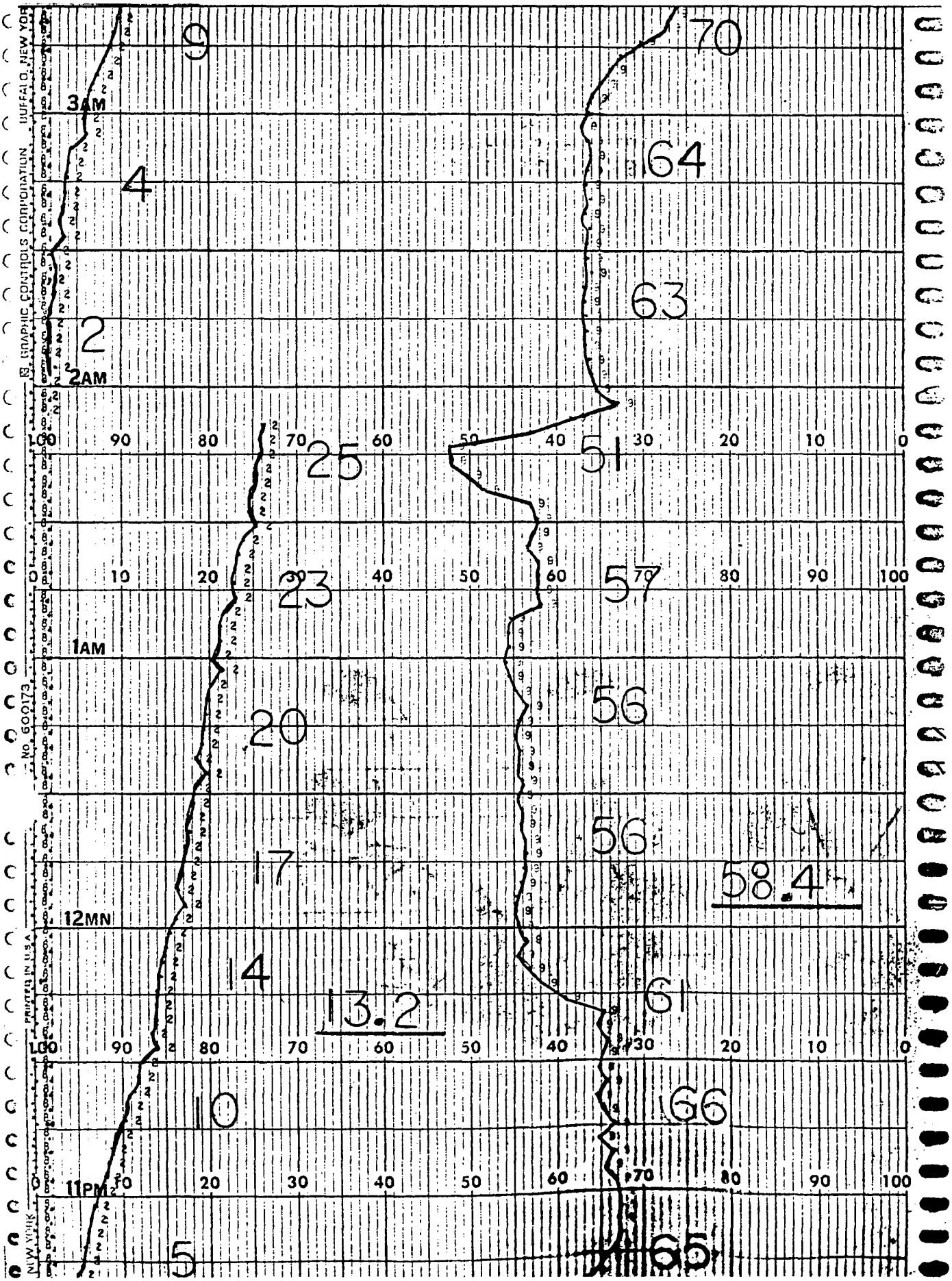
55
59.2
62
20
17
15
68
9
64


GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
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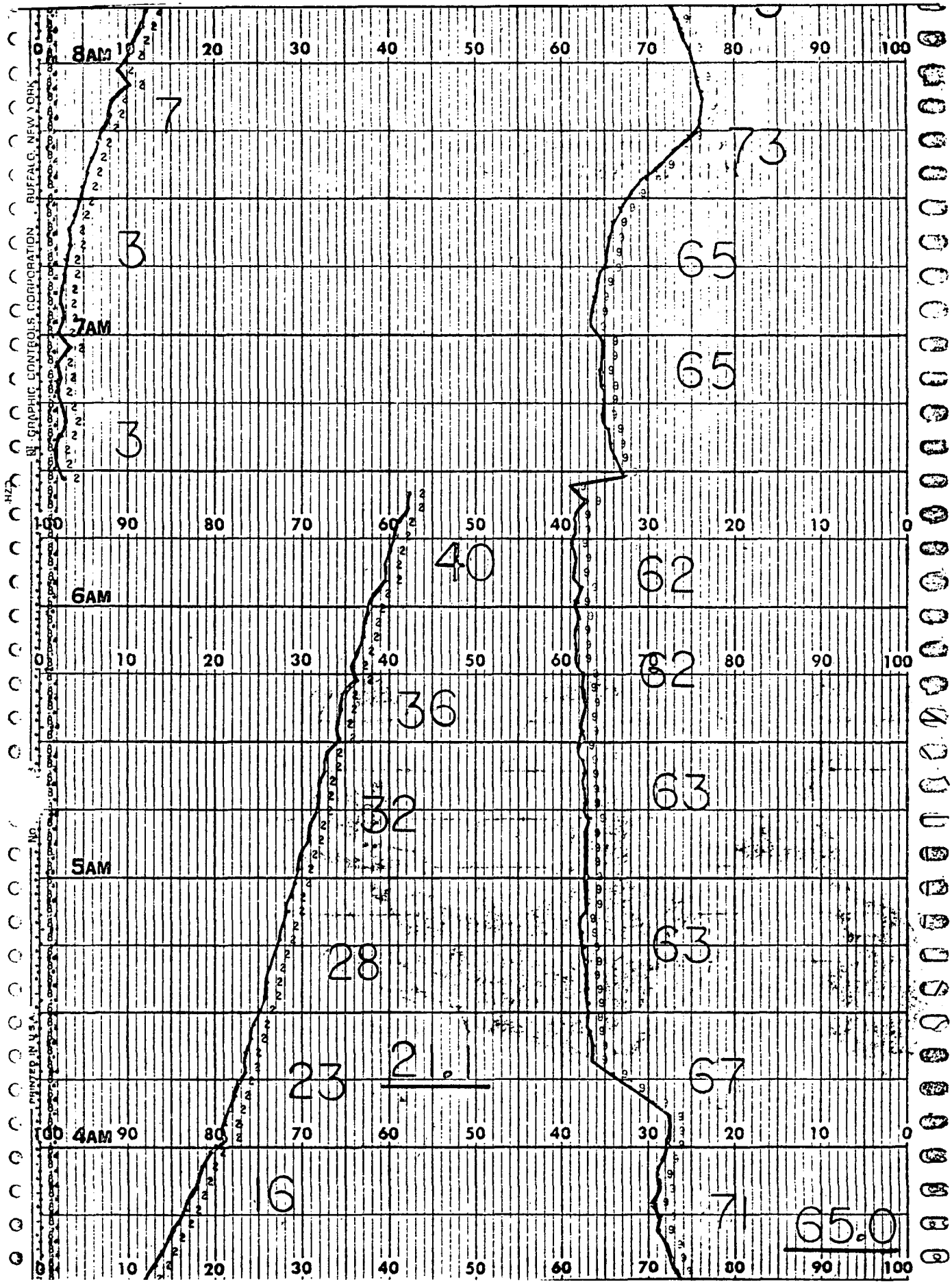
NEW YORK
3AM
2AM
1AM
12MN
11PM
9
4
2
25
23
20
7
4
13.2
10
5
70
64
63
51
57
56
56
58.4
61
66
65
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100


8AM
7AM
6AM
5AM
4AM
7
3
3
40
36
32
28
23
21°
6
73
65
65
62
62
63
63
67
71
65°
GRAPHIC CONTROLS CORPORATION . BUFFALO, NEW YORK
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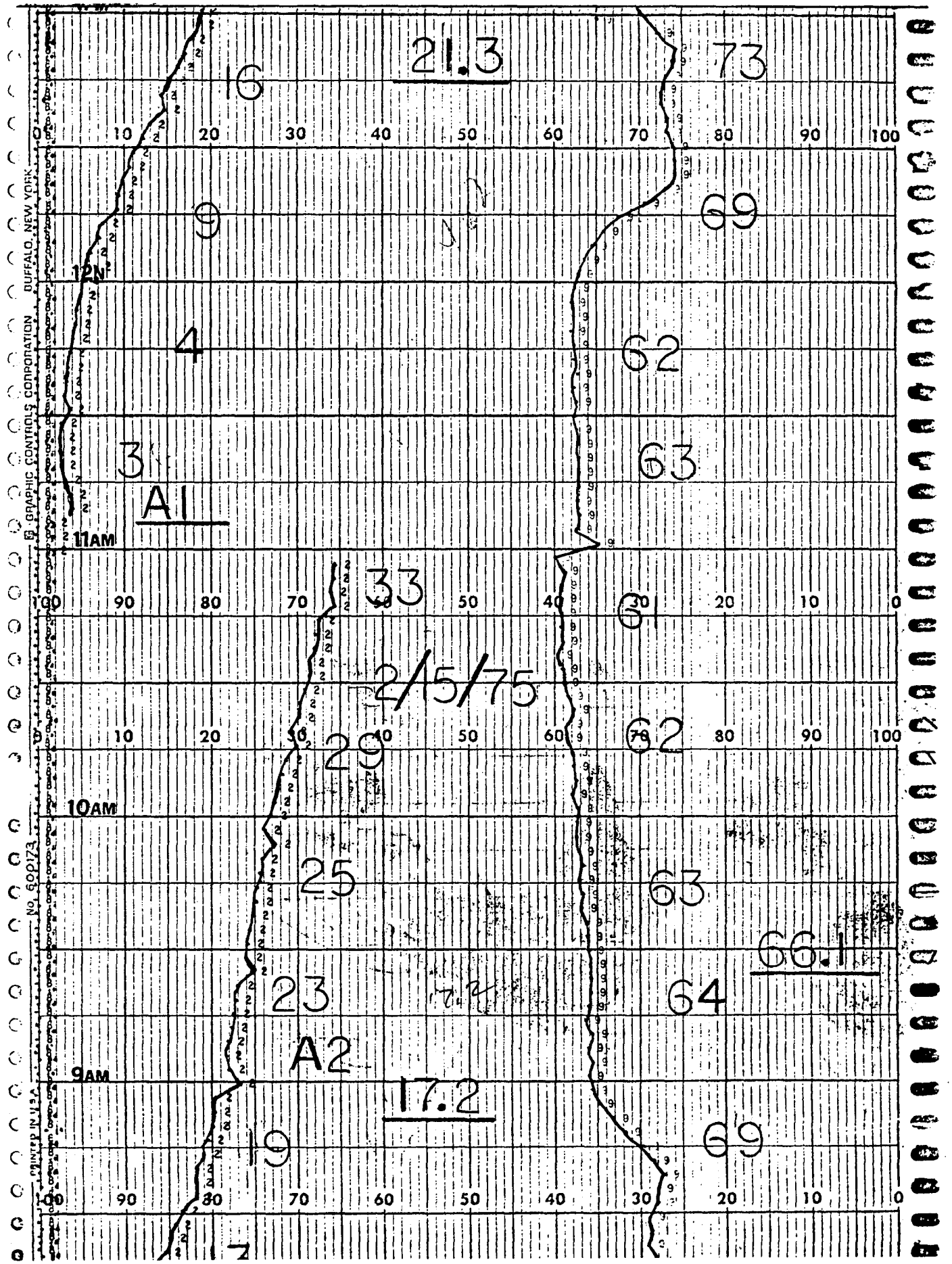
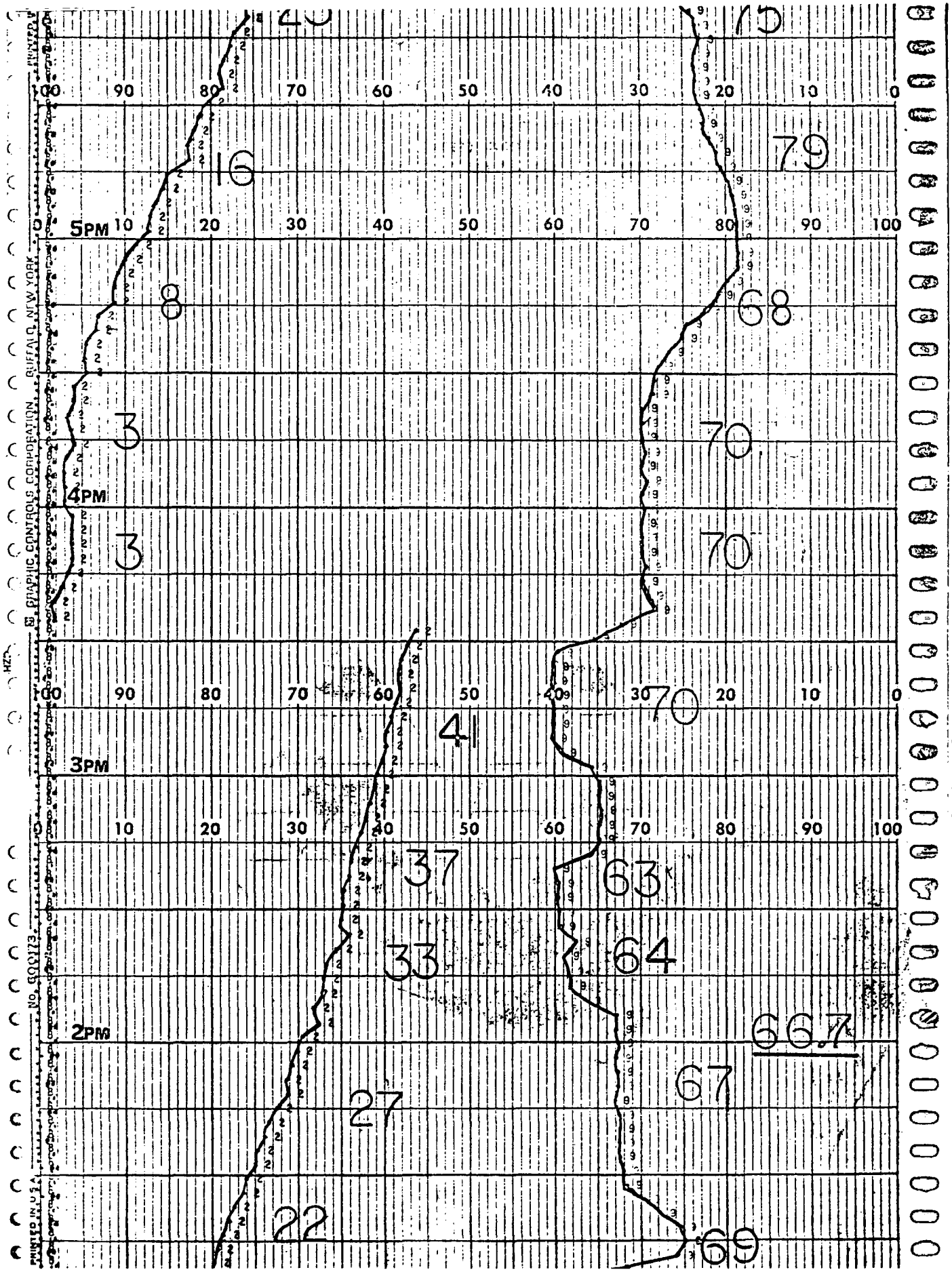

21.3
16
73
9
69
12N
4
62
3
63
A1
11AM
33
61
2/5/75
29
62
10AM
25
63
66.1
23
64
A2
9AM
17.2
19
69
7
BRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 60173
PRINTED IN U.S.A.


5PM
4PM
3PM
2PM
100 90 80 70 60 50 40 30 20 10 0
10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
79
68
70
70
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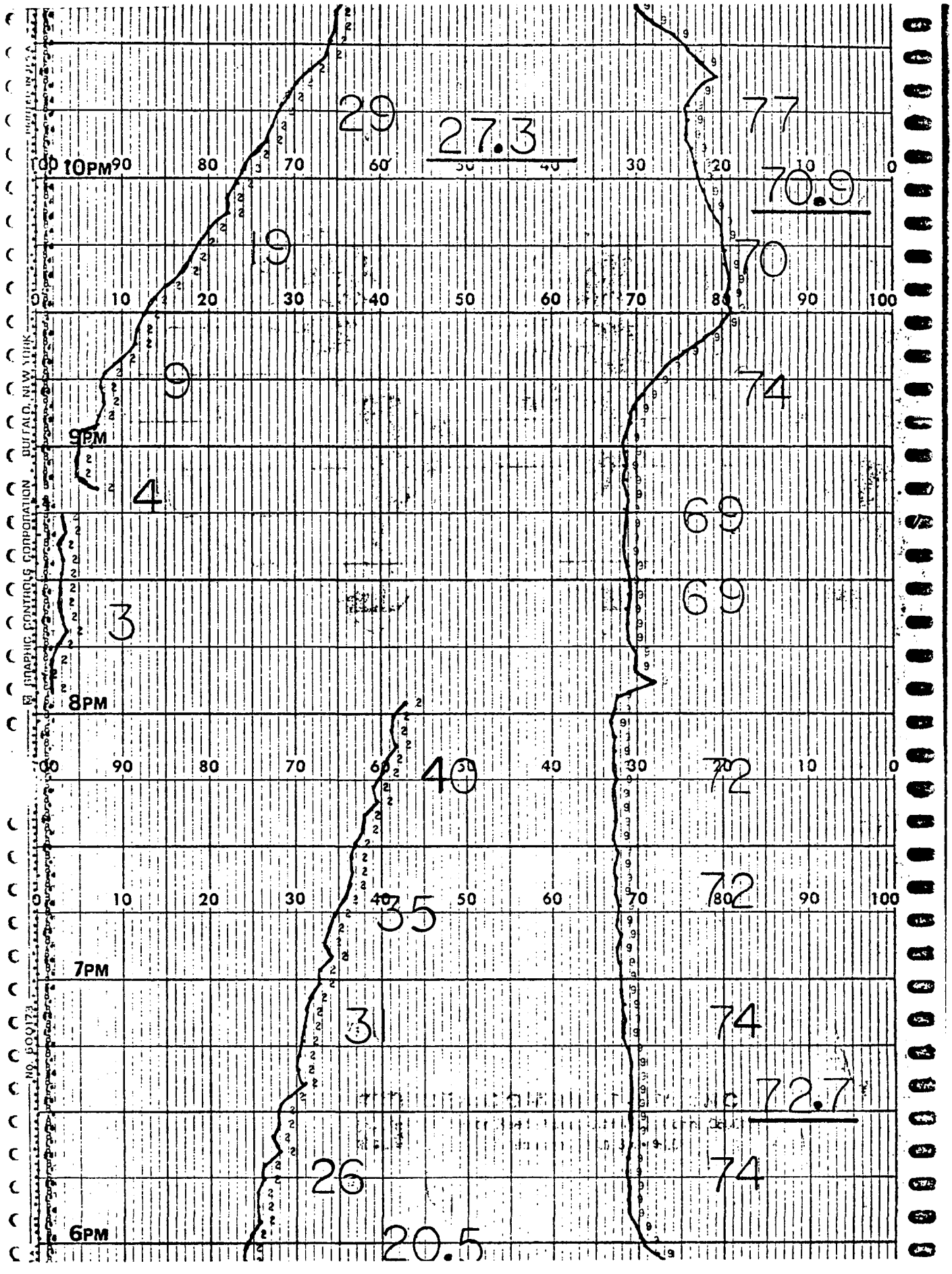
63
64
67
69
16
8
3
3
41
37
33
27
22


10PM
9PM
8PM
7PM
6PM
29
27.3
77
70.9
70
74
69
69
72
72
74
72.7
74
40
35
3
26
20.5
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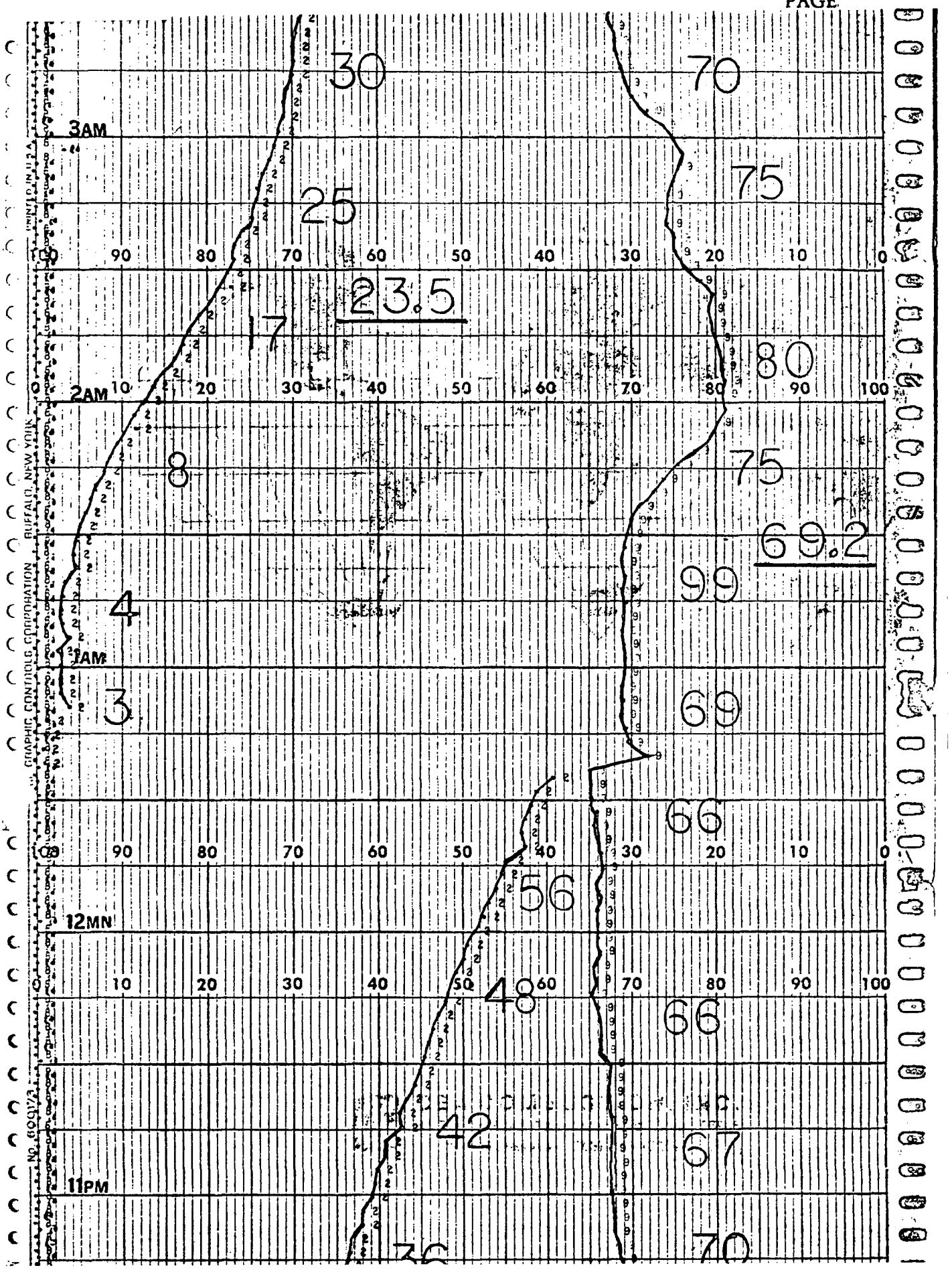
9
4
3
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 80V12


3AM
2AM
1AM
12MN
11PM
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
NO. 60173
30
25
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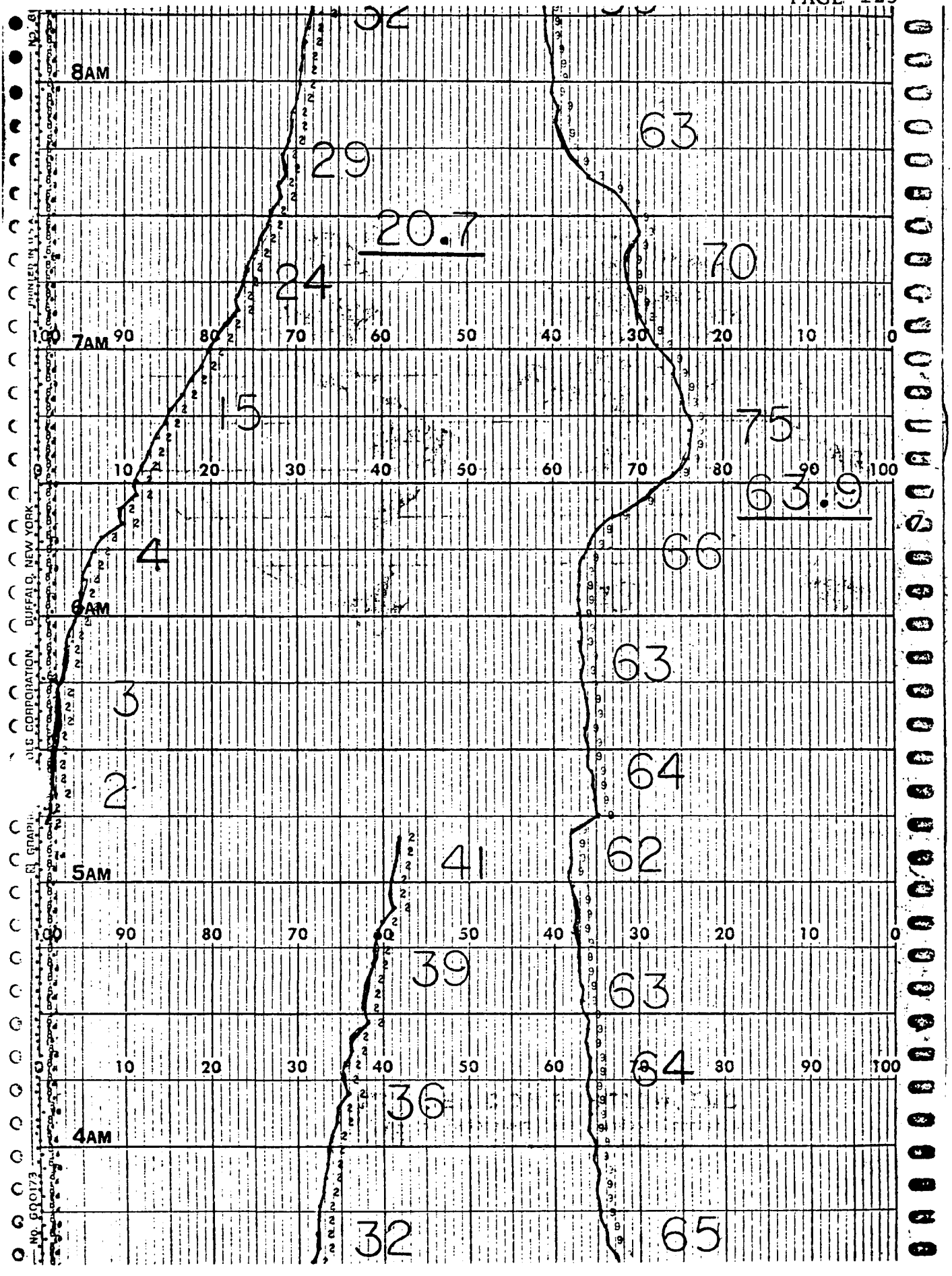
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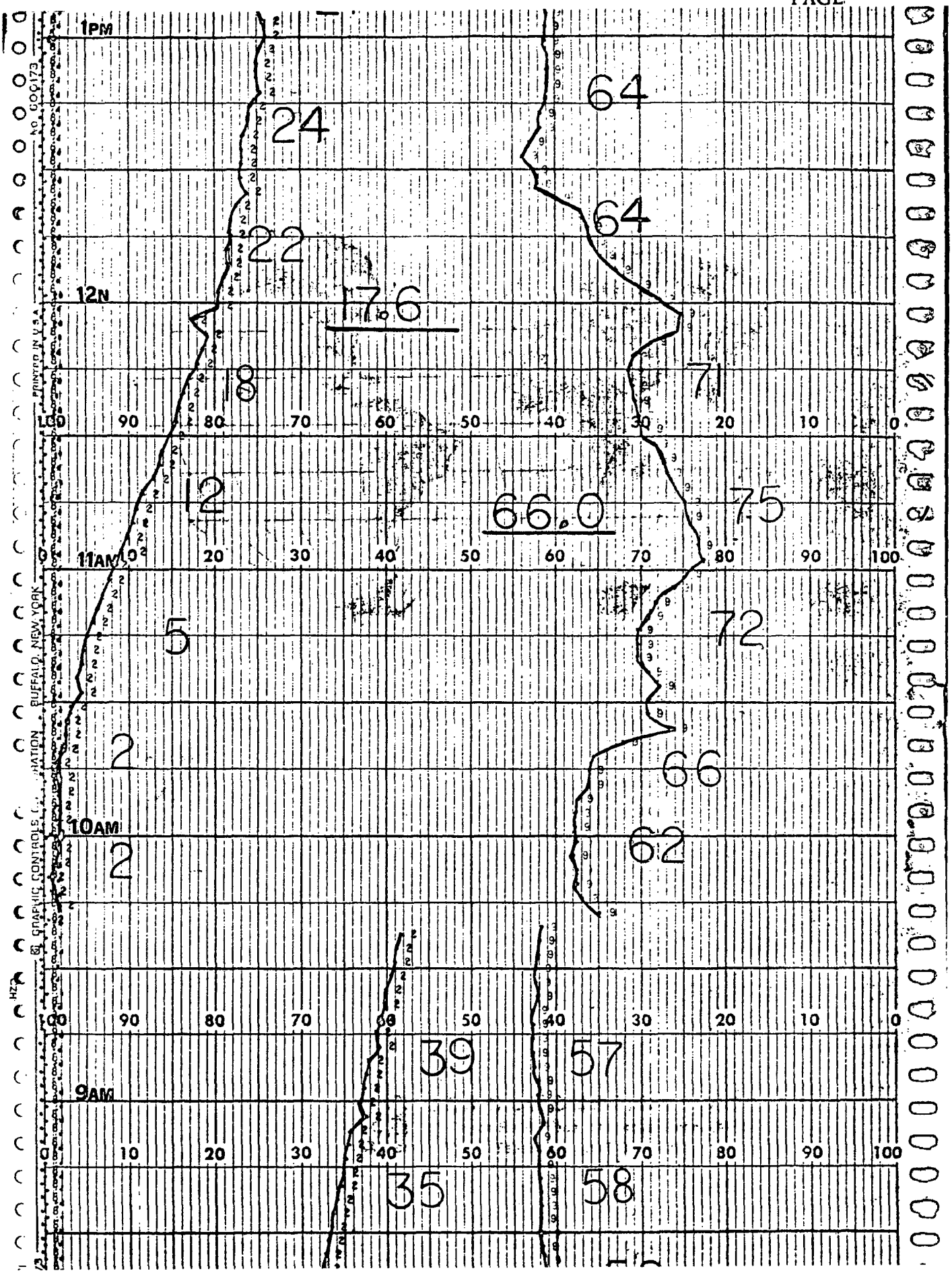
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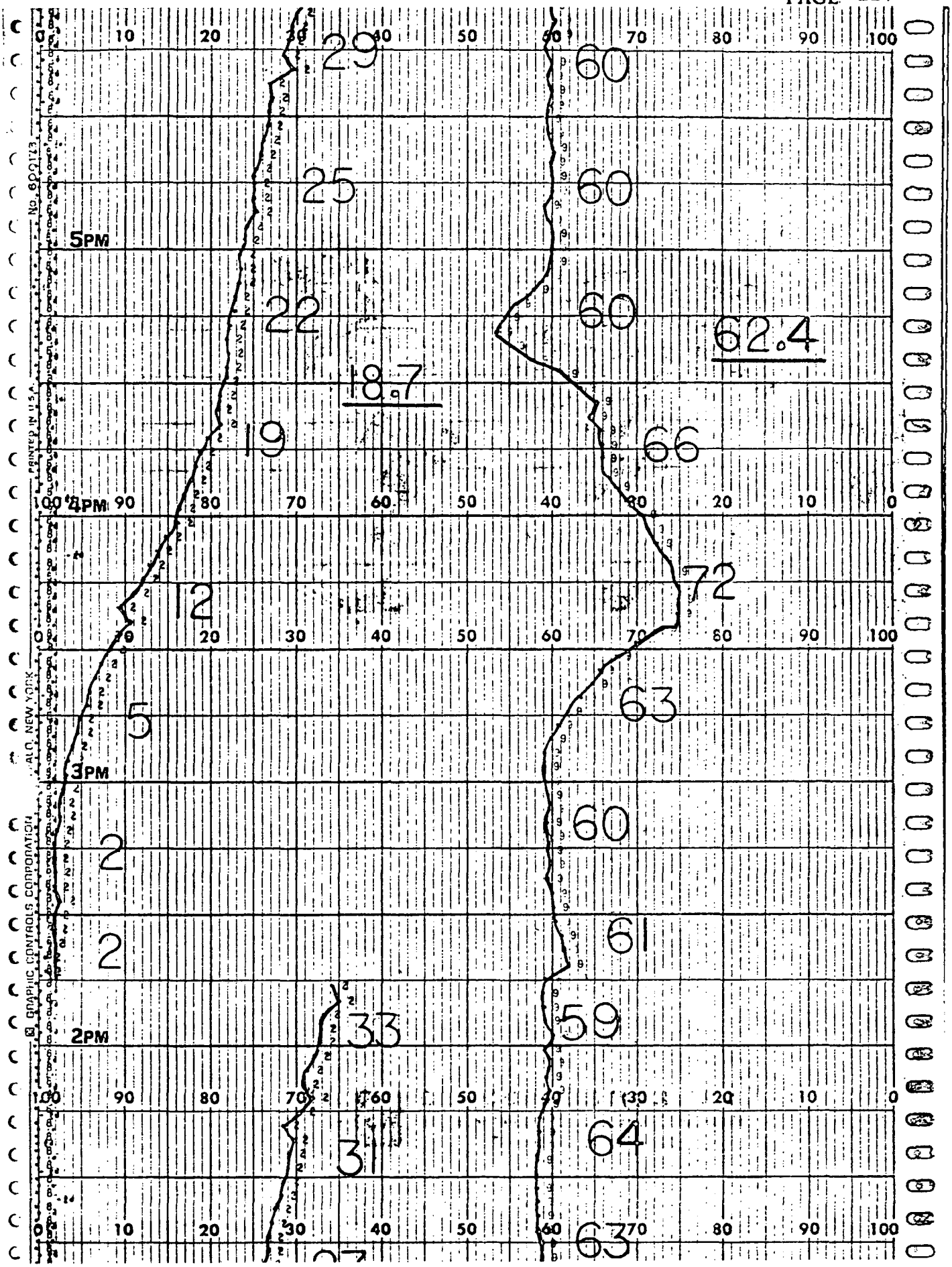
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62.4
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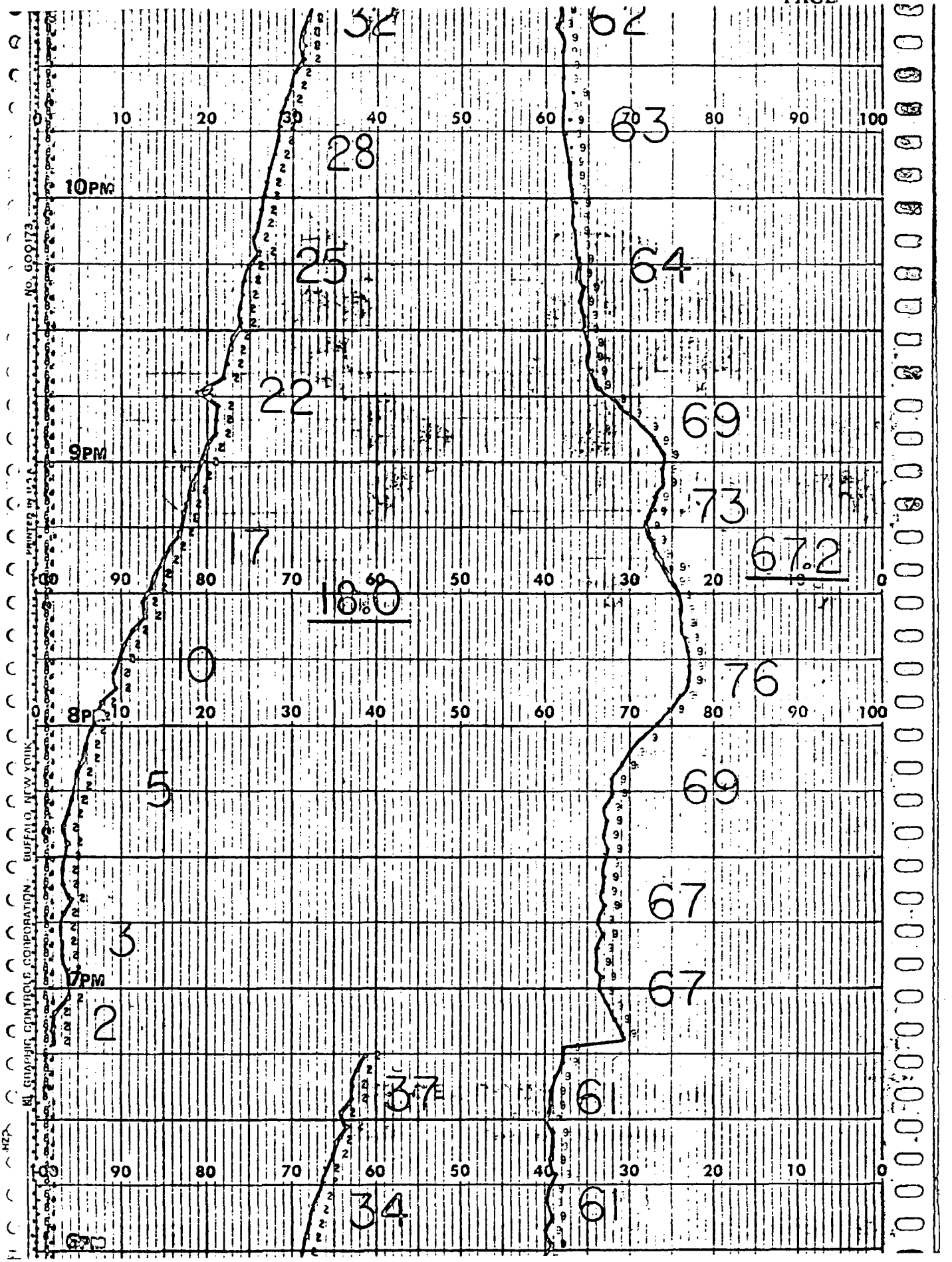
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
PRINTED IN U.S.A.
No. 60213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17
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5
3
2
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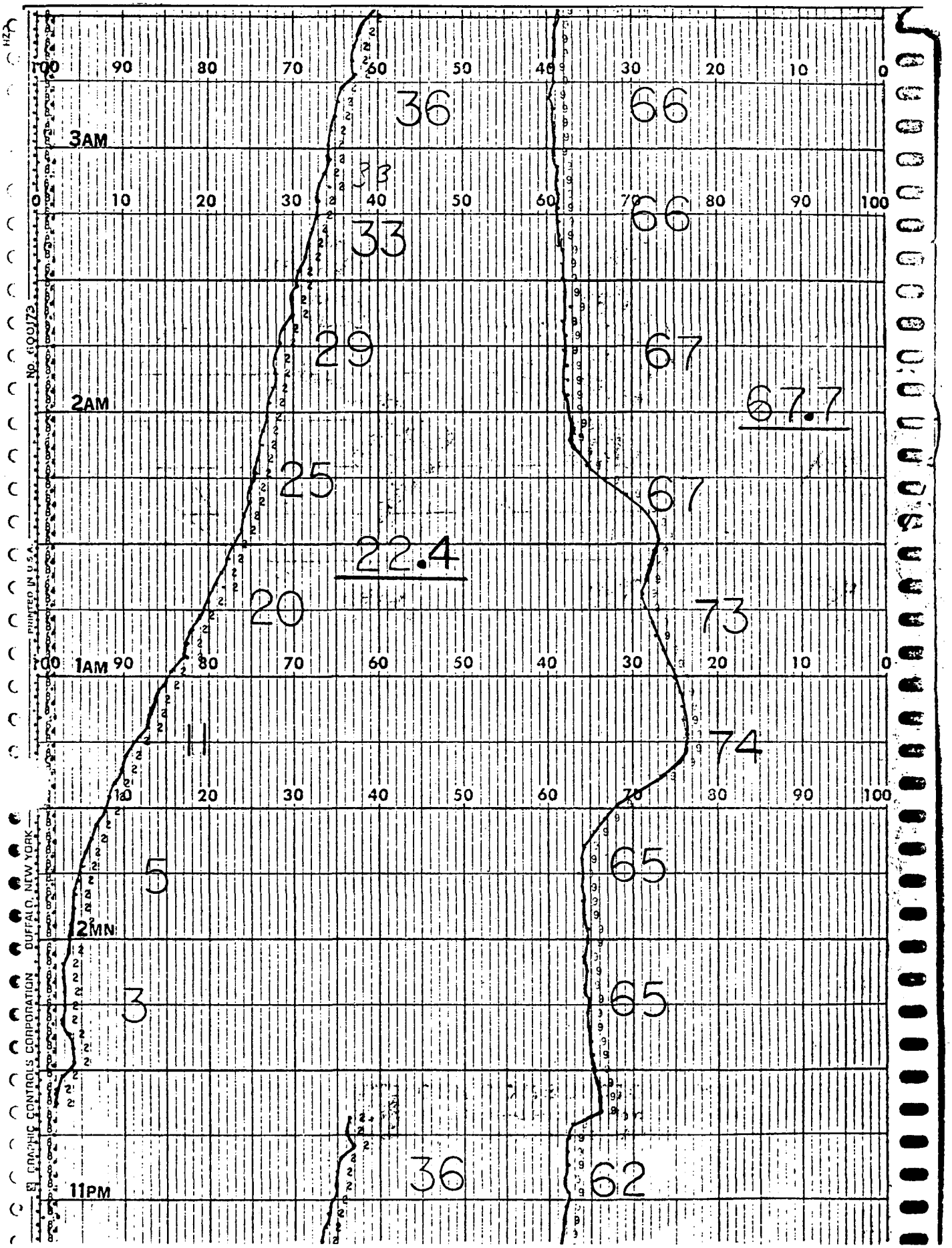
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 609173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67.7
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25
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22.4
20
73
100 1AM 90 80 70 60 50 40 30 20 10 0
74
0 10 20 30 40 50 60 70 80 90 100
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2MN
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36
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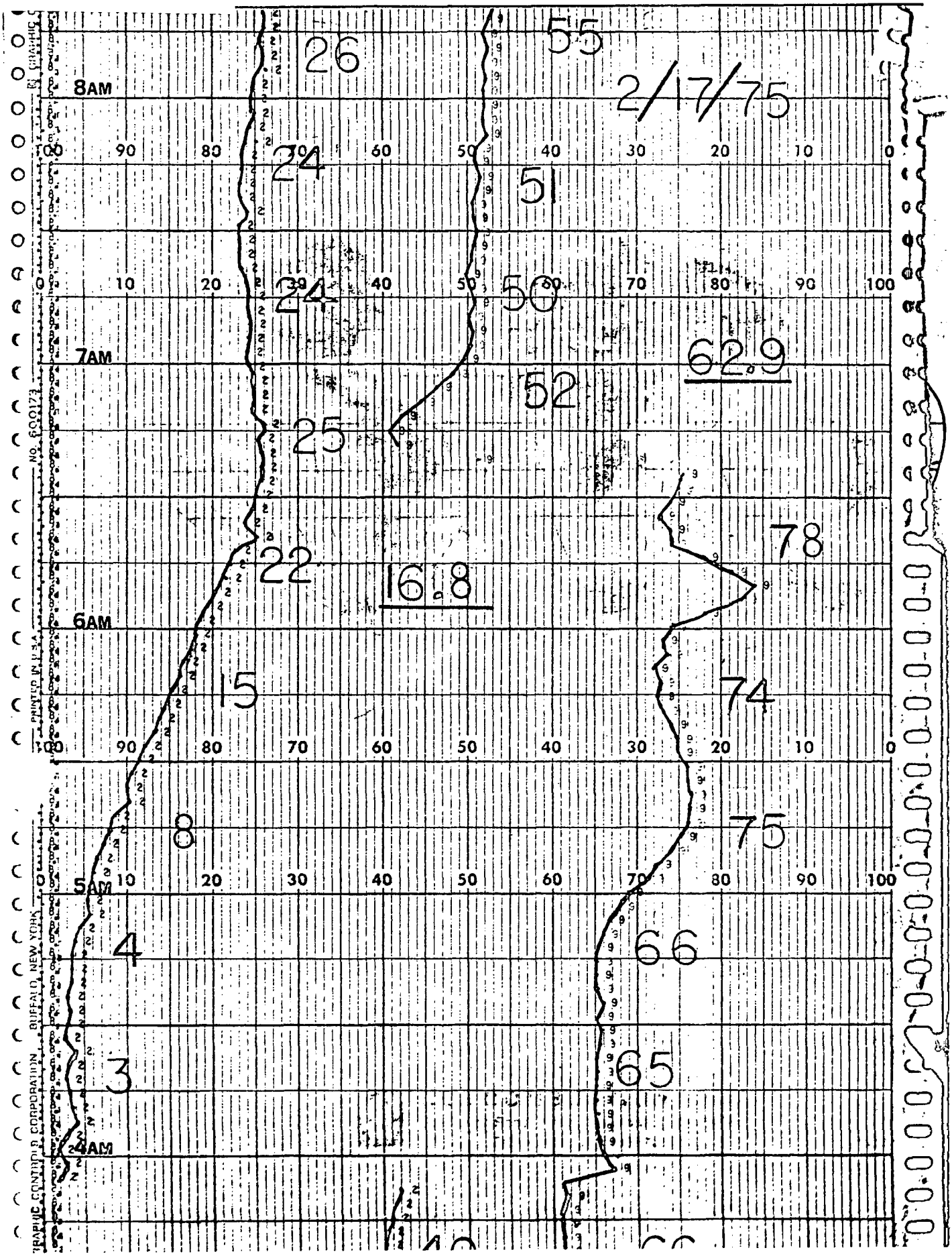
11PM
PRINTED IN U.S.A.
No. 600173
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK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7AM
6AM
5AM
4AM
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26
24
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25
22
15
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50
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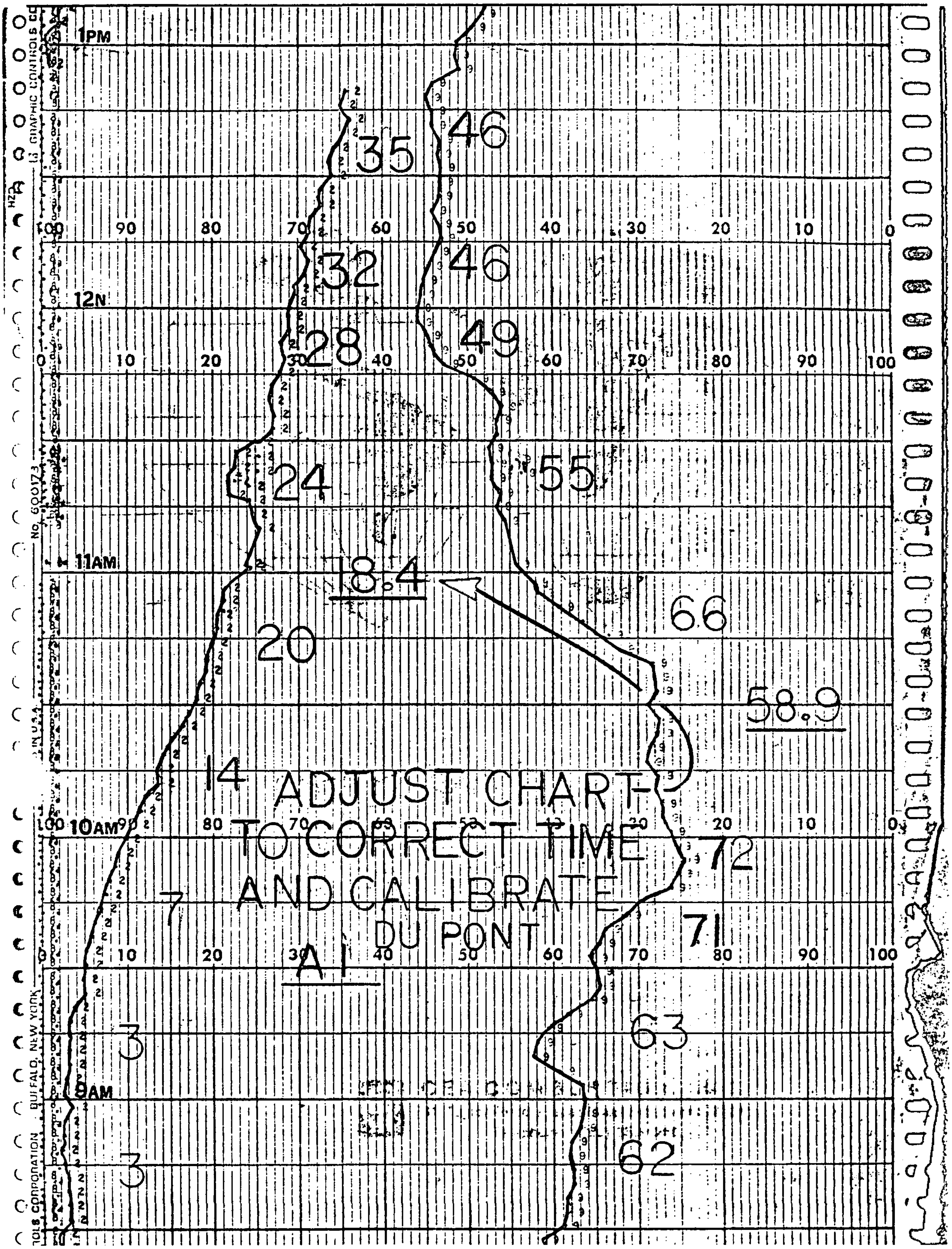
TRAFFIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
PRINTED IN U.S.A.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46
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46
12N
28
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0 10 20 30 40 50 60 70 80 90 100
24
55
11AM
18.4
66
20
58.9
14
ADJUST CHART
TO CORRECT TIME
AND CALIBRATE
DU PONT
10AM
72
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A1
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9AM
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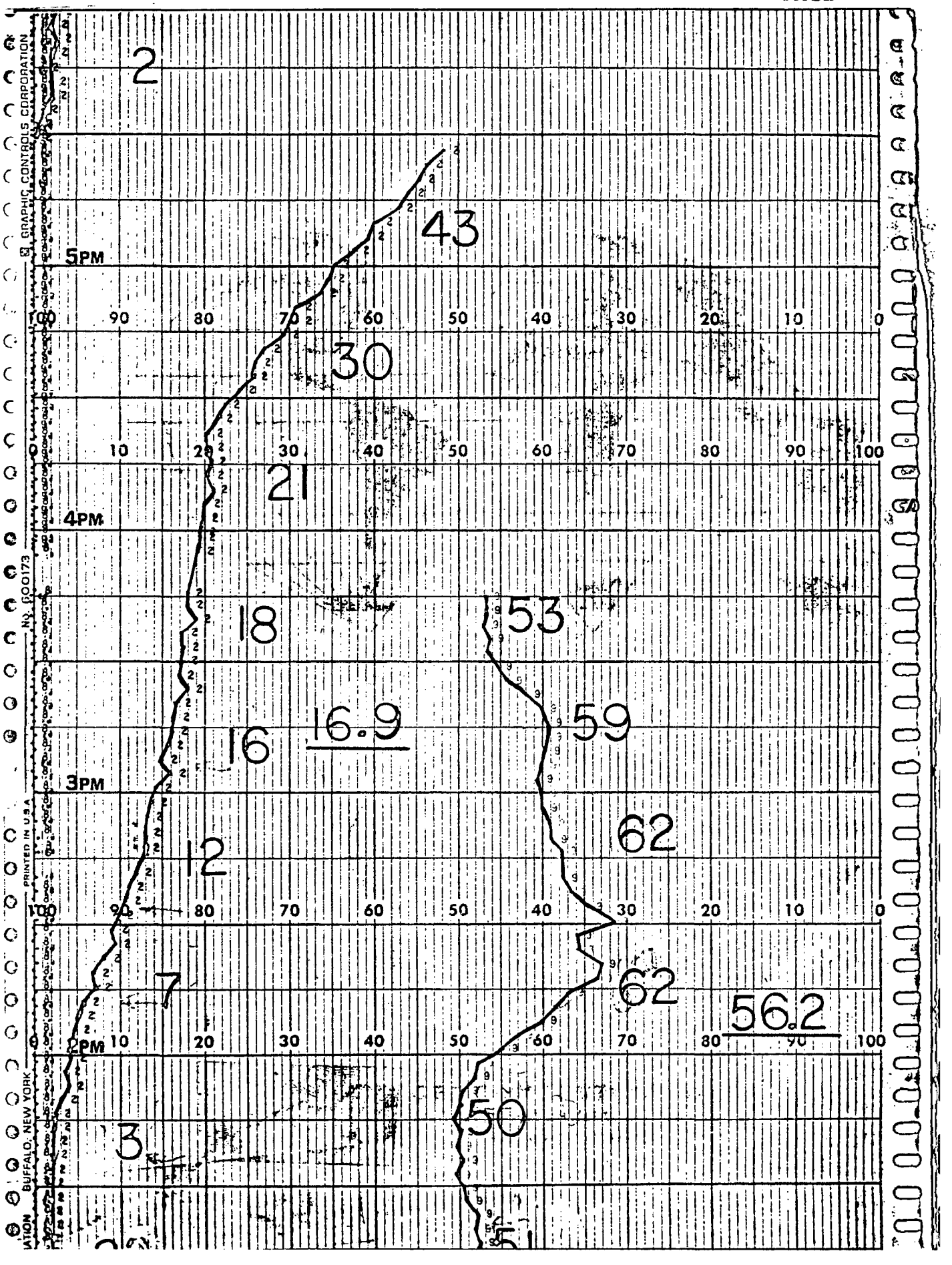
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
PRINTED IN U.S.A.
5PM
4PM
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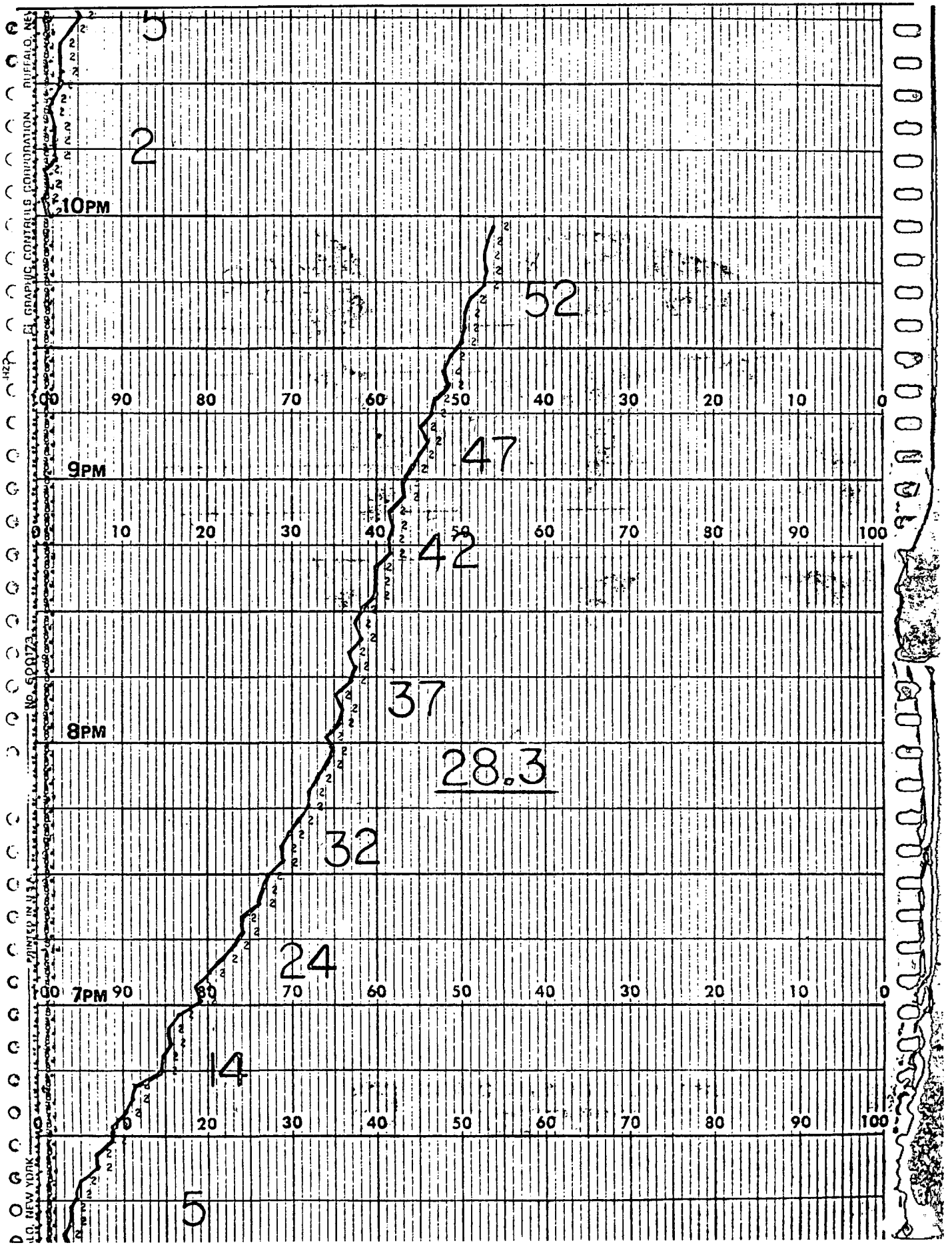
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8PM
7PM
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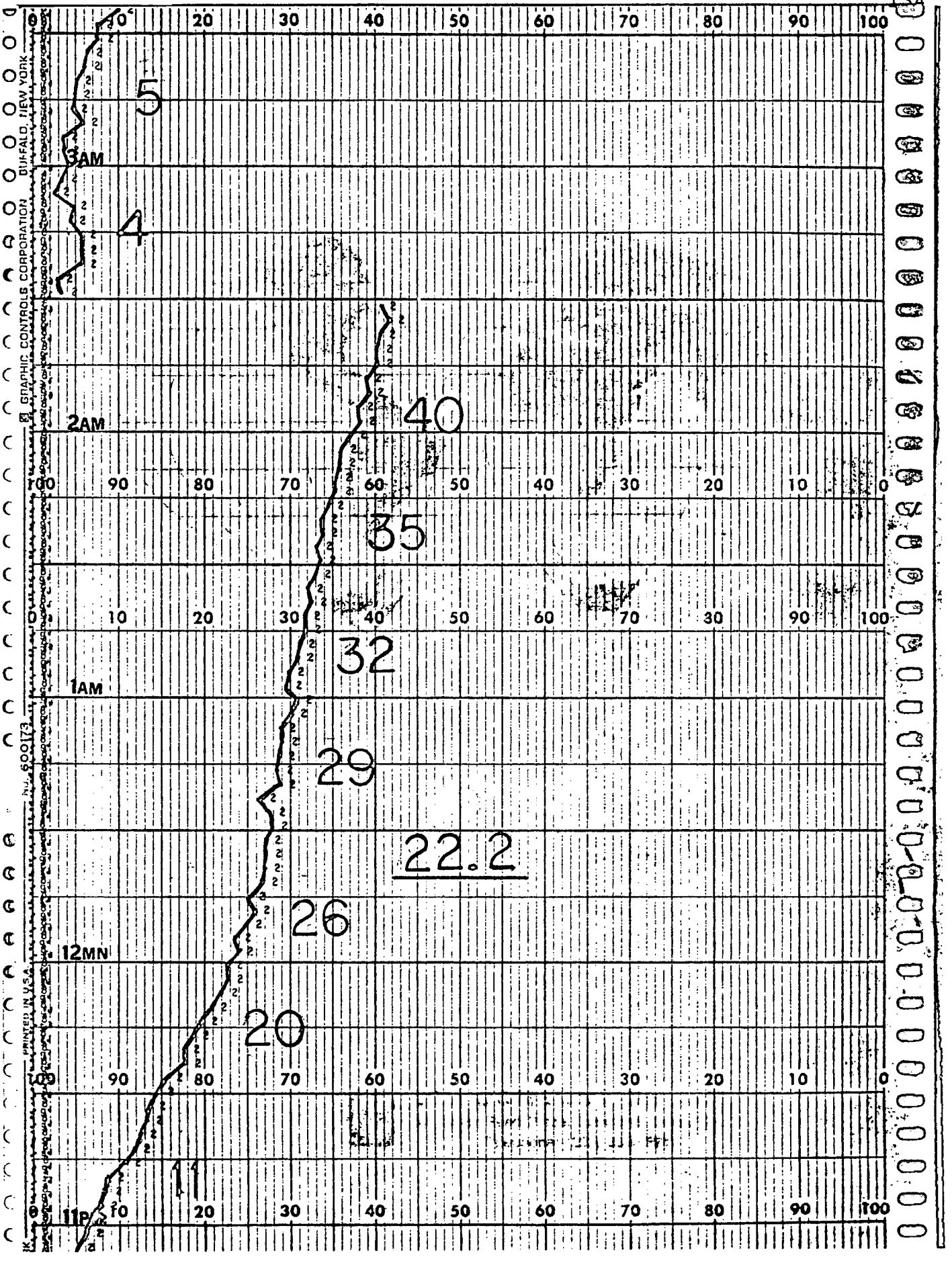
100


BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
PRINTED IN U.S.A.
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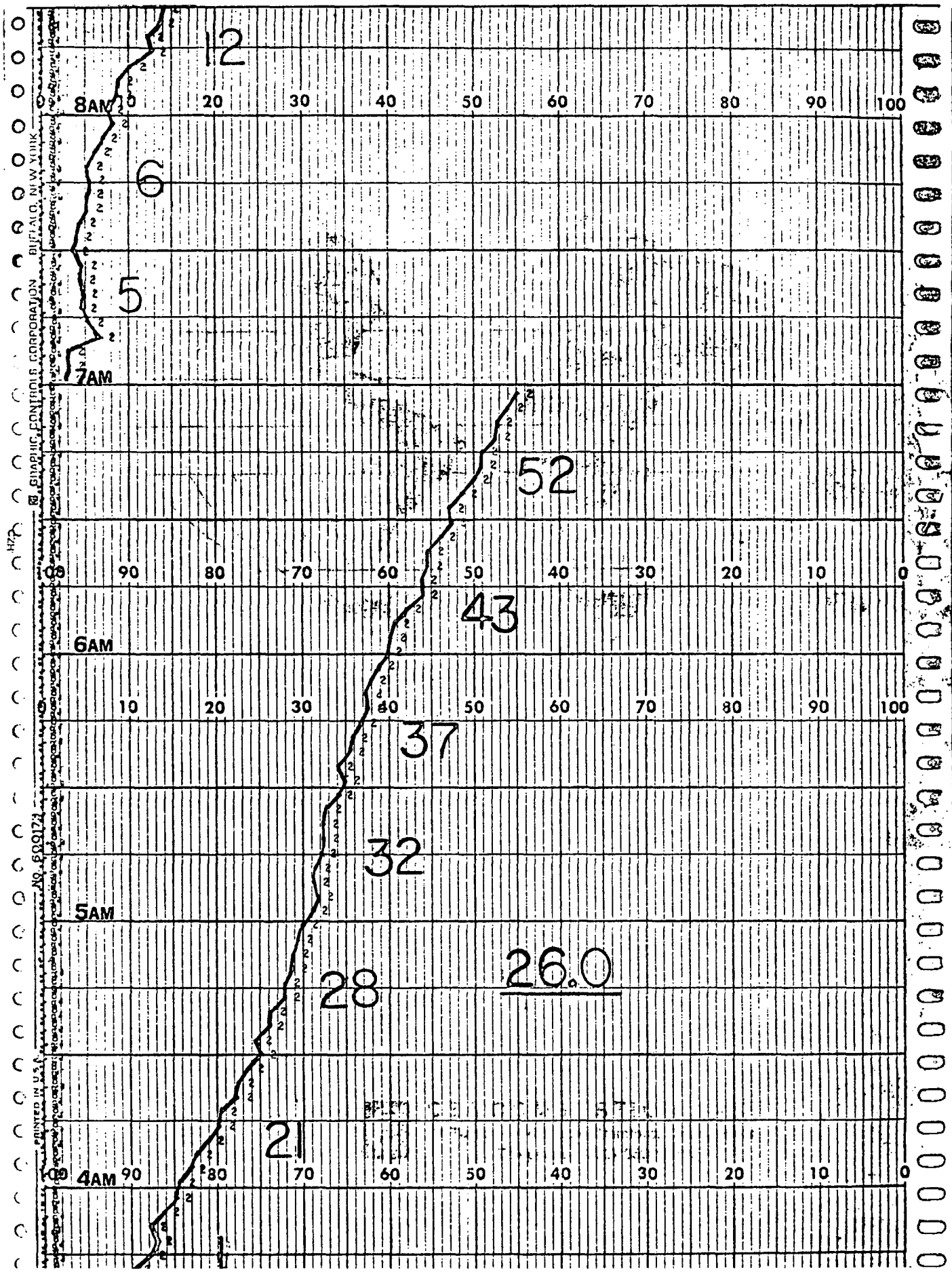
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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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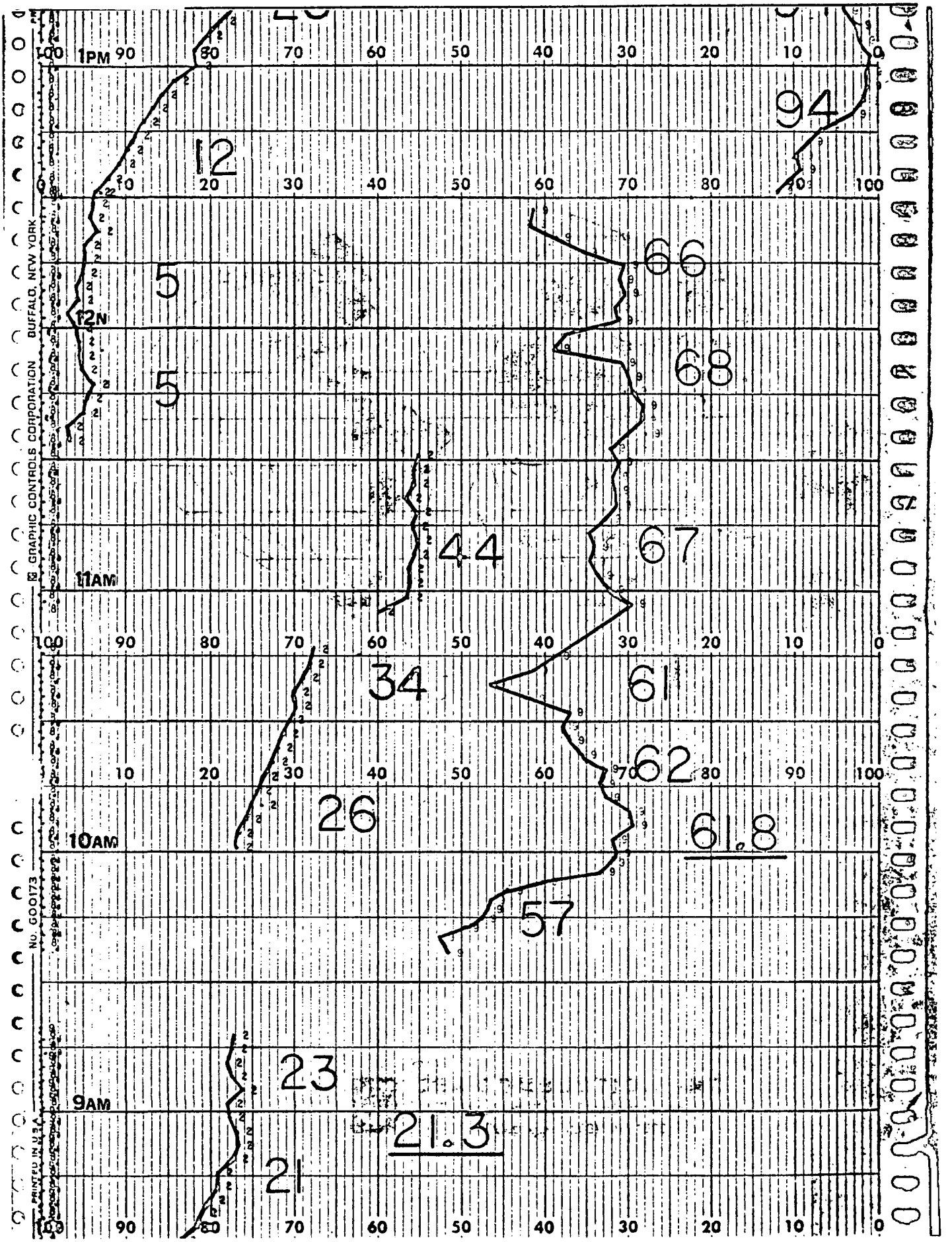
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12N
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10AM
9AM
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68
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61.8
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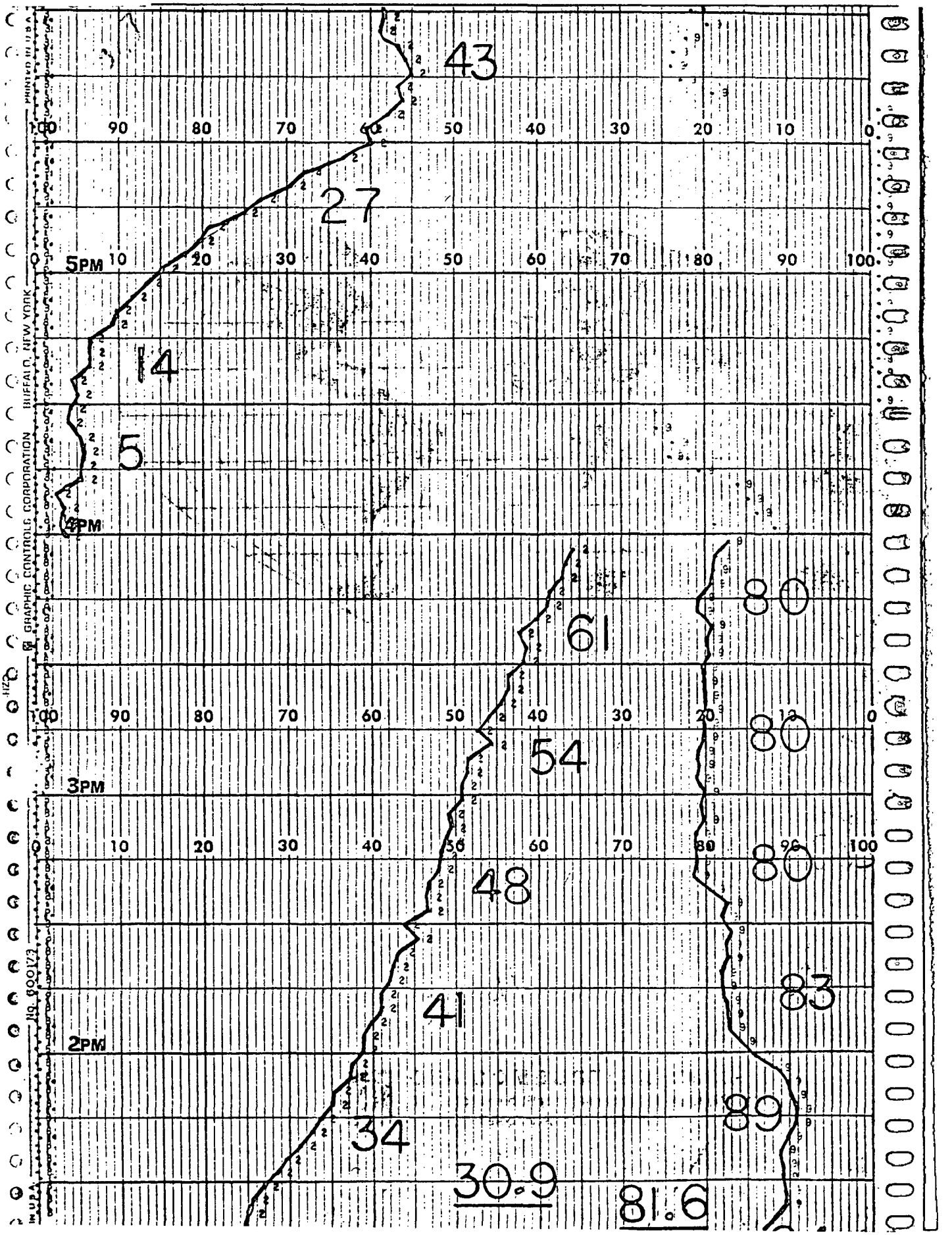
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. G00173
PRINTED IN U.S.A.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34
30.9
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83
89
81.6
5PM
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BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
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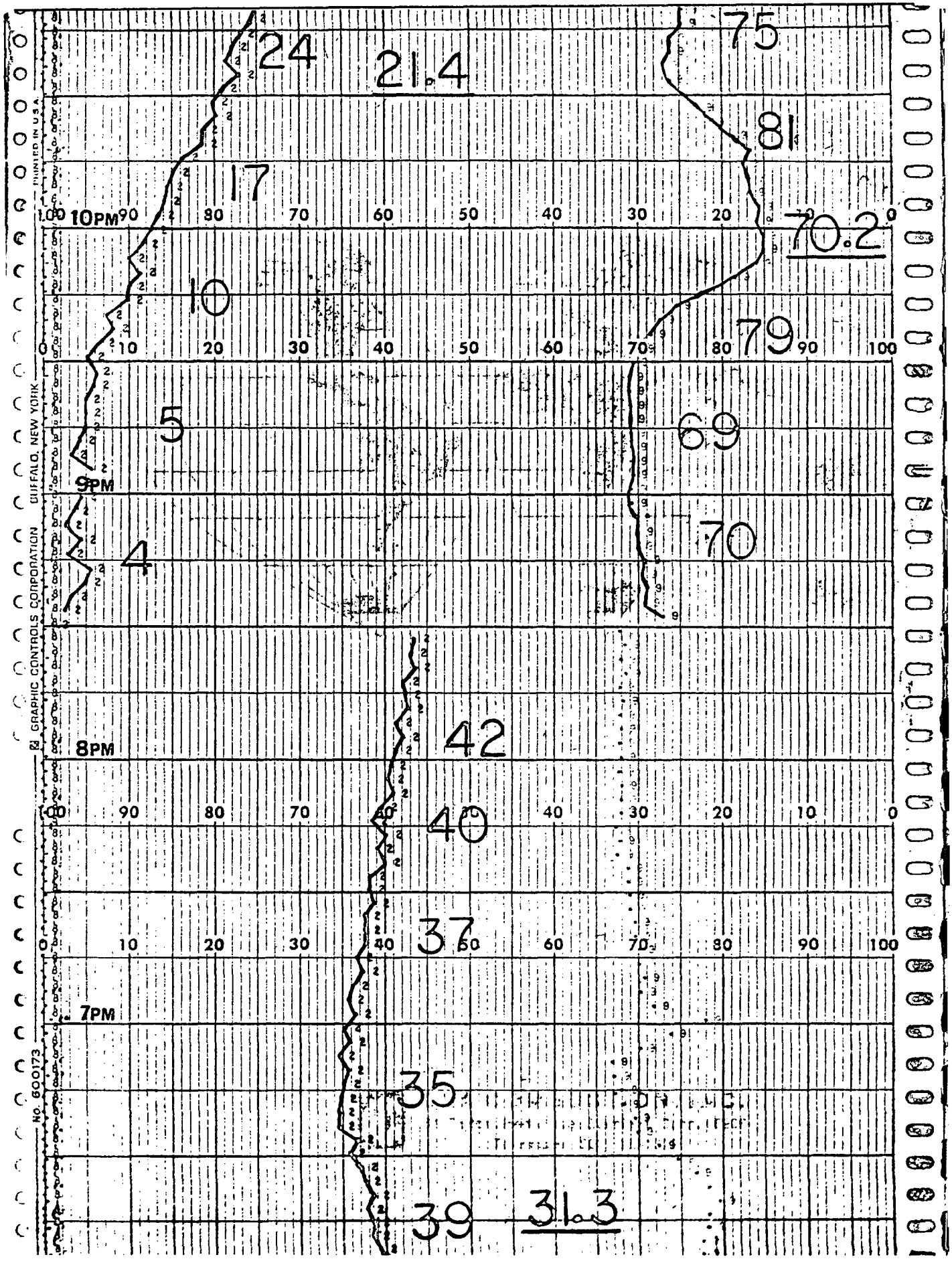
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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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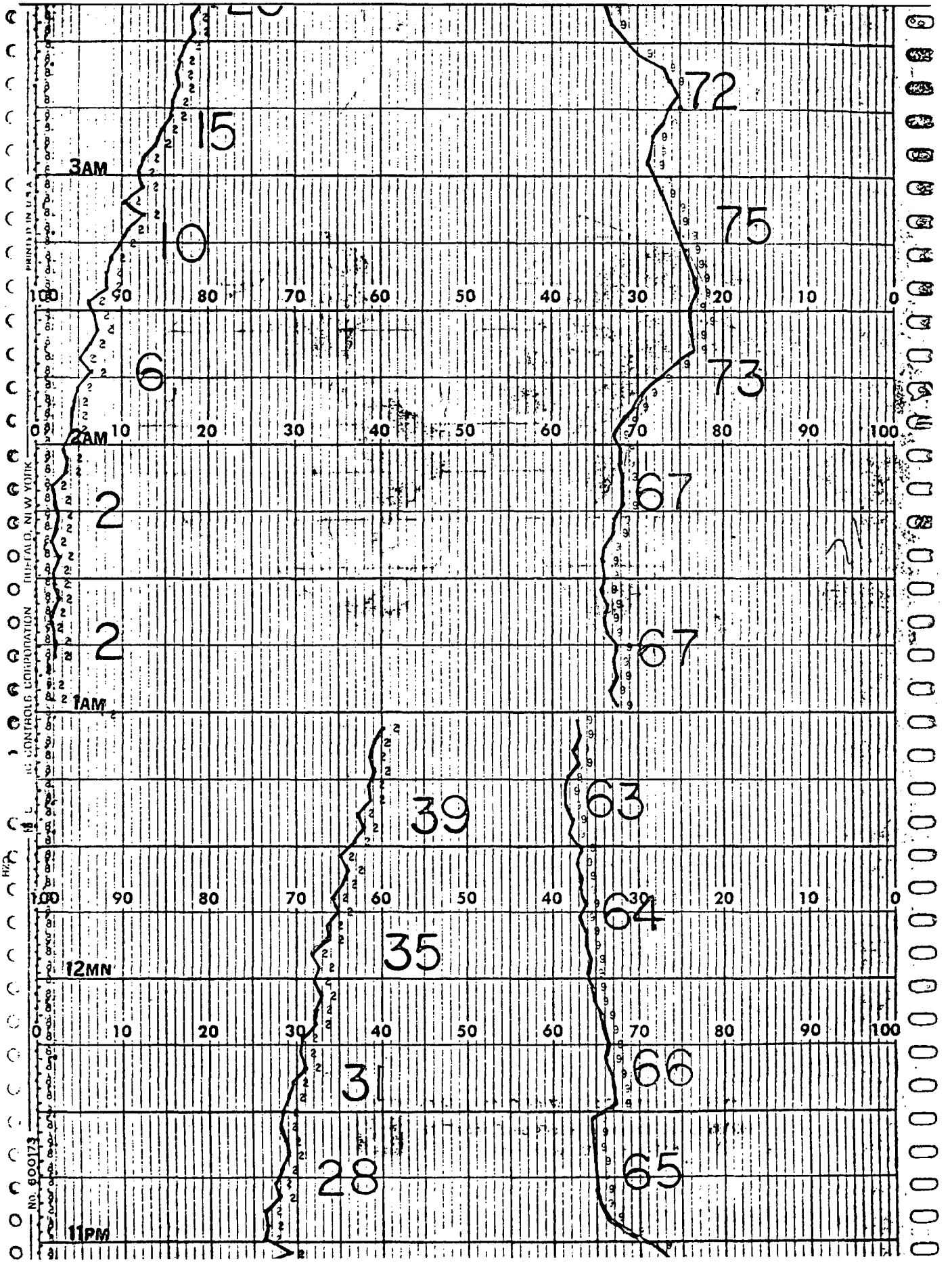
3AM
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12MN
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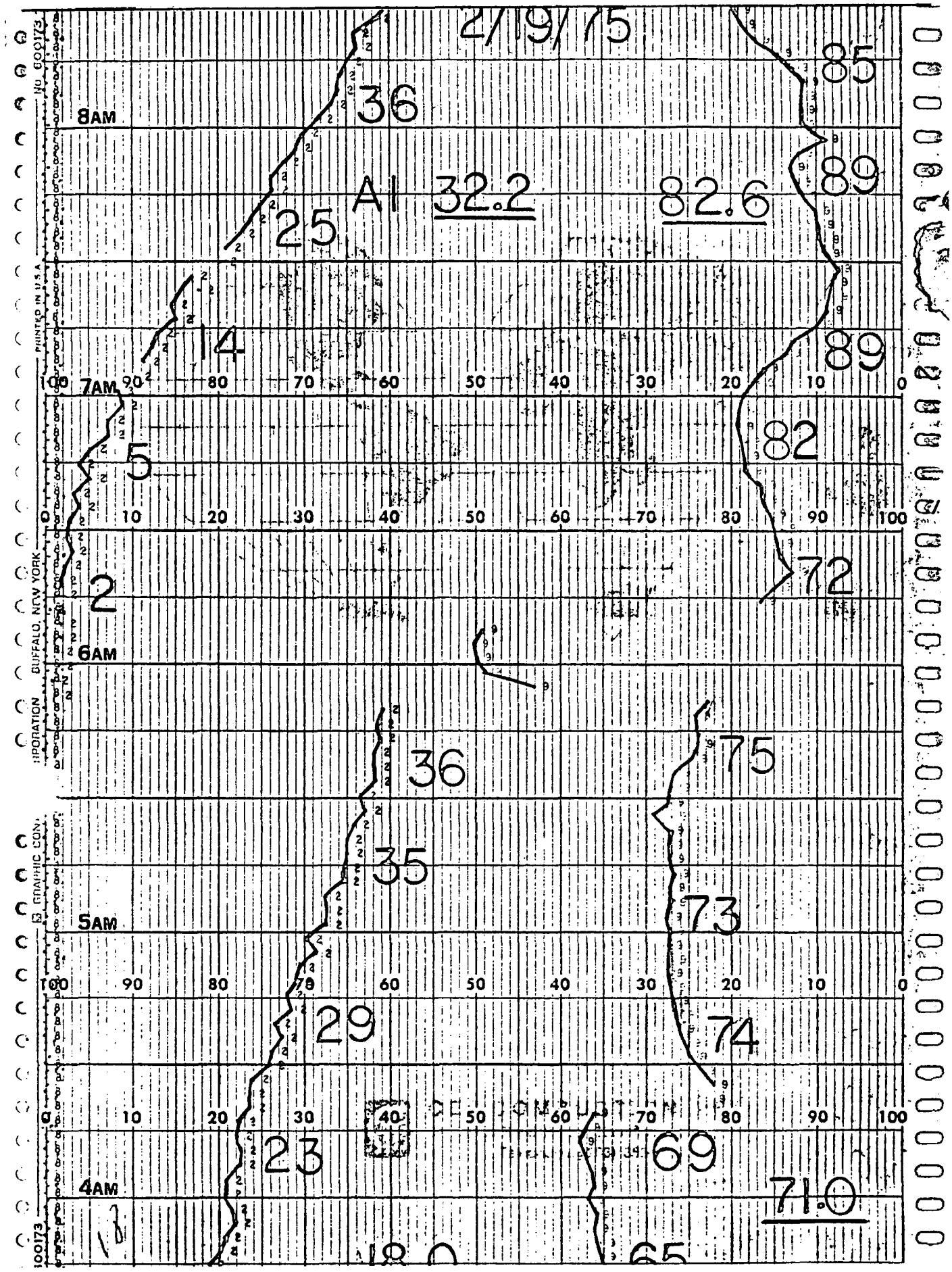
BUFFALO, NEW YORK
No. 600173


2/19/75
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BUFFALO, NEW YORK
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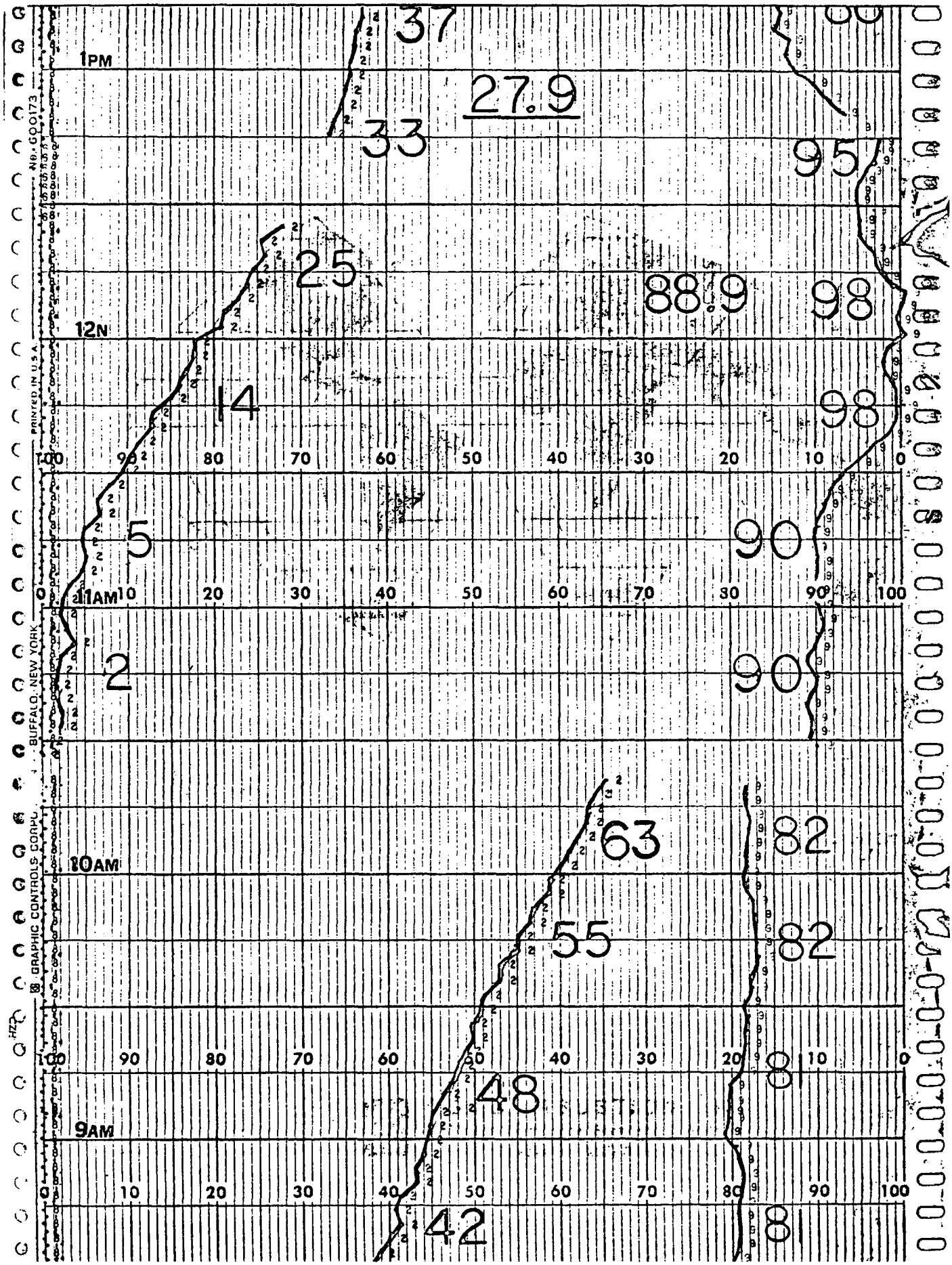
1PM
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10AM
9AM
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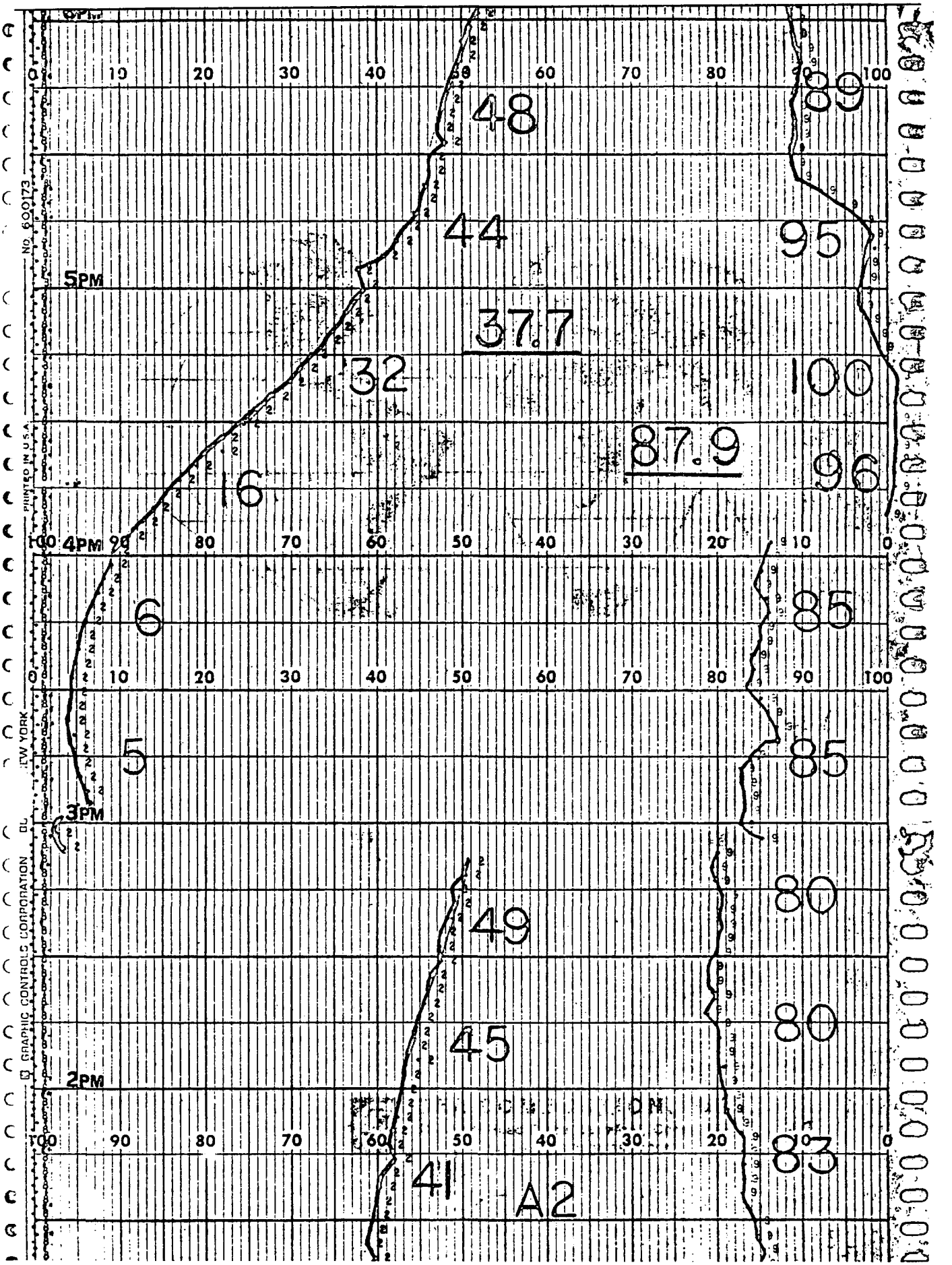
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPO
PRINTED IN U.S.A.
No. GO0173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3PM
2PM
10 20 30 40 50 60 70 80 90 100
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87.9
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96
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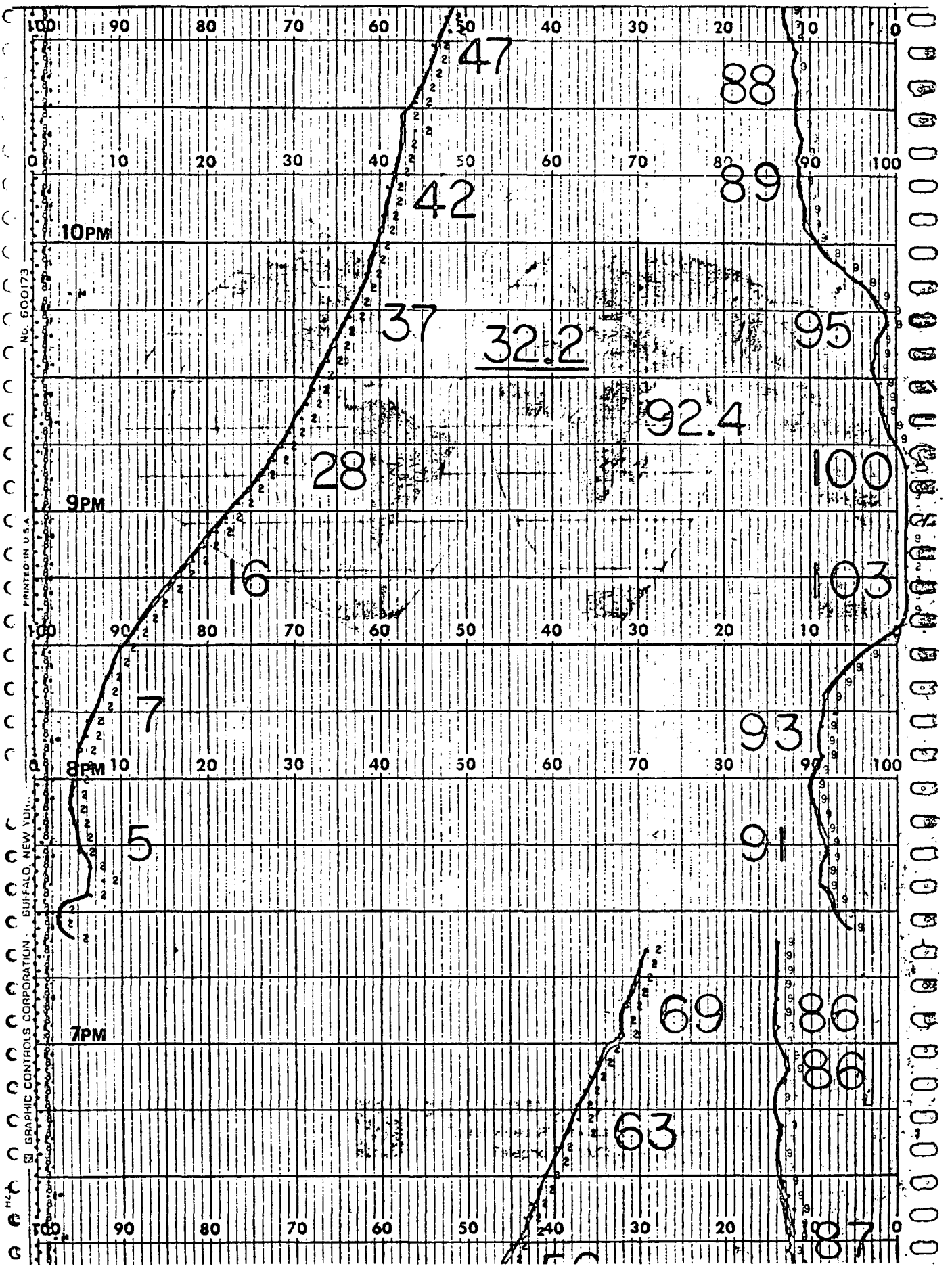
NO. 600173
GRAPHIC CONTROLS CORPORATION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92.4
100
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93
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9PM
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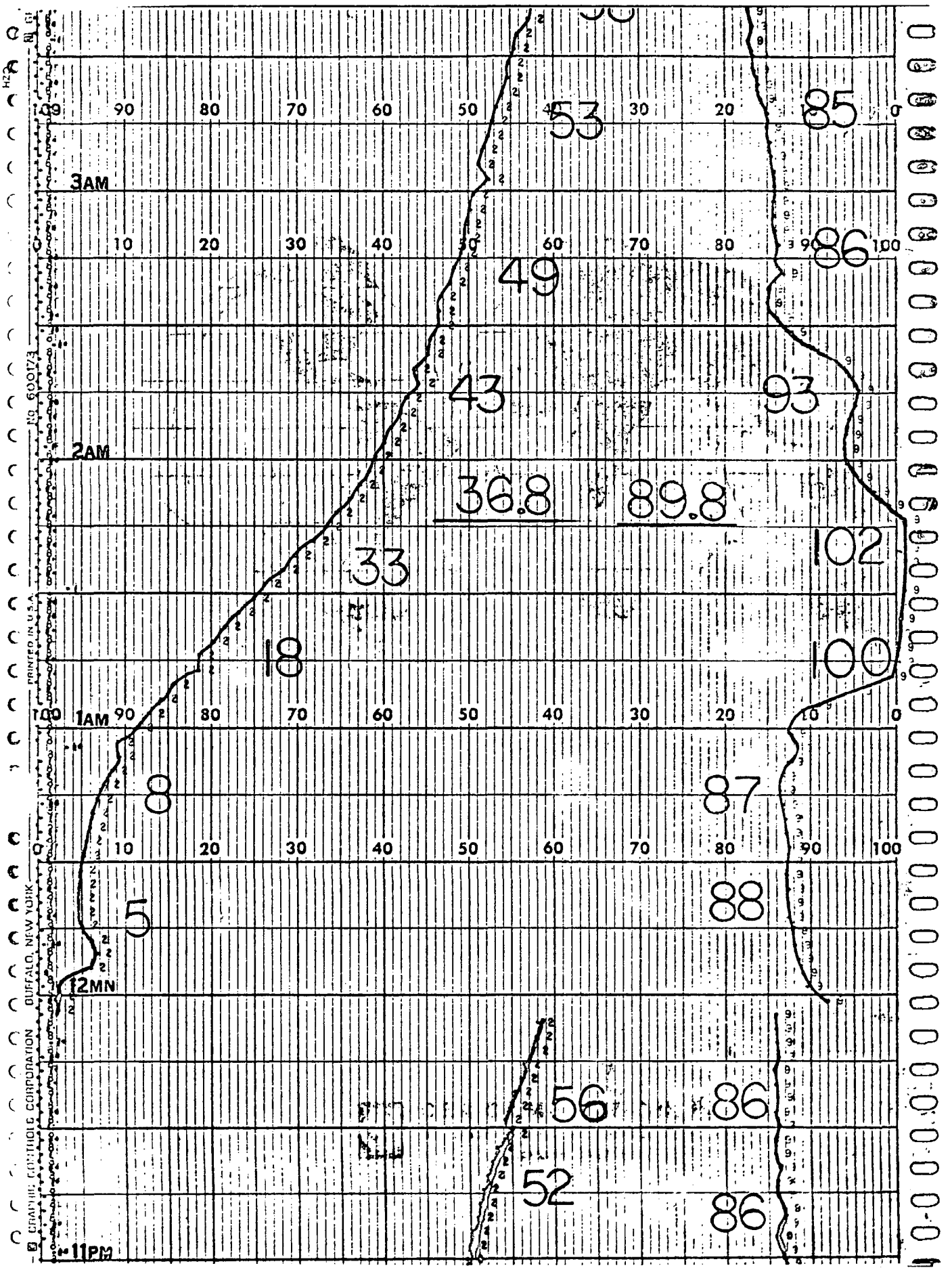
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK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1AM
12MN
11PM
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36.8
89.8
33
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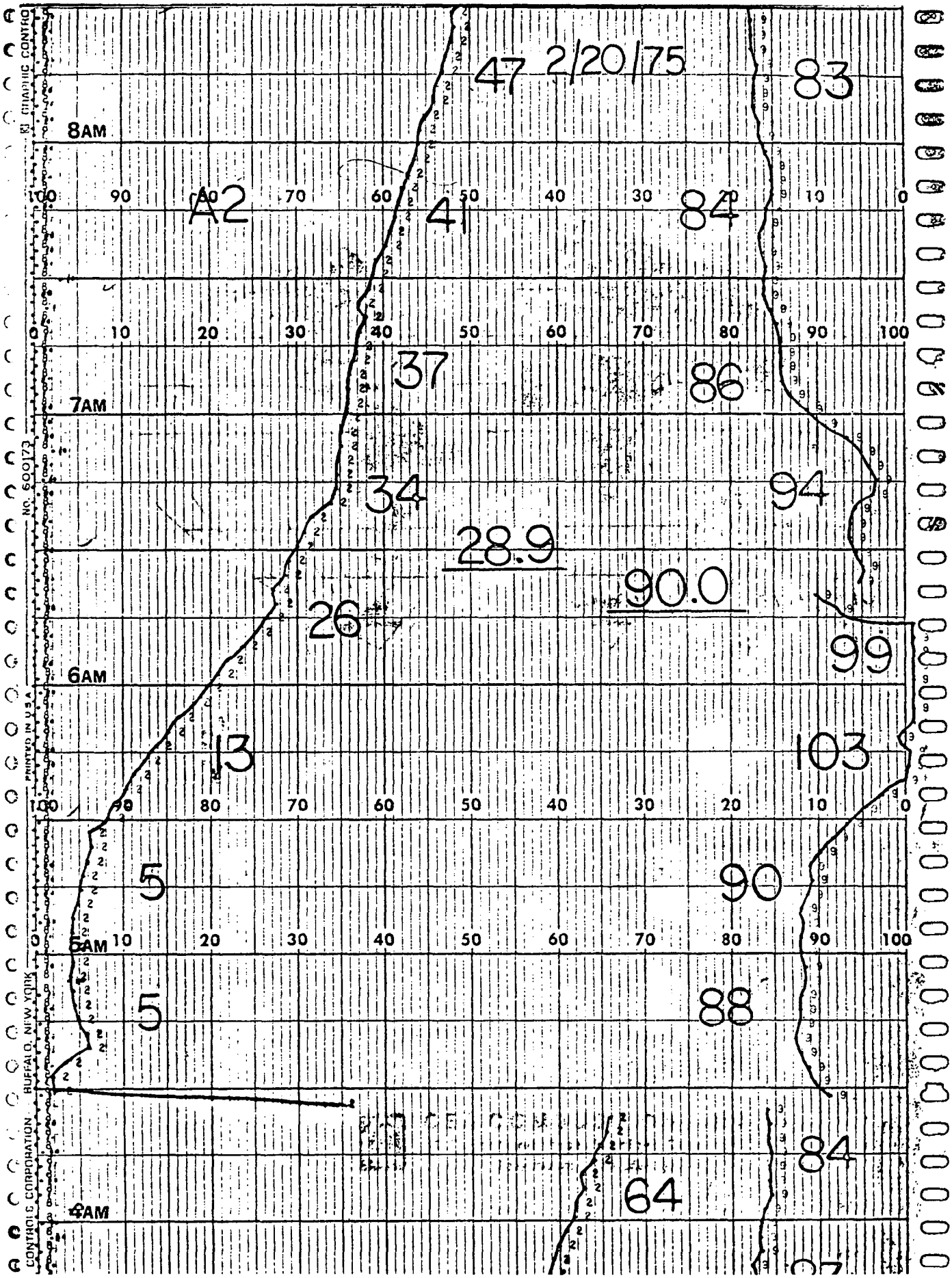
NO. 60073


47 2/20/75
83
8AM
A2
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7AM
34
94
28.9
90.0
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6AM
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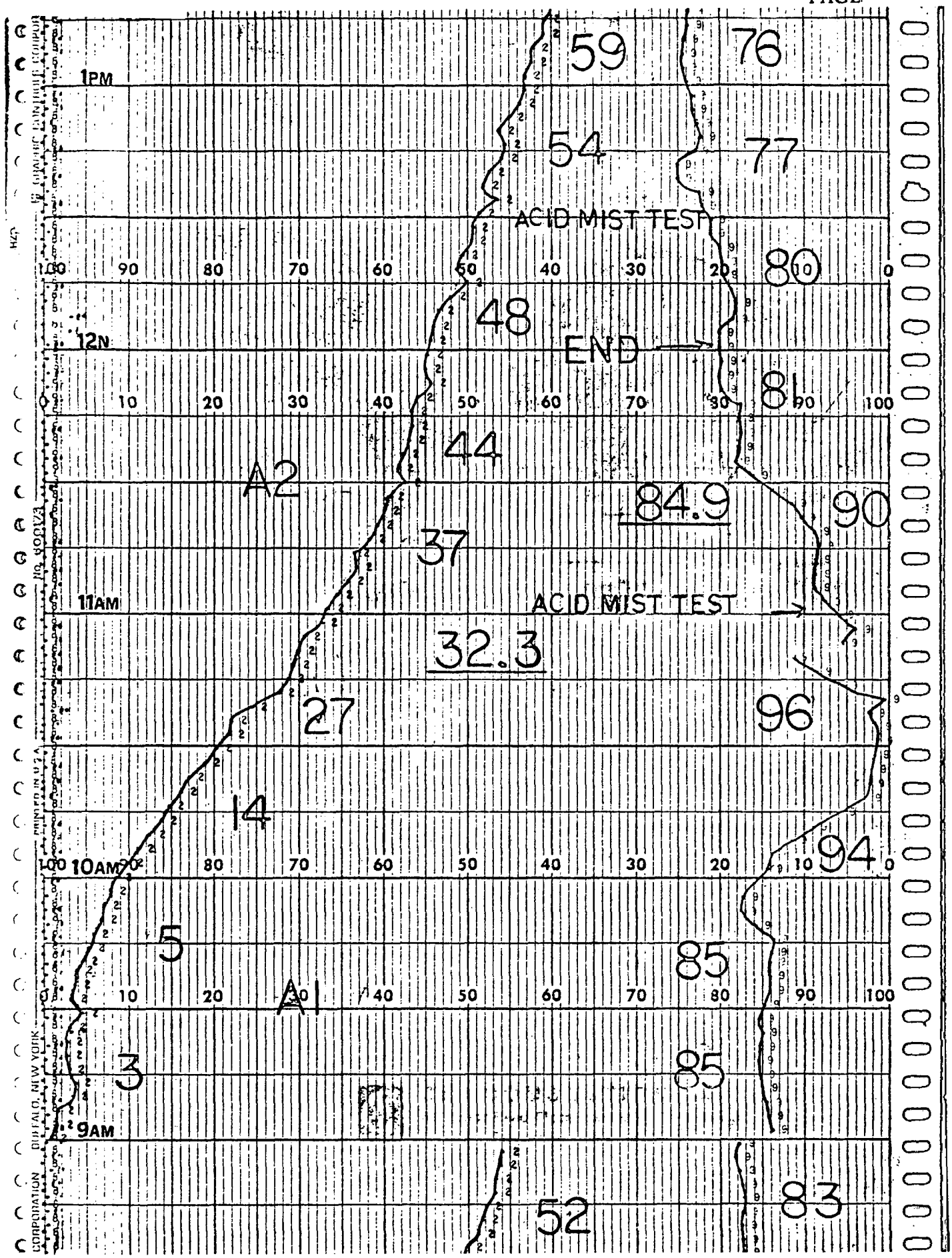
CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A. NO. 600172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9AM
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32.3
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14
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A2
A1
ACID MIST TEST
END
84.9
ACID MIST TEST
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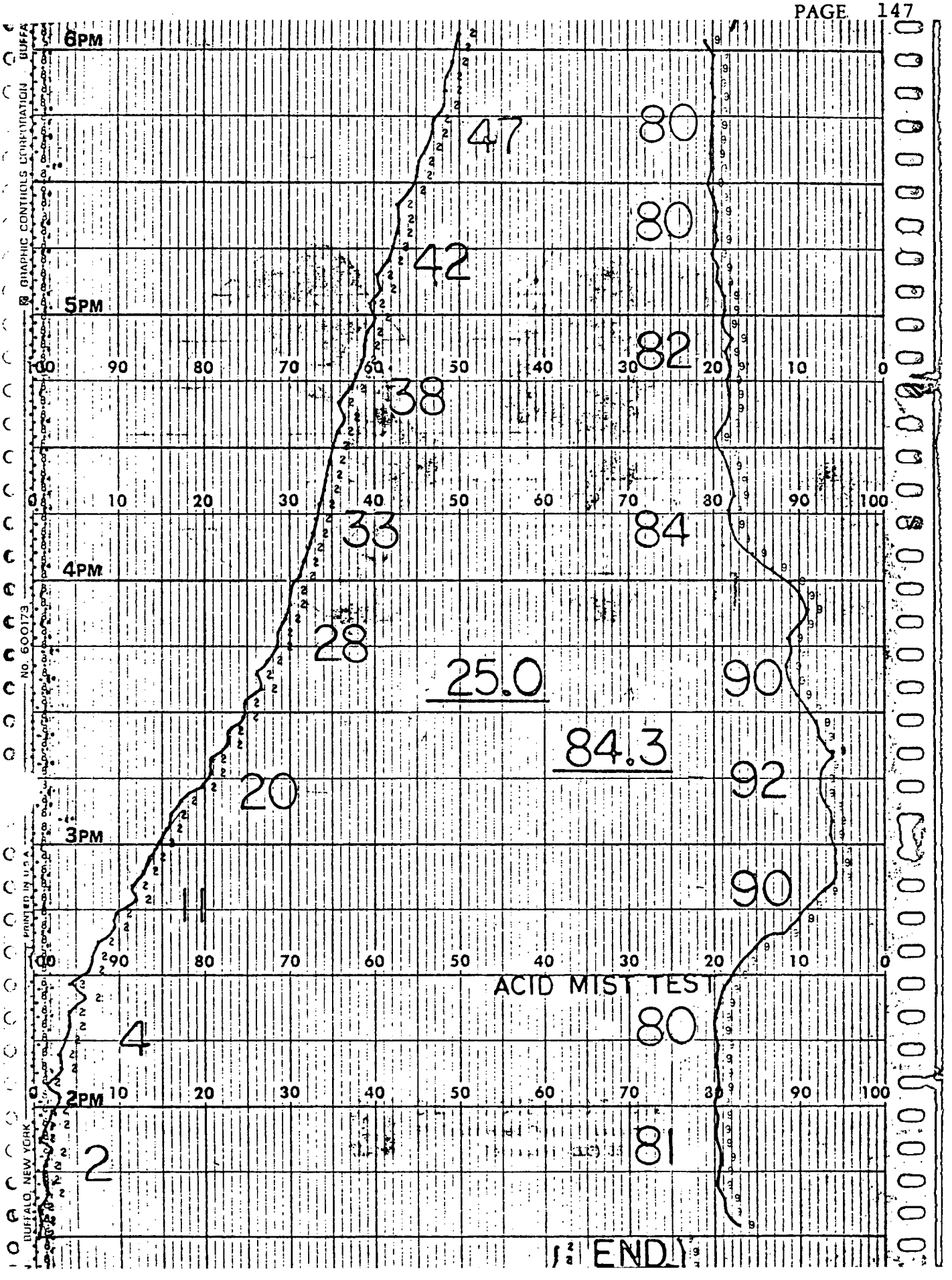
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90
92
90
80
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ACID MIST TEST
END
GRAPHIC CONTROLS CORPORATION BUFFA
NO. 600173
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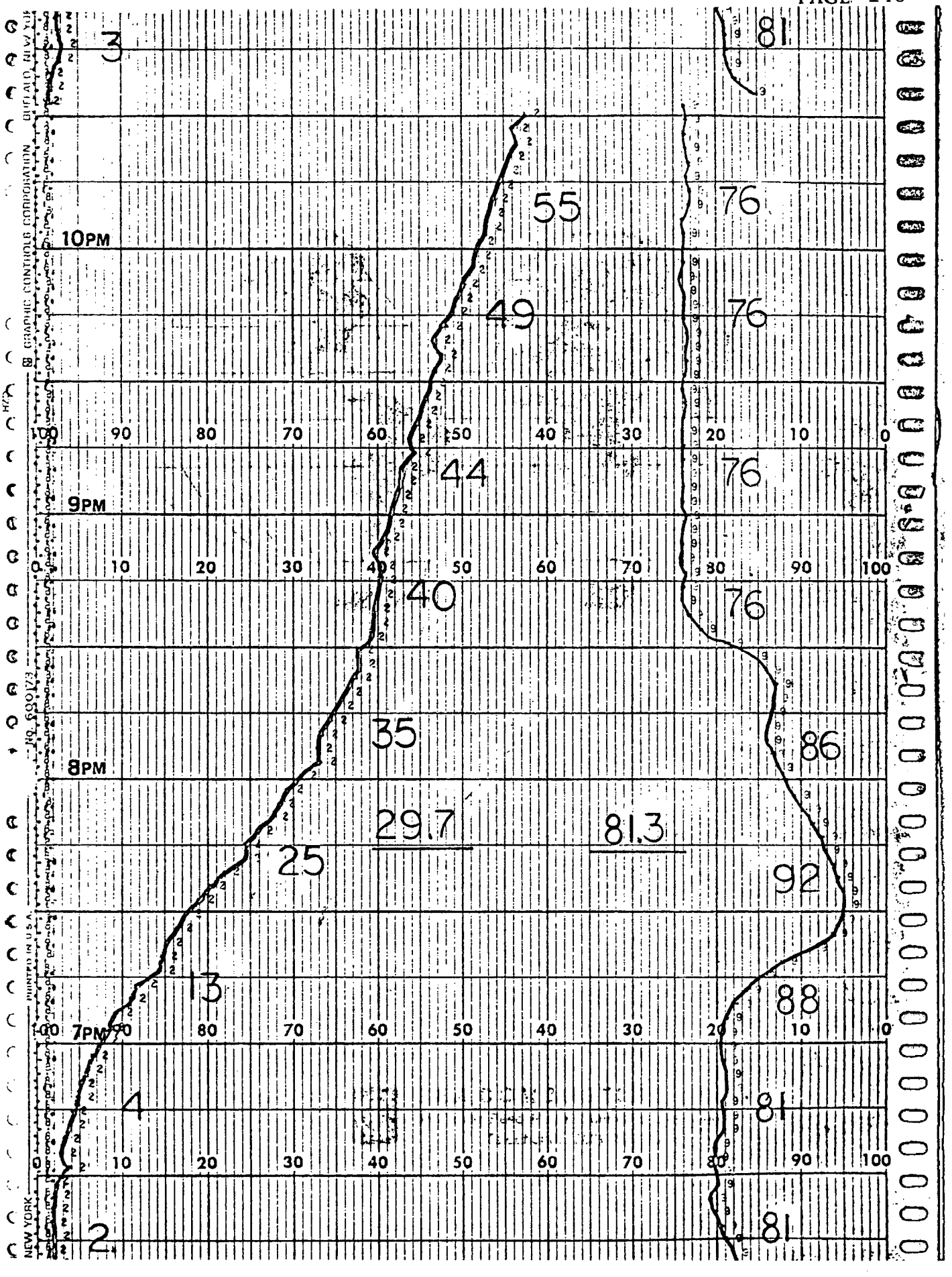
BUFFALO, NEW YORK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7PM
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29.7
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76
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81
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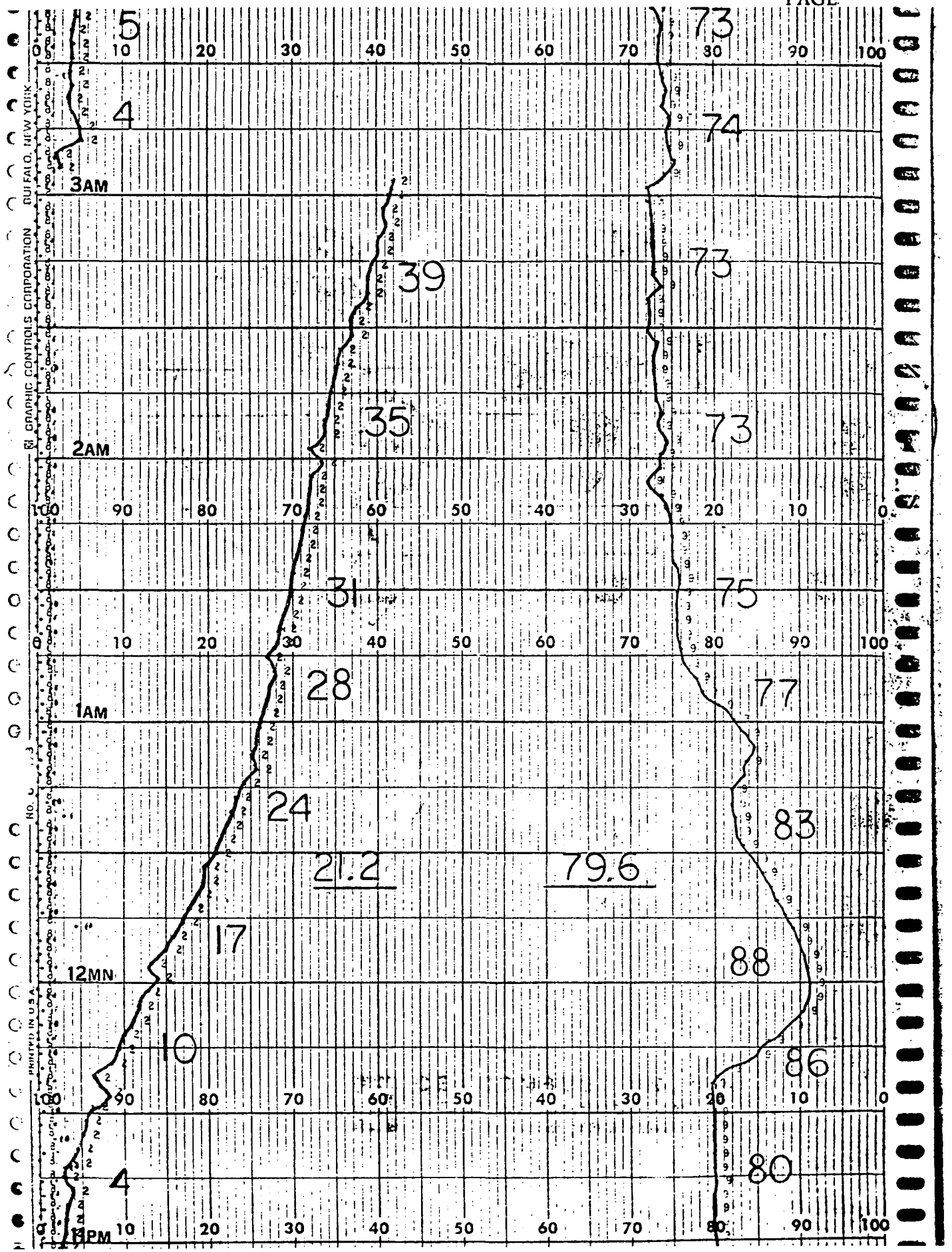
GRAPHIC CONTROLS CORPORATION BUFFALO NEW YORK
NEW YORK PRINTED IN U.S.A.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12MN
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1PM
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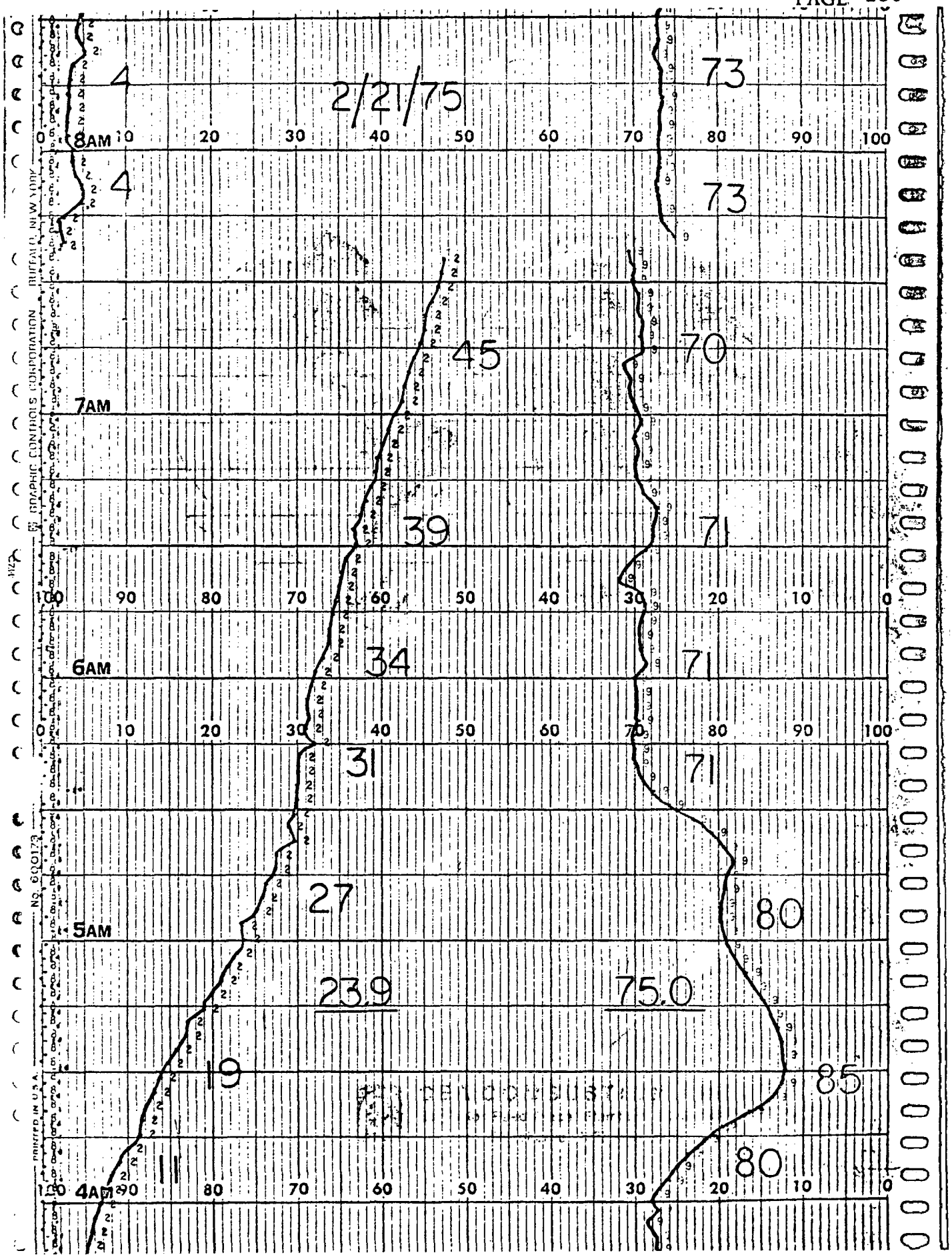
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
PRINTED IN U.S.A.


2/21/75
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8AM
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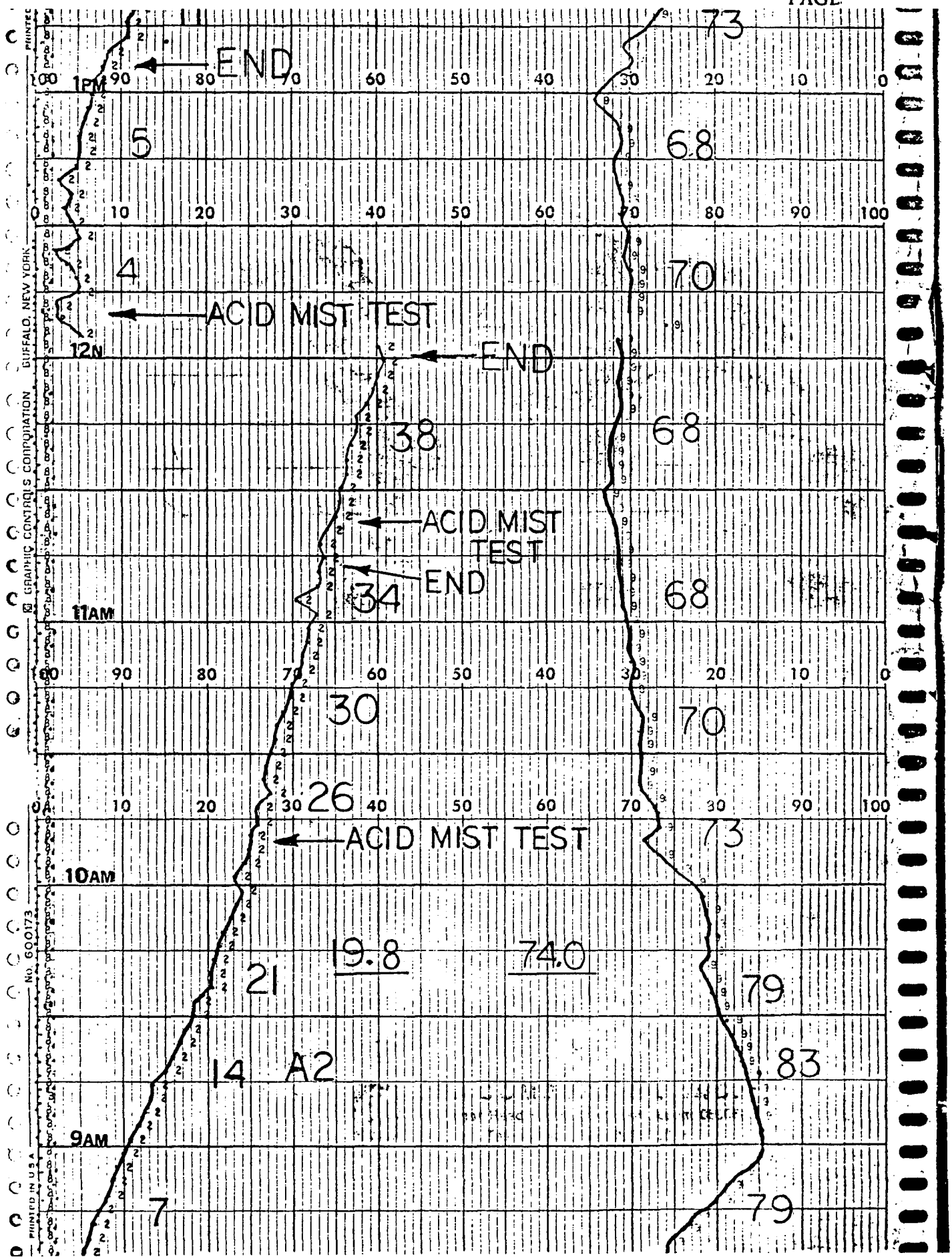
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
NO. 6QQ173
PRINTED IN U.S.A.


END
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68
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ACID MIST TEST
12N
END
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68
ACID MIST TEST
END
34
11AM
68
30
70
26
ACID MIST TEST
73
10AM
19.8
74.0
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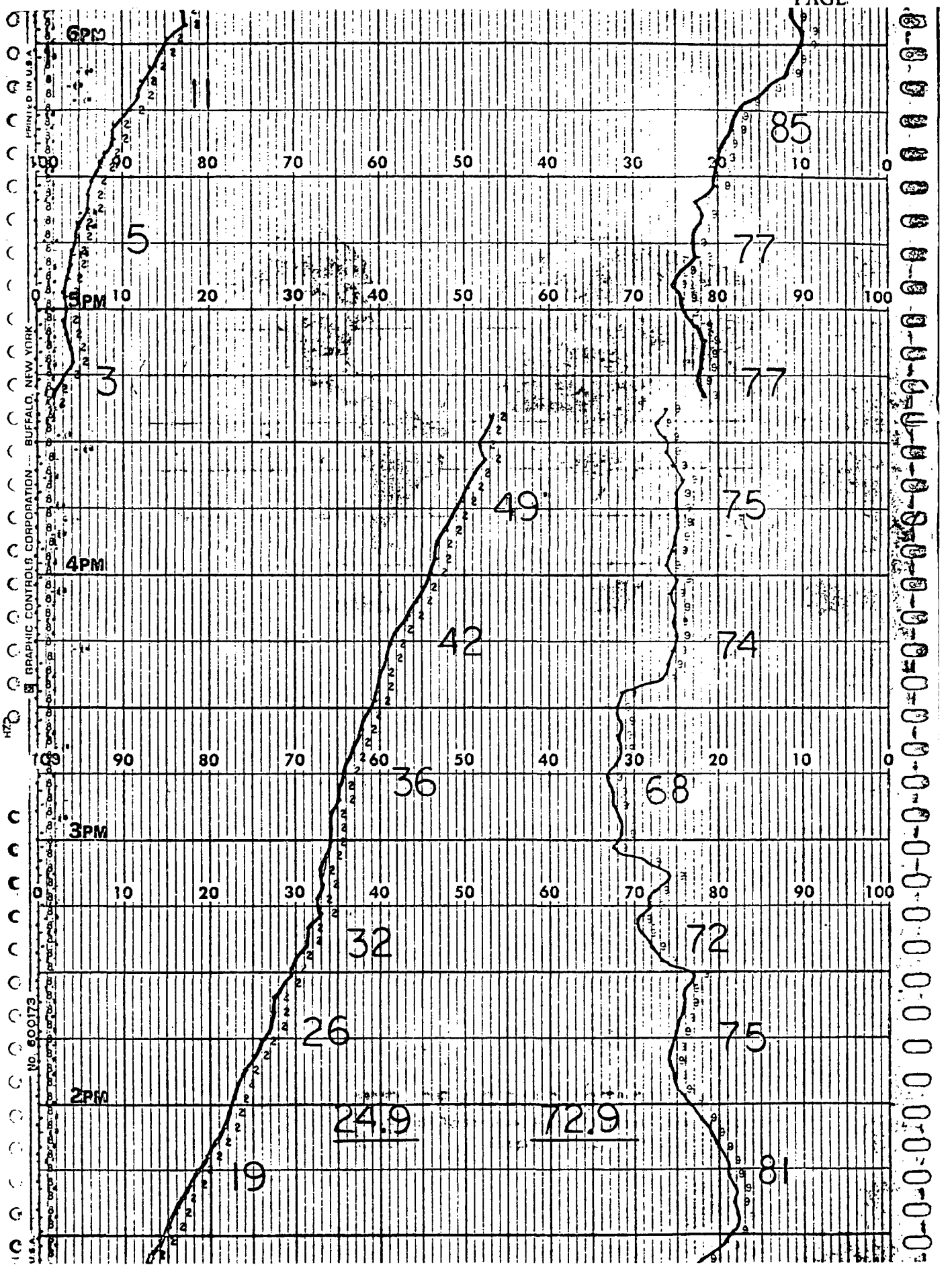
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
PRINTED IN U.S.A.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5PM
4PM
3PM
2PM
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72.9
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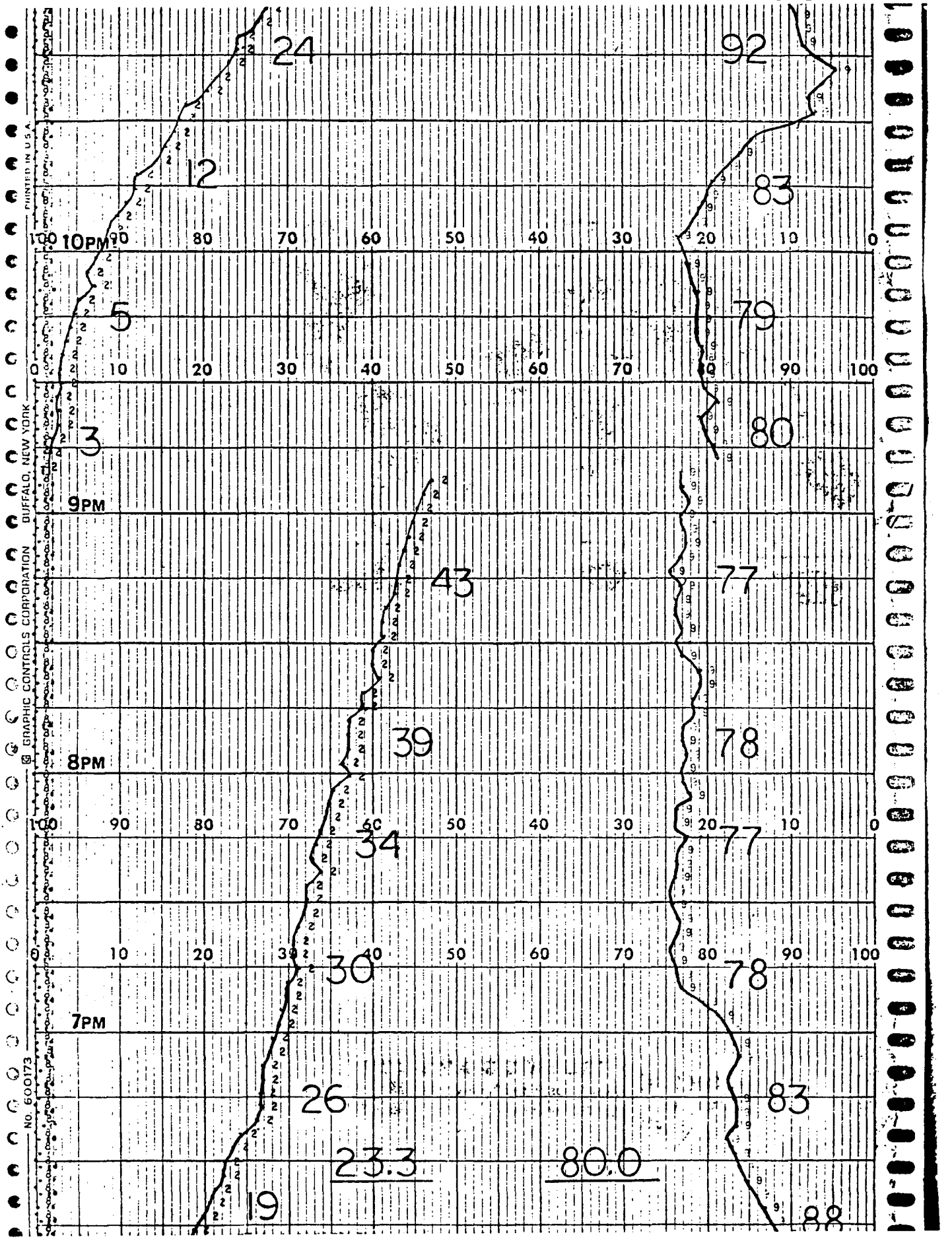
GRAPHIC CONTROLS CORPORATION — BUFFALO, NEW YORK
PRINTED IN U.S.A.
No. 600173
HZ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9PM
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7PM
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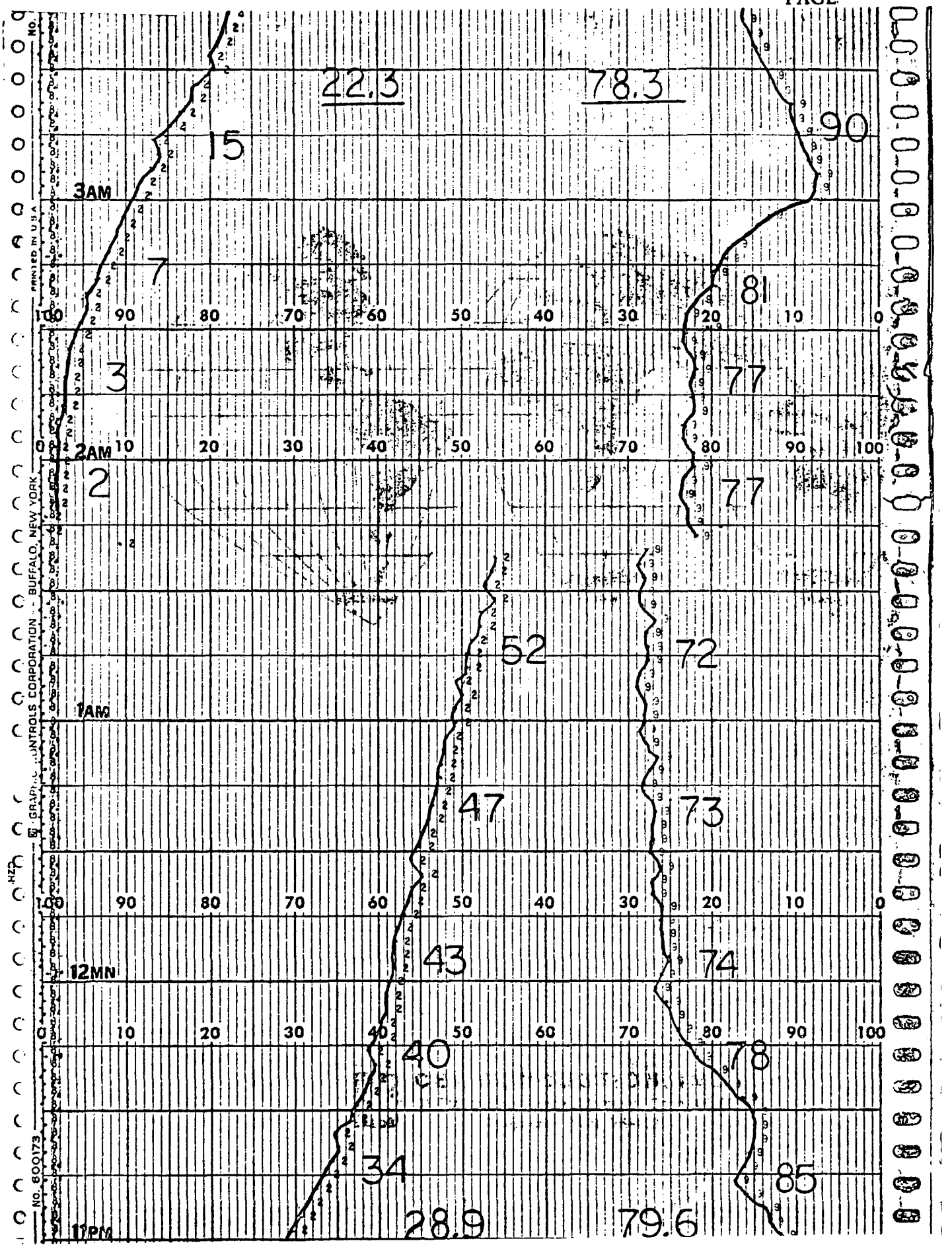
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
No. 600173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90
3AM
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2AM
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72
1AM
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73
43
74
12MN
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78
34
85
28.9
79.6
11PM
100 90 80 70 60 50 40 30 20 10 0
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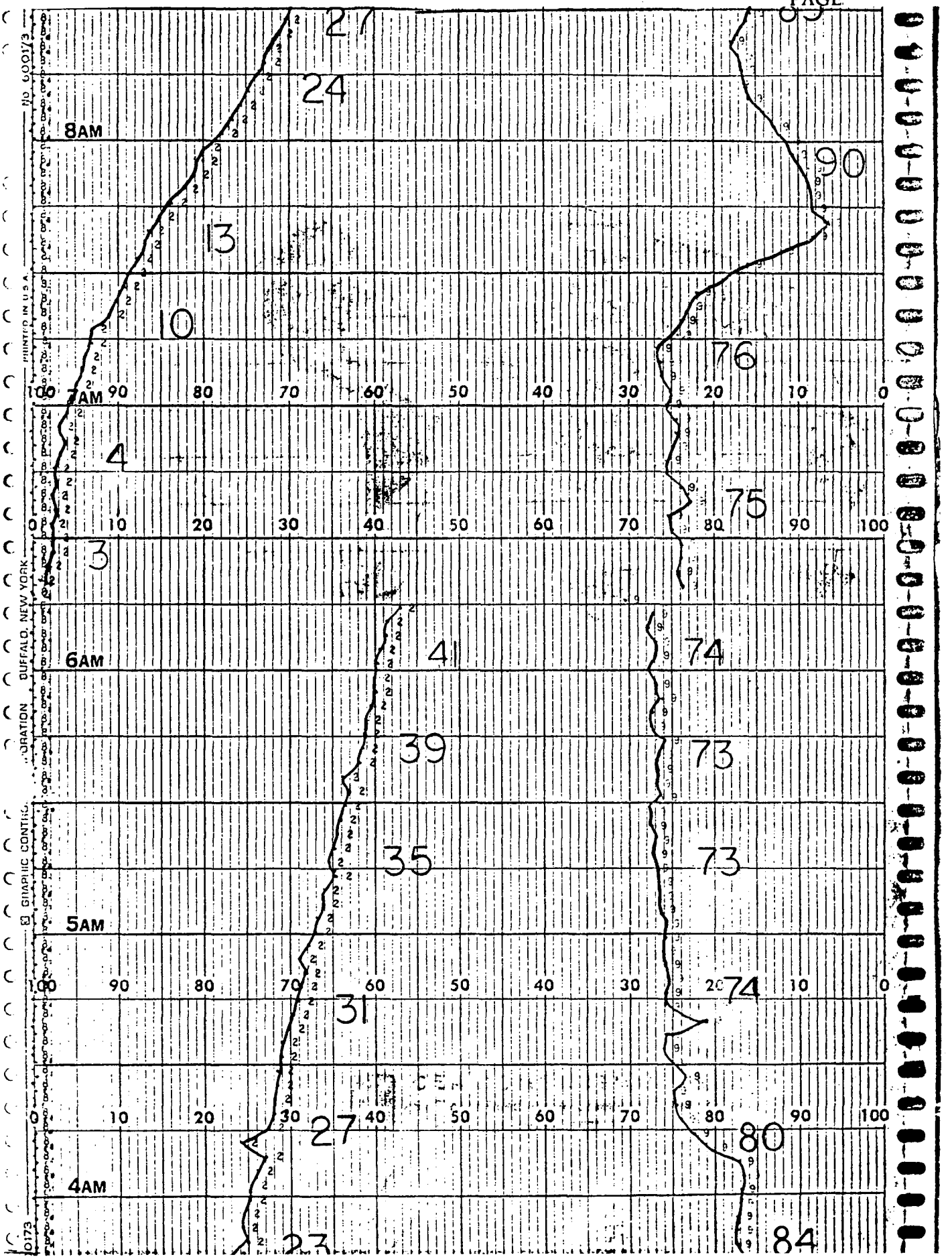
GRAPHIC CONTROLS CORPORATION — BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 800173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7AM
6AM
5AM
4AM
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
21
24
13
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3
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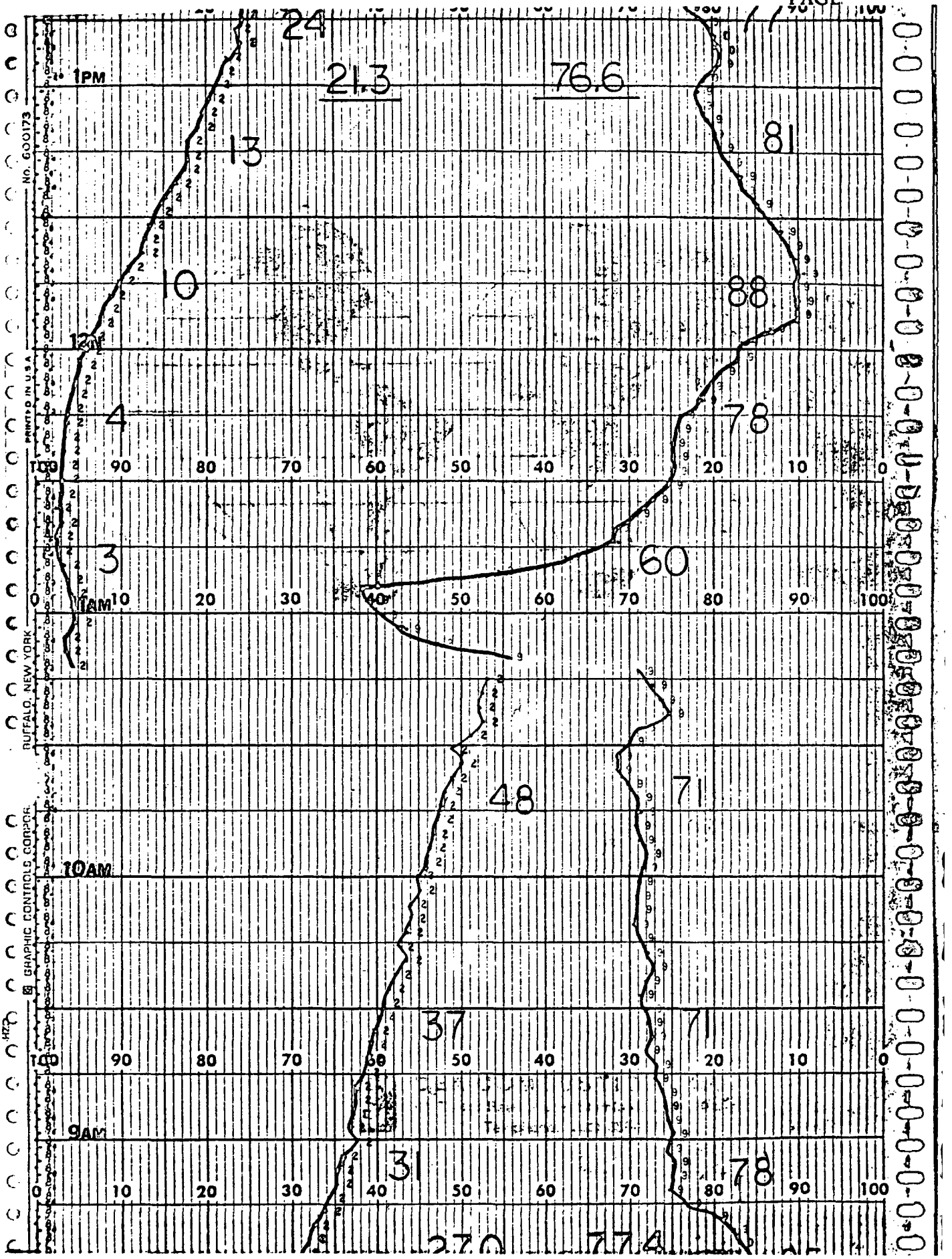
80
84
GRAPHIC CONTROL CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 6001/3
6173


24
21.3
76.6
1PM
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81
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88
12M
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78
100 90 80 70 60 50 40 30 20 10 0
3
60
0 10 20 30 40 50 60 70 80 90 100
1AM
48
71
10AM
37
71
100 90 80 70 60 50 40 30 20 10 0
9AM
31
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270
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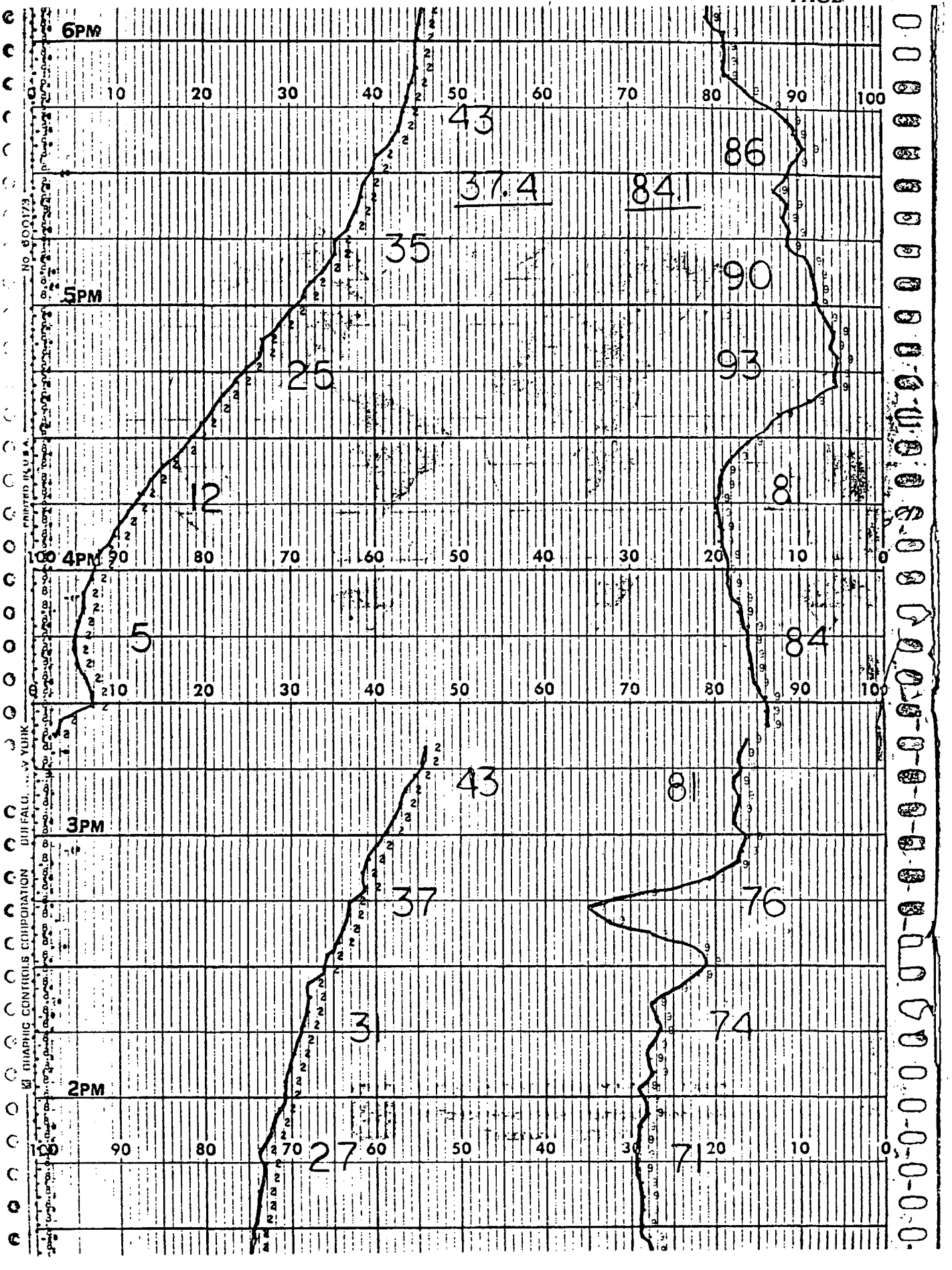
GRAPHIC CONTROLS CORPOR.
BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 600173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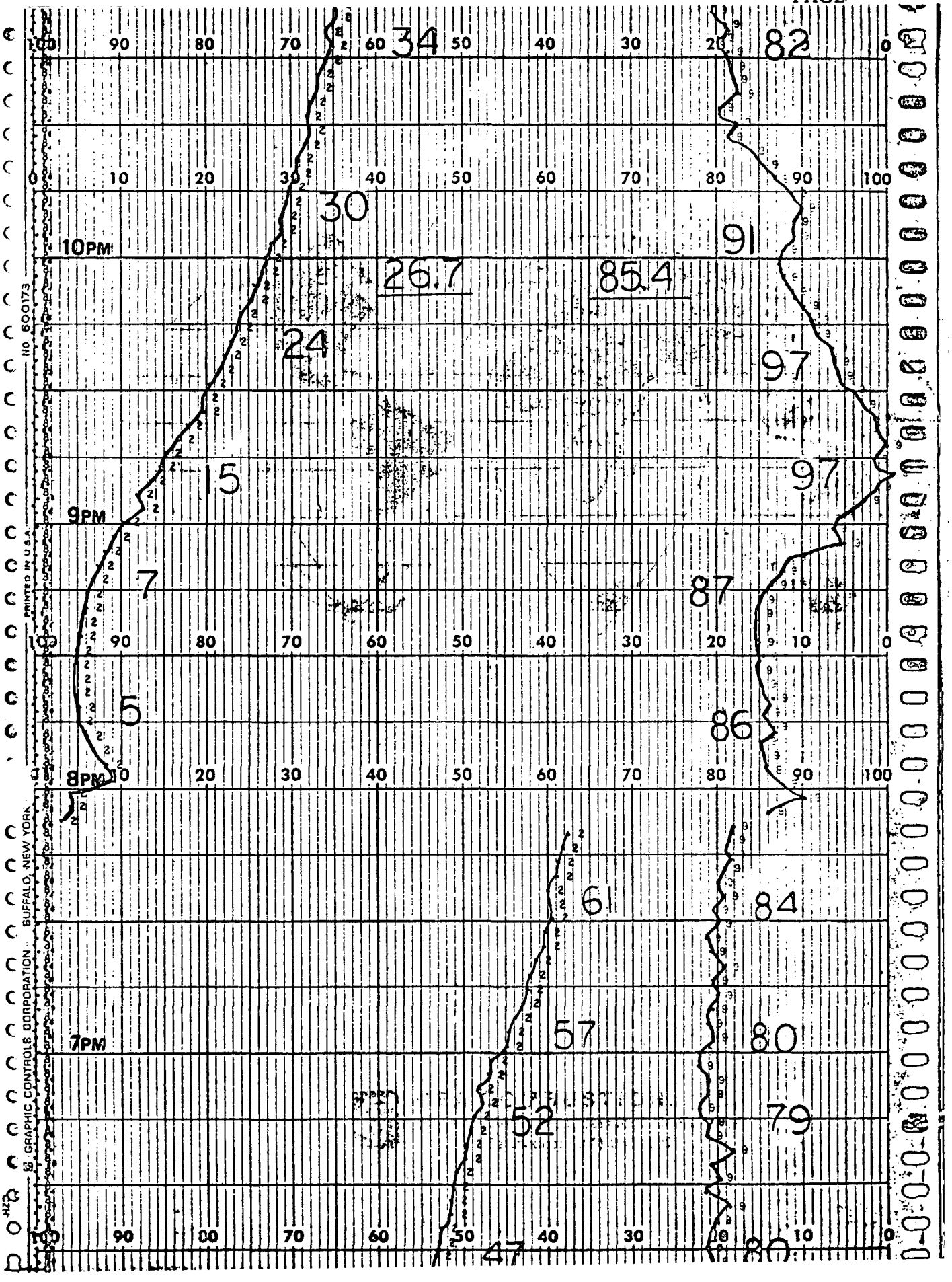
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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
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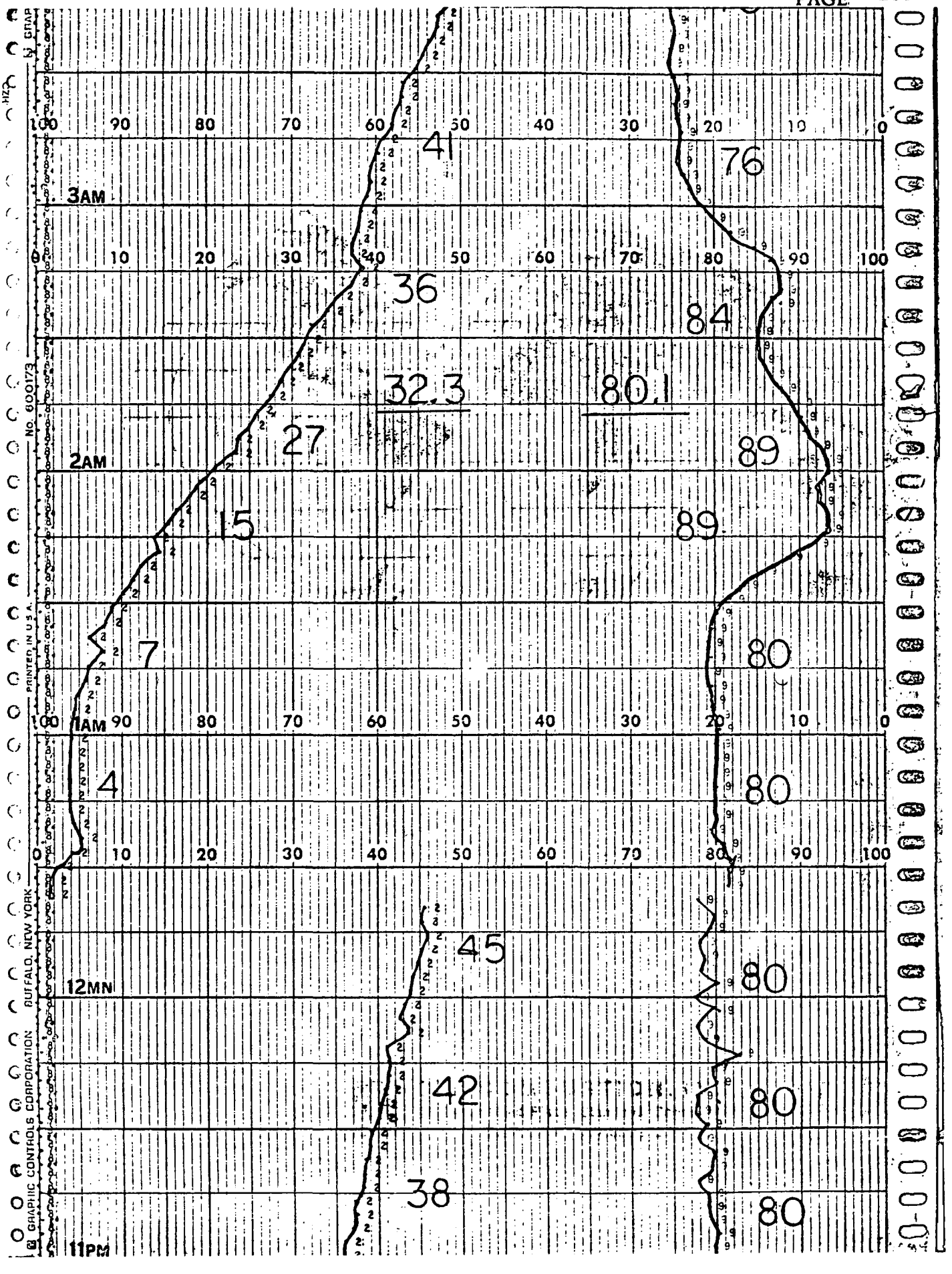
No. 600173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2AM
1AM
12MN
11PM
41
76
36
84
32.3
80.1
27
89
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89
7
80
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80
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80
38
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No. 600173
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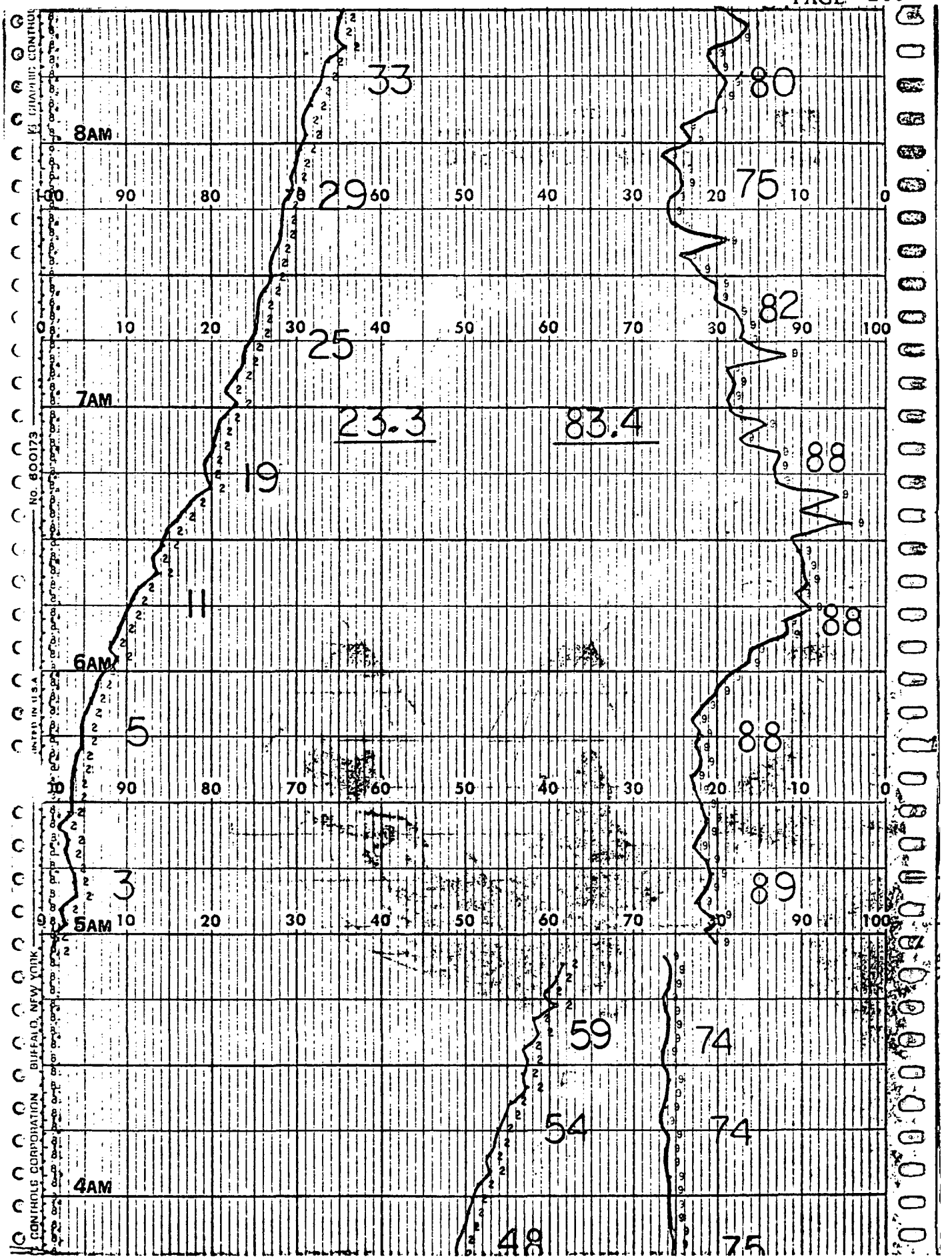
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION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4AM
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23.3
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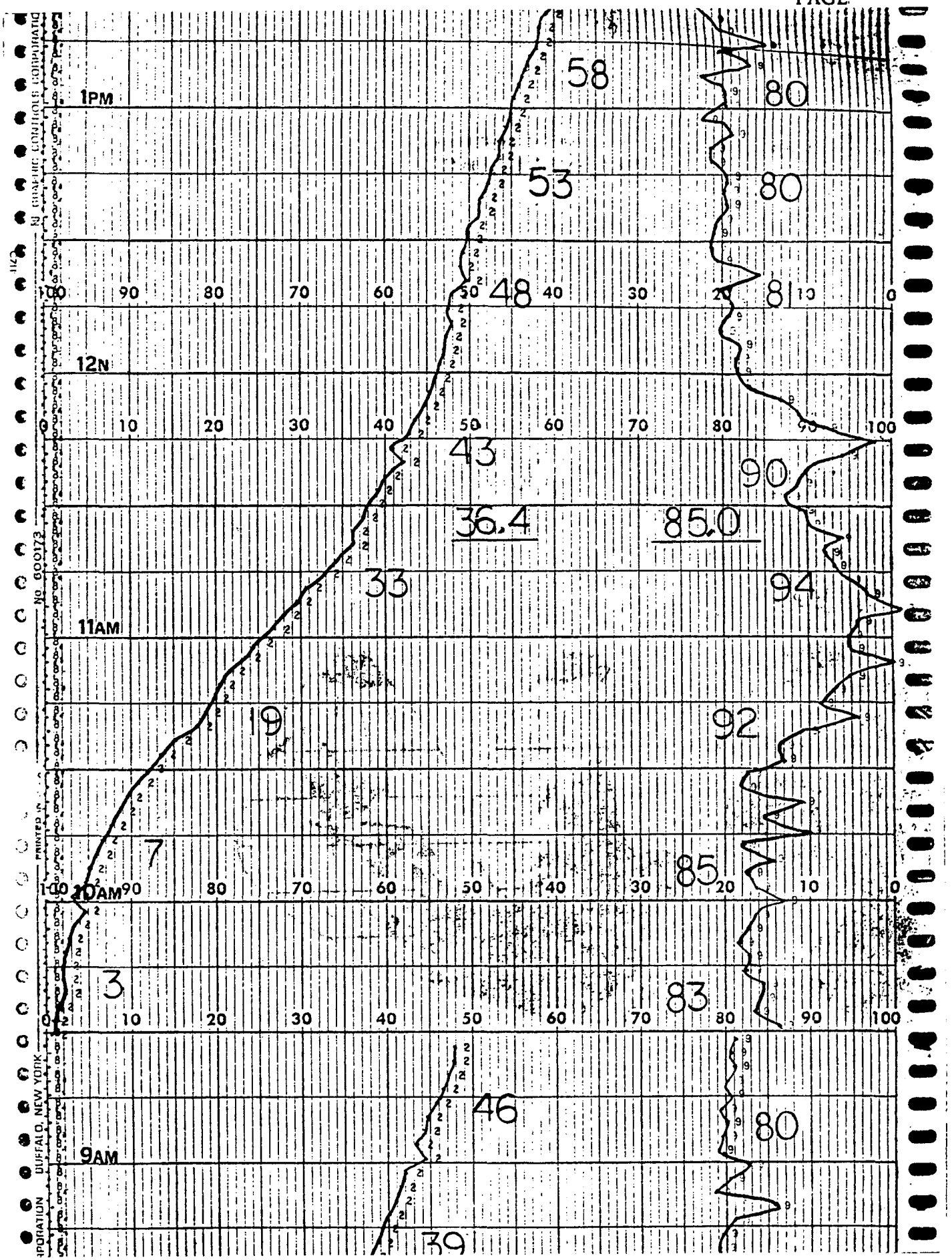
CONTROLS CORPORATION BUFFALO, NEW YORK
No. 800173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11AM
10AM
9AM
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36.4
33
19
7
3
46
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80
81
90
85.0
94
92
85
83
80
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0 10 20 30 40 50 60 70 80 90 100
No. 600173
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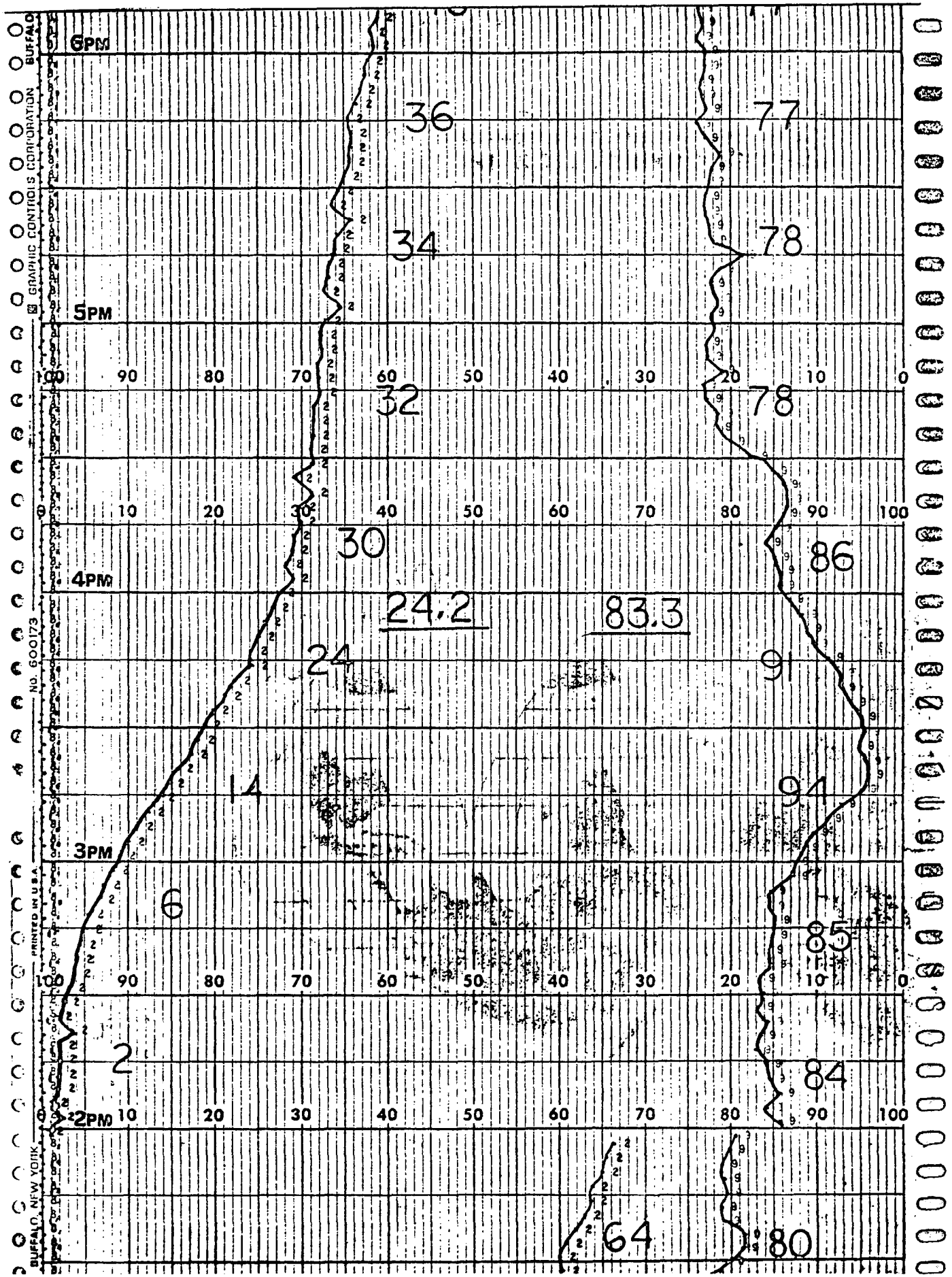
BUFFALO, NEW YORK
NJ GRAPHIC CONTROLS CORPORATION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5PM
4PM
3PM
2PM
36
34
32
30
24.2
24
14
6
2
77
78
78
86
83.3
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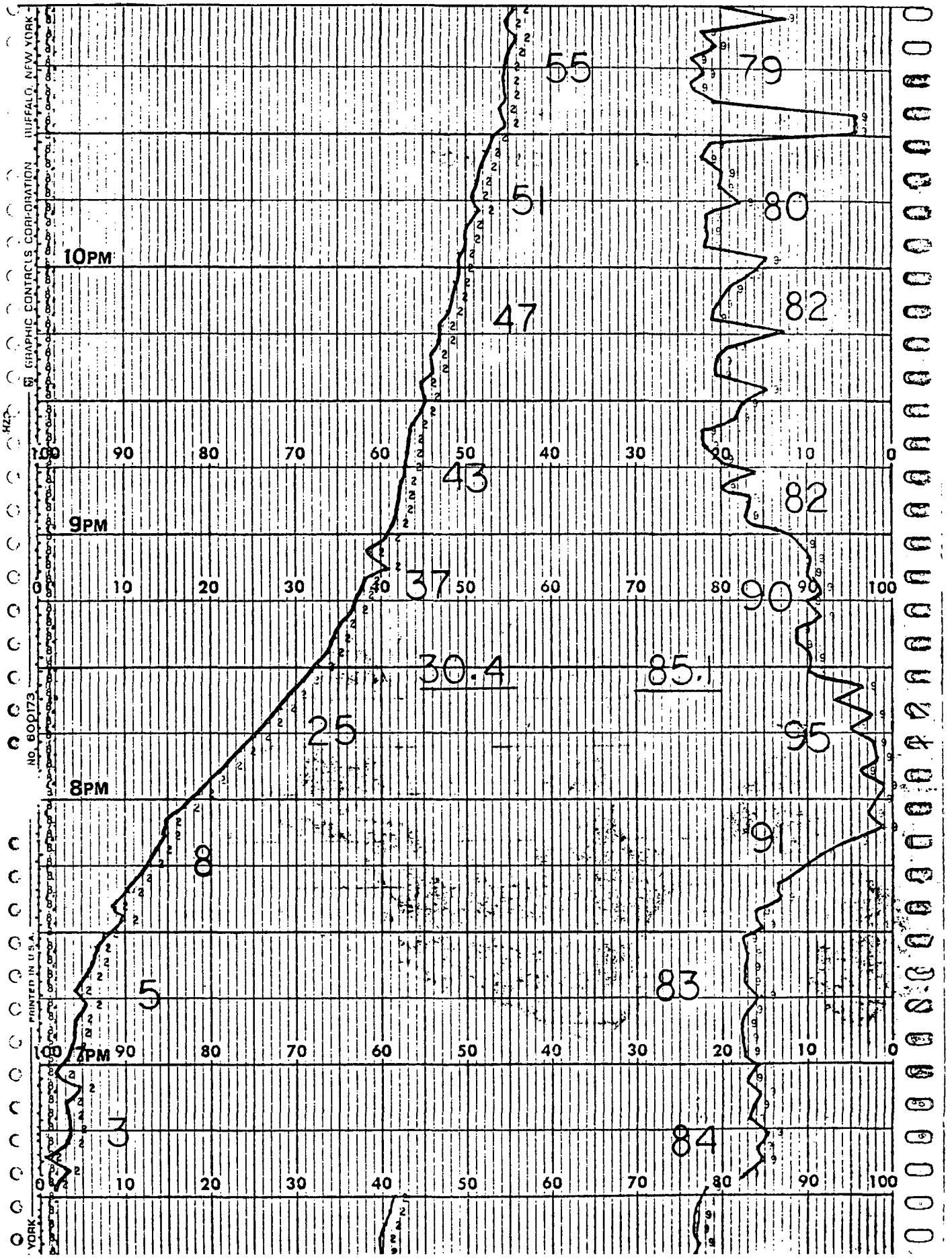
91
85
84
64
80
GRAPHIC CONTROLS CORPORATION BUFFALO
NO. 600173 PRINTED IN U.S.A.
BUFFALO, NEW YORK


GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
10PM
9PM
8PM
7PM
55
51
47
43
37
30.4
25
8
5
3
79
80
82
82
90
85.1
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91
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84
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
PRINTED IN U.S.A.
NO. 600173
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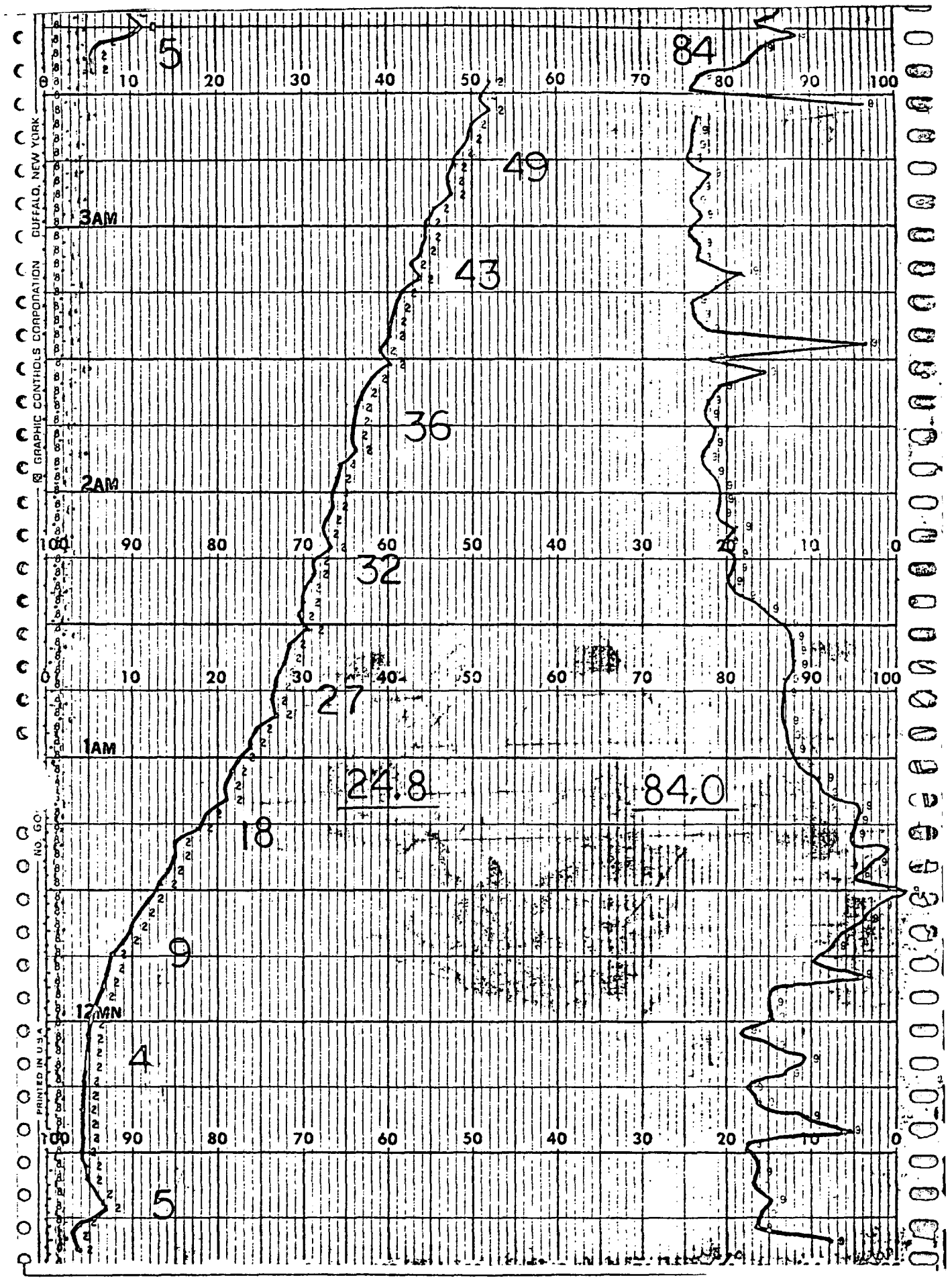
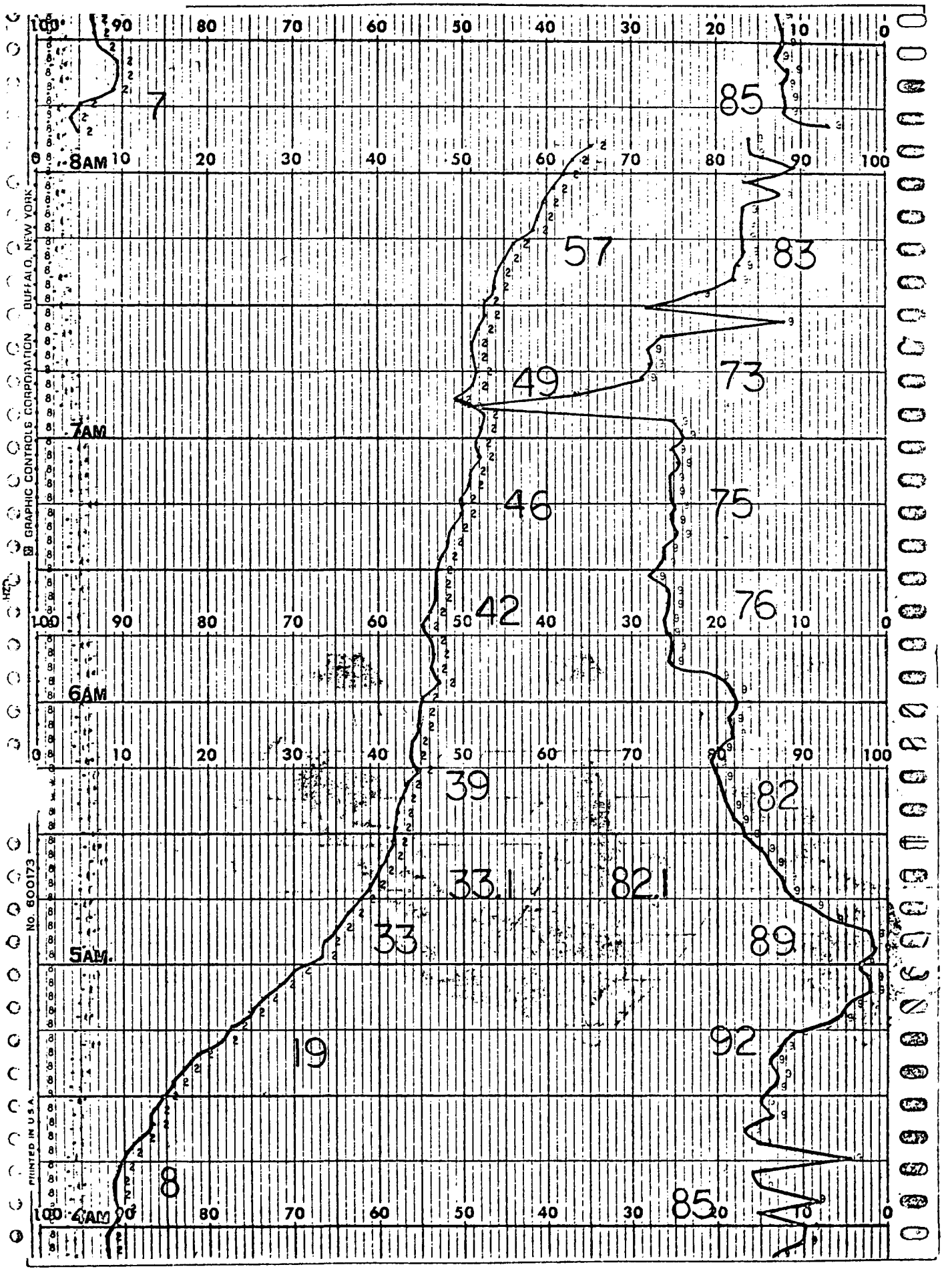

GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. GC
12MN
1AM
2AM
3AM
5
9
18
24.8
27
32
36
43
49
84
84.0
4
5


100 90 80 70 60 50 40 30 20 10 0
8AM
7AM
6AM
5AM.
4AM
7
85
57
83
49
73
46
75
42
76
39
82
33
82
33
89
19
92
8
85
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173
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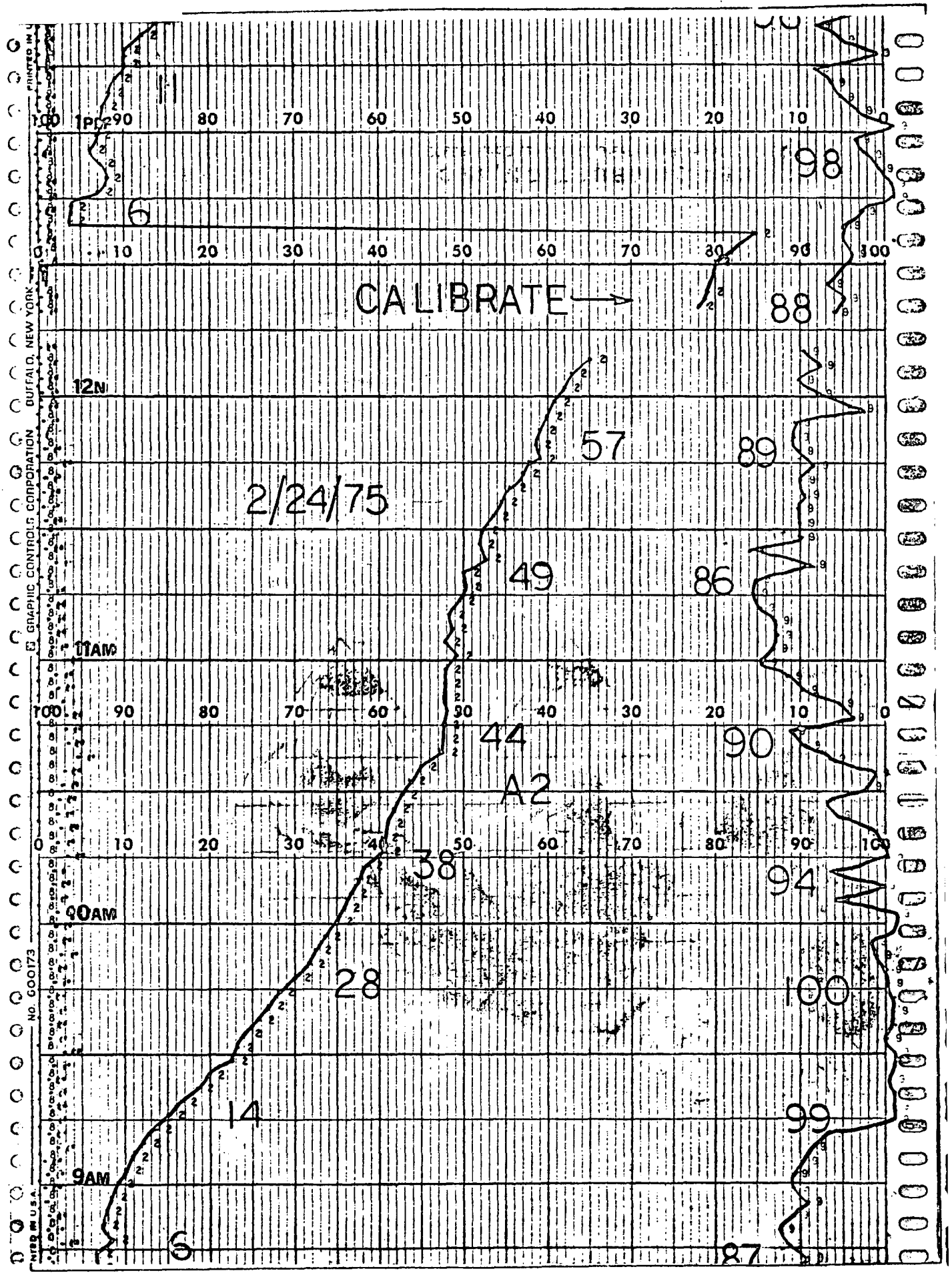
CALIBRATE
2/24/75
12N
11AM
10AM
9AM
6
14
28
38
44
49
57
88
89
86
90
94
100
99
87
98
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
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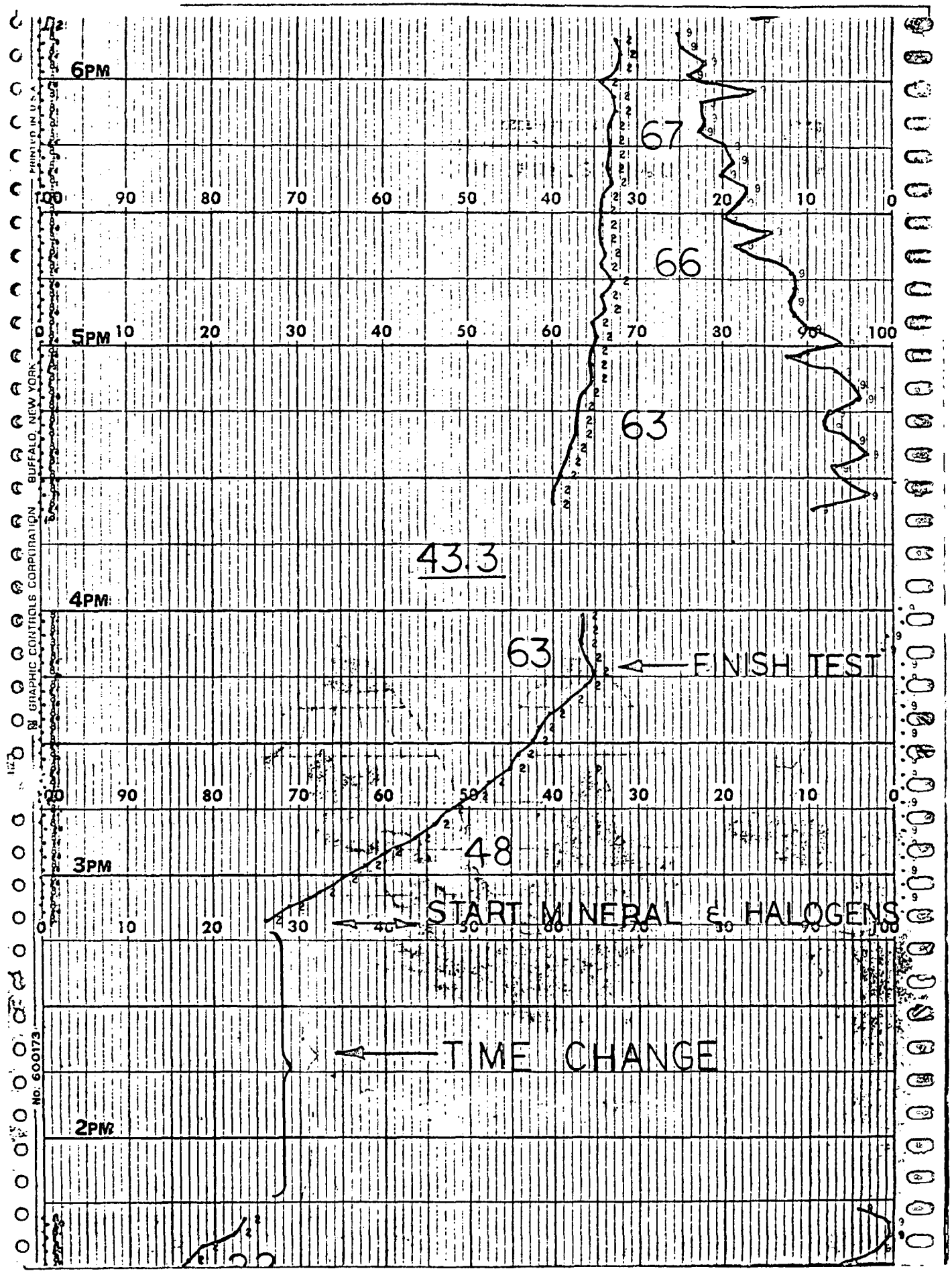
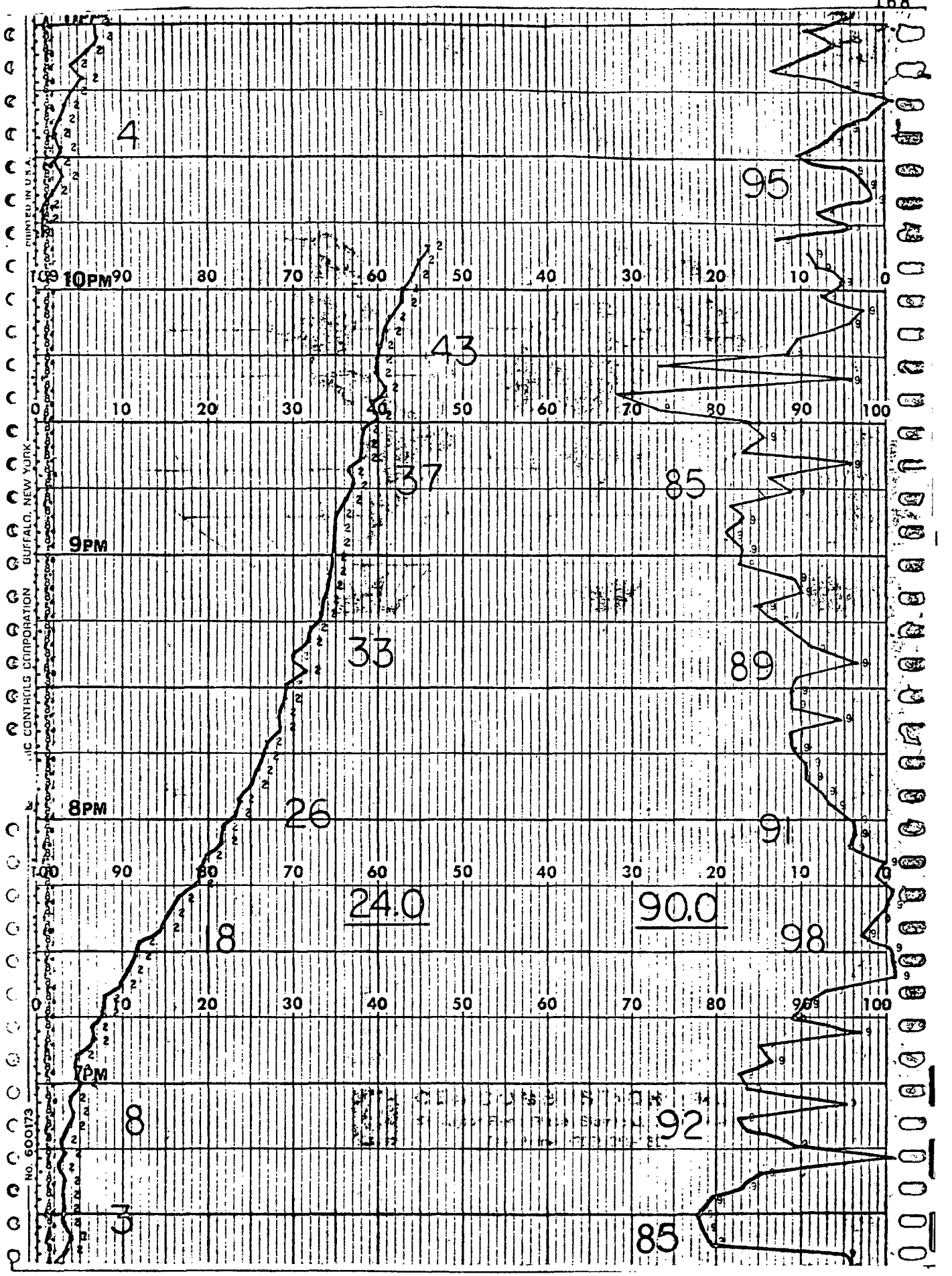

6PM
5PM
4PM
3PM
2PM
67
66
63
43.3
63
FINISH TEST
48
START MINERAL & HALOGENS
TIME CHANGE
PRINTED IN U.S.A.
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
No. 600173


10PM
9PM
8PM
7PM
4
43
37
33
26
18
8
3
95
85
89
91
98
92
85
24.0
90.0
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
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BUFFALO, NEW YORK
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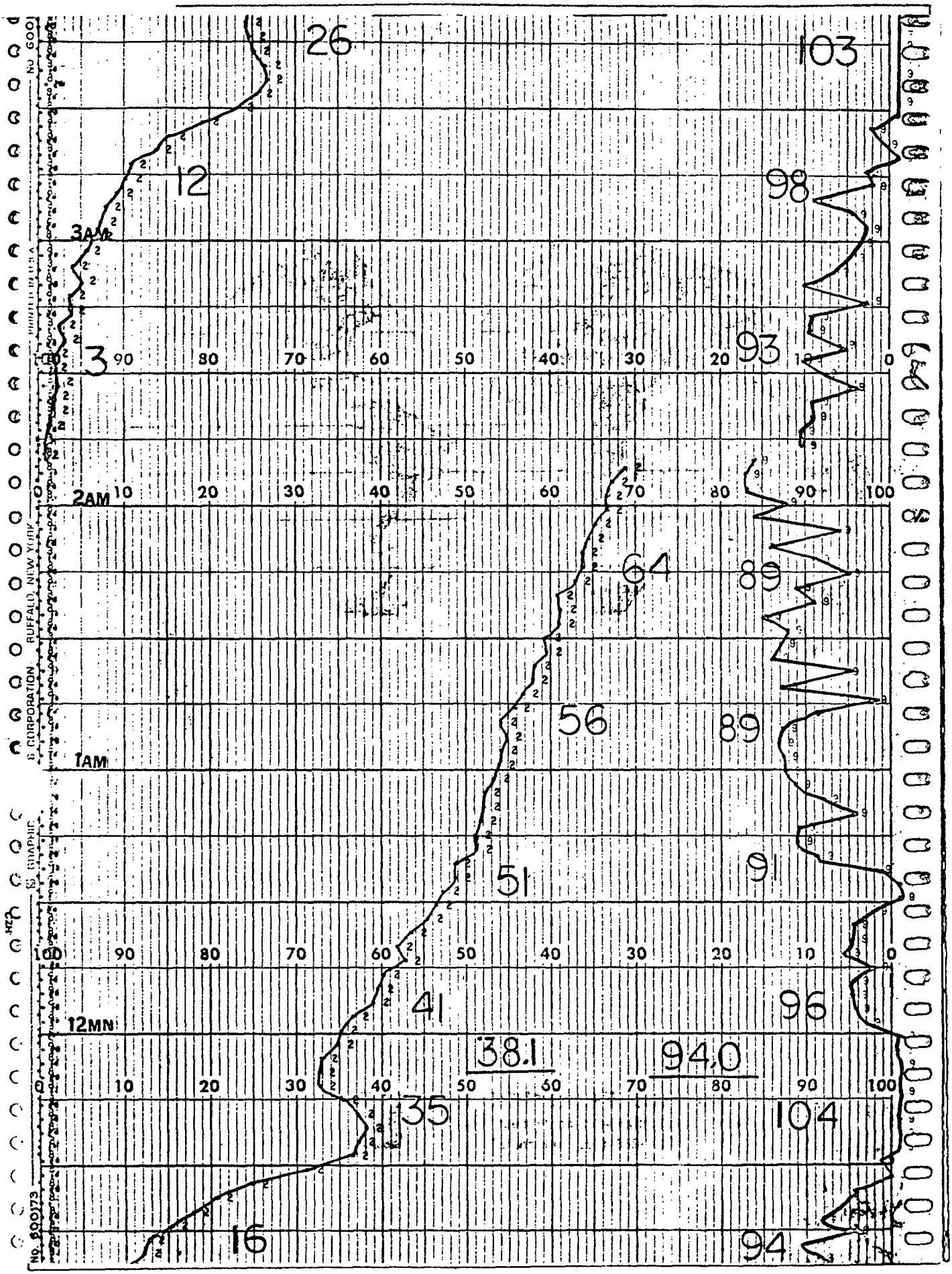
No. 600173


26
103
12
98
3AM
3
93
2AM
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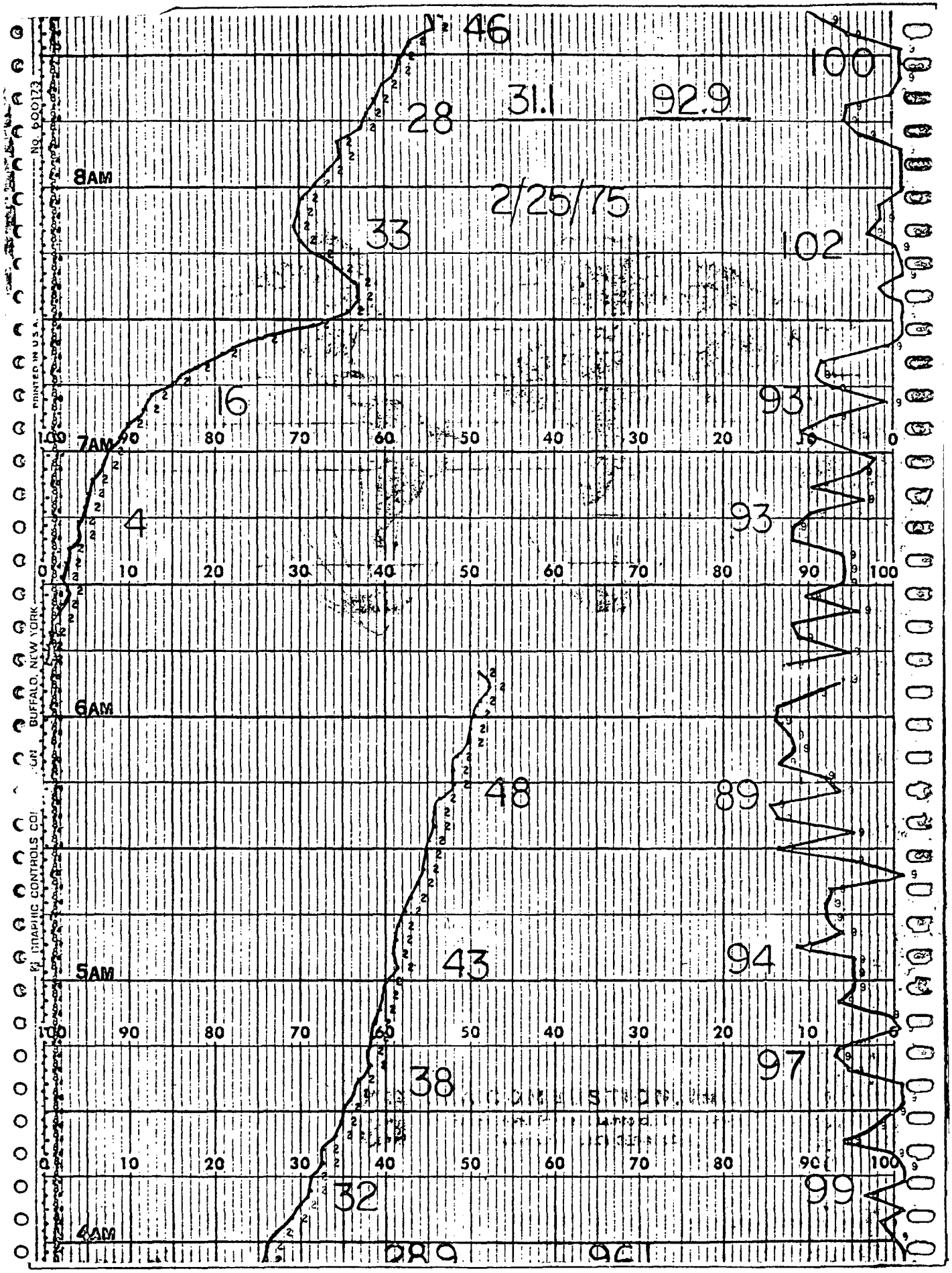
89
56
89
1AM
51
91
41
96
12MN
38.1
94.0
35
104
16
94


8AM
7AM
6AM
5AM
4AM
46
28
31.1
92.9
2/25/75
33
102
16
93
4
93
48
89
43
94
38
97
32
99
089
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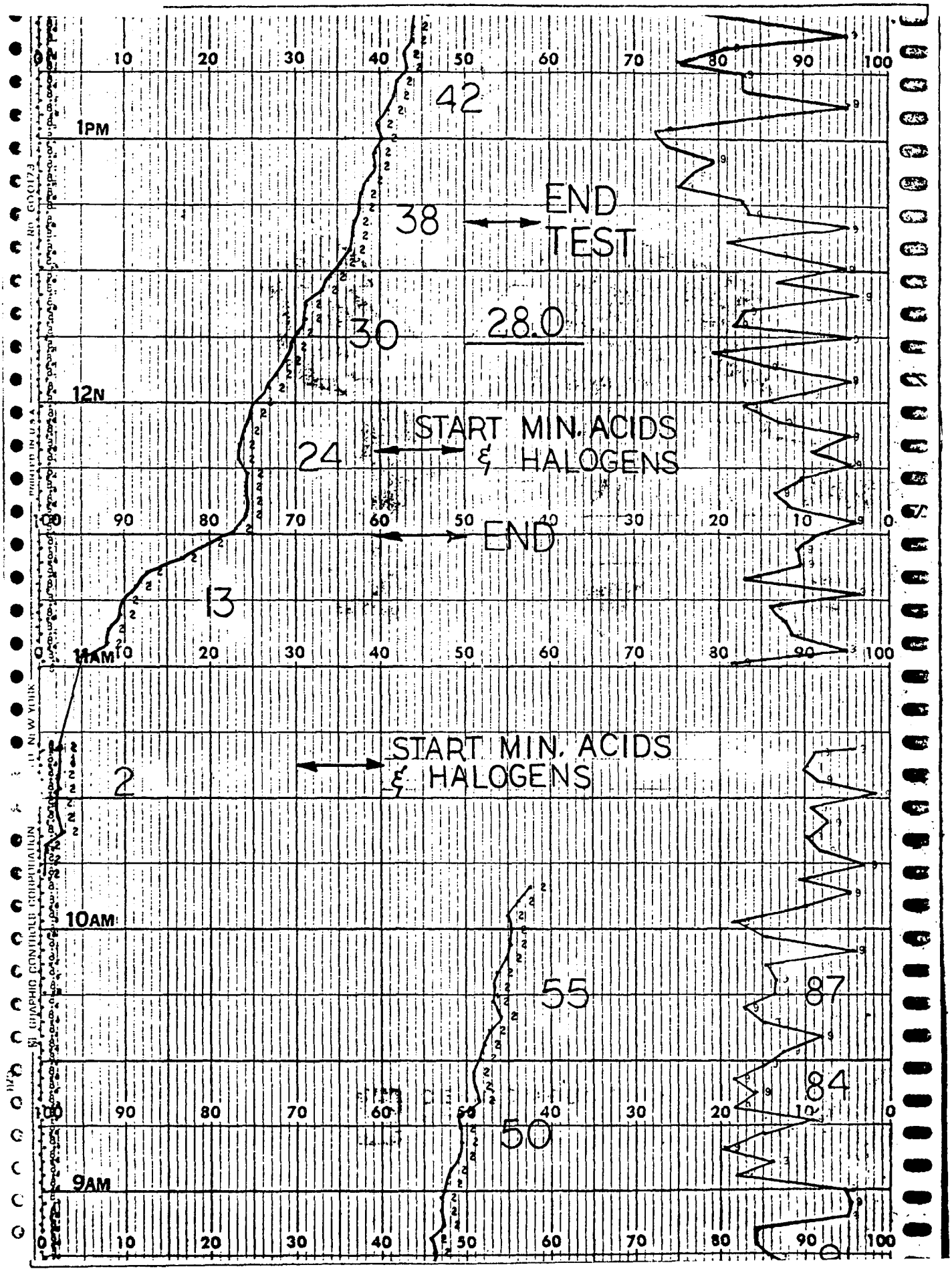
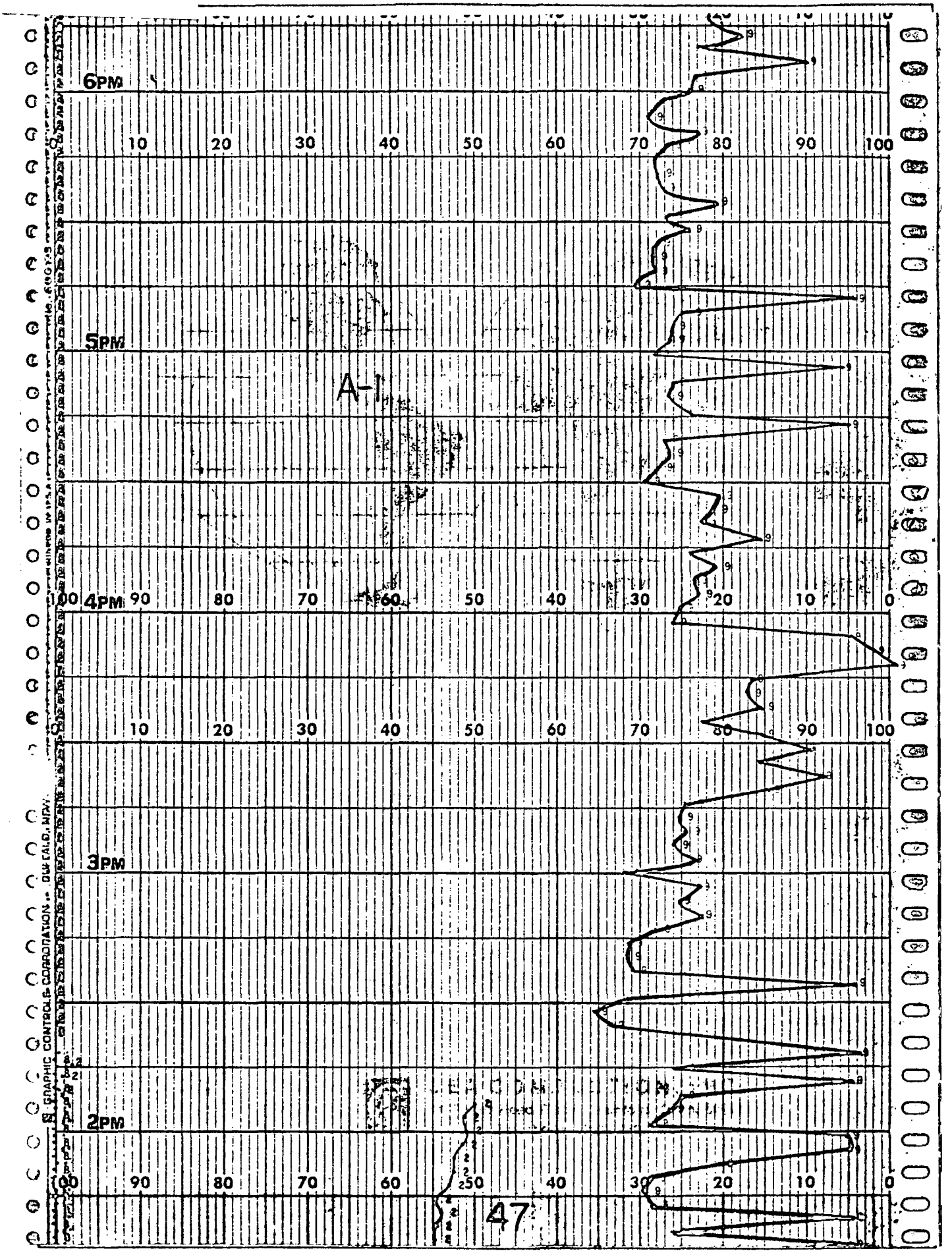

42
END
TEST
38
28.0
30
12N
START MIN. ACIDS
& HALOGENS
24
END
13
11AM
START MIN. ACIDS
& HALOGENS
2
10AM
55
87
84
50
9AM
0
1PM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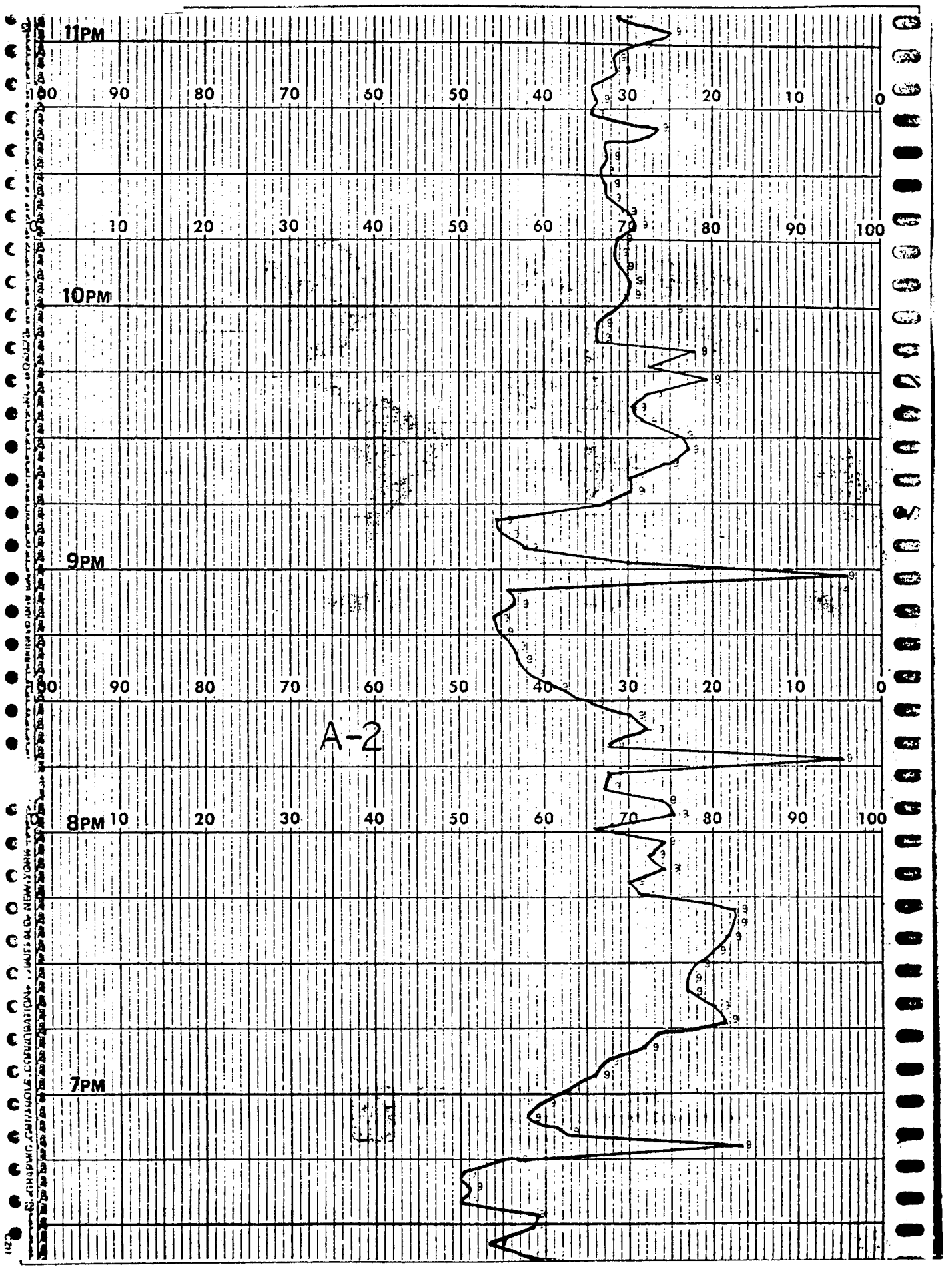
5PM
4PM
3PM
2PM
A-1
47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9PM
8PM
7PM
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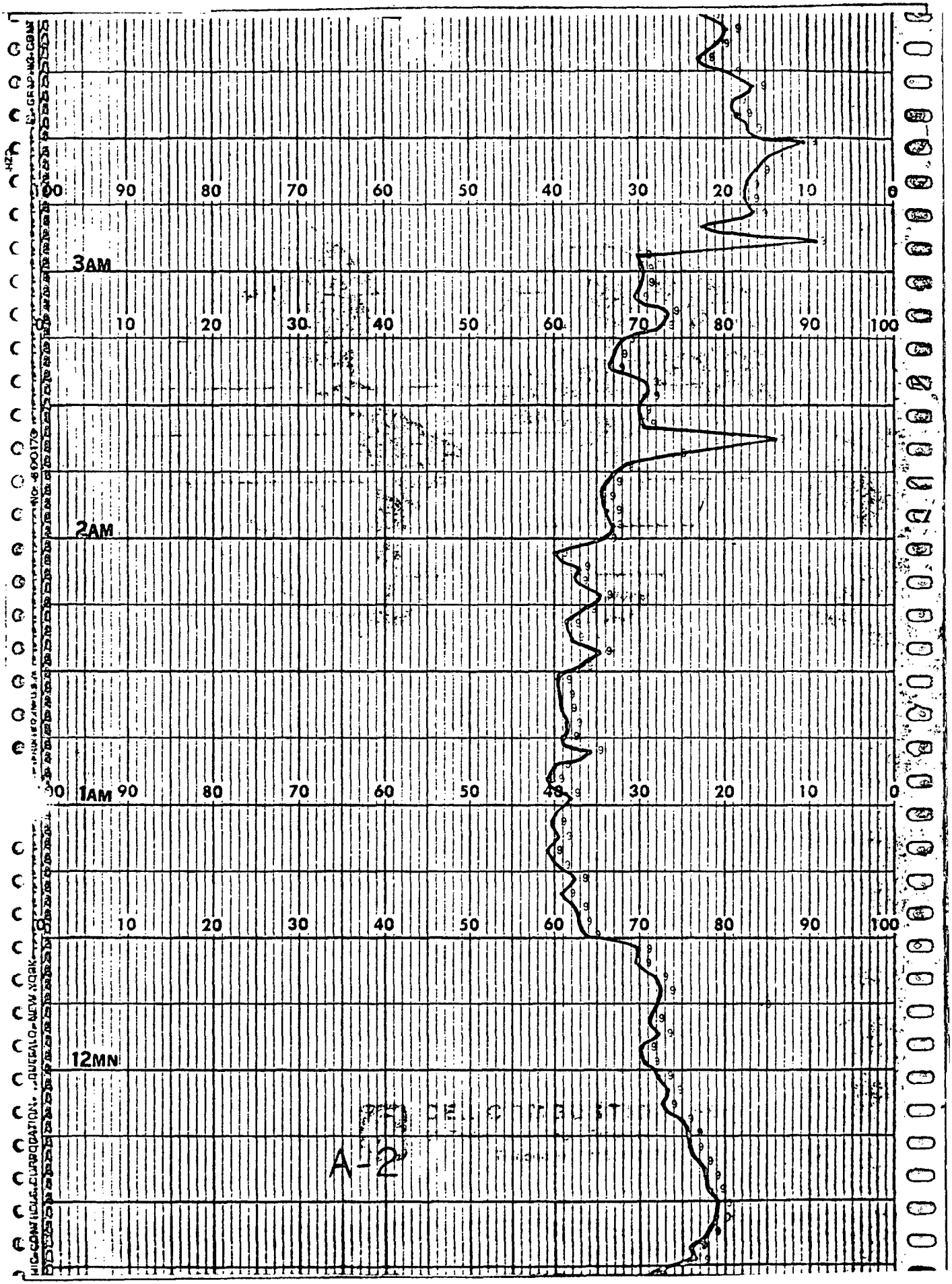
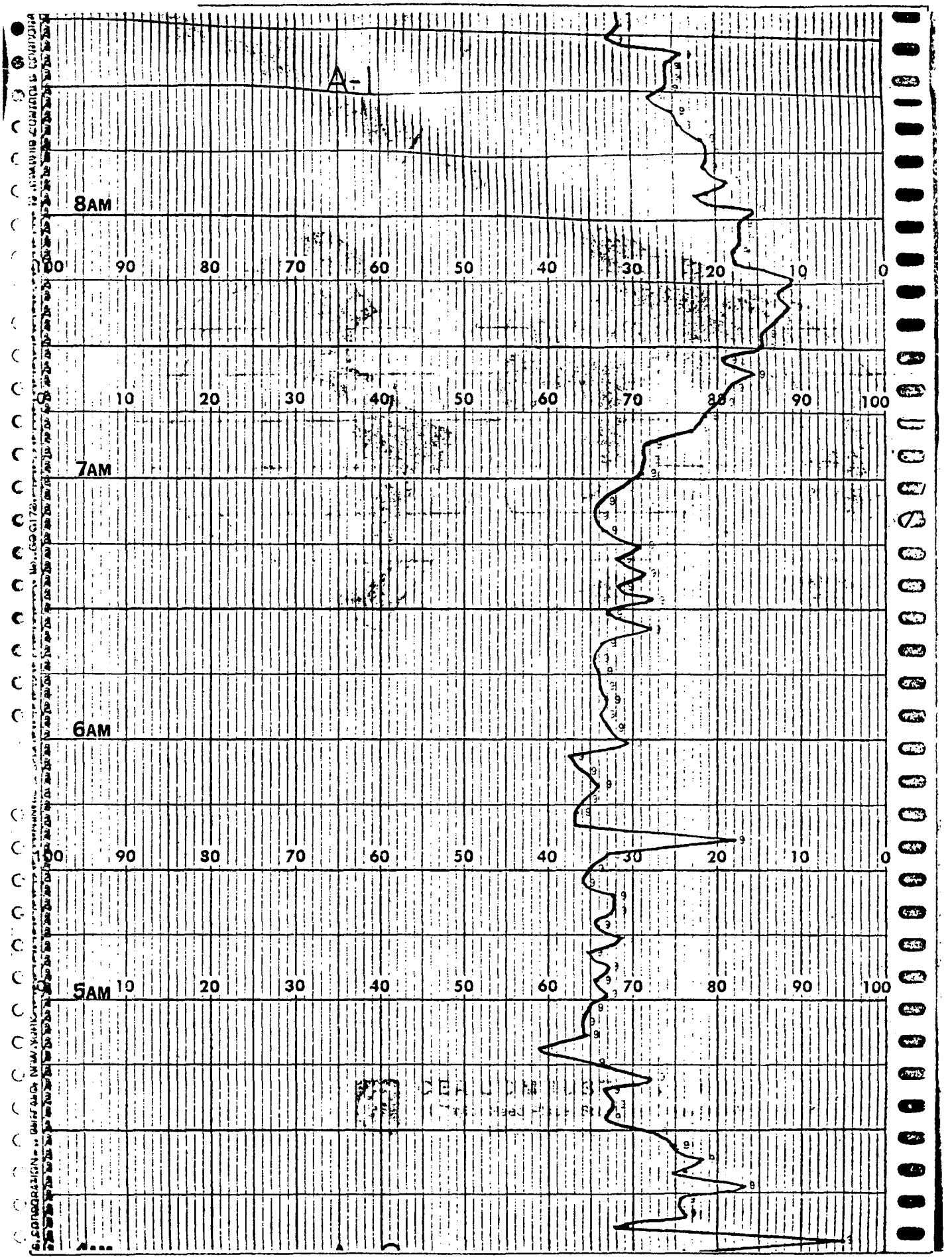
0 10 20 30 40 50 60 70 80 90 100
A-2


3AM
2AM
1AM
12MN
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100

A-2


A-1
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7AM
6AM
5AM
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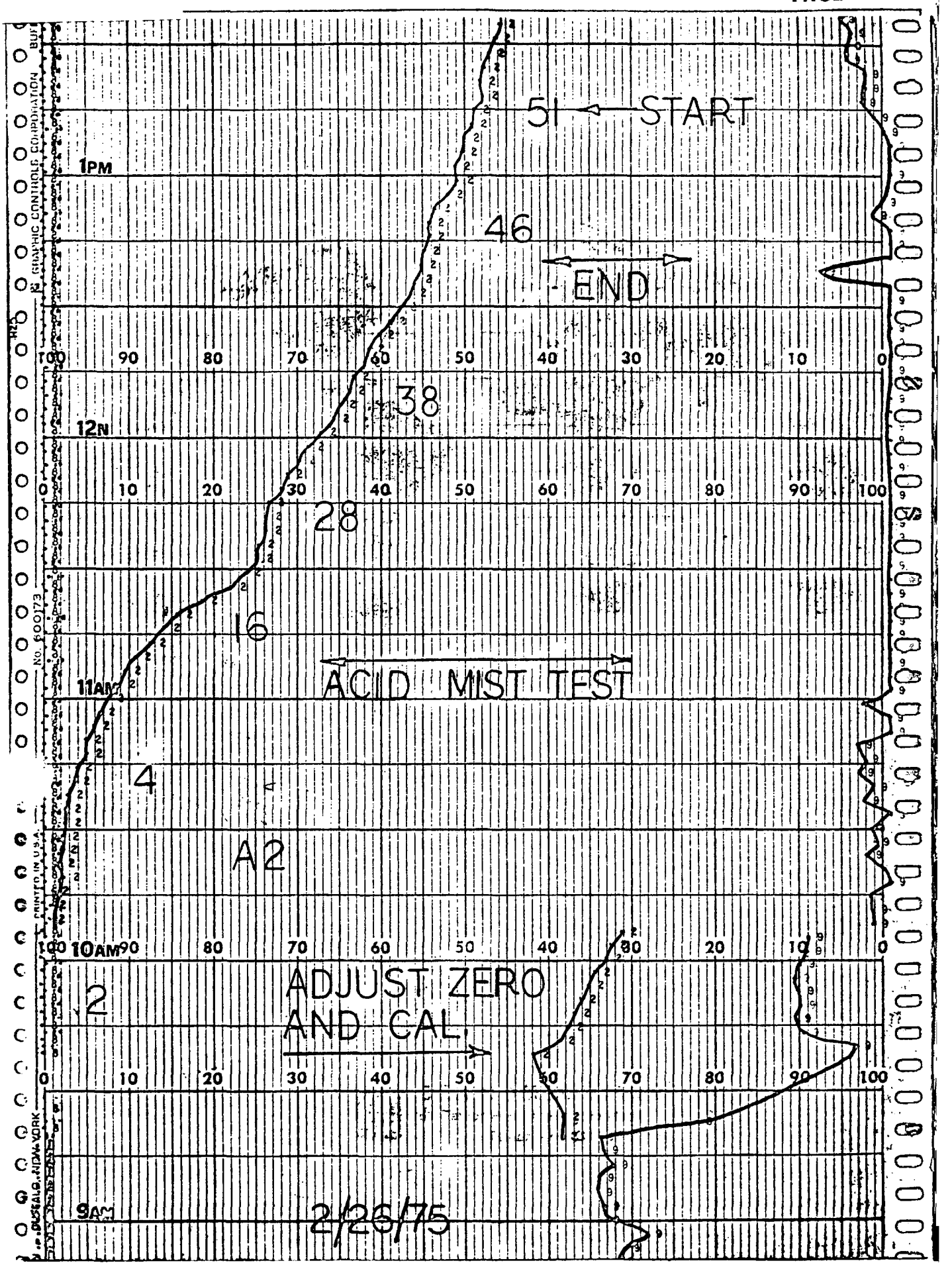
0 10 20 30 40 50 60 70 80 90 100


51 START
1PM
46
END
38
12N
28
16
ACID MIST TEST
11AM
4
A2
10AM
2
ADJUST ZERO
AND CAL
9AM
2/26/75
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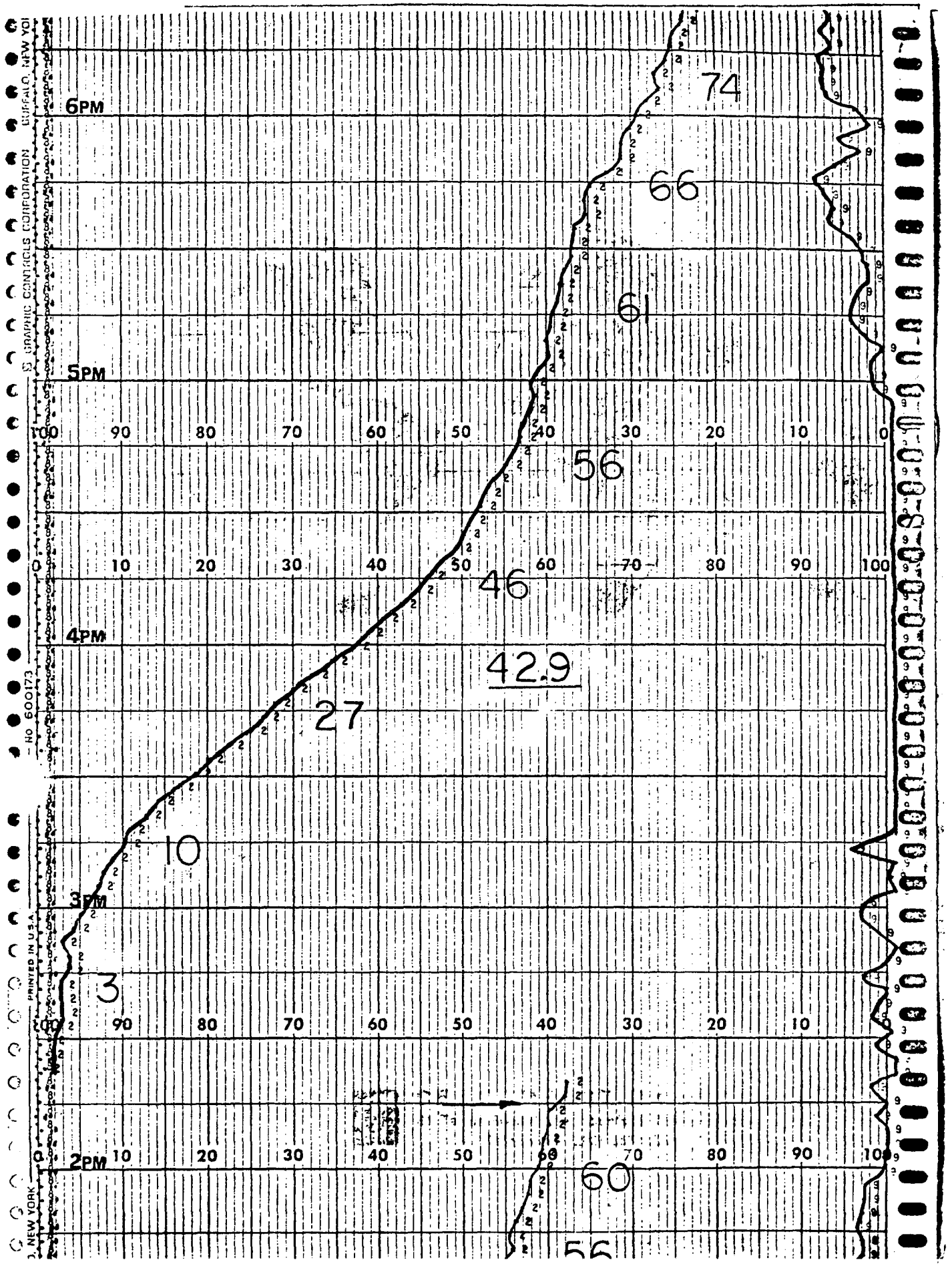
6PM
5PM
4PM
3PM
2PM
74
66
61
56
46
42.9
27
10
3
60
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YOR
NO 600173
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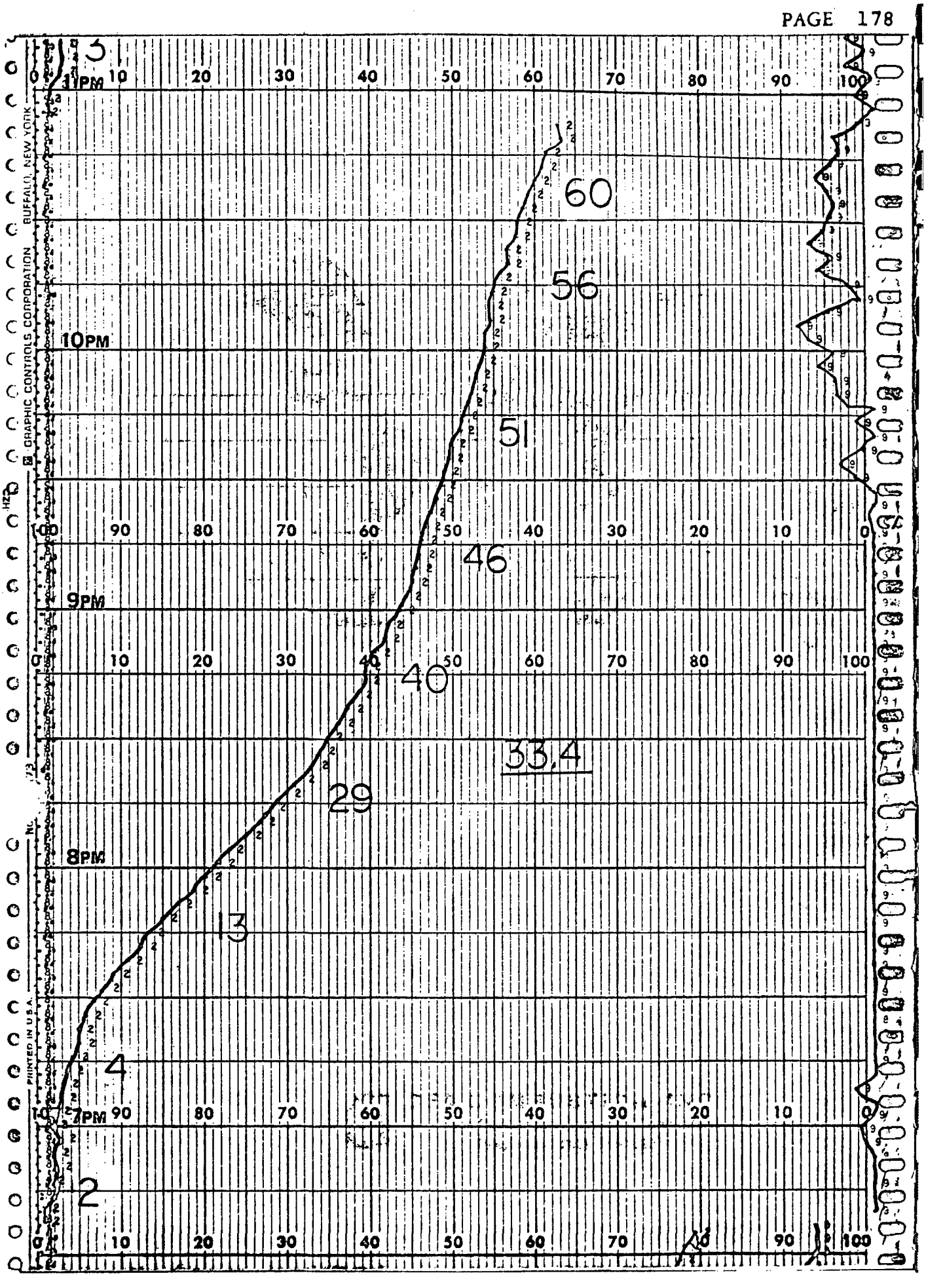
NEW YORK


GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
11PM
10PM
9PM
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7PM
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46
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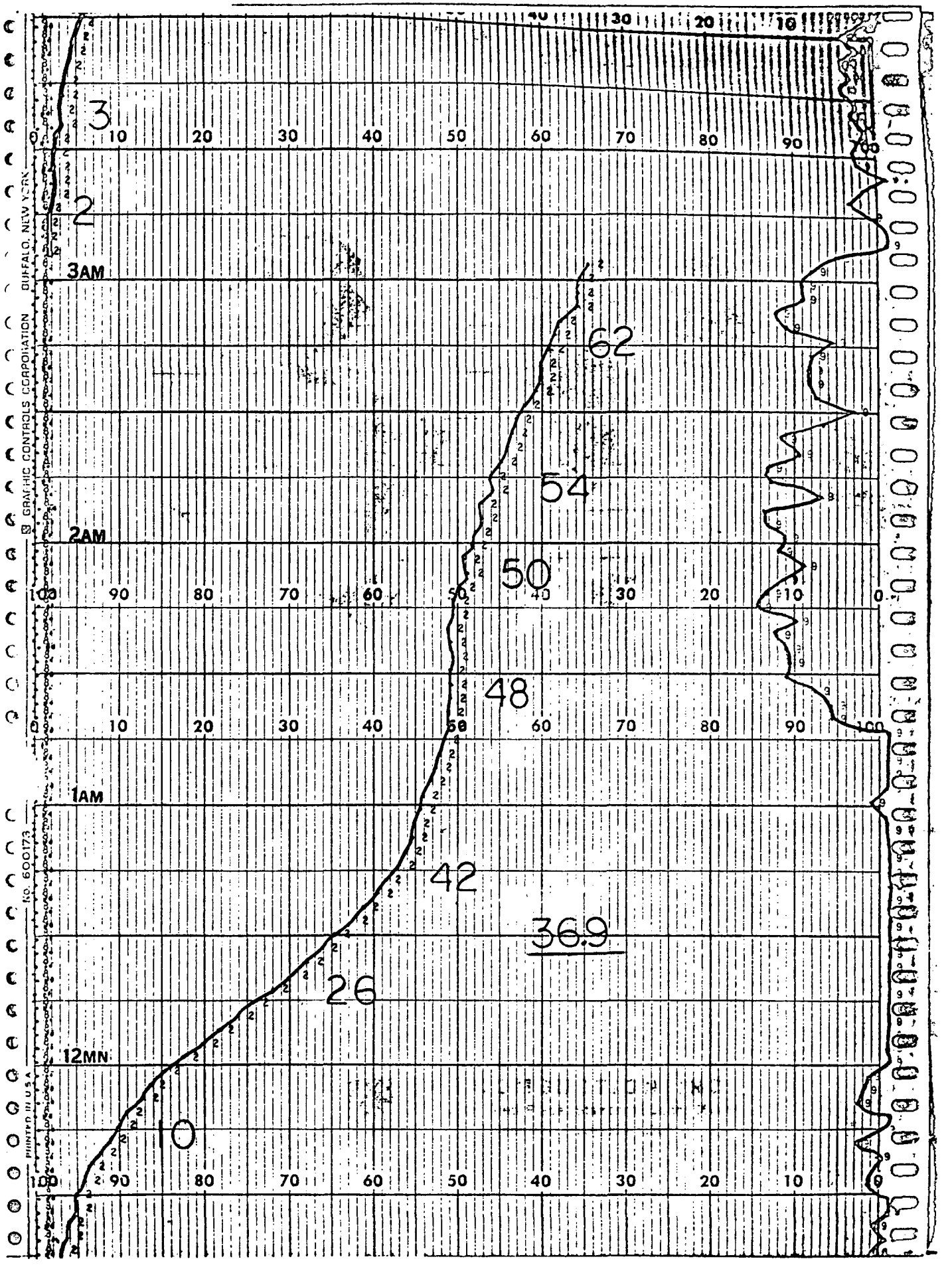
33.4
29
13
4
2


3
2
3AM
62
54
2AM
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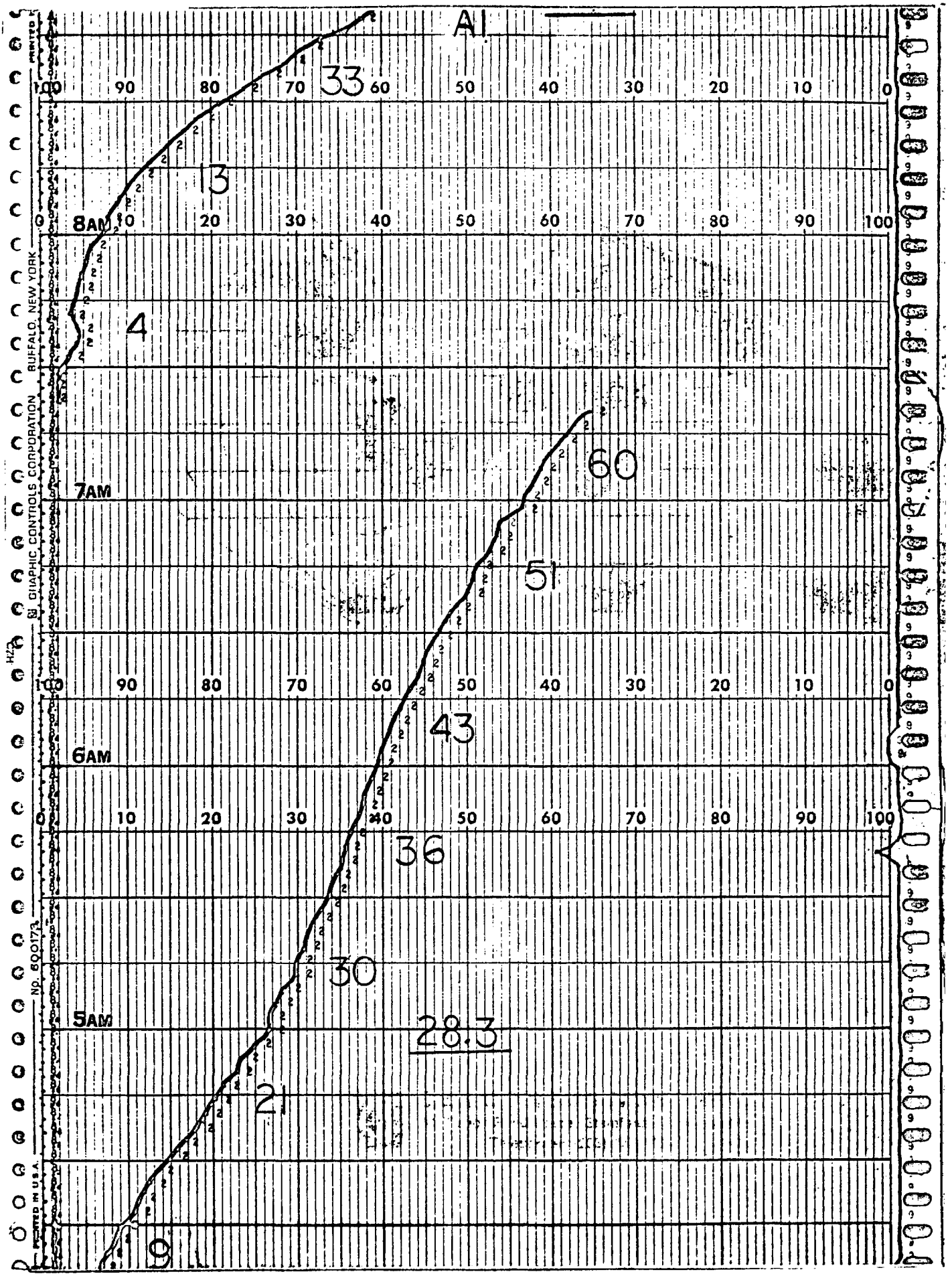
A1
33
13
8AM
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7AM
60
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5AM
28.3
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No. 60017
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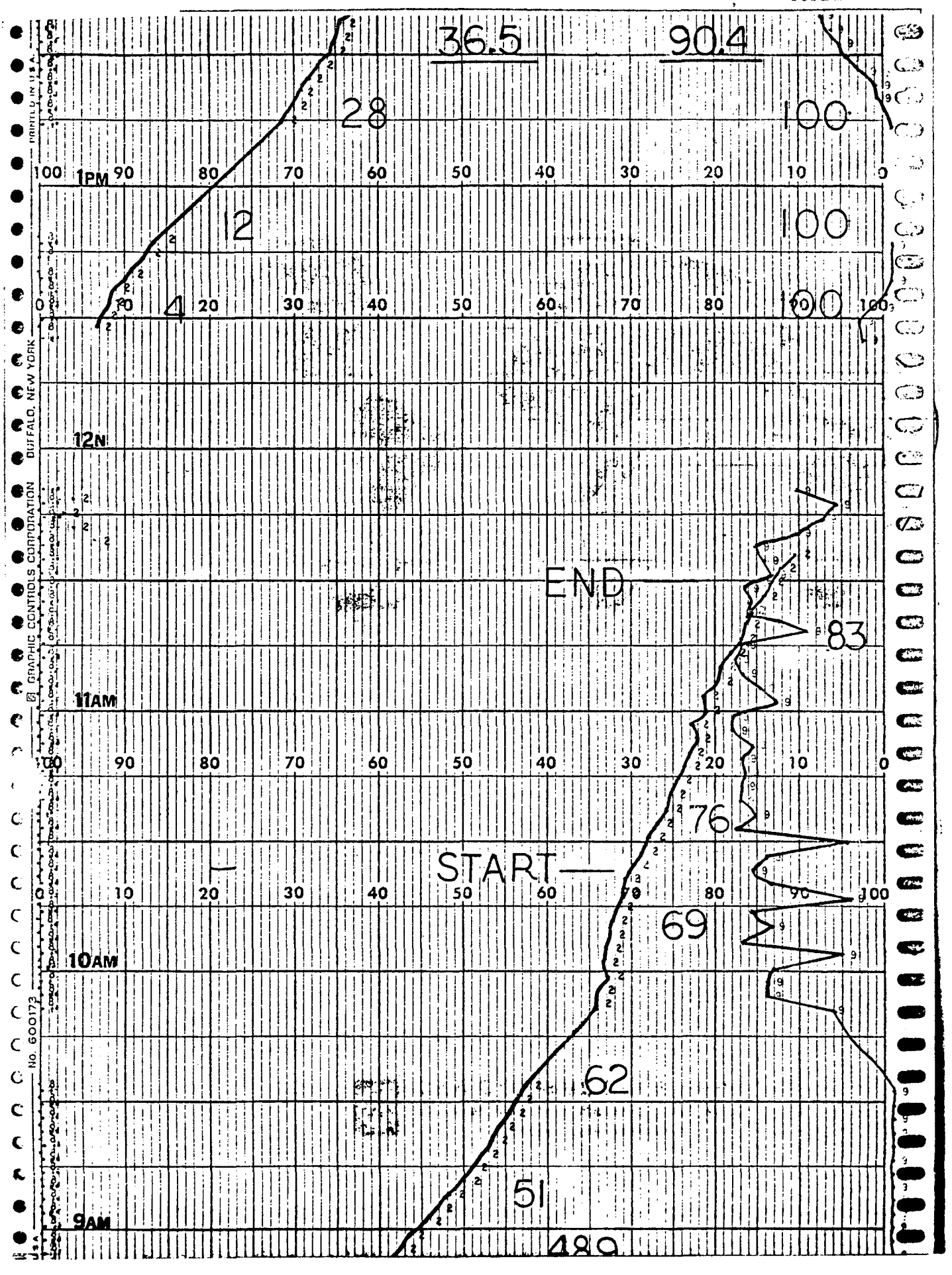
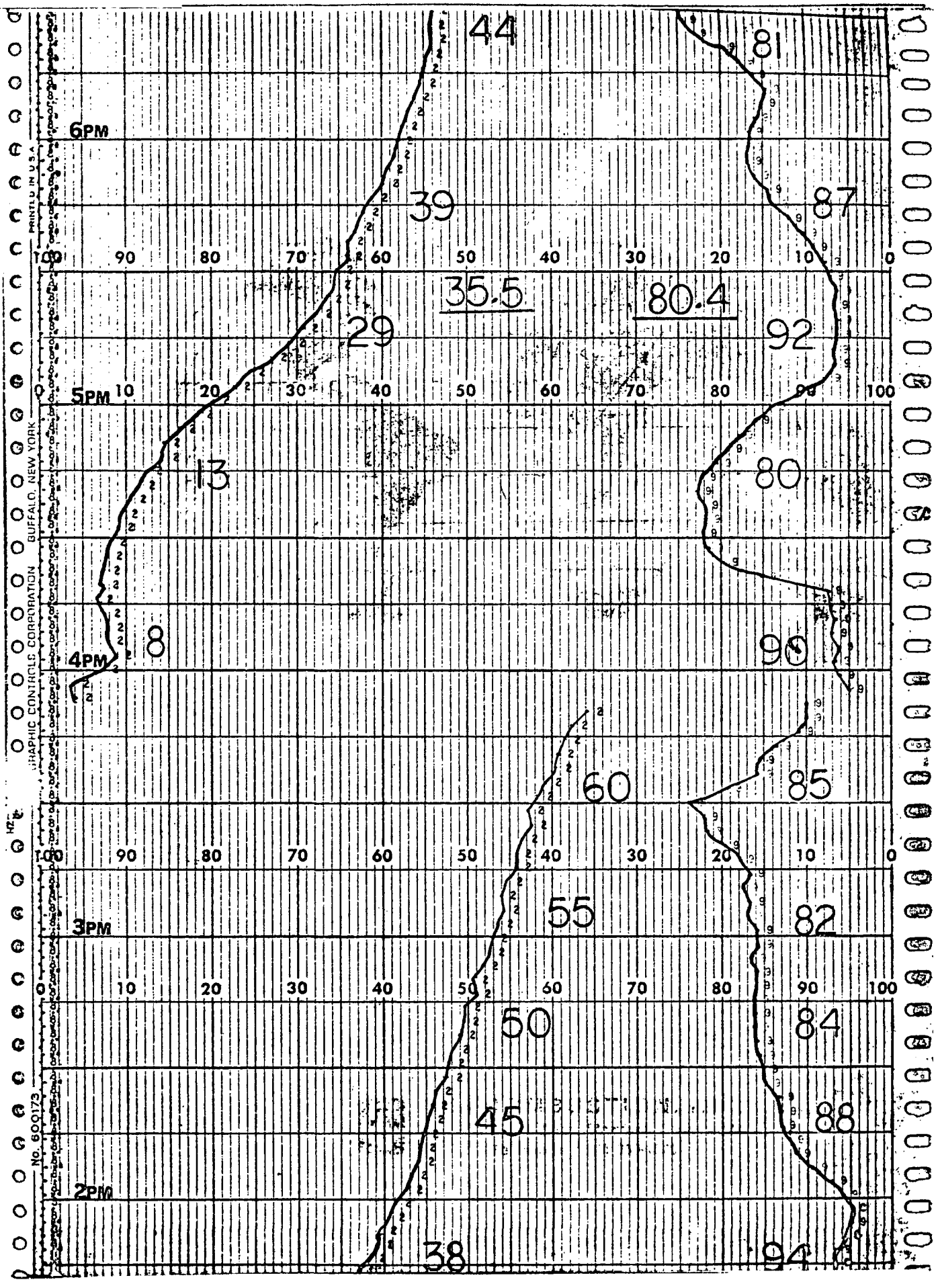

36.5
90.4
28
100
1PM
12
100
4
100
12N
END
83
11AM
76
START
69
10AM
62
51
9AM
489
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173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2PM
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13
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81
87
92
80
90
35.5
80.4
60
55
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82
84
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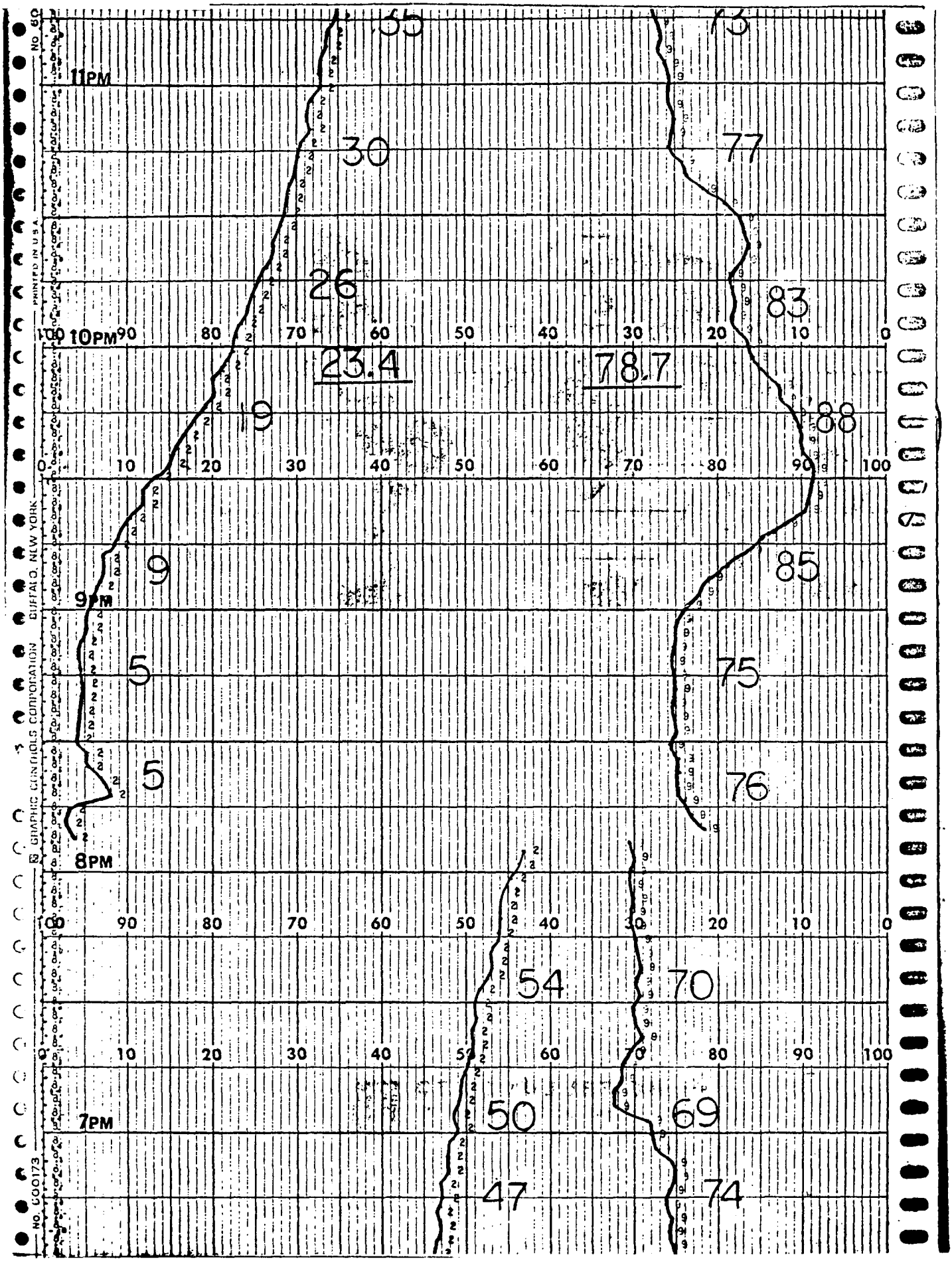
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 600173


11PM
10PM
9PM
8PM
7PM
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30
26
23.4
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9
5
5
54
50
47
73
77
83
78.7
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70
69
74
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 60
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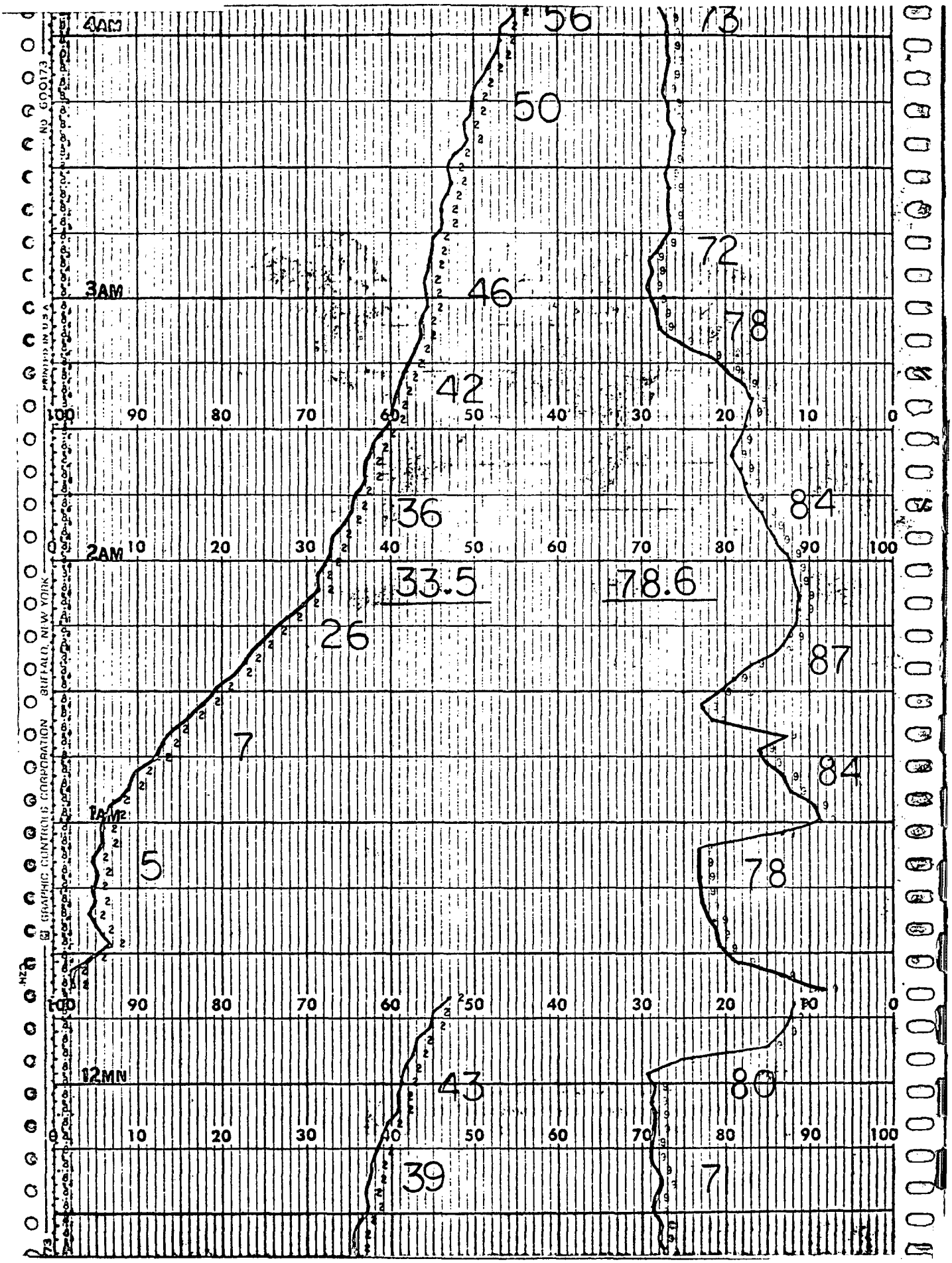
4AM
3AM
2AM
1AM
12MN
56
73
50
72
46
78
42
84
36
33.5
78.6
87
26
84
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5
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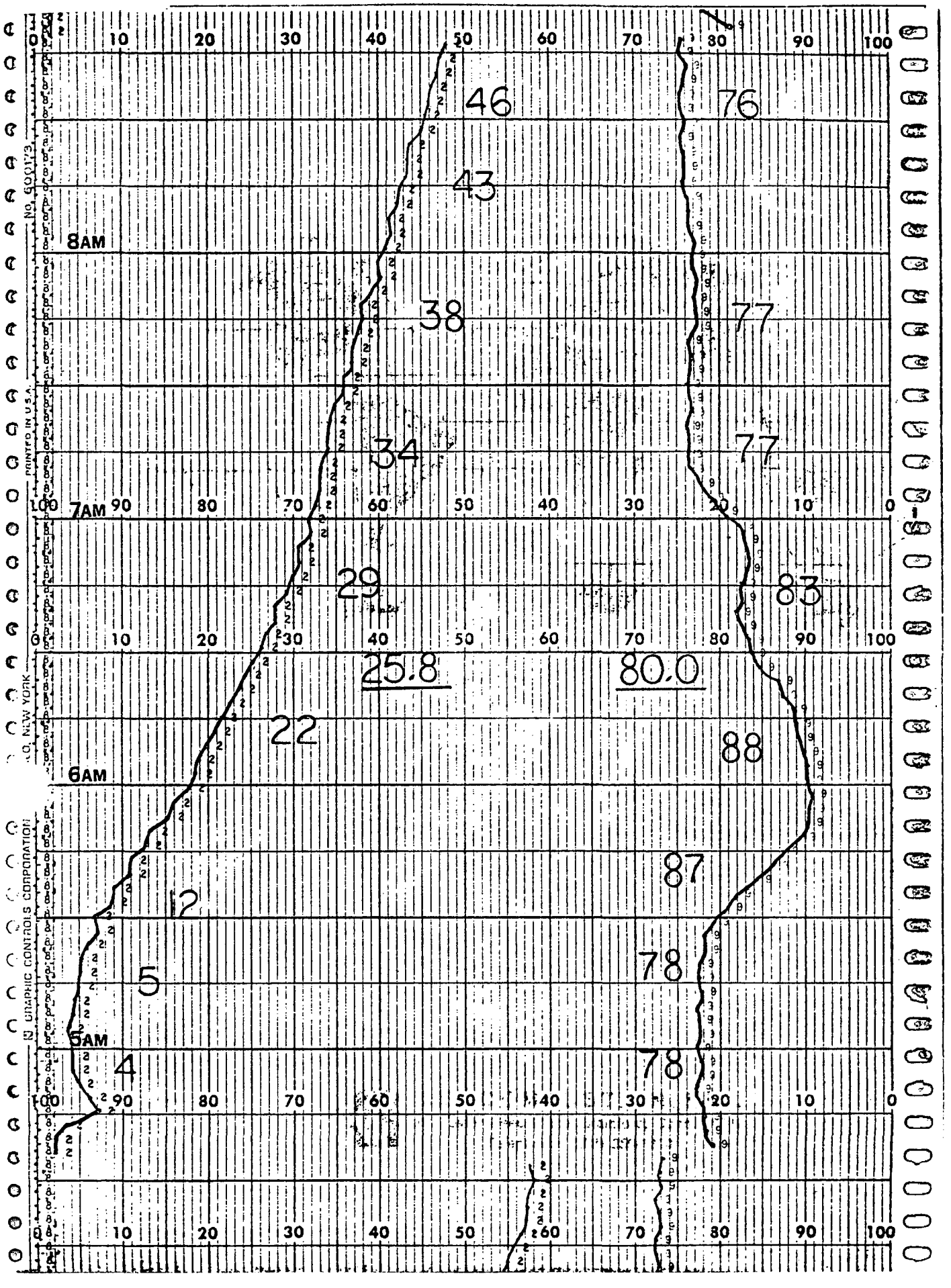
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
NO. 600173
PRINTED IN U.S.A.


8AM
7AM
6AM
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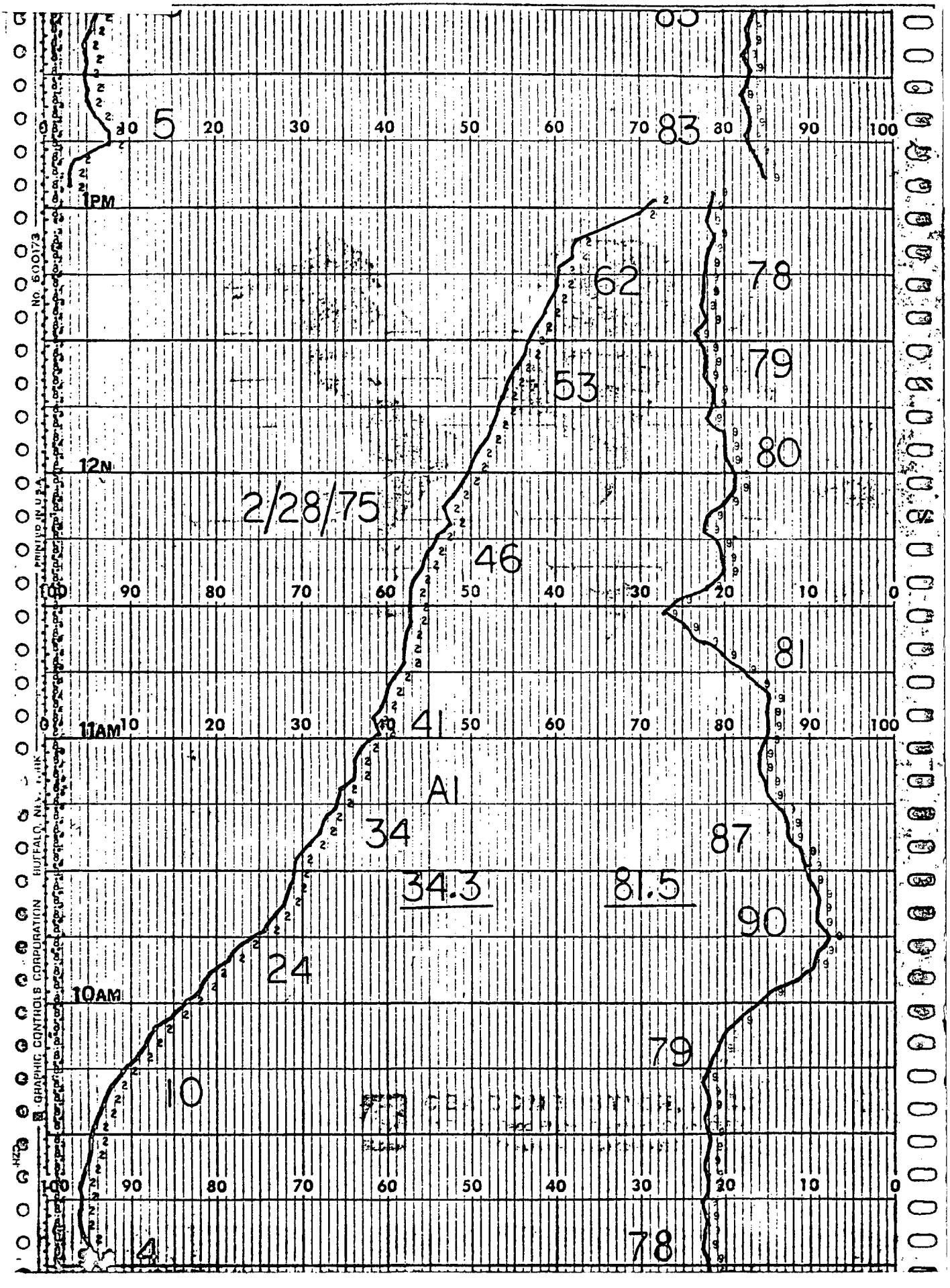
GRAPHIC CONTROLS CORPORATION


5
83
1PM
62
78
53
79
80
12N
2/28/75
46
81
11AM
41
AI
34
87
34.3
81.5
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24
10AM
79
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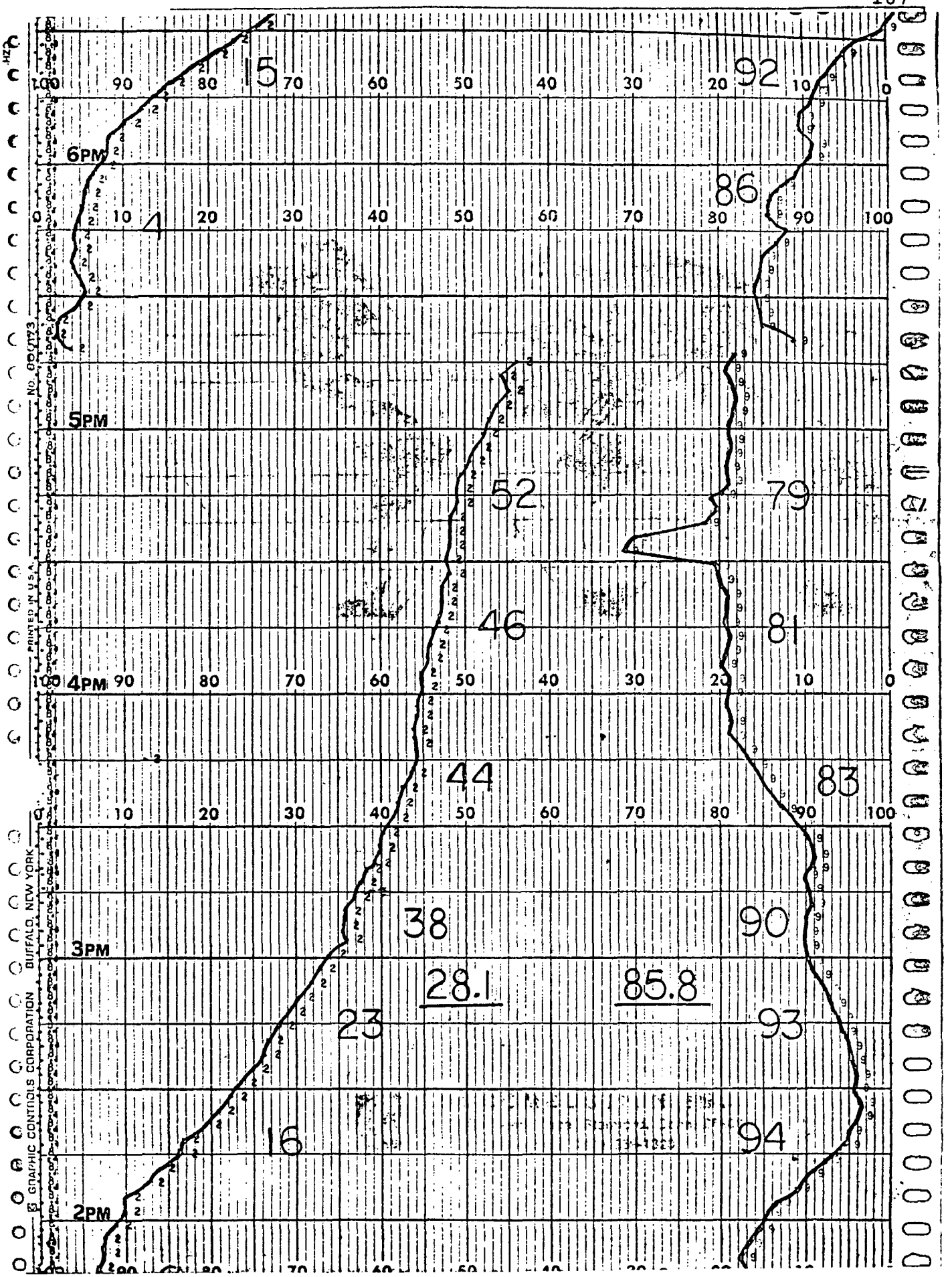
78
4
GRAPHIC CONTROLS CORPORATION BUFFALO, N.Y. U.S.A.
NO. 60017/3


6PM
5PM
4PM
3PM
2PM
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92
86
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94
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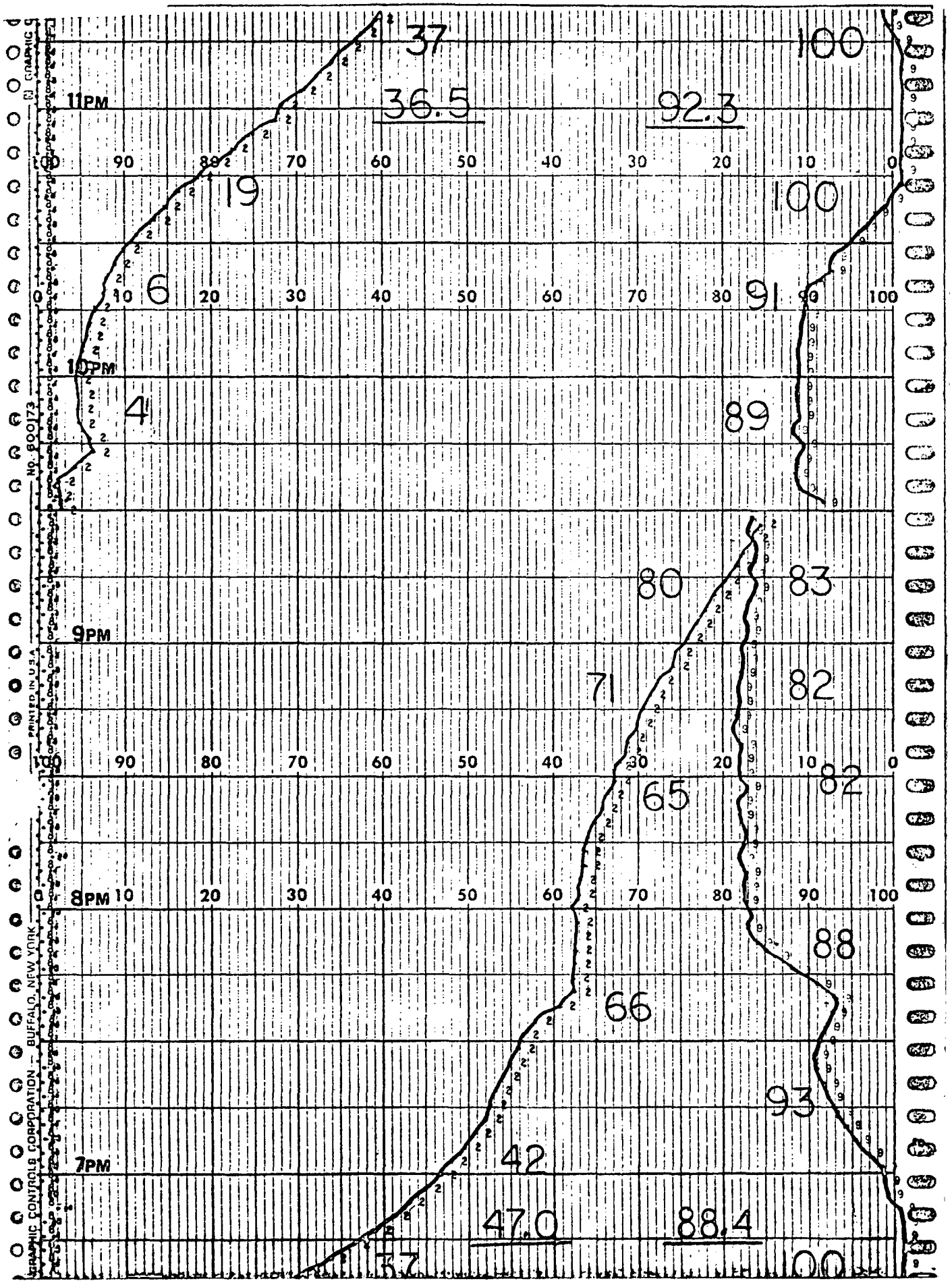
11PM
10PM
9PM
8PM
7PM
37
36.5
92.3
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100
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91
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89
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82
65
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47.0
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GRAPHIC CONTROLS CORPORATION — BUFFALO, NEW YORK
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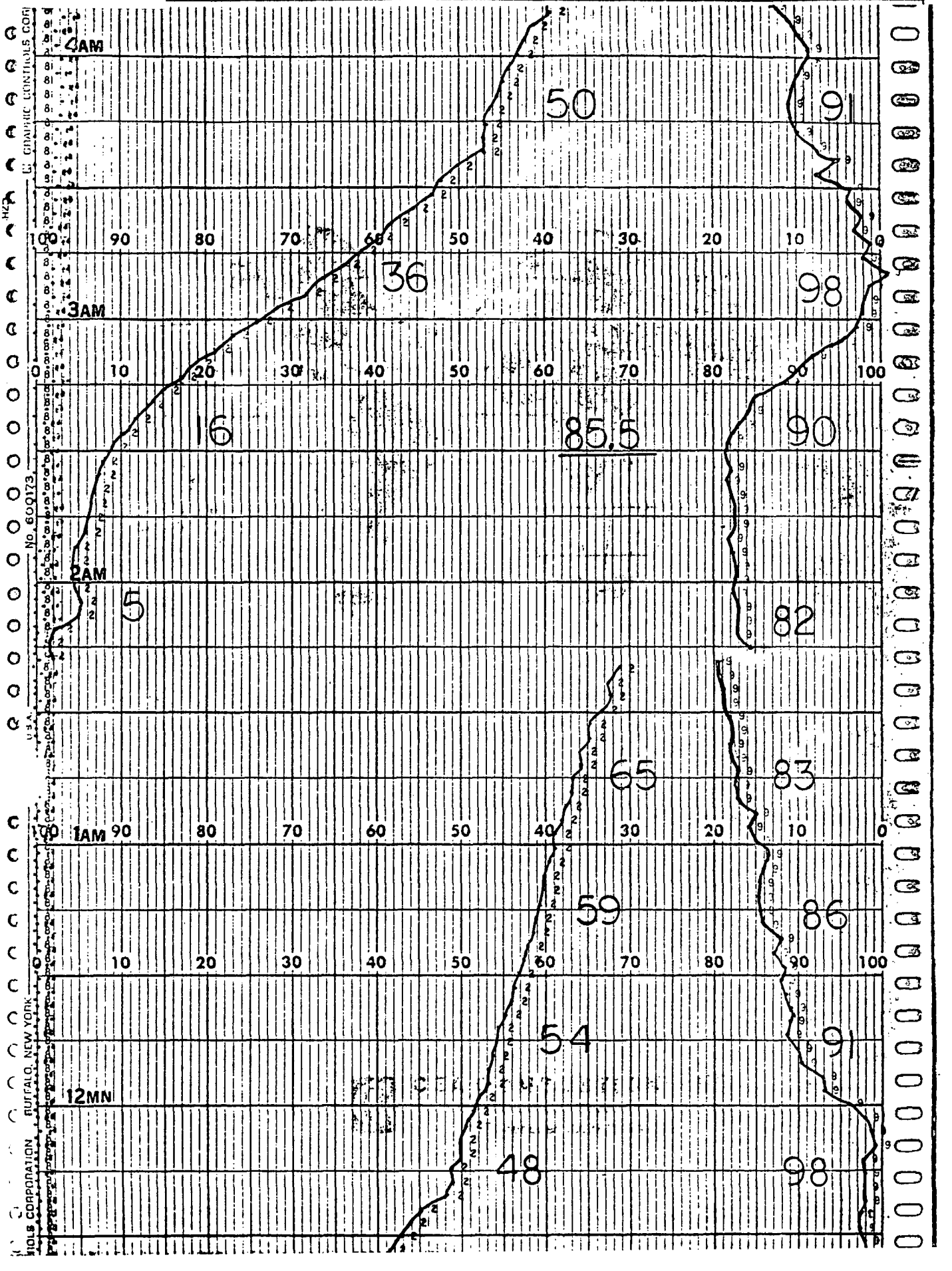
NO. 800173


4AM
3AM
2AM
1AM
12MN
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60
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16
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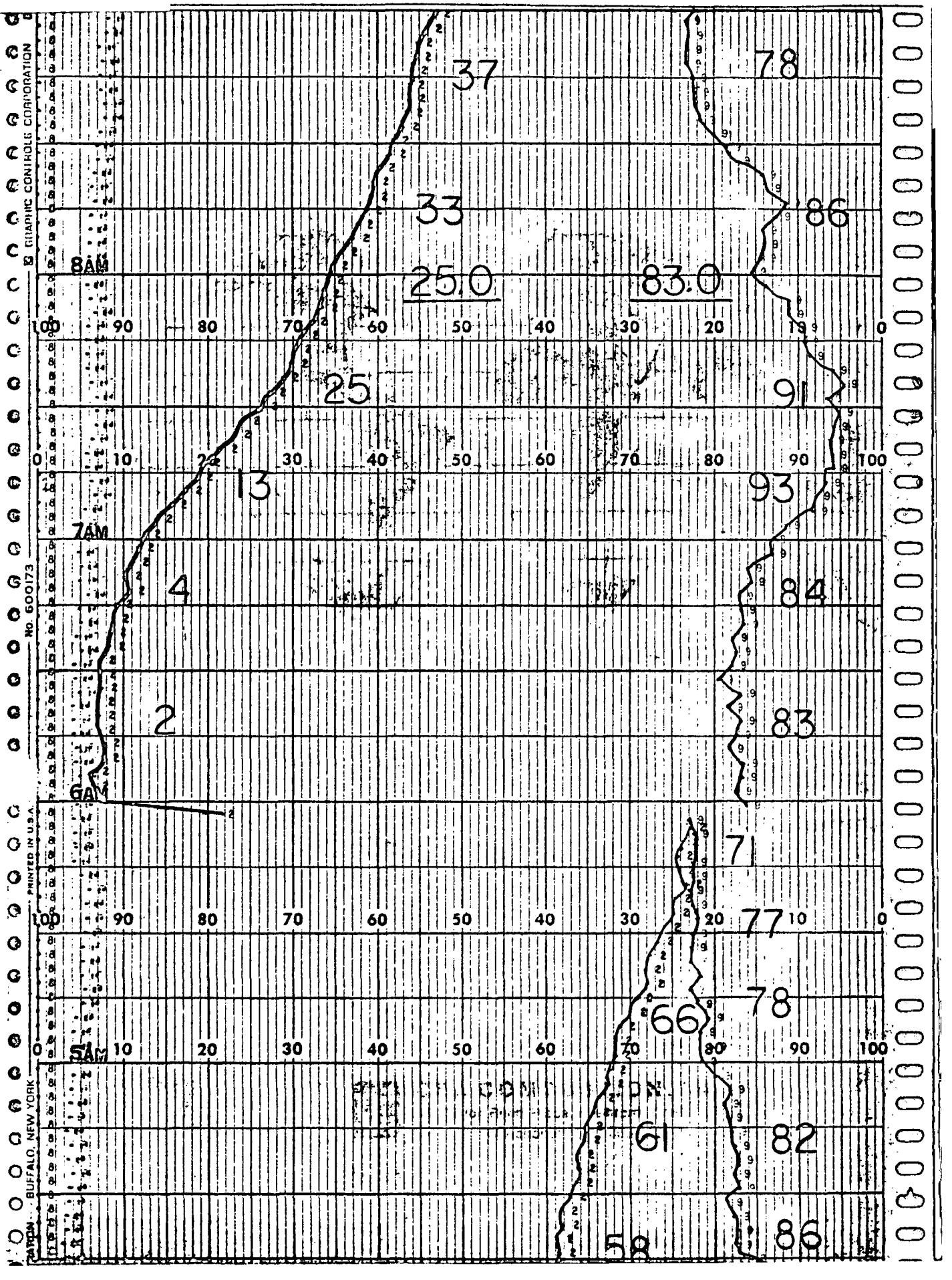
NO. 60Q173
BUFFALO, NEW YORK
U.S.A.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BUFFALO, NEW YORK
8AM
7AM
6AM
5AM
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250
830
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4
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86
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93
84
83
7
77
78
66
61
82
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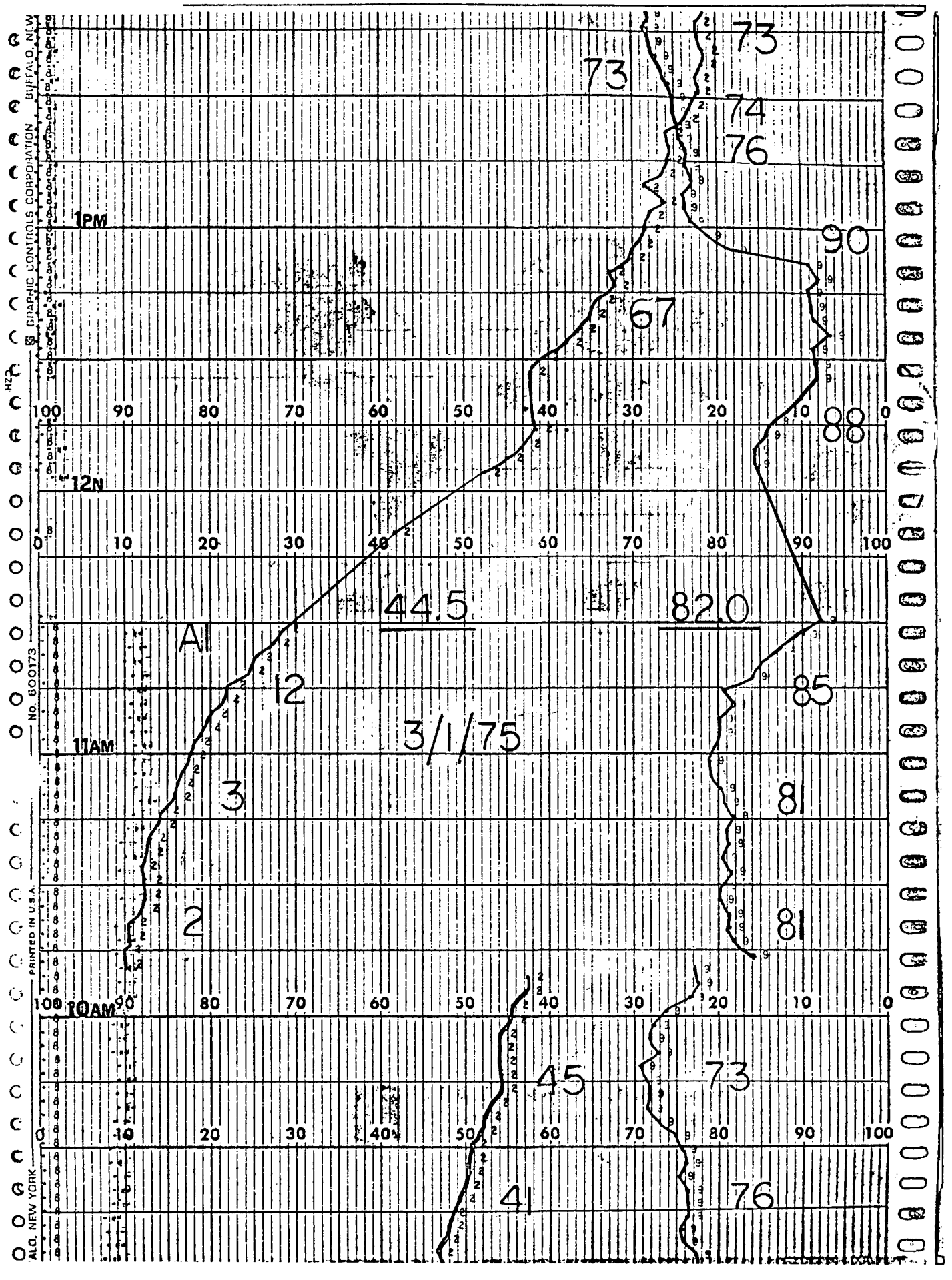
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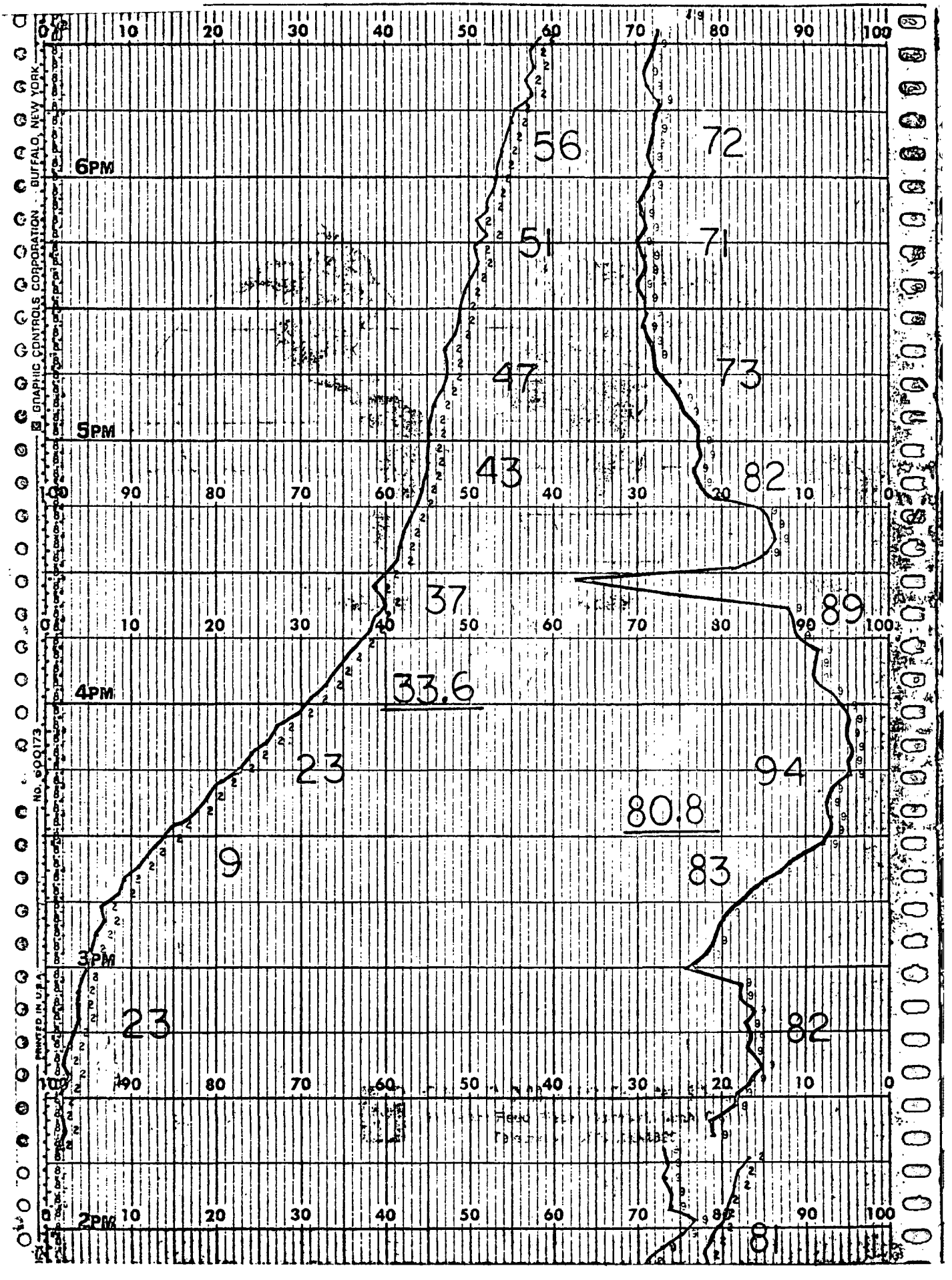
NO. 600173
PRINTED IN U.S.A.
ALO. NEW YORK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No. 600173
PRINTED IN U.S.A.
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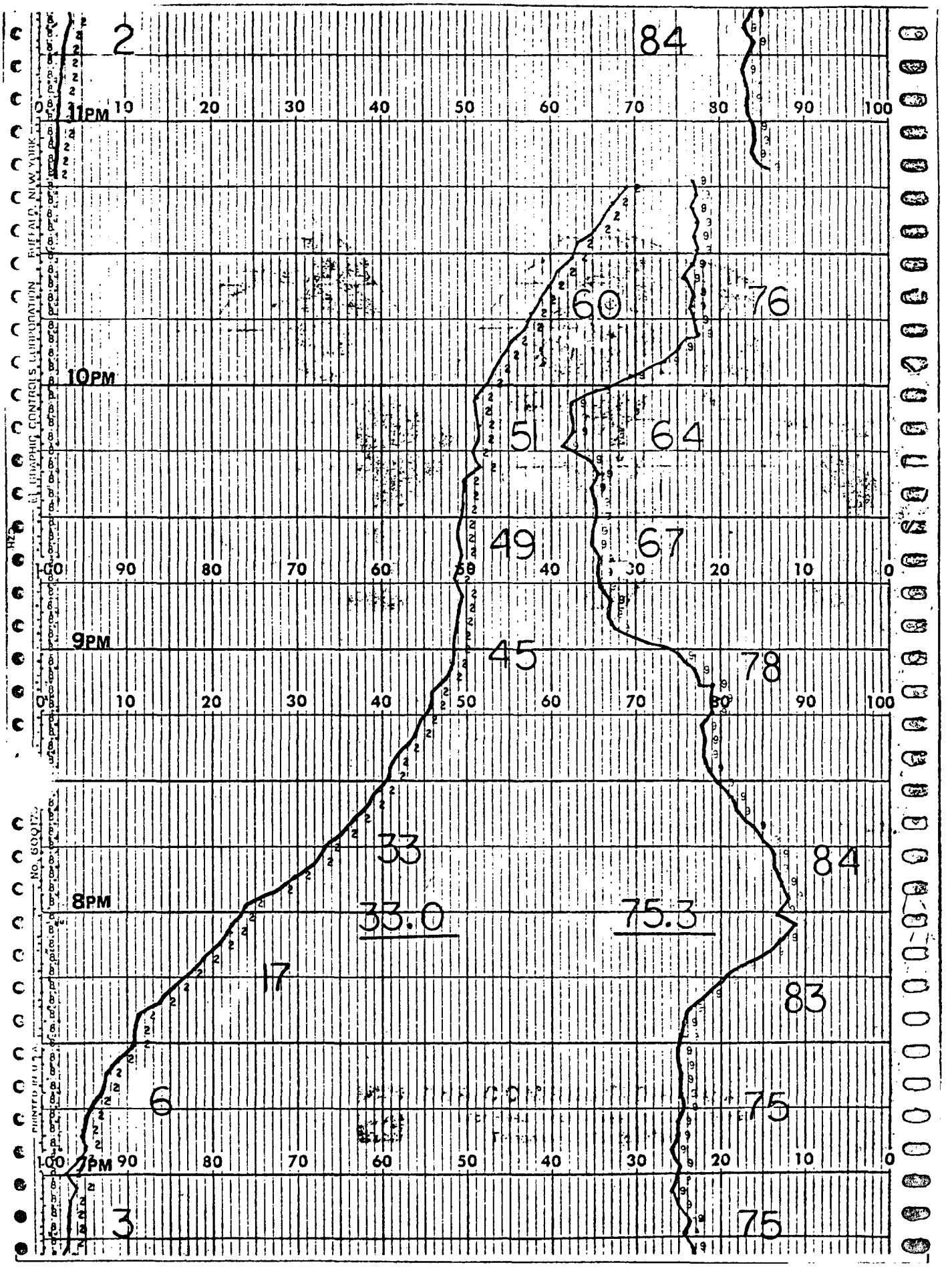
82
81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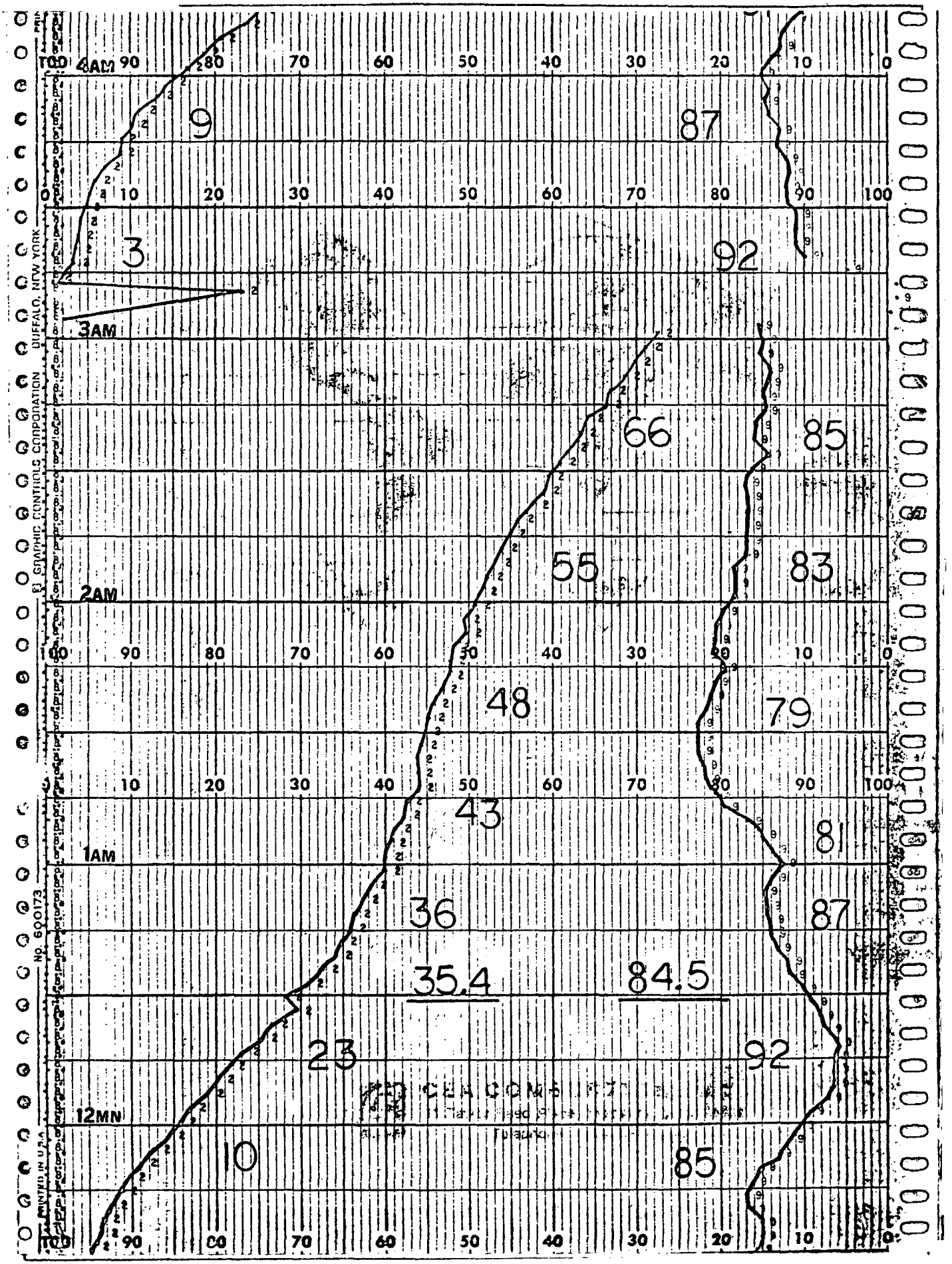
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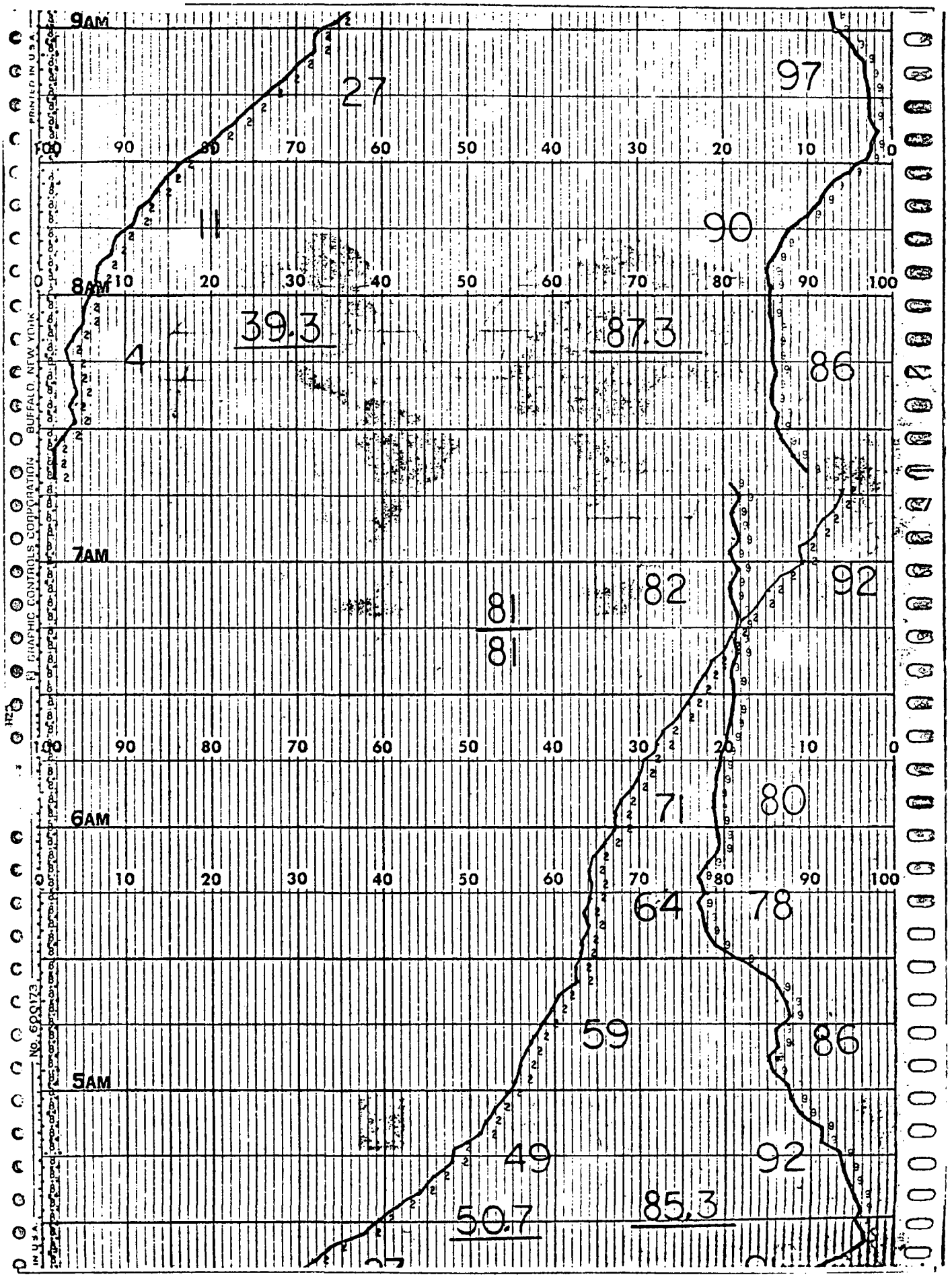
No. 600173
PRINTED IN U.S.A.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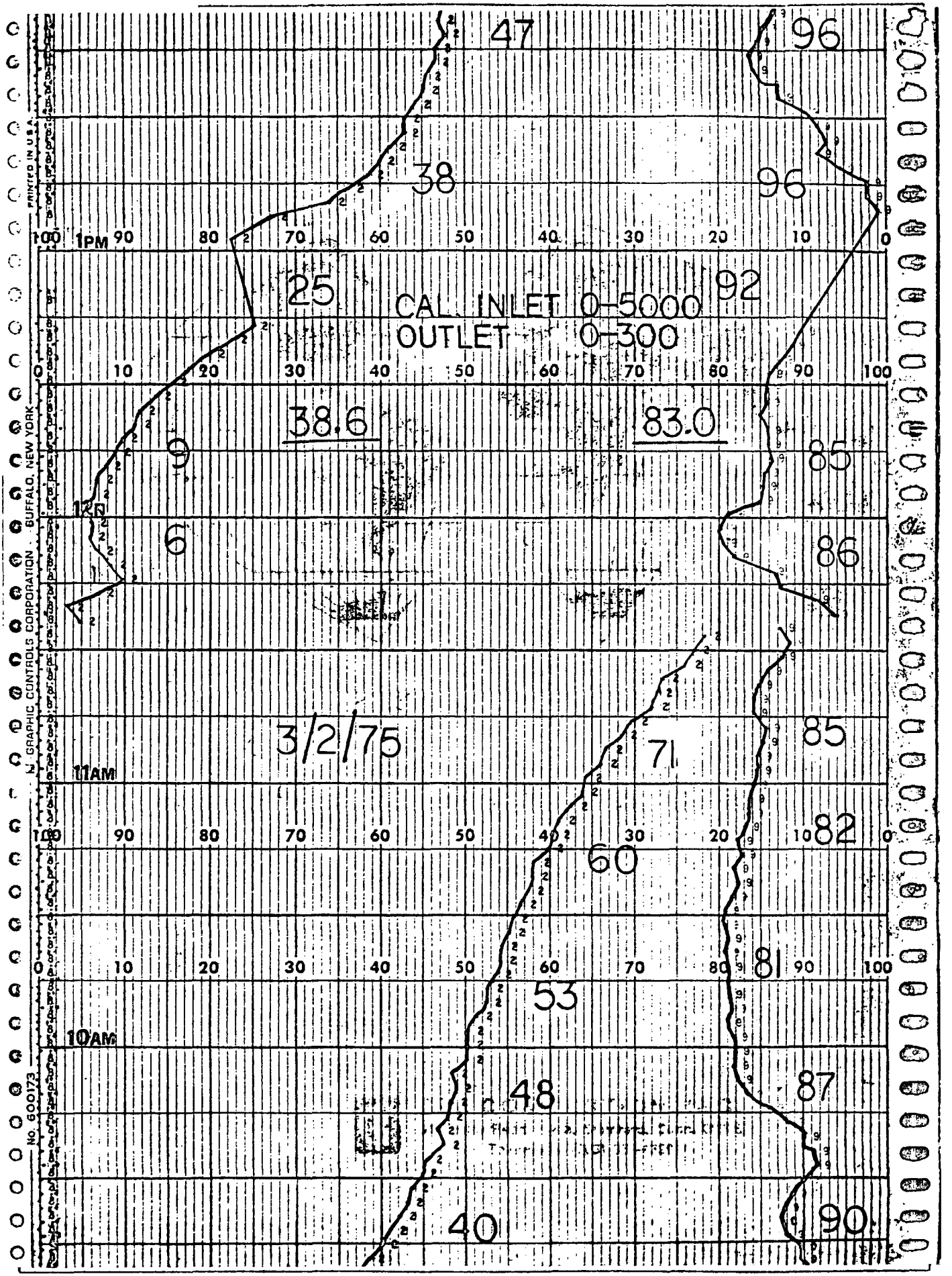
BUFFALO, NEW YORK
GRAPHIC CONTROLS CORPORATION
No. 60173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3/2/75
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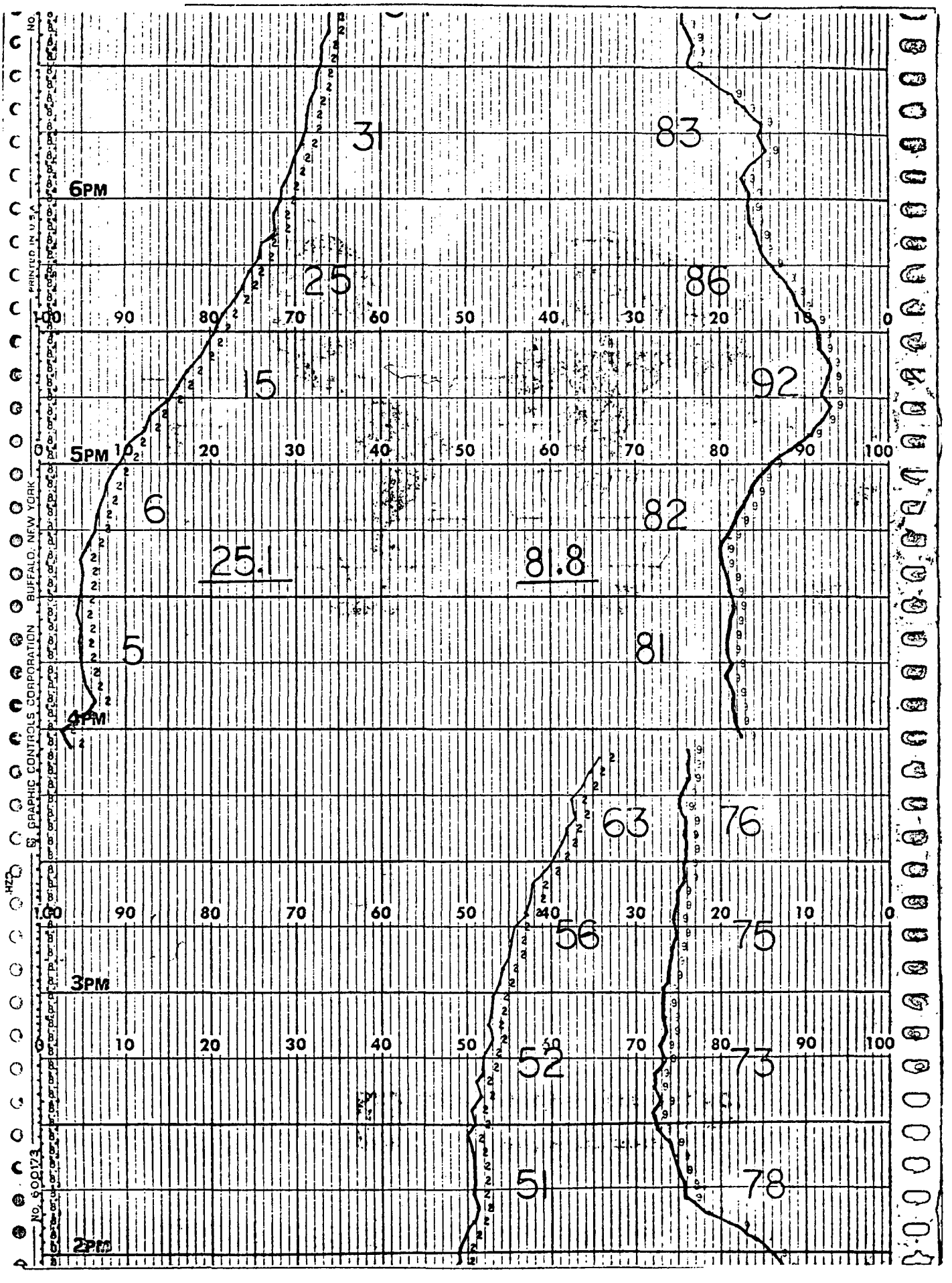
No. 600173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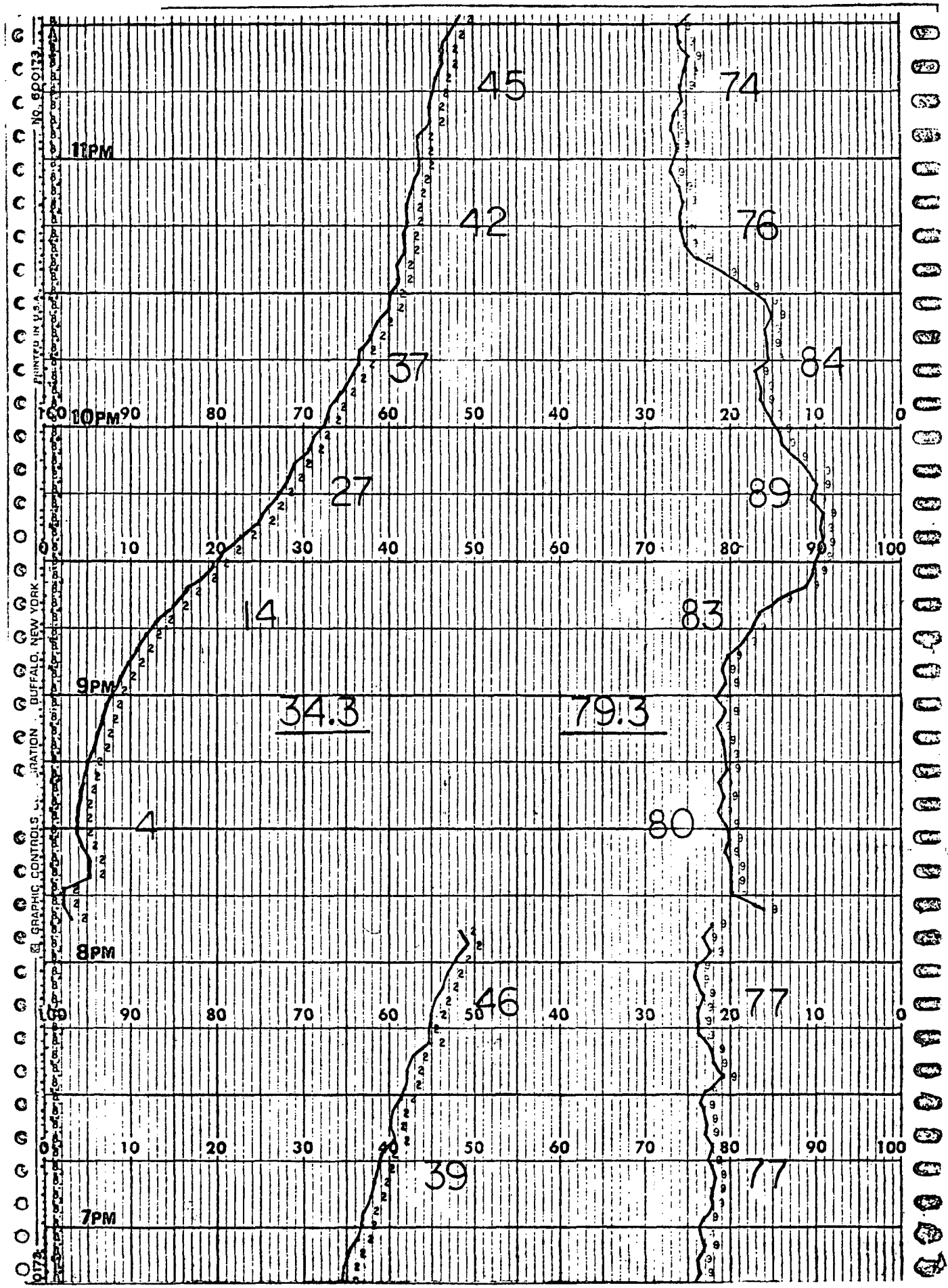
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No. 60173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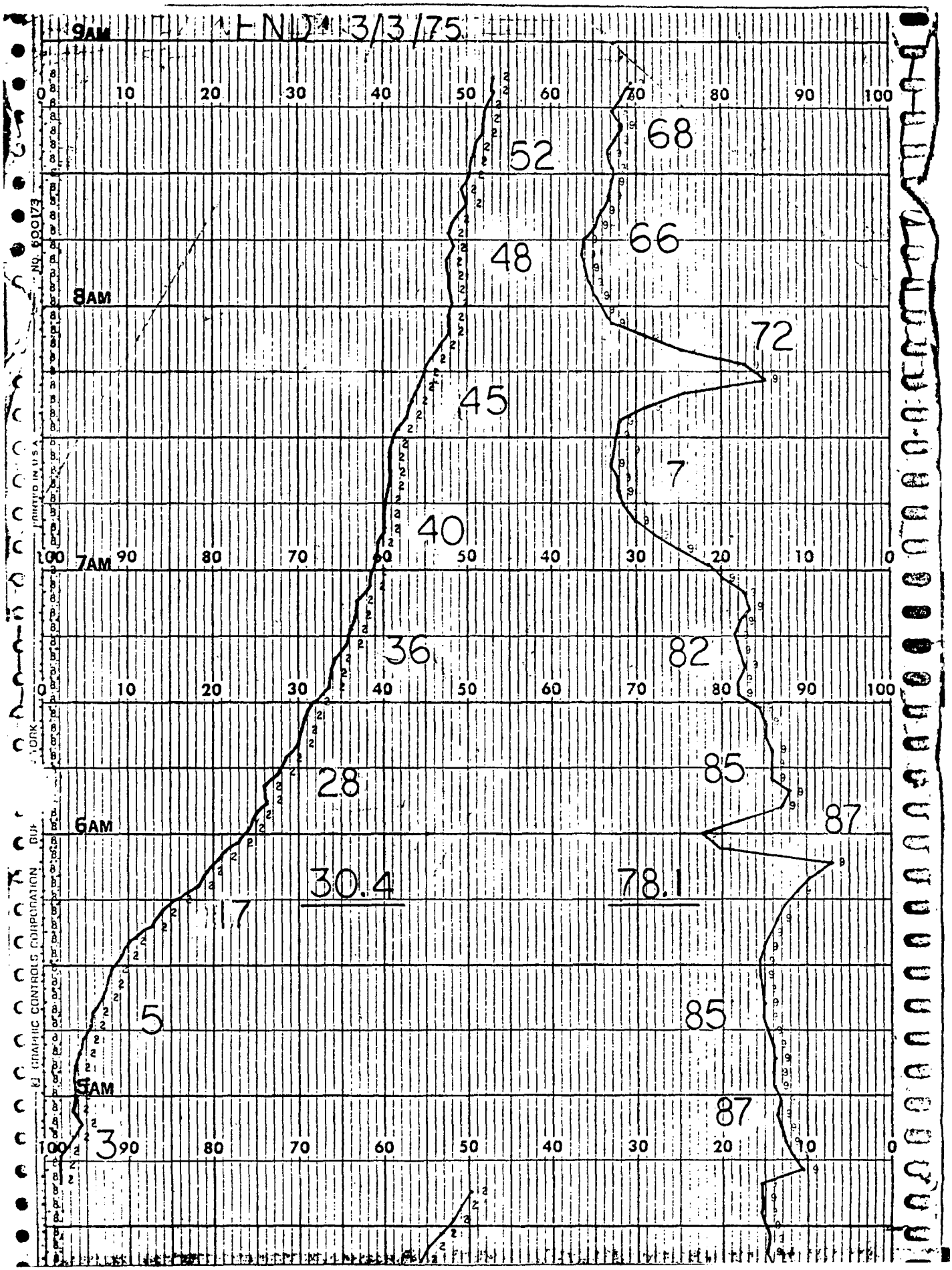
BUFFALO, NEW YORK
PRINTED IN U.S.A.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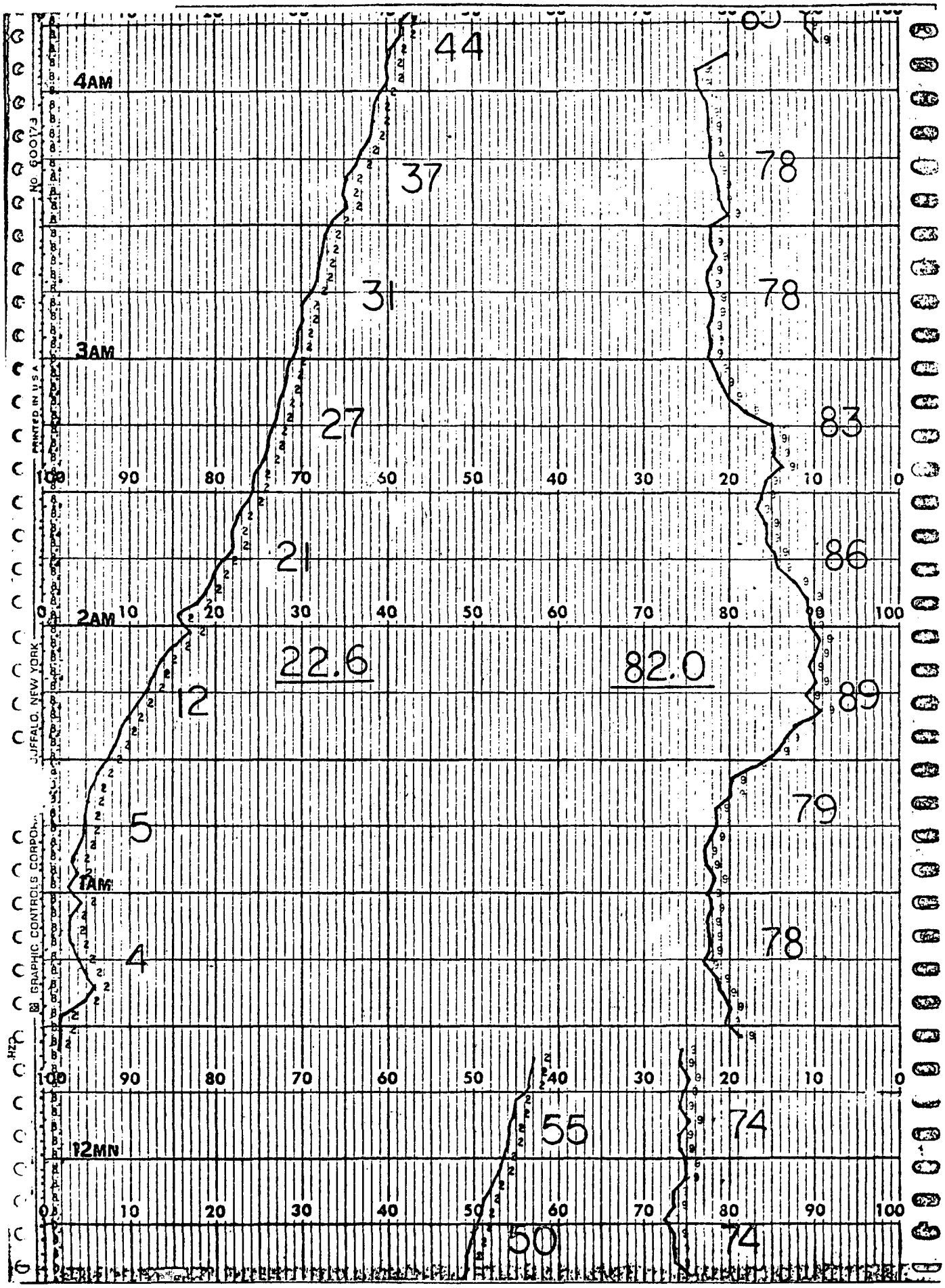
No. 600173
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK PRINTED IN U.S.A.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GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
NO. 60017-3

APPENDIX H

RAW DATA SHEETS - WET TESTS

1) SO_2 Calibration Standards
2) SO_2/Organic Sulfides
3) H_2SO_4 Mist/Organic Sulfides/SO_3
4) Chloride/Total Acid
5) Nitrogen Oxides
6) Moisture
7) Orsat
8) Visible Emissions

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2 PAGE 202

Material Sampled for SO_2

Date 12/3/74

Plant LAB. Location CAL GAS (4320 ppm) TANK VALU

Bar. Pressure 29.65 "Hg Comments:

Ambient Temp. 65

Run No. 31 32 33

Power Stat Setting -

Filter Used: Yes - No -

Operator KRB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1506	326.650	-	65
31			
1523	328.650	-	65
1545	330.675	-	65
32			
1605	332.675	-	65
1630	335.280	-	65
33			
1645	337.280	-	65

Comments:

TEST #	mg SO_2	ppm SO_2
31	558.7	3716
32	584.7	3889 - AVG. = 3847 ppm
33	591.7	3935

Impinger Bucket No.

Meter Box No.

NCAP 36 (12/67)

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_2

Date 2/2/75

Plant COULTON CHEMICAL Location CAL GAS (LOW RANGE)

Bar. Pressure 29.90 "Hg Comments:

Ambient Temp. 35

Run No. 1, 2, 3

Power Stat Setting —

Filter Used: Yes — No —

Operator KB

	CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1	1305	303.497	—	39
	1325	305.497	—	39
2	1415	307.515	—	41
	1435	309.515	—	49
3	1520	311.603	—	39
	1540	313.609	—	39

Comments:

TEST #	mg SO_2	ppm SO_2	
1	34.85	218.3	
2	34.45	218.4	AVG. = 217.6
3	34.85	216.2	

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_2

Date 2/5/75

Plant COULTON CHEMICAL Location CAL GAS (HI RANGE)

Bar. Pressure 29.87 "Hg Comments:

Ambient Temp. 35

Run No. 1, 2, 3

Power Stat Setting —

Filter Used: Yes — No —

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
0930	327.303	—	40
1005	328 303	—	40
1045	331.330	—	41
1120	332 330	—	41
1205	335.362	—	43
1235	336.362	—	43

Comments:

TEST #	mg SO_2	ppm SO_2
1	326.4	4104
2	322.8	4067
3	323.1	4087

Impinger Bucket No.

Meter Box No.

NCAP 36 (12/67)

JOB NO. Y-8479-2

Material Sampled for SO_2

Date 12/5/75

Plant COULTON CHEMICAL Location CAL GAS (MID RANGE)

Bar. Pressure 29.87 "Hg Comments:

Ambient Temp. 40

Run No. 1, 2, 3

Power Stat Setting —

Filter Used: Yes — No —

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1410	339.405	—	48
1430	341.405	—	48
		—	
1520	343.507	—	48
1550	345.507	—	48
1630	347.613	—	48
1700	349.613	—	48

Comments:

TEST #	mg SO_2	ppm SO_2
1	454.0	2900
2	451.6	2885
3	452.9	2893

Impinger Bucket No.

Meter Box No.

NCAP 36 (12/67)

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2

Date 2/12/75

Plant COULTON CHEM Location INLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. 28°

Run No. 1

Power Stat Setting _____

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM °F
1035	6.81	.041	54
1045	7.22	.041	55
1055	7.63	.041	55
1102	7.81	.041	55

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for SO_2

Date 2/12/75

Plant COULTON CHEMICAL Location OUTLET

Bar. Pressure 29.90 "Hg Comments:

Ambient Temp.

Run No. 2

Power Stat Setting —

Filter Used: Yes No J

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1197	9.35		62
1217	11.35		62

Comments:

Impinger Bucket No.

Meter Box No.

NCAR 36 (12/67)

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2

Date 2/12/75

Plant COULTON CHEMICAL Location PURASIV INLET

Bar. Pressure 29.90 "Hg Comments:

Ambient Temp.

Run No. 3

Power Stat Setting

Filter Used: Yes No

Operator KRB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1555	573.460		62
1625	574.460		62

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. 1-8479-2

Material Sampled for SO2 & ORGANIC SULFIDES

Date 2/14/75

Plant COASTAL CHEM Location INLET TRAILER

Bar. Pressure ~~29.90~~ 30.24 "Hg Comments:

Ambient Temp. 30°

Run No. 4 A

Power Stat Setting

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
0914	5.86	.04	52
0950	6.86	.04	54

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for SO_2 & ORGANIC SULFIDES

Date 2/14/74

Plant COULTON CHEMICAL Location INLET DUCT

Bar. Pressure ~~29.90~~ 30.24 "Hg Comments:

Ambient Temp. -30

Run No. 4B

Power Stat Setting 70

Filter Used: Yes ____ No J

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
925	318.800	.05	41
940	219.800	.05	20

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2 & ORGANIC SULFIDES

Date 2/14/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure 30.24 "Hg Comments:

Ambient Temp. 30°

Run No. 5

Power Stat Setting

Filter Used: Yes No —

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
11.34	78.12	0.10	55
1154	80.12	0.10	58

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2 & ORGANIC SULFIDES

Date 2/14/79

Plant COULTON CHEM Location OUTLET

Bar. Pressure 30.24 "Hg Comments:

Ambient Temp. 30

Run No. 6

Power Stat Setting

Filter Used: Yes ____ No —

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1224	2.27	1.0	58
1245	4.27	1.0	58

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_2 & ORGANIC SULFIDES

Date 2/17/75

Plant COULTON CHEMICAL Location INLET

Bar. Pressure 30.00 "Hg Comments:

Ambient Temp. 40

Run No. 7

Power Stat Setting —

Filter Used: Yes ____ No J

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1133	320.900		60
1200	321.900		63

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2 & ORGANIC SULFIDES

Date 2/17/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. 40°

Run No. 8

Power Stat Setting —

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1135	600.10	.06	64
1210	602.10	.06	69

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO₂ ORGANIC - SULFIDES

Date 2/17/75

Plant COULTON CHEMICAL Location INLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. _____

Run No. 9

Power Stat Setting _____

Filter Used: Yes _____ No J

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1320	324.020		69
1350	325.020		69

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_2

Date 2/17/75

Plant COULTON CHEMICAL Location OUTLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. _____

Run No. 10

Power Stat Setting _____

Filter Used: Yes _____ No J

Operator KRB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1340	608.000		62
1410	610.500		64

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_2

Date 2/17/75

Plant COULTON CHEMICAL Location OUTLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. _____

Run No. 11

Power Stat Setting _____

Filter Used: Yes ____ No J

Operator KRB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1435	326.200		72
1505	328.700		72

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2

Date 2/18/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. 40°

Run No. 12

Power Stat Setting _____

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1116	613.160	.13	63
1131	615.160	.13	65

Comments: 135

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for SO_2

Date 2/18/75

Plant COULTON CHEMICAL Location INLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. _____

Run No. 13

Power Stat Setting _____

Filter Used: Yes ____ No ✓

Operator KB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1110	331.540		64
1130	332.540		64

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for H2SO4 - MIST, ORGANIC SULFIDES 23

Date 2/20/75

Plant COULTON CHEMICAL Location PURASIV INLET

Bar. Pressure 29.70 "Hg Comments:

Ambient Temp. -35

Run No. 1

Power Stat Setting 60%

Filter Used: Yes ✓ No. #C983

Operator KRB

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1105	339.100	.05	42
1117	339.55	.05	41
1200	341.100	.05	44

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for [redacted], [redacted], H_2SO_4 & ORGANIC SULFIDES 72, 73

Date 2/20/73

Plant COULTON CHEM Location PORASIV INLET

Bar. Pressure _____ "Hg Comments:

Ambient Temp. _____

Run No. 2 & 3

Power Stat Setting _____

Filter Used: Yes ✓ No # 47-C287

Operator _____

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1230	341.500	.05	40
1335	344.830	.05	43
1420	345.000	.05	40
1500	347.000	.05	44

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for H_2SO_4 - ORGANIC SULFIDES

Date 2/12/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure 29.50 "Hg Comments: 7.6

Ambient Temp. 42

Run No. 4

Power Stat Setting 70

Filter Used: Yes ✓ No# 47-D131

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1022	347.015	.04	55
1012	349.015	.04	65

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for H_2SO_4, ORGANIC SULFIDES

Date 2/21/75

Plant Coulton Chemical Location OUTLET

Bar. Pressure 29.90 "Hg Comments: 77

Ambient Temp. 45

Run No. 5

Power Stat Setting 70

Filter Used: Yes ✓ No # 47-098

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1128	649.020	.05	70
1115	651.020	.05	58

Comments: PURGE 629.35

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 9-8479-2

Material Sampled for H_2SO_4, ORGANIC SULFIDES

Date 2/21/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure 29.50 "Hg Comments: 78

Ambient Temp. 45

Run No. 6

Power Stat Setting 70

Filter Used: Yes ✓ No #42-C 130

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1225	351.020	.04	57
1315	353.020	.04	57

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8475-2

Material Sampled for SO_3, ACID MIST

Date 2/26/75

Plant COULTON CHEM Location INLET

Bar. Pressure 29.90 "Hg Comments:

79, 80

Ambient Temp. 20°

Run No. 1 & 2

Power Stat Setting

Filter Used: Yes ~~—~~ No #47 DIST

Operator

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1117	353.100		38
1212	353.800		50
1315	356.533		48
1335	367.155		53

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for H_2SO_4 MIST, SO_3

Date 2/27/75

Plant COULTON CHEMICAL Location INLET

Bar. Pressure _____ "Hg Comments: 81

Ambient Temp. 30

Run No. 3

Power Stat Setting _____

Filter Used: Yes J No _____

Operator _____

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1032	362.000		30
1110	365.000		37

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for SO_2, Acid Mist

Date 2/26/75

Plant COULTON CHEM Location OUTLET

Bar. Pressure 29.90 "Hg Comments: 82

Ambient Temp. 35

Run No. 1

Power Stat Setting 65

Filter Used: Yes ✓ No # 47-086

Operator JF, RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1120	111.045	.04	35
1210	113.045	.04	48

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for SO_3, ACID MIST

Date 2/26/75

Plant Coulter Chemical Location OUTLET

Bar. Pressure 29.90 "Hg Comments: 83

Ambient Temp. 35

Run No. 2 FILTER

Power Stat Setting 65 47-C238.

Filter Used: Yes ✓ No

Operator SF + RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1325	113.070	.04	42
1455	116.550	.04	55

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. 8479-2 PAGE 229

Material Sampled for H_2SO_4, SO_3

Date Feb 27 1975

Plant Coulter Location outlet

Bar. Pressure 29.92 "Hg Comments:

Ambient Temp. 18-

Run No. 3

Power Stat Setting 65

Filter Used: Yes ✓ No

Operator RLH, JF

24

47-D118

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1030	115.5-60		26
1130	116.975		30

Comments:

Impinger Bucket No.

Meter Box No.

NCAR 36 (12/67)

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for MINERAL ACIDS, HALOGENS

Date 2/6/75

Plant COULTON CHEM. Location INLET

Bar. Pressure 29.67 "Hg Comments:

Ambient Temp. 30

Run No. 1

Power Stat Setting

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
0927	16.00	1.17	49
1021	76.00	1.17	53

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8475-2

Material Sampled for MINERAL ACIDS - HALOGENS

Date 2/6/75

Plant COULTER CHEM Location INLET

Bar. Pressure 29.60 "Hg Comments:

Ambient Temp. 30

Run No. 2

Power Stat Setting —

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1030	576.20	1.20	46
1100	636.20	1.20	60

Comments:

Impinger Bucket No. _____

Meter Box No. _____

NCAR 36 (12/67)

GAS SAMPLING FIELD DATA

JOB NO. 847-2

Material Sampled for MINERAL ACIDS, HALOGENS

Date 2/6/75

Plant CRYSTAL CHEM Location INLET

Bar. Pressure 29.60 "Hg Comments:

Ambient Temp. 30

Run No. 3

Power Stat Setting —

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1110	636.40	1.7	44
1205	696.40	1.7	76

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for MINERAL ACIDS, HALOGENS

Date 2/6/75

Plant COULTON CHEMICAL Location PURASIV OUTLET

Bar. Pressure 29.60 "Hg Comments:

Ambient Temp. 35

Run No. 1

Power Stat Setting —

Filter Used: Yes ____ No J

Operator ____

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
0915	382.685	1.0	48
1004	443.802	1.0	50

Comments:

Impinger Bucket No. ____

Meter Box No. ____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for MINERAL ACIDS, HALOGENS

Date 2·6·75

Plant COULTON CHEMICAL Location OUTLET

Bar. Pressure 29.60 "Hg Comments:

Ambient Temp. 30

Run No. 2

Power Stat Setting —

Filter Used: Yes ____ No X

Operator EK

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1010	3.802	1.6	48
1045	65.802	1.6	52

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 8479-2

Material Sampled for MINERAL ACIDS, HALOGENS

Date 2·6·75

Plant COULTON CHEMICAL Location OUTLET

Bar. Pressure 29.60 "Hg Comments:

Ambient Temp. 30

Run No. 3

Power Stat Setting ——

Filter Used: Yes ____ No X

Operator GVK

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1058	5.60	1.6	48
1135	65.65	1.6	53

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. 4-8475-2

Material Sampled for HALOGENS, MINERAL ACIDS

Date 2/24/75

Plant COULTON CHEM Location WLET #1

Bar. Pressure 29.85 "Hg Comments:

Ambient Temp. 38

Run No. 1

Power Stat Setting

Filter Used: Yes No —

Operator

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1452	651.910		40°
1550	711.910		40°

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for Halogens + Mineral Acids

Date Feb 25, 1975

Plant Conoco Chemical Location INLET

Bar. Pressure 29.80 "Hg Comments:

Ambient Temp. 35

Run No. 2

Power Stat Setting

Filter Used: Yes ✓ No

Operator KB, A.S.

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1040	718.600		40
1140	827.540		45

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

Material Sampled for Halogens + Mineral Acids

Date Feb 25, 1975

Plant Coulton Chemical Location Inlet

Bar. Pressure 29.80 "Hg Comments:

Ambient Temp. 35

Run No. 3

Power Stat Setting

Filter Used: Yes ✓ No

Operator KB + AS

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1150	827.930		41
1250	967.550		44

Comments:

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. 4-8479-2

Material Sampled for HALOGENS, MINERAL ACIDS

Date 2/24/75

Plant COOLING TOWER Location OUTLET

Bar. Pressure 29.85 "Hg Comments:

Ambient Temp. 38

Run No. 1

Power Stat Setting

Filter Used: Yes ____ No ✓

Operator RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1452	712.627	1.0CFM	49
1550	772.780	1.0CFM	62

Comments:

Impinger Bucket No. _____

Meter Box No. _____

GAS SAMPLING FIELD DATA

JOB NO. Y-8479-2

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Material Sampled for HALOGENS + MINERAL ACIDS

Date Feb 25, 1975

Plant Coulton Chemical Location OUTLET

Bar. Pressure 29.90 "Hg Comments:

Ambient Temp. 35

Run No. 2

Power Stat Setting

Filter Used: Yes ✓ No

Operator RLM, JF

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1040	772.880	1.0	38
1140	832.940	1.0	54

Comments:
2 354

Impinger Bucket No.

Meter Box No.

GAS SAMPLING FIELD DATA

JOB NO. Y-9421-2

Material Sampled for Halogen + Mineral Acids

Date Feb 25 1975

Plant Coulter Chemical Location Butte

Bar. Pressure 29.9 "Hg Comments:

Ambient Temp. 50

Run No. 3

Power Stat Setting

Filter Used: Yes ✓ No

Operator JF + RLM

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFM)	METER TEMPERATURE TM
1153	833.294	1.0	39
1250	893.853	1.0	54

Comments:

Impinger Bucket No.

Meter Box No.

OXIDES OF NITROGEN FIELD DATA

Job No. 8479-3

Client EPA

Plant Location COULTON CHEMICAL

Unit No. INLET TO PURASIV

Sampling Location INLET

Operator

53 54 50 55 52 51

Run Number	1	2	3	4	5	6
Date	2/6	2/6	2/6	2/6	2/6	2/6
Flask Number	22	10	58	25	46	8
Flask Volume Corrected (liters) (V_f)	2.088	2.040	2.017	2.075	2.082	2.014
Initial Flask Vacuum (in.Hg) (Pi)	24.9	25.1	24.9	24.8	25.6	25.0
Final Flask Vacuum (in.Hg) (P_f	-1.4	-1.3	1.0	-.9	-.2	.2
Flask Temperature (T_f)	40	40	40	40	40	40
% O_2						

OXIDES OF NITROGEN FIELD DATA

Job No. 8479-2

Client EPA

Plant Location COULTON CHEMICAL

Unit No. OUTLET TO PURASIV

Sampling Location OUTLET

Operator OK

	56	57	—	58	59	60
Run Number	1	2	3	4	5	6
Date	2/6	2/6	2/6	2/6	2/6	2/6
Flask Number	24	18	33	32	28	27
Flask Volume Corrected (liters) (V_f)	2.057	2.079	2.059	2.046	2.088	2.107
Initial Flask Vacuum (in.Hg) (Pi)	24	24.5	NG	24.9	25	25
Final Flask Vacuum (in.Hg) (P_f	-.6	-.2		-.8	-.1	-.3
Flask Temperature (T_f)	40	40		40	40	40
% O_2	6.0	6.0		6.0	6.0	6.0

OXIDES OF NITROGEN FIELD DATA

Job No. 4-8479-2

Client EPA

Plant Location COULTON CHEM

Unit No. PURASIV

Sampling Location INLET

Operator K.B.

	~~1~~	61	62	63	64	65
Run Number	1B	2B	3B	4B	5B	6B
Date	2/25-	2/25-	2/25	2/25-	2/25-	2/25-
Flask Number	46	28	10	58	8	22
Flask Volume Corrected (liters) (V_f)	2.082	2.058	2.040	2.017	2.014	2.088
Initial Flask Vacuum (in.Hg) (Pi)	23	23.1	23.3	23.3	23.2	23.4
Final Flask Vacuum (in.Hg) (Pf	X	1.0	1.3	0	1.8	0
Flask Temperature (T_f)	40	40	40	40	40	40
% O_2						

OXIDES OF NITROGEN FIELD DATA

Job No. 4-8479-2

Client EPA

Plant Location COULTON CHEM.

Unit No. PURASIV

Sampling Location OUTLET

Operator RLM, J. F.

	66	67	68	69	70	71
Run Number	1B	2B	3B	4B	5B	6B
Date	2/25	2/25	2/25	2/25	2/25	2/25
Flask Number	25	33	24	27	32	18
Flask Volume Corrected (liters) (V_f)	2.025	2.030	2.057	2.107	2.046	2.079
Initial Flask Vacuum (in.Hg) (Pi)	24.8	25.4	25.0	24.6	24.6	24.9
Final Flask Vacuum (in.Hg) (Pf	2.5	1.9	0	2.0	2.8	2.3
Flask Temperature (T_f)	40	40	40	40	40	40
% O_2						

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. 4-8479-2

DATE - 2/12/75

TIME - 0930 - 1105

INLET READING - .210

OUTLET READING - .195

INLET DEW POINT - 56 °C

OUTLET DEW POINT - 65 °C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 5 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. Y-8479-2

DATE - 2/14/75

TIME - 1450 - 1535

INLET READING - .212

OUTLET READING - .180

INLET DEW POINT - 55°C

OUTLET DEW POINT - 66°C

INLET MOISTURE - 20 ppm

OUTLET MOISTURE - 4 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. 4-8479-2

DATE - 2/15/75

TIME - 1005-1120

INLET READING - .200

OUTLET READING - .175

INLET DEW POINT - 58° C

OUTLET DEW POINT - 68 °C

INLET MOISTURE - 15 ppm

OUTLET MOISTURE - 3 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. 4-8479-2

DATE - 2/16/75

TIME - 0915-1055

INLET READING - .215

OUTLET READING - .195

INLET DEW POINT - 54°C

OUTLET DEW POINT - 65°C

INLET MOISTURE - 22 ppm

OUTLET MOISTURE - 5 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. Y-8479-2

DATE - 2/17/75

TIME - 1325 - 1445

INLET READING - .210

OUTLET READING - .180

INLET DEW POINT - 56°C

OUTLET DEW POINT - 66°C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 4 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. Y-8479-2

DATE - 2/18/75

TIME - 1445-1520

INLET READING - .210

OUTLET READING - .180

INLET DEW POINT - 56 °C

OUTLET DEW POINT - 66 °C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 4 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. 4-8479-2

DATE - 2/19/75

TIME - 0830-1000

INLET READING - .210

OUTLET READING - .180

INLET DEW POINT - 56°C

OUTLET DEW POINT - 66°C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 4 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. Y-8479-2

DATE - 2/20/75

TIME - 0925-1050

INLET READING - .210

OUTLET READING - .195

INLET DEW POINT - 56°C

OUTLET DEW POINT - 65°C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 5 ppm

MOISTURE FIELD DATA SHEET - HYGROMETER

JOB NO. Y-8479-2

DATE - 2/21/75

TIME - 0820 - 0955

INLET READING - .210

OUTLET READING - .195

INLET DEW POINT - 56°C

OUTLET DEW POINT - 65°C

INLET MOISTURE - 18 ppm

OUTLET MOISTURE - 5 ppm

JOB NO. Y-84792

ORSAT FIELD DATA

Location INLET - OUTLET Comments:

Date 2/3/75

Time 1530

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	3.5	7.8	0.0
OUTLET	2.9	6.0	0.0

JOB NO. Y-8479-2 ORSAT FIELD DATA

Location INLET-OUTLET Comments:

Date 2/6

Time 1100

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	2.7	5.2	0.0
OUTLET	2.8	5.2	0.0

JOB NO. Y-8479-2 ORSAT FIELD DATA

Location INLET-OUTLET Comments:

Date 2/6/75

Time 1200

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	2.2	5.6	0.0
OUTLET	2.2	7.2	0.0

JOB NO. 4-8479-2 ORSAT FIELD DATA

Location INLET-OUTLET Comments:

Date 2/24/75

Time 1030

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	4.7	5.3	0.0
OUTLET	4.8	5.6	0.0

JOB NO. Y-8479-2 ORSAT FIELD DATA

Location INLET-OUTLET Comments:

Date 2/24/75

Time 1120

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	4.8	5.8	0.0
OUTLET	4.3	5.7	0.0

JOB NO. Y-8479-2 ORSAT FIELD DATA

Location INLET-OUTLET Comments:

Date 2/27/75

Time 1300

Operator JF

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
INLET	3.8	4.4	0.0
OUTLET	3.9	4.5	0.0

REPORT NO. Y-8479-2

VISUAL EMISSIONS

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Outlet & INLET

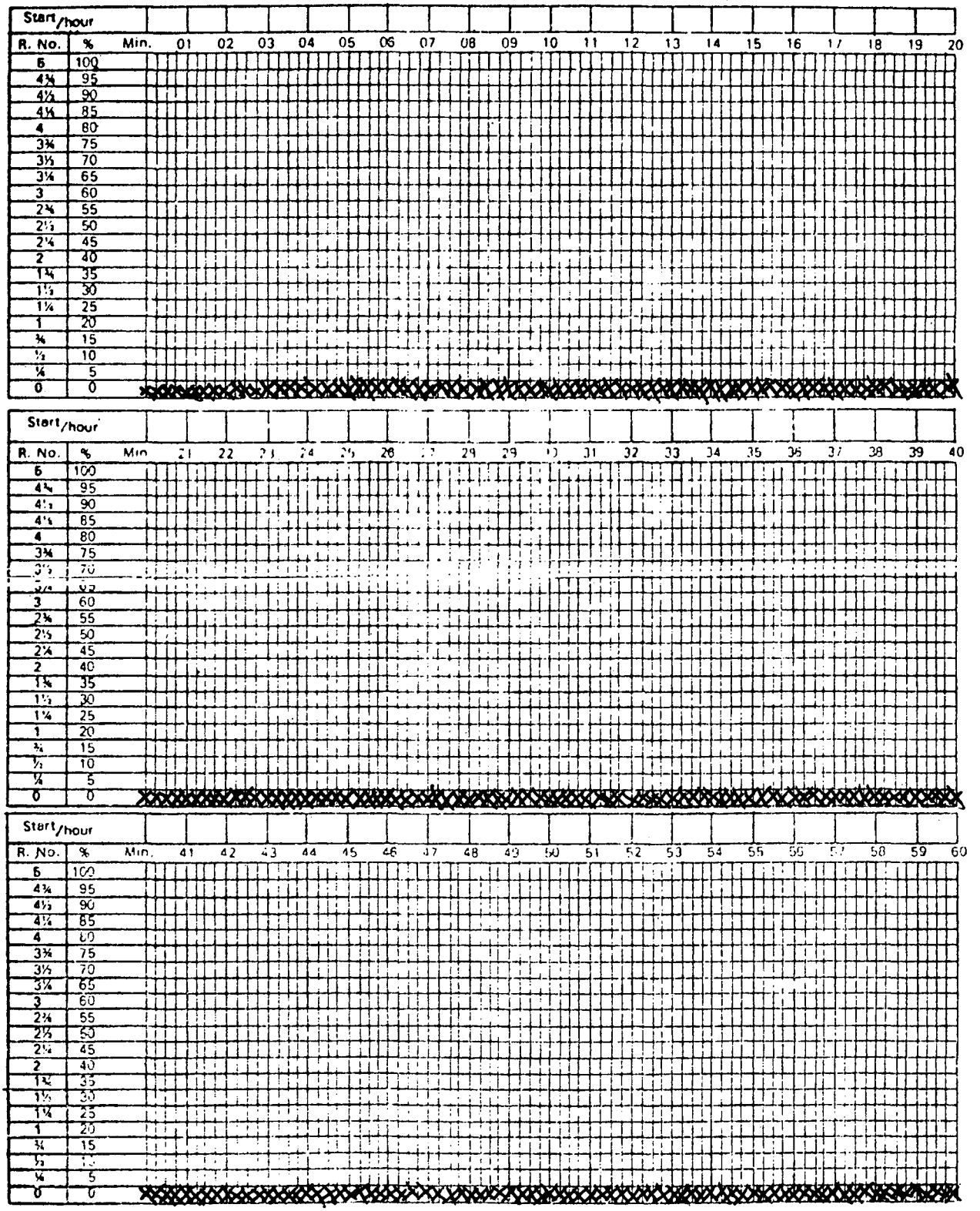
ENVIRONMENTAL PROTECTION AGENCY

RECORD OF VISIBLE EMISSIONS

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, OH10

TIME OF OBSERVATION: FROM 11:20 A.M. P.M. TO 12:20 A.M. P.M. DATE Feb 5



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Coulton Chemical (H_2SO_4 production)

Type of Air Contaminants SO_2, SO_3 & Acid mist

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet _____

Height of Point of Discharge Above Ground Level, feet 60 FT.

Background Description Gray overcast sky it's also snowing

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other Snowing

Wind Direction North Wind Velocity, mi/hr 3-5

Plume Description:

Detached: Yes ☐ No ☒

Color: Black ☐ White ☐ Other None

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐
Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments Reading very difficult due to the weather conditions: including sky color & steam production located very near stack.

Signed Alan Sutherland Title Smoke Reader
Environmental Engineer

REPORT NO. Y-8479-2

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INLET & OUTLET

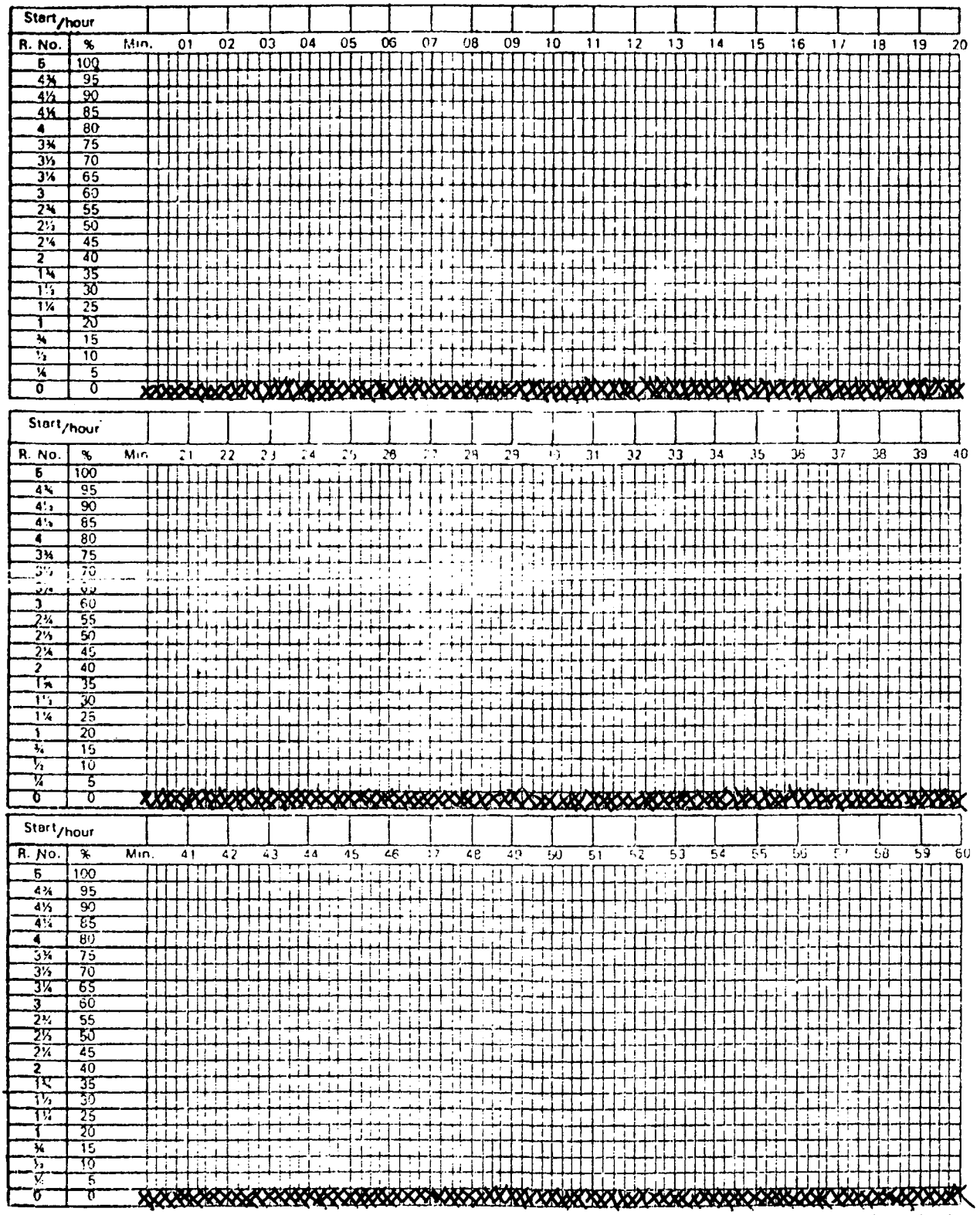
ENVIRONMENTAL PROTECTION AGENCY

RECORD OF VISIBLE EMISSIONS

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, OHIO

TIME OF OBSERVATION: FROM 2:15 A.M. P.M. TO 3:15 A.M. P.M. DATE Feb 5



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REPORT NO. Y-8479-2

Outlet
&
INLET

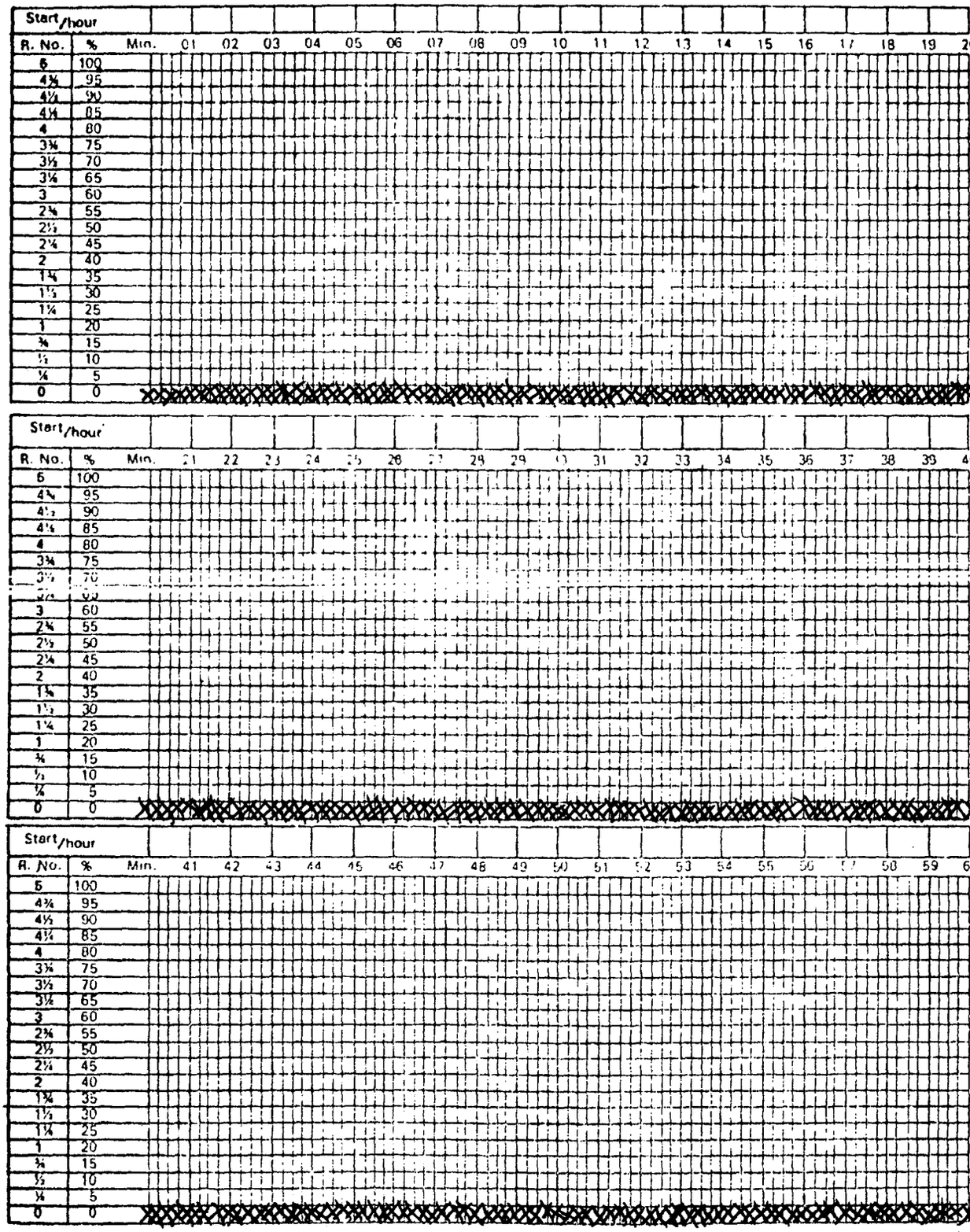
ENVIRONMENTAL PROTECTION AGENCY

RECORD OF
VISIBLE EMISSIONS

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 9:30 A.M. P.M. TO 10:30 A.M. P.M. DATE Feb. 6



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements

Source of Air Contaminants Coulton Chemical (H_2SO_4 Plant) Inlet & Outlet

Type of Air Contaminants SO_2 SO_3 Acid mist

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet _____

Height of Point of Discharge Above Ground Level, feet 60 FT

Background Description Grey Sky

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other Snowing

Wind Direction South Wind Velocity, mi/hr 3-5

Plume Description:

Detached: Yes ☐ No ☒

Color: Black ☐ White ☐ Other None

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐
Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments Reading very difficult due to the sky color and snowing, there was also steam from a nearby exhaust covering the stack at times.

Signed Alan Sutherland Title Env. Engineer
Smoke Reader

ENVIRONMENTAL PROTECTION AGENCY

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 11:00 A.M. P.M. TO 12:30 A.M. P.M. DATE Feb 6

RECORD OF VISIBLE EMISSIONS

Start/hour

R. No.	%	Min. 01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
5	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

Start/hour

R. No.	%	Min. 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
5	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

Start/hour

R. No.	%	Min. 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
5	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Coulton Chemical (H_2SO_4 Plant)

Type of Air Contaminants SO_2, SO_2 Acid mist

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet 180 Ft

Height of Point of Discharge Above Ground Level, feet 60 FT

Background Description Grey Sky

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other Snowing

Wind Direction South Wind Velocity, mi/hr 3-5

Plume Description:

Detached: Yes ☐ No ☒

Color: Black ☐ White ☐ Other NONE

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments Readings very difficult due to poor background of steam at times covering stack.

Signed Alan Sutherland Title Env. Engineer

Smoke Reader

REPORT NO. Y-8479-2

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Outlet & INLET

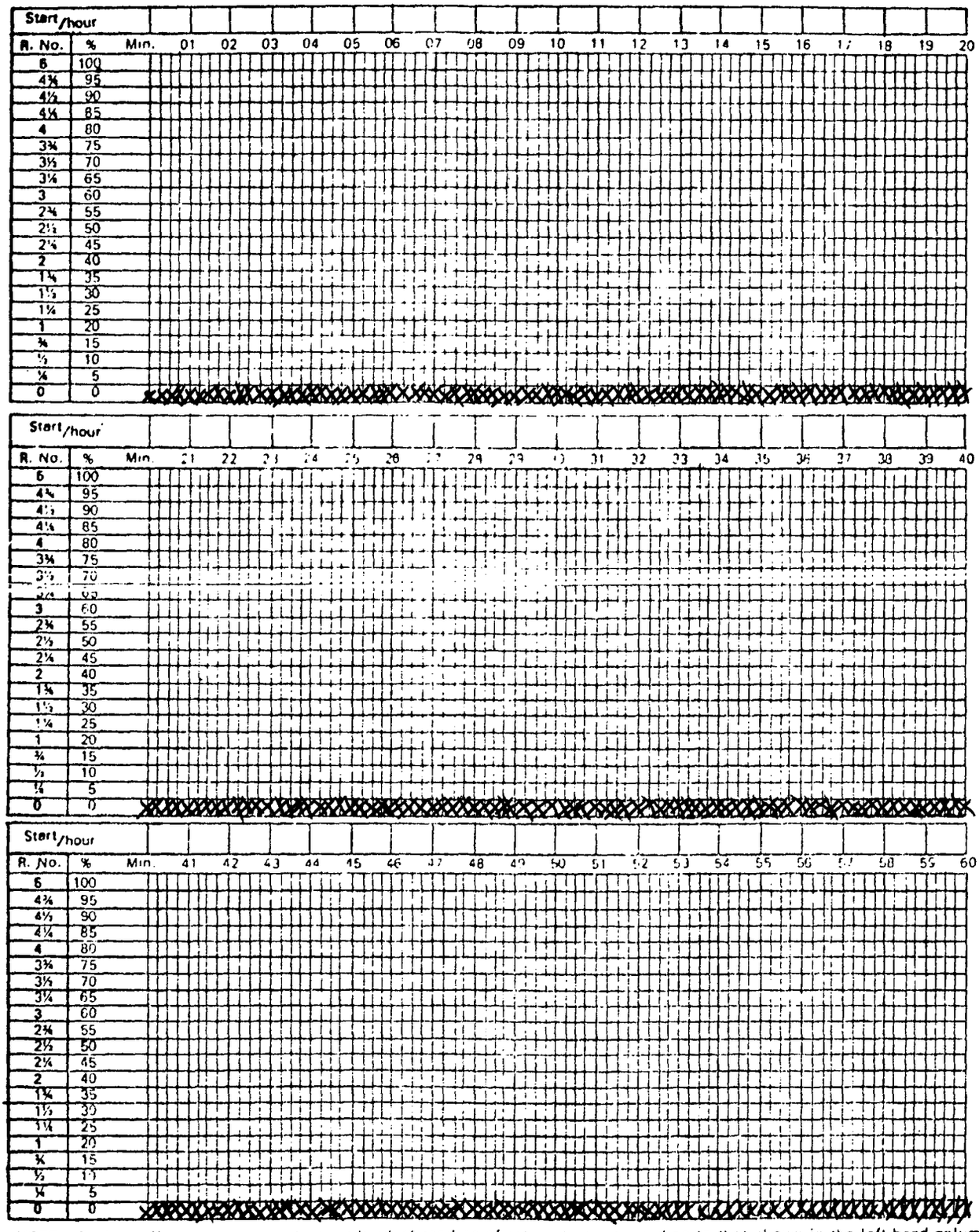
ENVIRONMENTAL PROTECTION AGENCY

RECORD OF VISIBLE EMISSIONS

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 1:15 A.M. P.M. TO 2:15 A.M. P.M. DATE Feb 6



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Coalton CHEMICAL (H_2SO_4 plant) INLET & OUTLET

Type of Air Contaminants SO_2 SO_3 Acid mist

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet 180 Ft.

Height of Point of Discharge Above Ground Level, feet 60 FT

Background Description GREY SKY

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other SNOWY

Wind Direction SOUTH Wind Velocity, mi/hr 3-5

Plume Description:

Detached: Yes ☐ No ☒

Color: Black ☐ White ☐ Other NONE

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments READING VERY difficult due to poor background & steam at times covering stack

Signed Alan Sutherland Title ENV. ENGINEER SMOKE READER

REPORT NO. Y-8479-2

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ENVIRONMENTAL PROTECTION AGENCY

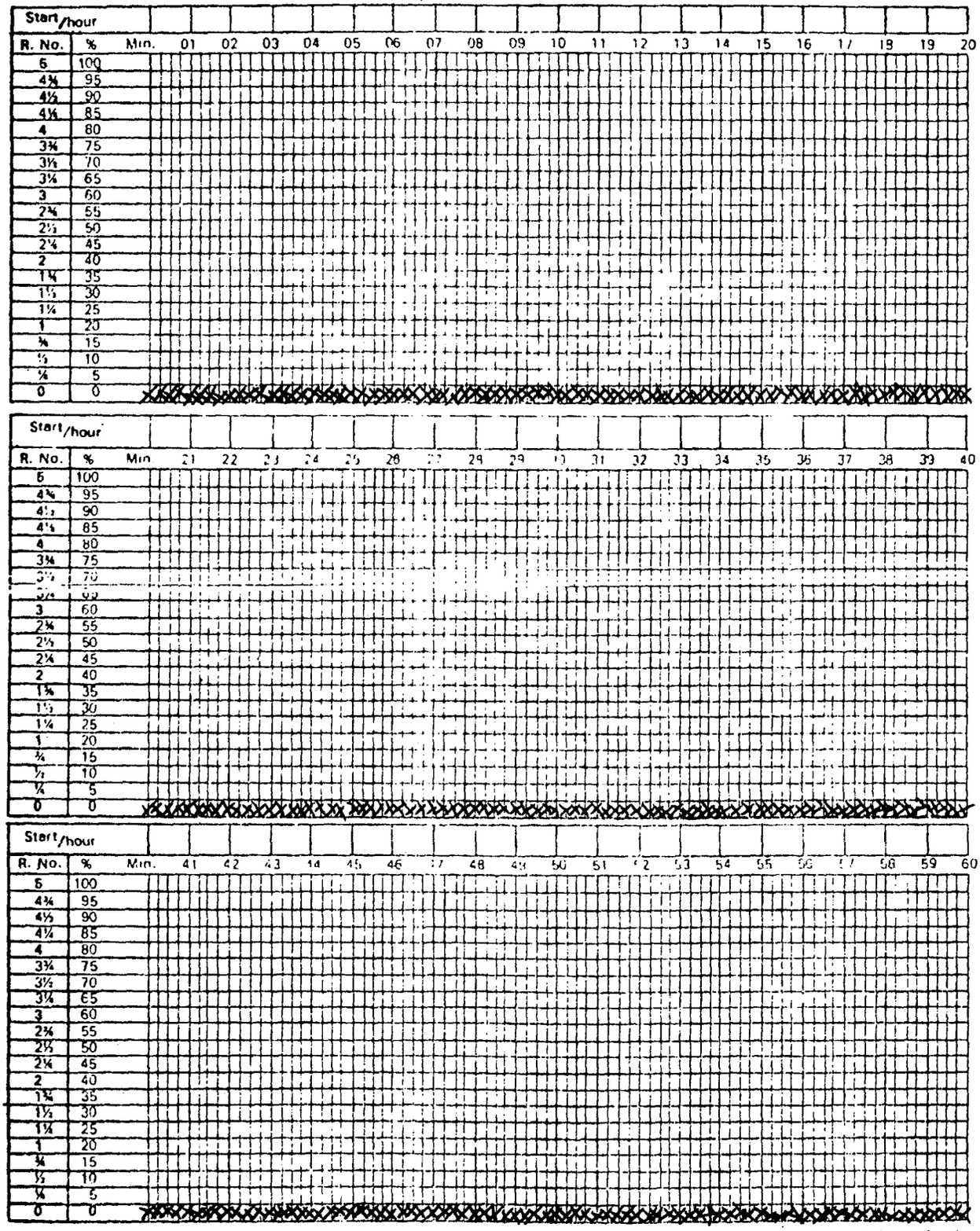
Inlet
&
Outlet

RECORD OF VISIBLE EMISSIONS

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 9:00 A.M. P.M. TO 10:00 A.M. P.M. DATE Feb 7



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an 'S' in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the 'S', insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Inlet & outlet

Source of Air Contaminants Carlton Chemical (H_2SO_4 plant)

Type of Air Contaminants SO_2 SO_3 Acid mist

Point of Discharge: Stack ☒ Other ____

Point of Observation:

Distance to Base of Point of Discharge, feet 180 ft.

Height of Point of Discharge Above Ground Level, feet 60 Ft.

Background Description Blue sky

Weather: Clear ☐ Overcast ☐ Partly Cloudy ☒ Other ____

Wind Direction Southwest Wind Velocity, mi/hr 10-12

Plume Description:

Detached: Yes ☐ No ☐

Color: Black ☐ White ☐ Other Dark

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) ____ (Minimum) ____

Comments Readings at times impossible since steam completely covered stack for 5 min. at a time. In these cases I just marked it as V.

Signed Allen Sutherland Title Env. Engineer Smoke Reader

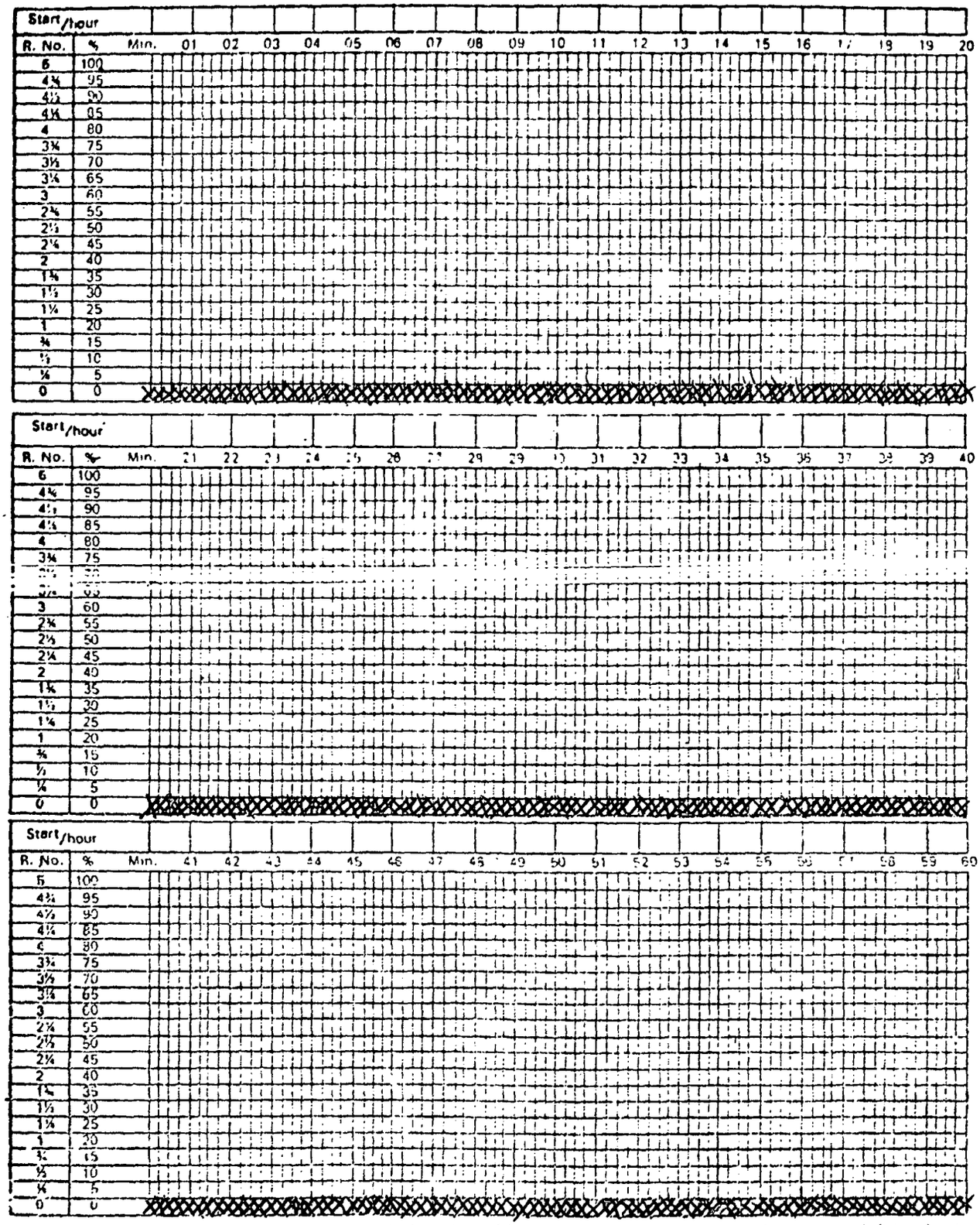
ENVIRONMENTAL PROTECTION AGENCY

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 2:50 A.M. P.M. TO 3:50 A.M. P.M. DATE 2/24/75

RECORD OF VISIBLE EMISSIONS



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ½ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Stack (Coulton Chemical)

Type of Air Contaminants

Point of Discharge: Stack ☒ Other

Point of Observation:

Distance to Base of Point of Discharge, feet

Height of Point of Discharge Above Ground Level, feet

Background Description

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other

Wind Direction Wind Velocity, mi/hr

Plume Description:

Detached: Yes ☐ No ☐

Color: Black ☐ White ☐ Other None

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) (Minimum)

Comments No emissions visible from stack. Readings were at times questionable due to the readers view being obsured by steams (generated) from nearby equipment.

Signed Allan Sutherland Title Smoke Reader

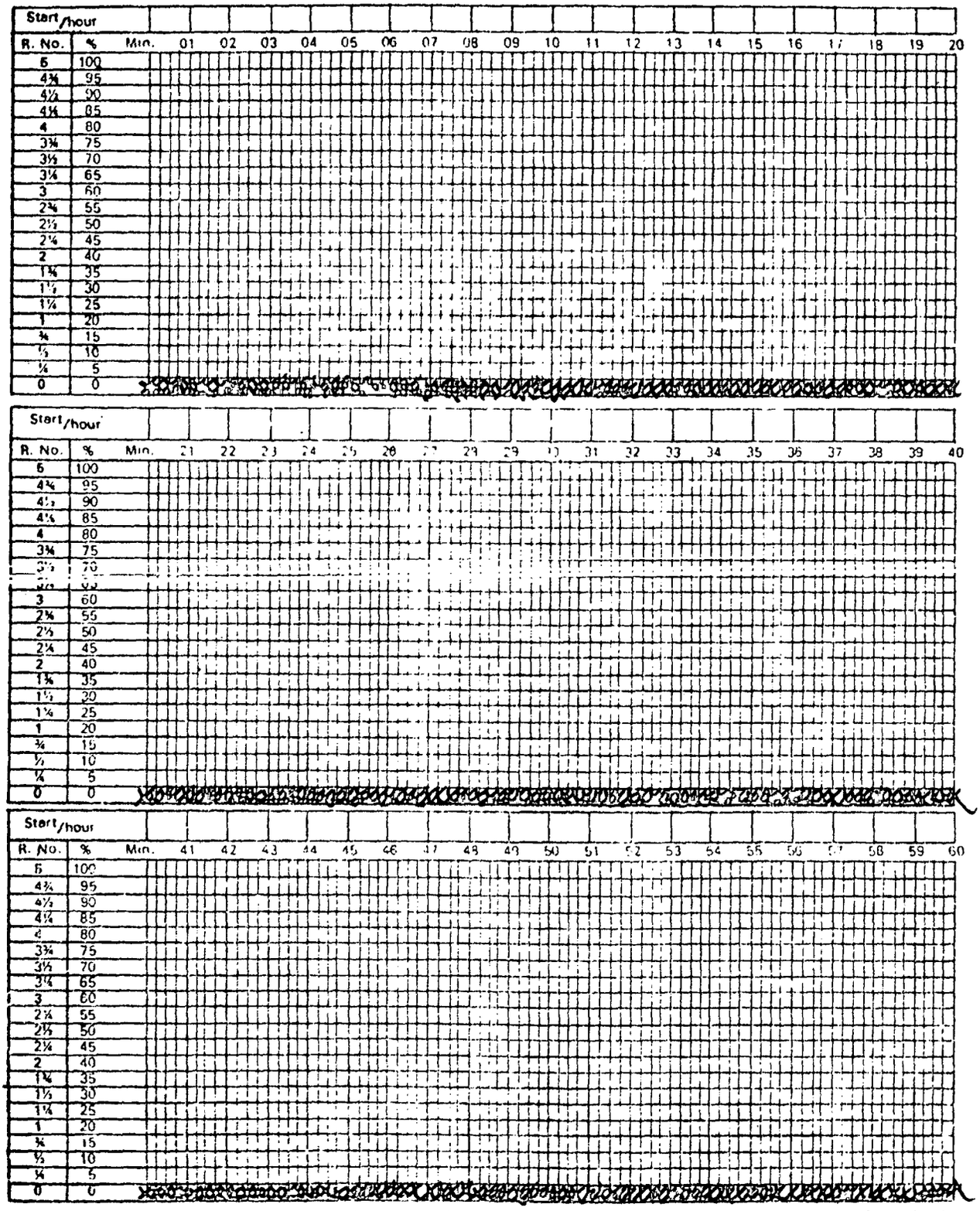
ENVIRONMENTAL PROTECTION AGENCY

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 1:00 A.M. P.M. TO 2:00 A.M. P.M. DATE 2/25/75

RECORD OF VISIBLE EMISSIONS



NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Coulton Chemical (H_2SO_4 Production)

Type of Air Contaminants SO_2, SO_3, Acid mist

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet _____

Height of Point of Discharge Above Ground Level, feet 60 FT.

Background Description GRAY SKY

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other SNOWING

Wind Direction NORTH Wind Velocity, mi/hr 3-5

Plume Description:

Detached: Yes ☐ No ☒

Color: Black ☐ White ☐ Other NONE

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐
Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments READING WAS VERY difficult due to THE WEATHER CONDITION; I.E. SKY COLOR AND STEAM from AT TIMES COVERING THE STACK

Signed Alan Sutherland Title ENV. ENGINEER

SMOKE READER

ENVIRONMENTAL PROTECTION AGENCY

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

RECORD OF VISIBLE EMISSIONS

TIME OF OBSERVATION: FROM 1:00 A.M. P.M. TO 2:00 A.M. P.M. DATE 2/25/75

R. No.	%
5	100
4¾	95
4½	90
4¼	85
4	80
3¾	75
3½	70
3¼	65
3	60
2¾	55
2½	50
2¼	45
2	40
1¾	35
1½	30
1¼	25
1	20
¾	15
½	10
¼	5
0	0

Start/hour

Min. 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20

Start/hour

Min. 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Start/hour

Min. 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Stack (Coulton Chemical)

Type of Air Contaminants NO_x, SO_x, ~~[redacted]~~ expected.

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet _____

Height of Point of Discharge Above Ground Level, feet _____

Background Description clear blue sky

Weather: Clear ☒ Overcast ☐ Partly Cloudy ☐ Other Sunny

Wind Direction _____ Wind Velocity, mi/hr 10-20

Plume Description:

Detached: Yes ☐ No ☐

Color: Black ☐ White ☐ Other _____

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments No Emissions visible from Stack; due to wind direction as opposed to Sun position it was impossible for the Reader to position himself to meet both of the EPA Method #9 Requirements. Also Readings at times were obsured by Steam.

Signed Alan Sutherland Title Smoke Reader

ENVIRONMENTAL PROTECTION AGENCY

COMPANY NAME Coulton Chemical

EQUIPMENT LOCATION (ADDRESS) Toledo, Ohio

TIME OF OBSERVATION: FROM 10:30 A.M. P.M. TO 11:30 A.M. P.M. DATE 2/27/75

RECORD OF VISIBLE EMISSIONS

Start/hour

R. No.	%	Min. 01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
6	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

Start/hour

R. No.	%	Min. 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
6	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

Start/hour

R. No.	%	Min. 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
6	100																				
4¾	95																				
4½	90																				
4¼	85																				
4	80																				
3¾	75																				
3½	70																				
3¼	65																				
3	60																				
2¾	55																				
2½	50																				
2¼	45																				
2	40																				
1¾	35																				
1½	30																				
1¼	25																				
1	20																				
¾	15																				
½	10																				
¼	5																				
0	0																				

NOTE: Each small square represents an individual reading of intensity corresponding to that shown in the left-hand column over a time span of ¼ minute. Insert an "S" in the top row of blank squares to indicate the exact minute of the start of observation. In the next square after the "S", insert the hour in which the measurement was made. Each page of this form can thus be used to record 1 hour of measurements.

Source of Air Contaminants Stack (Coulton Chemical)

Type of Air Contaminants SO_x, NO_x, Hydrocarbons

Point of Discharge: Stack ☒ Other _____

Point of Observation:

Distance to Base of Point of Discharge, feet 160 ft

Height of Point of Discharge Above Ground Level, feet 40 ft

Background Description Road (standing) Grey overcast sky.

Weather: Clear ☐ Overcast ☒ Partly Cloudy ☐ Other Sunny at times

Wind Direction SW Wind Velocity, mi/hr 10-12

Plume Description:

Detached: Yes ☐ No ☐

Color: Black ☐ White ☐ Other None

Plume Dispersion Behavior: Looping ☐ Coning ☐ Fanning ☐

Lofting ☐ Fumigating ☐ See Comments ☐

Estimated Distance (feet) Plume Visible (Maximum) _____ (Minimum) _____

Comments No visible emissions; Readings at times were impossible due to steam generated by nearby equipment which covered the stack, when sun is out, the readings are conducive to EPA Method 9 ie Sun at observers back and read at right angle to direction of flow

Signed Alan Sutherland Title Smoke Reader

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/2-76-047		

4. TITLE AND SUBTITLE	5. REPORT DATE
Molecular Sieve Tests for Control of Sulfuric Acid Plant Emissions	March 1976
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Karl R. Boldt and Richard F. Timmons	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
York Research Corporation One Research Drive Stamford, Connecticut 06906	1AB014; ROAP 21ADH-006
	11. CONTRACT/GRANT NO.
	68-02-1401, Task 2
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711	Task Final; 9/74-12/75
	14. SPONSORING AGENCY CODE
	EPA-ORD

15. SUPPLEMENTARY NOTES Project officer for this report is E. J. Wooldridge, Ext 2547.

16. ABSTRACT The report gives results of tests of a molecular sieve control system for sulfuric acid plant tail gas. The system, the PuraSiv S, was developed by Union Carbide Corporation and is now operating at the Coulton Chemical Corporation's plant in Oregon, Ohio. The PuraSiv S utilizes a molecular sieve adsorbent material that releases SO2 when heat is applied. The SO2 is recycled for an additional 2-3% production of acid. The report evaluates the PuraSiv S, using data gathered during a 4-week test period. SO2 concentrations were continuously measured and recorded by a DuPont 460/1 Photometric Gas Analyzer at both the inlet and outlet gas streams. Average removal efficiency was 98.0%. Average SO2 emissions during the tests were below 100 ppm.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Sulfuric Acid	Stationary Sources	07B
Chemical Plants	Molecular Sieves	07A
Absorbers (Materials)	Tail Gas	11G
Surlfur Dioxide	PuraSiv S	
Adsorption		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Unlimited	Unclassified	280
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (9-73)