IN-DEPTH SURVEY REPORT:

OF

GLAS PLY BOAT COMPANY
MARYSVILLE, WASHINGTON

SURVEY CONDUCTED BY:
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DATE OF SURVEY:
November 30-December 3, 1981

REPORT WRITTEN BY:
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Materials Processing Section
Engineering Control Technology Branch
Division of Physical Sciences and Engineering
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45226

Purpose of Survey:

This in-depth survey was performed to evaluate the ventilation system of the Glas Ply Boat Company. This plant was selected because it was recommended as the best example of general ventilation by the University of Washington School of Public Health based upon their own studies of fiberglass boat building (FRP).

Employer Representatives Contacted:

Mr. Ken Hopen, President
Mr. Dick Teigan, Marketing Director
Mr. John Lindell, Plant Superintendent
Mr. Ted Pederson, Lamination Foreman

Employee Representatives Contacted:

None

Standard Industrial Classification of Plant:

SIC 3732 Boatbuilding and Repairing

Analytical Work Performed by:

Utah Analytical Laboratories

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INTRODUCTION:

The Glas Ply Boat Company is located in Marysville, Washington. It is a privately owned company producing a line of boats up to 42 feet in length. During the period of the survey, boats ranging from 17 to 28 feet were under production. The plant lay-out is shown in Figure 1. The main mold building is about two years old, having replaced one destroyed by fire. The system is designed to supply air along two central lines of ceiling ducts and diffuse laterally to exhaust ports located near floor level. See Figure 2. The main building houses not only the molding operations but also the hull and deck assembly operations. This adds considerable space not devoted to styrene lamination operations to the building and increases the effective dilution volume.

This in-depth survey was performed at the Glas Ply Boat Company to evaluate the effectiveness of general ventilation for removing styrene vapors from the vicinity of lamination operations and for controling the general level of styrene in the building. The approach used in this survey was to monitor the exposure of lamination workers for periods of 1/2 hour, to monitor the levels of styrene in the building, to measure air velocity and direction in the building and to observe work practices used to minimize worker exposure.

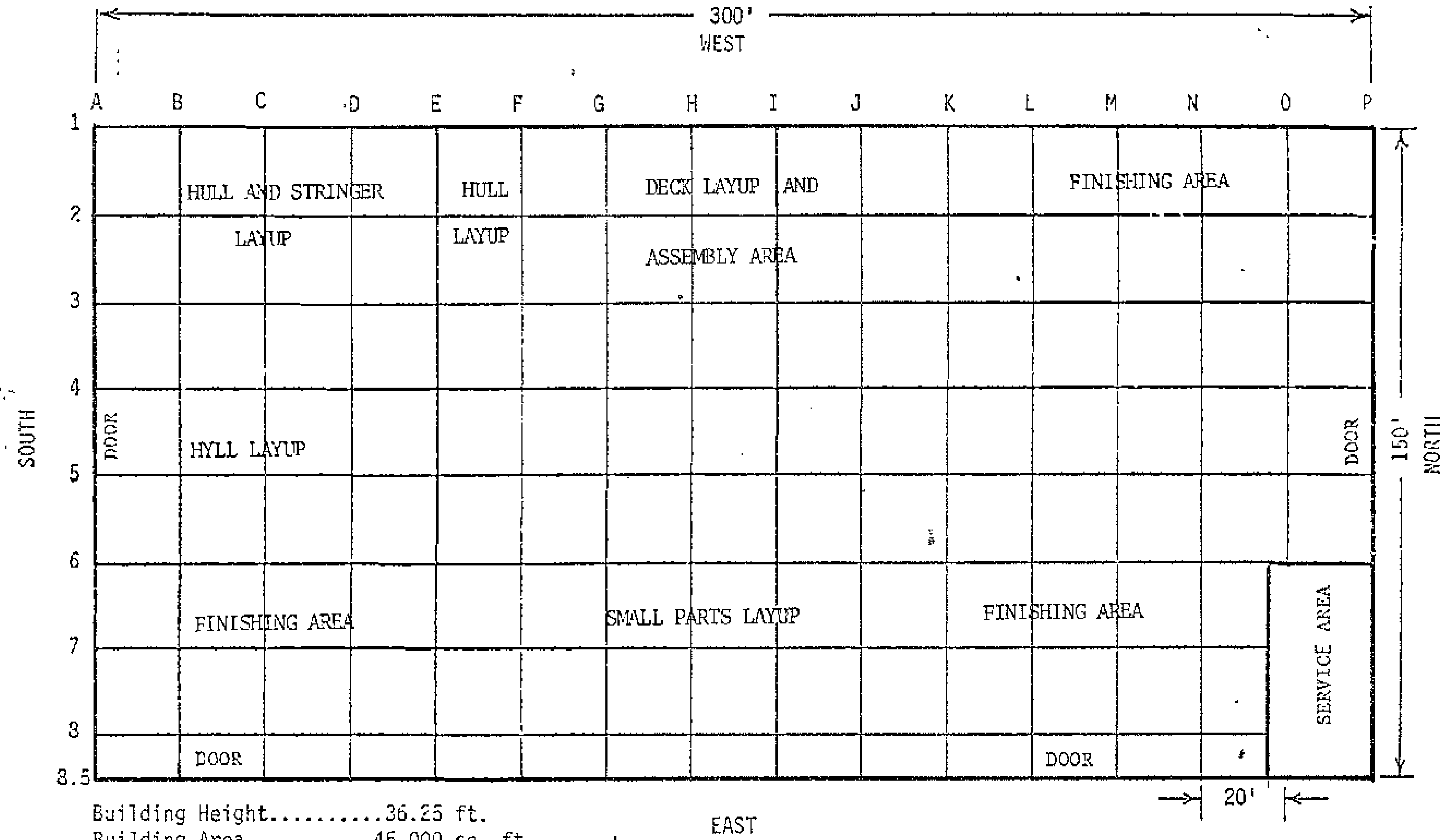
The selection of this plant for the survey was based upon a preliminary survey and recommendation of the University of Washington School of Public Health industrial hygiene survey of the fiber reinforced plastic boatbuilding industry in the State of Washington. The evaluation criteria is the capability to maintain a styrene vapor concentration below the OSHA PEL of 100 ppm and to prevent exposures to higher concentrations of styrene for brief periods of time. The same criteria applies to acetone with a PEL of 1000 ppm.

OPERATIONS AND PRODUCTION:

The production rate at the Glas Ply plant was about 1/3 of normal. This low production rate may affect the background levels of styrene in the building but is should not have much effect on the exposure levels of the lamination workers. There were 30 workers in the plant, 12 in the Main Mold Building. The production schedule for the week of November 30 to December 5, 1981 included the hull lay-up of one each of 17, 19, 21, 23, 24 and 28 foot boats and the finish-up of a 26 and a 28 foot boat. The plant operated one shift per day from 7:00 AM to 3:30 in the afternoon.

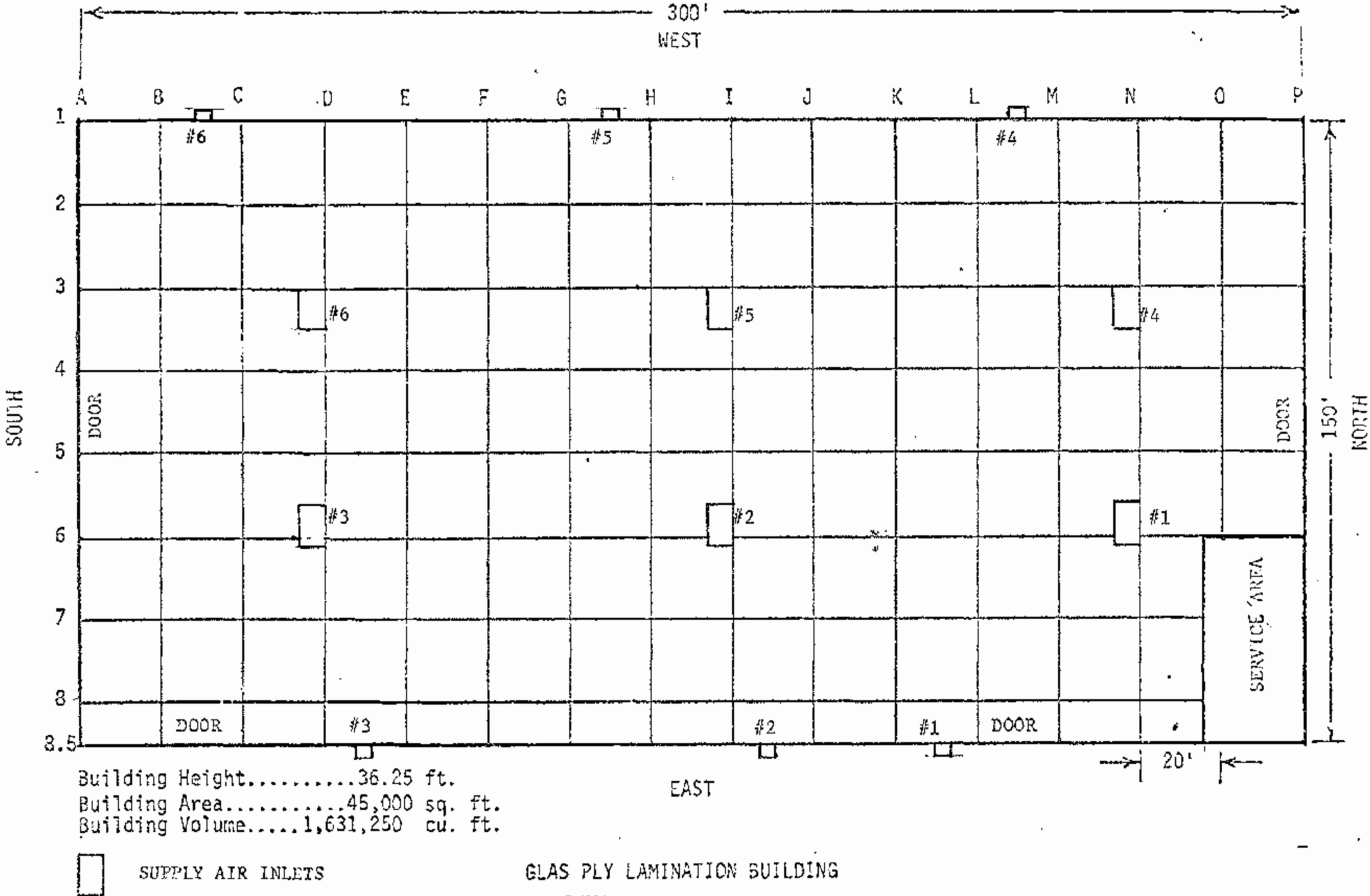
The boat construction in this plant is performed in several buildings. The main mold building is used for hull and deck lay-up and assembly of larger boats. It measures 300' by 150' with an average height of about 36'. Assembly and finishing of smaller boats is done in one of several smaller buildings in the plant.

Hull lay-up is done in tiltable molds located at the southern end of the main mold building. Decks and small parts are laid-up in stationary molds in the southern to central part of the main mold building. The assembly of large boats is performed in the east end of the main mold building. The location of these operations in the main mold building are shown in Figure 3.



Building Height..........36.25 ft.
Building Area..........45,000 sq. ft.
Building Volume.....1,631,250 cu. ft.

GLAS PLY LAMINATION BUILDING
FIGURE 1. PLANT LAYOUT

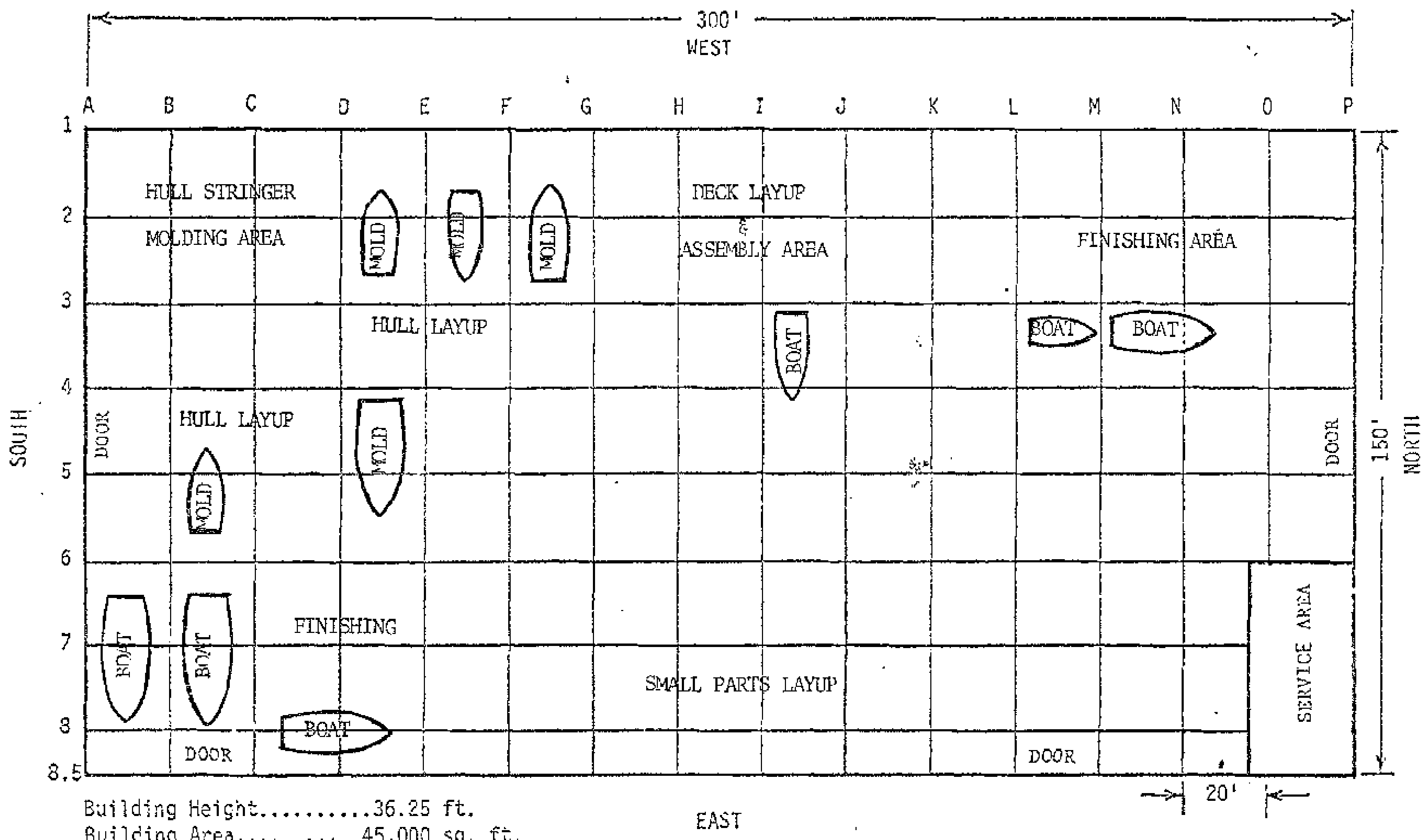


Building Height..........36.25 ft.
Building Area..........45,000 sq. ft.
Building Volume.....1,631,250 cu. ft.

GLAS PLY LAMINATION BUILDING

LAYOUT OF ROOF VENTS

FIGURE 2.



Building Height.........36.25 ft.
Building Area..........45,000 sq. ft.
Building Volume.....1,631,250 cu. ft.

GLAS PLY LAMINATION BUILDING
WORK LAYOUT DURING STUDY
OF MAY - JUNE, 1981

FIGURE 3.

Smaller boats are assembled in older buildings. The woodworking shop and the électrical shop are separate areas in the older buildings associated with assembly operations. There are no styrene exposures in the assembly procedures in older buildings.

The materials used to manufacture these boats are; woven glass fiber roving, chopped glass fiber strand, styrene polyester resin, styrene polyester gel coat, polyurethane resins, a peroxide catalyst and paint. Acetone is used as a cleaning agent to remove styrene resin from equipment, skin and clothing. Polyurethane resin is used for float tank filler. This material is applied during hull and deck lay-up; it is supplied by Reichold Chemical Company, Inc.

The boat mold is an inverted shape of the boat. The mold is made of fiber reinforced plastic (FRP) formed on a hull form called the "plug" made especially for that purpose or copied from the hull of an existing boat. The mold has a high polish [illegible] smooth surface of the boat form from which it is made but also from a polished layer of carnuba wax added for easy mold release. The cleaned and polished mold is first sprayed with gel coat which will be the exterior finish of the boat. Gel coating is usually done in the afternoon or evening so that the resin lamination can begin with the morning shift.

The resin and glass woven roving (24 Oz/square yard) are layered in a continuous operation by laminating one half of the hull, then tilting the boat to laminate the other half. This tilting the mold from side to side continues until the desired hull thickness is attained. If the resin is cured for too long a period, say 48 hours, between laminations the surface is normally sanded to assure interlaminar adhesion. To avoid having hulls sit over the weekend, they are seldom begun unless it is certain that they can be completely laminated by Friday.

The next step in preparing the boat hull is the installation of the hull bracing. This bracing consists of longitudinal stringers and traverse bulkheads straddling the stringers. Motor mounts and deck supports further strengthen the hull. The completed hull is now ready for removal from the mold for which considerable force is required. Gantry cranes supply the release force accompanied by hammer blows to the mold and the injection of water between the mold and the hull. The hull is placed into a cradle to await the attachment of the deck. After attachment of the deck, the inside of the hull is painted with gel coat. The boat is now ready for the installation of the motors, electrical systems and the basic plumbing. It is at this point that the smaller boats leave the main mold shop to be outfitted in another building.

The small parts are laid-up on the east side of the main mold building. The gel coat and one layer of woven roving are applied to the mold. The chopper gun is used to build up the thickness of the small part. The chopper gun used by Glas Ply is the Glas Craft air supplied spray-gun. This type of spray-gun creates a mist of the styrene resin which contributes to the styrene in the room air. No special hooding is used to control styrene emissions from this operation.

The styrene resin used at Glas Ply is manufactured by the Reichhold Chemical Company and is identified in their Technical Bulletin as 33-096 Polylite(TM) Polyester Resin. The styrene content is listed as less than 50% and less than 0.2% dimethyl aniline. The remainder is unsaturated polyester. The polyurethane resin used is Reichold Polylite 34-748 and 34-846. The Urethane Pour-Forth Foam System is used for application of the foam.

The gel coat used by Glas Ply is produced by Glidden Coatings and Resins Division of SCM. The product identification is:

760-W-15115-A	Off White Neo Gel-Kote
760-W-15118	Interior Kote

The Off White Neo Gel-Kote contains 38% weight styrene, which is less than that in the resin. Manufacturer's Technical Bulletins for all resin materials are contained in Appendix A.

The materials consumption during the 4 day period of the test, Monday through Thursday, was obtained from Mr. Ted Pederson, Lamination Manager. Quantities used are as follows:

Styrene Polyester resin	5625 lbs
Gel coat	250 lbs
Acetone (200 gallons)	1320 lbs

HAZARD ANALYSIS-STYRENE AND ACETONE:

Evaluation Procedures

Ten workers in the Main Mold Building had direct exposure to styrene. Four of these workers were engaged in the lamination of hulls, another four laminated decks and smaller parts and one individual performed all the spraying of gel coat. The remaining worker painted the interiors of finished boats with a pigmented polyester resin and performed other duties not associated with exposure to styrene. The other two persons were the Lamination Foreman and the Plant Superintendant

To determine control effectiveness, the breathing zone concentration of styrene and acetone were measured over the course of three days by personal samples on selected workers. The personal samples were collected for consecutive 30 minute (nominal) periods to determine what specific operations might result in compromised control. Styrene and acetone were collected on 150 mg charcoal tubes with personal pumps operated at 100 cc/min. The tubes were separated into front and back sections and desorbed in 1 ml of carbon disulfide. Analyses were performed by gas chromatography using a flame ionization detector at the Utah Biological Testing Laboratories (UBTL).

To determine the role of background levels of styrene in the total exposure of workers, area samples were collected at points adjacent to work sites. Except for duration (240 minutes) and sampling rate (10 cc/min.), sampling and analyses were identical to the personal samples noted above. To determine if any significant temporal trends were occuring (i.e. buildup of styrene over the shift), selected areas of the plant were monitored over the course of the study with an HNu™ Portable Gas Detector and chart recorder.

CONTROLS:

General Ventilation-Design

The plant ventilation system consists of six subsystems for supply air and six subsystems for exhaust air. The supply systems have blowers located on the roof; each has an inlet opening of 61 inches square. The air is supplied to the building at near ceiling height along the two lines of inner support columns. The exhaust system inlets are located about 2 feet above the floor and around the periphery of the building to match the corresponding supply system. The intent of the ventilation engineer was apparently to provide a flush of air from the cer[illegible] building to each side with a downward flow of air. This ventilation system was evaluated by determining the supply and exhaust flows and the velocity and direction of the ambient air flow in the lamination section of the building.

Air Flow Measurements

The velocity of air into and exiting from the exhaust system were measured. Only the inlet air velocity of the supply system was measured because the exit louvers were inaccessible within the building. The inlet velocity of the exhaust air was measured at points located in four equal areas of each filter. Each of the six exhaust systems had 15 inlet filters measuring 22" x 22" (3.36 ft^2). The average air velocity through a filter was 460 FPM with a range of 240 to 780 FPM. The total exhaust flow calculated on this basis was 139,000 CFM. The exhaust air systems vented through vertical ducts reaching to roof level. These ducts are 37" x 29" (7.45 ft^2). The total exhaust flow from this approach is 130,000 CFM. The latter value is assumed to be the best estimate of the exhaust flow because the high exit velocities (3000 FPM) were more steady and in a more accurate range of the velometer. This is supported by the lower standard deviation (SD) of these readings compared to a normalized standard deviation of 732 of the values obtained from exhaust air inlet measurements.

The exhaust blowers are located outside the building with vertical exhaust ducts reaching flush with the roof line. A calculated effective stack height of this exhaust air is only 12 feet in a 25 MPH wind. This is not sufficient to prevent looping of the exhaust air into some of the air intakes. There is a real potential of recycling exhaust air into the supply air inlets.

A detailed flow pattern was obtained around the exhaust air inlet of system #3 in Bay D-E at the east wall. This is illustrated in Figure 4 with the lines of equal flow delineated. The section shown is one of six perpendicular profiles and is located near the middle of the four filter array. Figure 5 shows the flow isopleths in the plane of the grill (about 8 inches from the wall). This Figure indicates, by the steep velocity gradient near the floor, 12/2/81

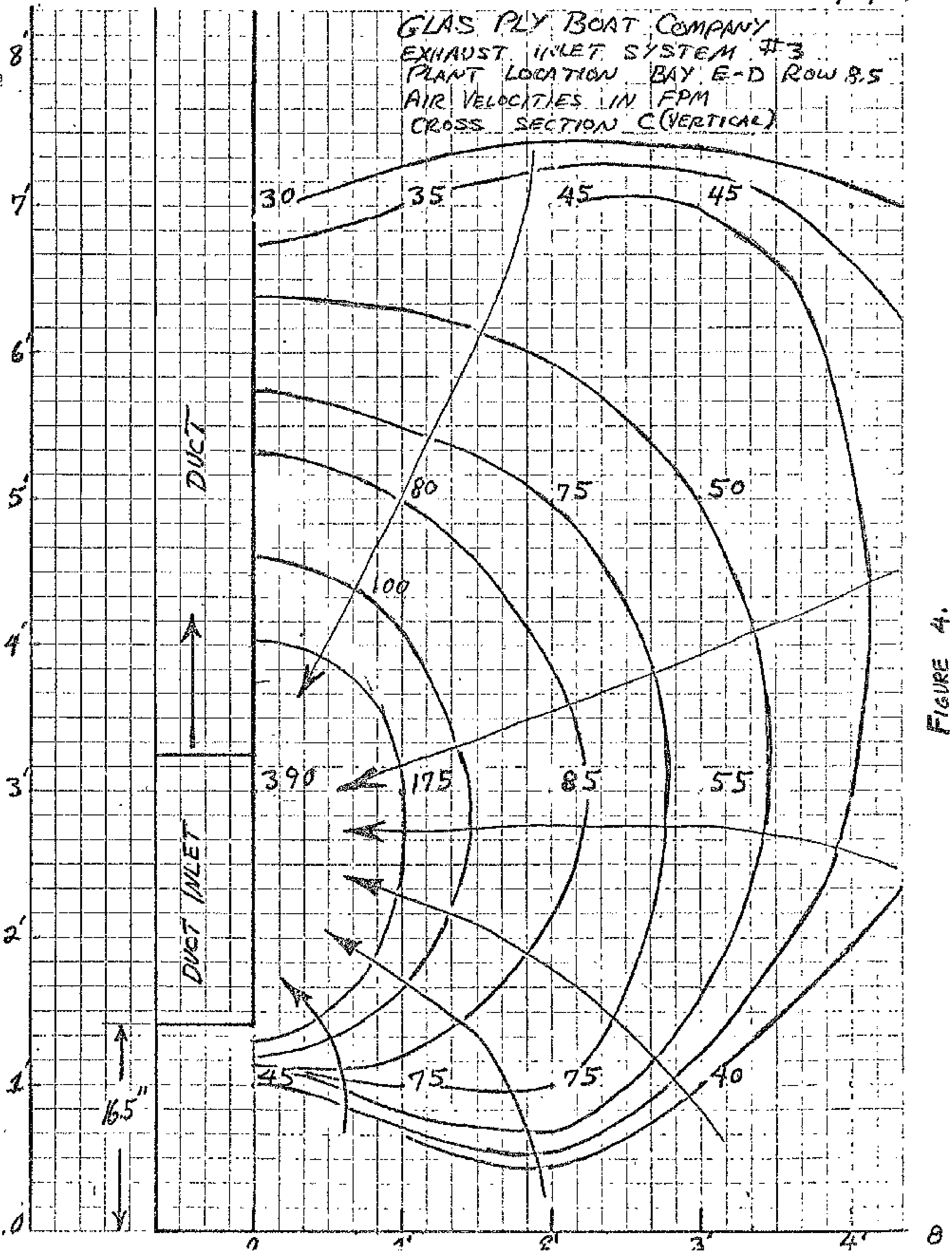
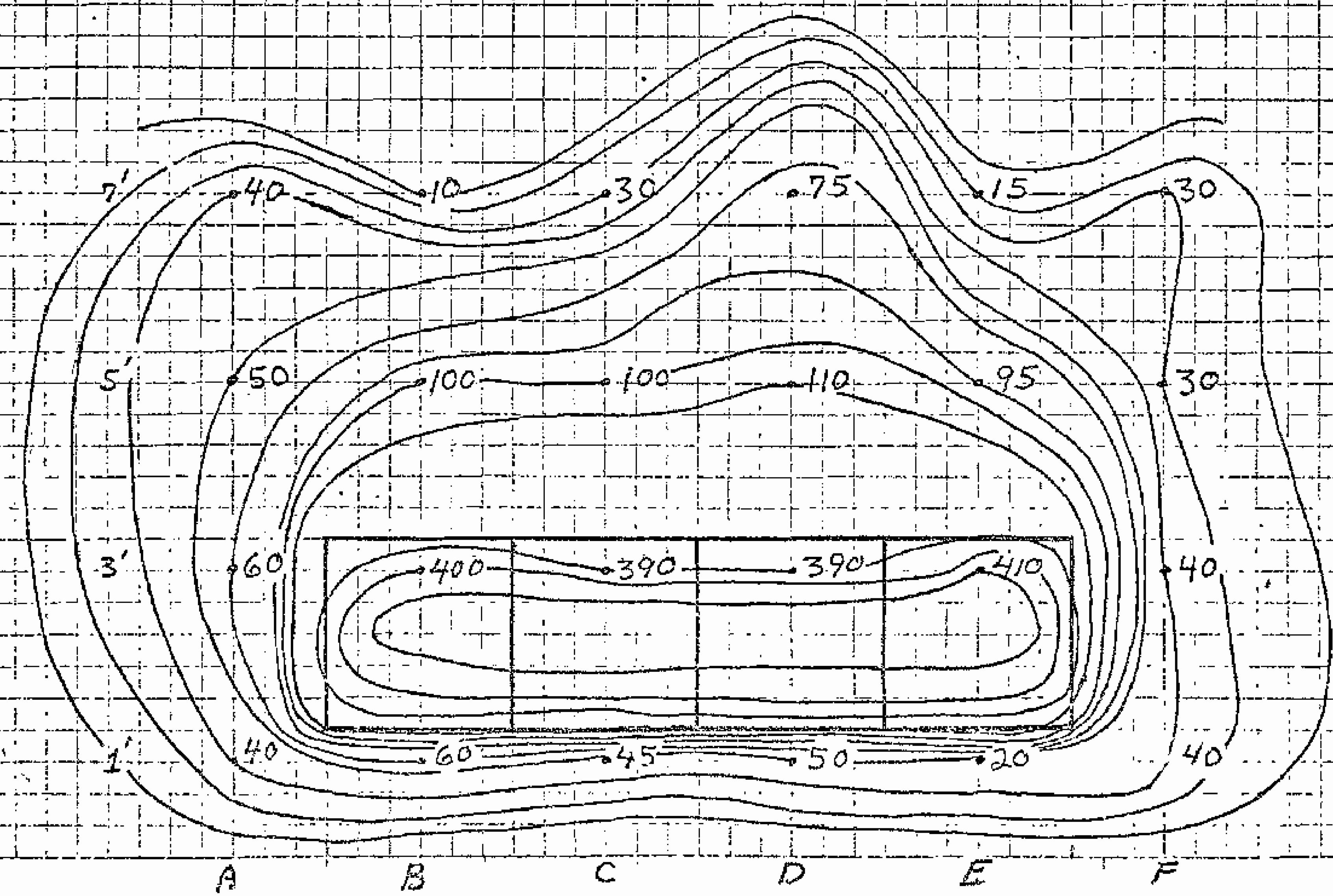


FIGURE 4.

GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION, BAY E-D, ROW 8.5
AIR VELOCITIES IN FPM
CROSS SECTION AT THE GRILL

FIGURE 5.



that these exhaust air inlets could be effective in removing vapors from the immediate vicinity at the worker level. Spray-on work is not located in front of these exhaust ducts to take advantage of this collecting capacity. The remainder of the inlet flow patterns are located in Appendix A.

The evaluation of the inlet supply air flow presented some problems. The air inlet is very near the blower on the roof, which resulted in unsteady readings; a 20 MPH crosswind also may have interfered. The inlet duct is 61 inches square (25.8 FT^2) and 4 velocity readings were taken on each grill. The total inlet flow calculated from these velocities is 189,000 CFM compared to the 130,000 CFM estimate of the exhaust air flow. Since there was no indication that the supply and exhaust air flows were unbalanced it is assumed that the best estimate of the supply/exhaust air flow is 130,000 CFM. This flow results in about 5 air changes per hour in the plant.

The effectiveness of the system should be expressed in terms of the styrene concentration in the building and the PEL or target concentration. Since it is imperative that the actual styrene concentration is below the PEL, an efficiency expression is inappropriate because the concentration cannot be compared to a theoretical limit. The best expression of effectiveness is the ratio of the target concentration (PEL) to the measured building concentration (C). This is referred to as the design safety factor, K, and varies from 3 to 10 depending upon the toxicity of the material.

$$K = \frac{PEL}{C} \quad \text{or} \quad \frac{TLV}{C}$$

It is desirable to operate with a ratio of 3 or greater. The mean value of styrene concentration in the building was 20 ppm, the range was 9 ppm to 32 ppm, and the standard deviation was 7.2 ppm. The PEL/C for styrene is 5 and is 60 for acetone.

If this concept is applied to the mean personal exposure data, (45 ppm styrene), 2.2 is the value for the effectivness. A graph of the effectiveness of the ventilation system vs the room air styrene concentraion is shown in Figure 6.

The study of the air movements in the building were carried out by taking measurements in a grid pattern with fourteen points across the building from east to west and eighteen points from south to north. The total number of readings taken was 252. This area covered all parts of the building where plastics lamination was done. This spacing of the data points on the sampling grid was 11 1/4 feet east to west and 10 feet north to south. The air velocity was measured by two instruments, the TSI and the Kurz hot wire anemometers. The direction of the air flow was determined from watching a puff of smoke from a smoke tube and noting the direction of the smoke in the east/west vertical plane. The sample sheets for these tests are shown in Appendix B. A sample data sheet is shown in Figure 7. The arrows indicate direction only. The air flow patterns in the east/west vertical plane are shown in Figure 8. The remainder

FIGURE 7. SAMPLE DATA SHEET

DATA SHEET FOR CIRCULATING AIR VELOCITY

GLAS PLY BOAT COMPANY IN MARYSVILLE, WASHINGTON (MOLD BUILDING)

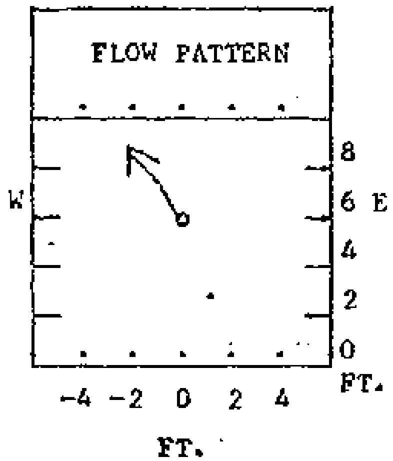
DATE: 11/2 SAMPLE SHEET NUMBER: 8

INSTRUMENT TYPE: TSI

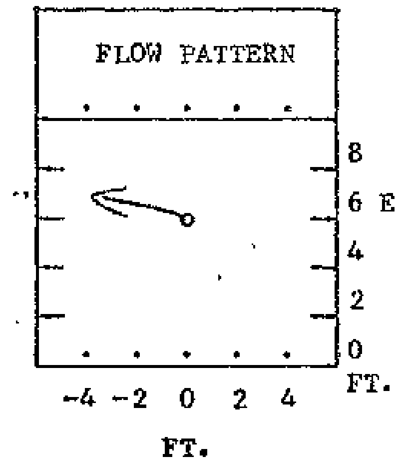
INVESTIGATORS: T C

COMMENTS:

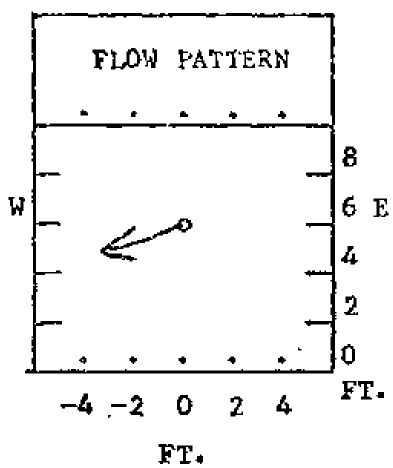
SAMPLE POINT
0.5, 1.5
TIME
VELOCITY
10 fpm



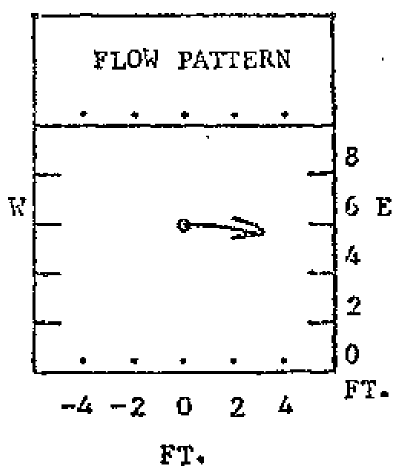
SAMPLE POINT
0.5, 2.0
TIME
VELOCITY
30 fpm



SAMPLE POINT
0.5, 2.5
TIME
3:30 P
VELOCITY
40 fpm



SAMPLE POINT
0.5, 3.0
TIME
VELOCITY
30 fpm



GLAS PLY BOAT COMPANY APPLICATION BUILDING

APPARENT AIR CIRCULATION IN BUILDING CROSS SECTION

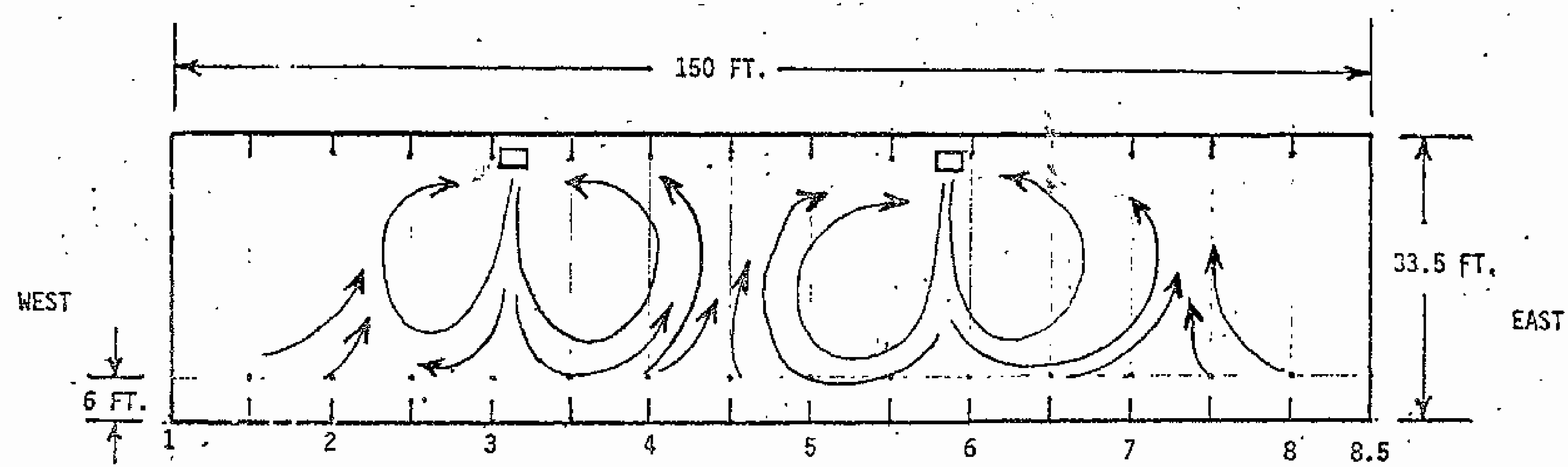


FIGURE 8.

of these cross sections are contained in Appendix C. The air velocity in feet per minute (FPM) at each data point is indicated under the sample position. The overhead air supply ducts are indicated just inside the line of columns supporting the roof beams. The air vents in this duct are located midway between the columns. In some cases no data are indicated because floor objects prevented access to the area.

A study of these diagrams, especially Figure 8, shows the generally turbulent air flow pattern generated by the air streams directed downward from the inlet air louvers. The highest velocities occur near or directly under the vents. In some cases the viscous drag of the inlet air air induces a persistent flow of air away from the walls. The small amount of data obtained does not permit a total picture of the flow patterns since the turbulance dispersed the smoke so rapidly that it was difficult to trace the flow more than 8 to 10 feet. It is not difficult, however, to visualize the eddy flow pattern generated by the line of louvered inlets. It is also highly probable that the air flowing from each set of louvers interacts with the air flowing from adjacent sets of louvers which adds to the turbulence. The ventilation system maintains a low styrene background level by turbulent mixing of the vapors in the large volume of the building air which is changed 5 times per hour.

Work Practices

The work practices observed by employees were limited to assignment of work tasks and certain housekeeping measures. Many workers had beards and side burns which would cause fit problems if they chose to use respirators. It was noted both from visual observations and from employee interviews that the spraying operations were the single greatest source of exposure; each two man boat hull lamination crew was observed to share spray-up responsibility and thus limit total exposure. In general, the employee not spraying would maintain some separation from the spray.

In the lay-up of small parts there was no preference given to the direction of spraying with the chopper gun. The spray-on was done in the open floor area where the direction of air flow was difficult to sense. The general air turbulence apparently disperses the resin spray very quickly.

The build-up of resin and glass fibers on the floor was limited by covering the floor with brown kraft paper which was periodically removed. The build-up of residues was also periodically removed with a rake. The clean-up was performed on a demand basis. The small parts area was cleaned most frequently because of the greater chopper gun overspray.

Other practices not recommended but observed are: using acetone to wash styrene from hands, arms, and clothing as the primary control; leaving cans of acetone uncovered (some were cemented open by resin); sanding plastic surfaces without dust filter respirators; painting inside boats with inadequate local ventilation; and spraying acetone into the air when cleaning spray equipment prior to breaks and the end of the shift. Some workers used an emollient hand creme not specifically designed as a barrier creme to avoid the degreasing effects of styrene resin and acetone. Workers using this creme said it was very helpful for avoiding skin irritation from acetone exposure.

RESULTS OF PERSONAL SAMPLING:

Exposures to styrene and acetone are reported in the form of an environmental profile for each worker/shift in Figures 9 through 18. Eight-hour time-weighted average (TWA) concentrations were calculated from these profiles and are presented in Table I. In no case was either the OSHA TWA limit for styrene of 100 ppm (420 mg/m^3) or acceptable ceiling concentration of 200 ppm (840 mg/m^3 exceeded. Only the deck laminators exceeded the ACGIH TLV^R (1981) of 50 ppm (215 mg/m^3). Approximately 10% of the individual 30 minute samples exceeded the 100 ppm (420 mg/m^3) STEL (short term exposure limit) recommended by the ACGIH.

TABLE I

PERSONAL SAMPLING SUMMARY

WORKER	DAY	8 HR. TWA CONCENTRATION (ppm) STYRENE	ACETONE	TASK
A	1	26	31	Varied
B	1	24	27	Stringers in Hull
C	1	21	14	Stringers in Hull
A	2	37	36	Varied
B	2	45	27	Hull Laminator
C	2	34	29	Hull Lamination
D	3	65	60	Deck Lamination
E	3	66	57	Deck Lamination
F	3	72	102	Deck Lamination
G	3	51	63	Small Parts
H	2	123*	69	Hull Painting
	OSHA PEL	100	1000	
	ACGIH TLV**	50	1000	
	STEL**	100	1250	

Mean 45 ppm Styrene
SD 19 ppm Styrene
This excludes the values from worker "H"

* Not 8HR TWA
** 1981

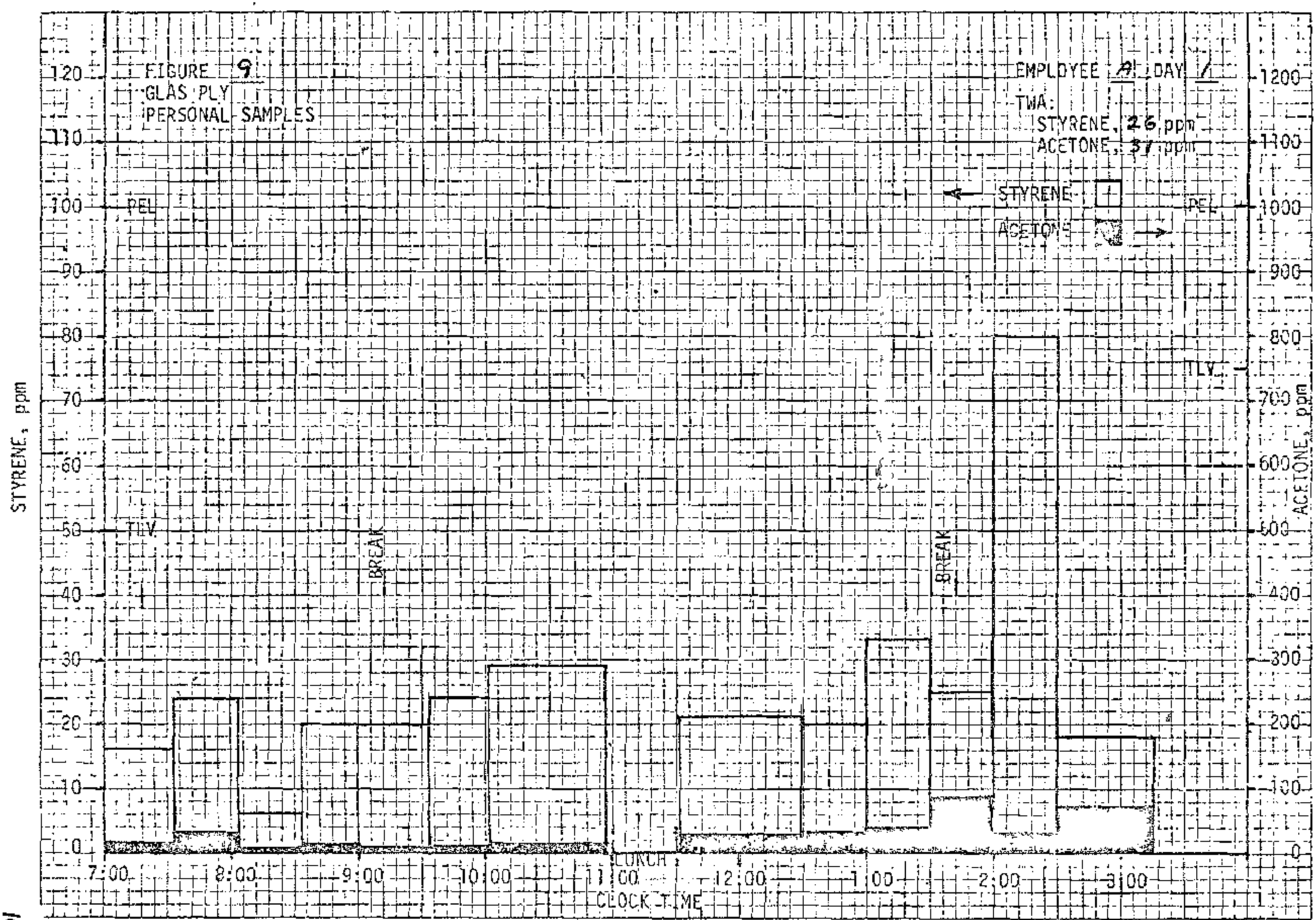


FIGURE 9
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE A DAY 1
TWA:
STYRENE, 26 ppm
ACETONE, 37 ppm
STYRENE
ACETONE
PEL
TLV
BREAK
LUNCH
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
CLOCK TIME
STYRENE, ppm
ACETONE, ppm
0
10
20
30
40
50
60
70
80
90
100
110
120
100
200
300
400
500
600
700
800
900
1000
1100
1200

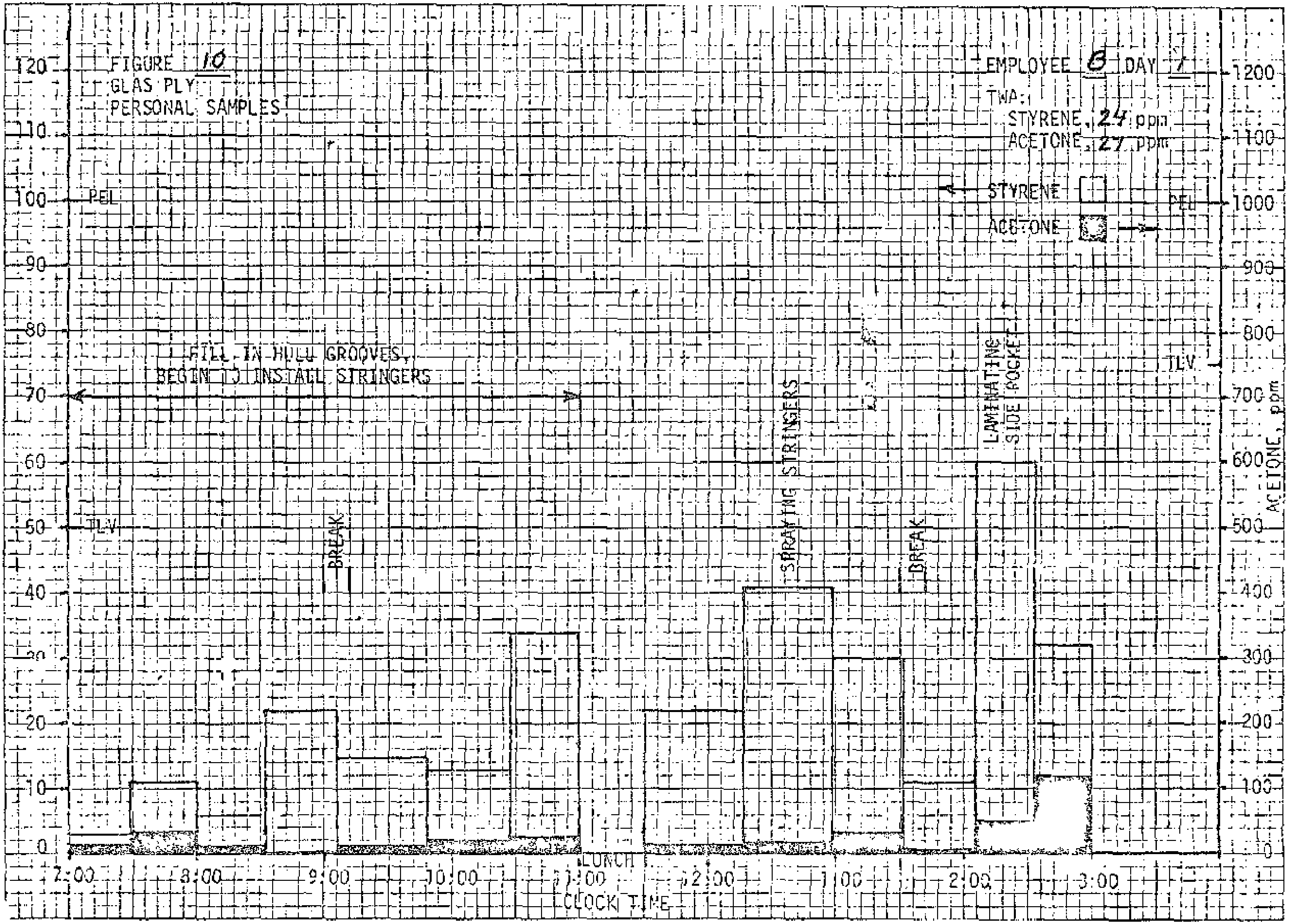


FIGURE 10
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE B DAY 1
TWA:
STYRENE, 24 ppm
ACETONE, 27 ppm
STYRENE
ACETONE
PEL
TLV
FILL IN HULL GROOVES,
BEGIN TO INSTALL STRINGERS
BREAK
SPRAYING STRINGERS
BREAK
LAMINATING SIDE POCKET
LUNCH
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
CLOCK TIME
STYRENE, ppm
ACETONE, ppm

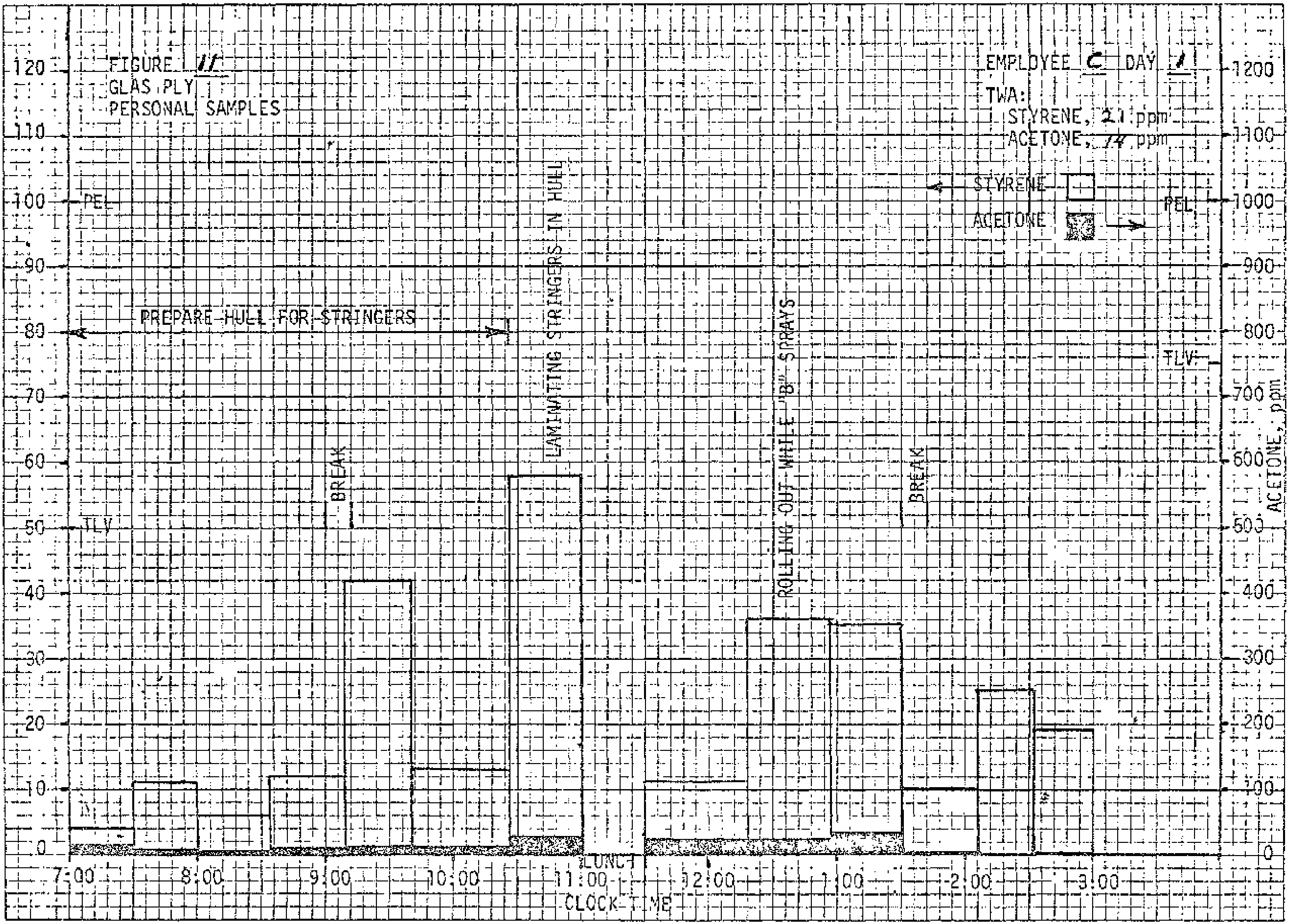


FIGURE 11
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE C DAY 1
TWA:
STYRENE, 21 ppm
ACETONE, 74 ppm
STYRENE
ACETONE
PEL
TLV
PREPARE HULL FOR STRINGERS
BREAK
LAMINATING STRINGERS IN HULL
LUNCH
ROLLING OUT WHILE "B" SPRAYS
BREAK
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00

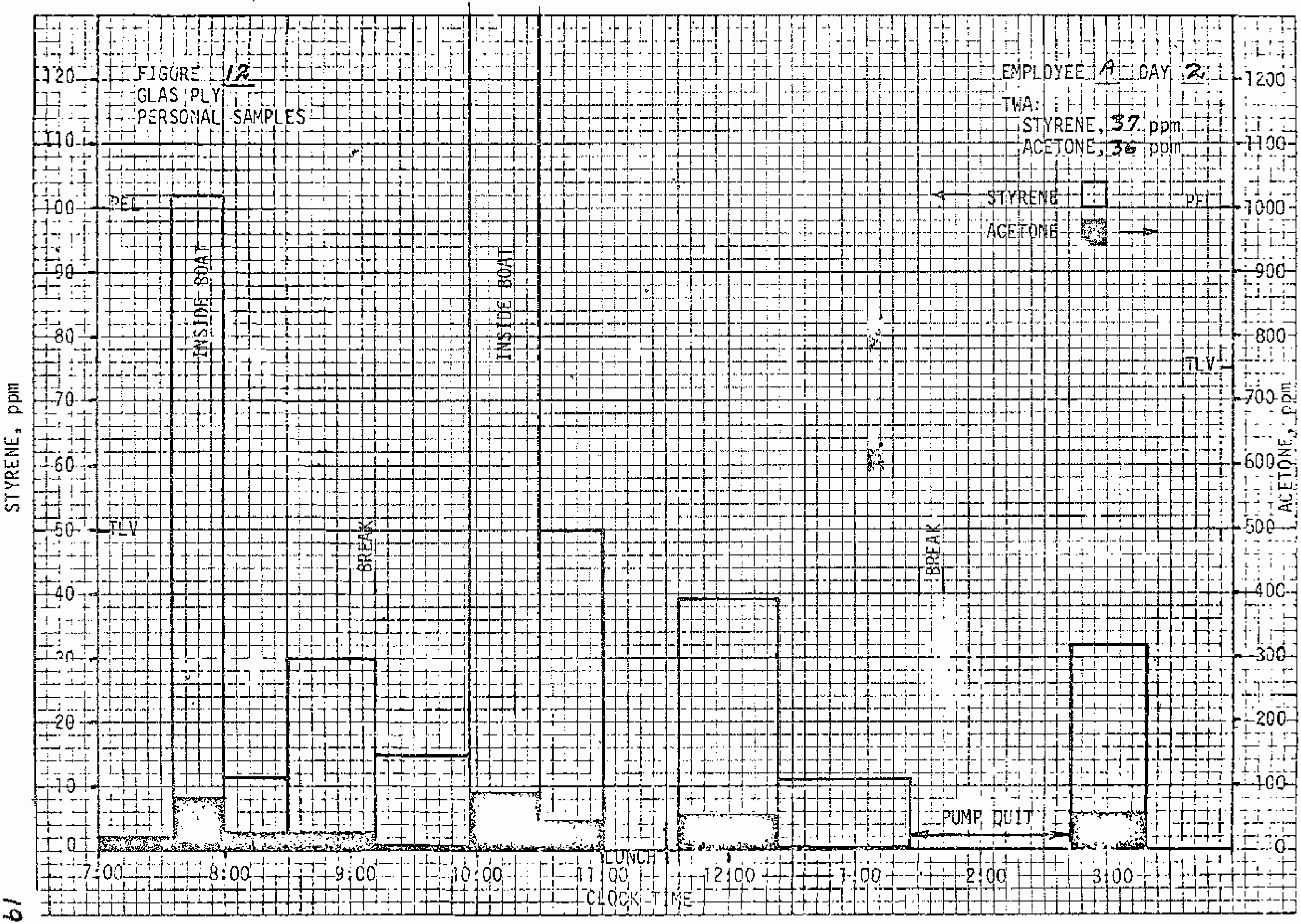


FIGURE 12
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE A DAY 2
TWA:
STYRENE, 37 ppm
ACETONE, 36 ppm
STYRENE
ACETONE
PEL
TLV
INSIDE BOAT
INSIDE BOAT
BREAK
BREAK
LUNCH
PUMP QUIT
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00

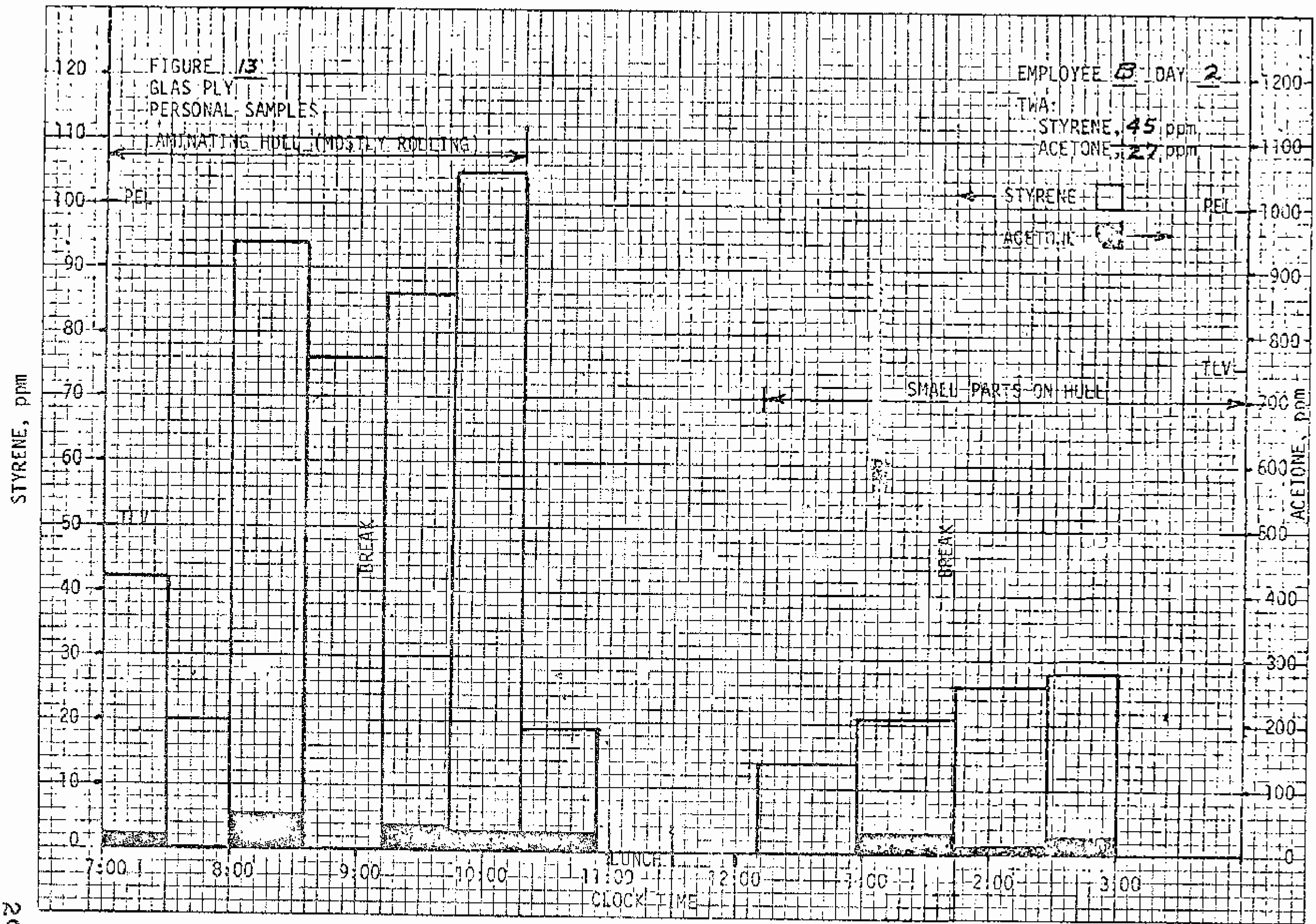


FIGURE 13
GLAS PLY
PERSONAL SAMPLES
LAMINATING HULL (MOSTLY ROLLING)
EMPLOYEE B DAY 2
TWA:
STYRENE, 45 ppm
ACETONE, 27 ppm
STYRENE
ACETONE
PEL
TLV
BREAK
SMALL PARTS ON HULL
BREAK
LUNCH
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
0
10
20
30
40
50
60
70
80
90
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

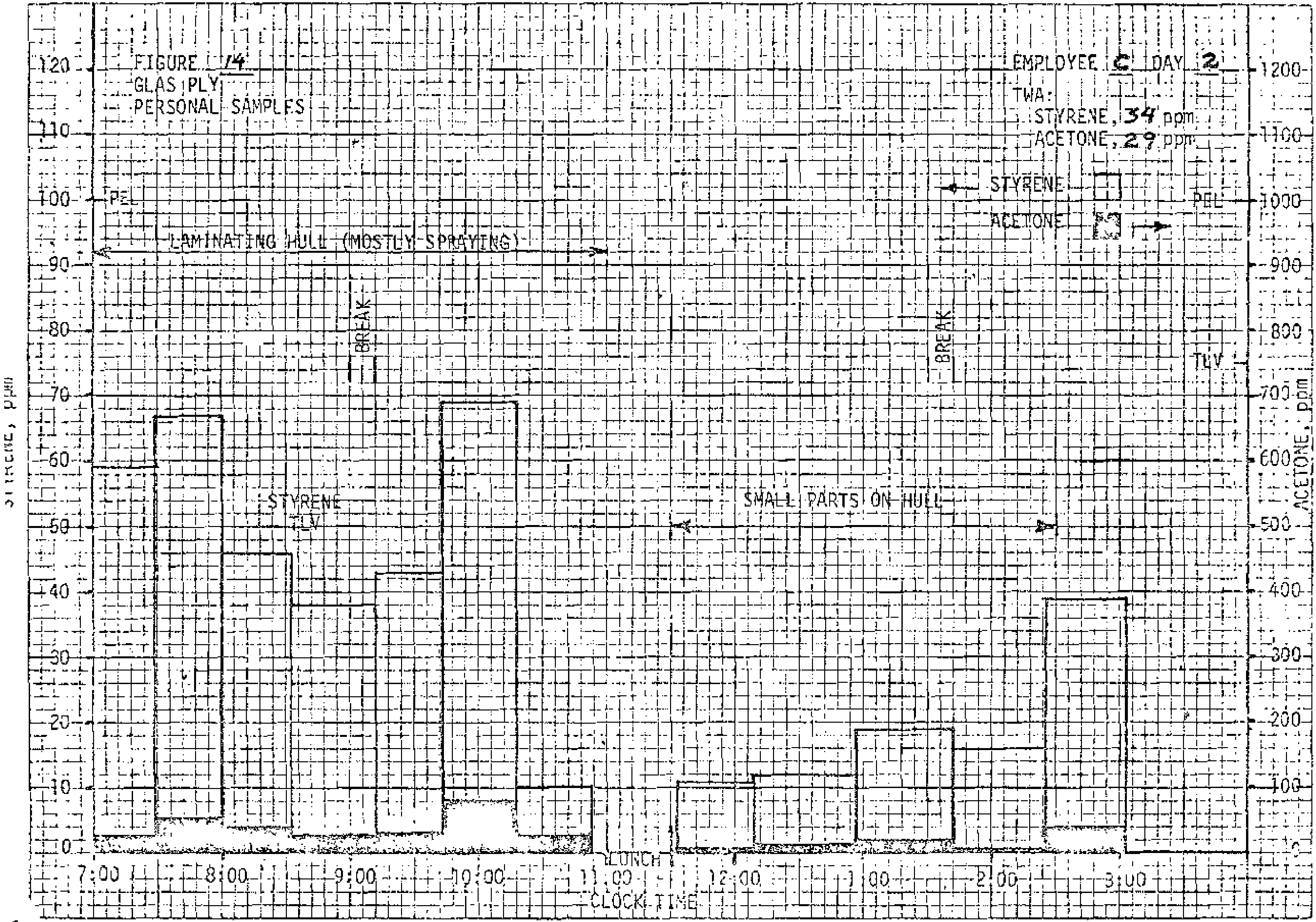


FIGURE 14
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE C DAY 2
TWA:
STYRENE, 34 ppm
ACETONE, 29 ppm
STYRENE
ACETONE
PEL
TLV
LAMINATING HULL (MOSTLY SPRAYING)
BREAK
STYRENE TLV
SMALL PARTS ON HULL
LUNCH
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
CLOCK TIME
STYRENE, ppm
ACETONE, ppm

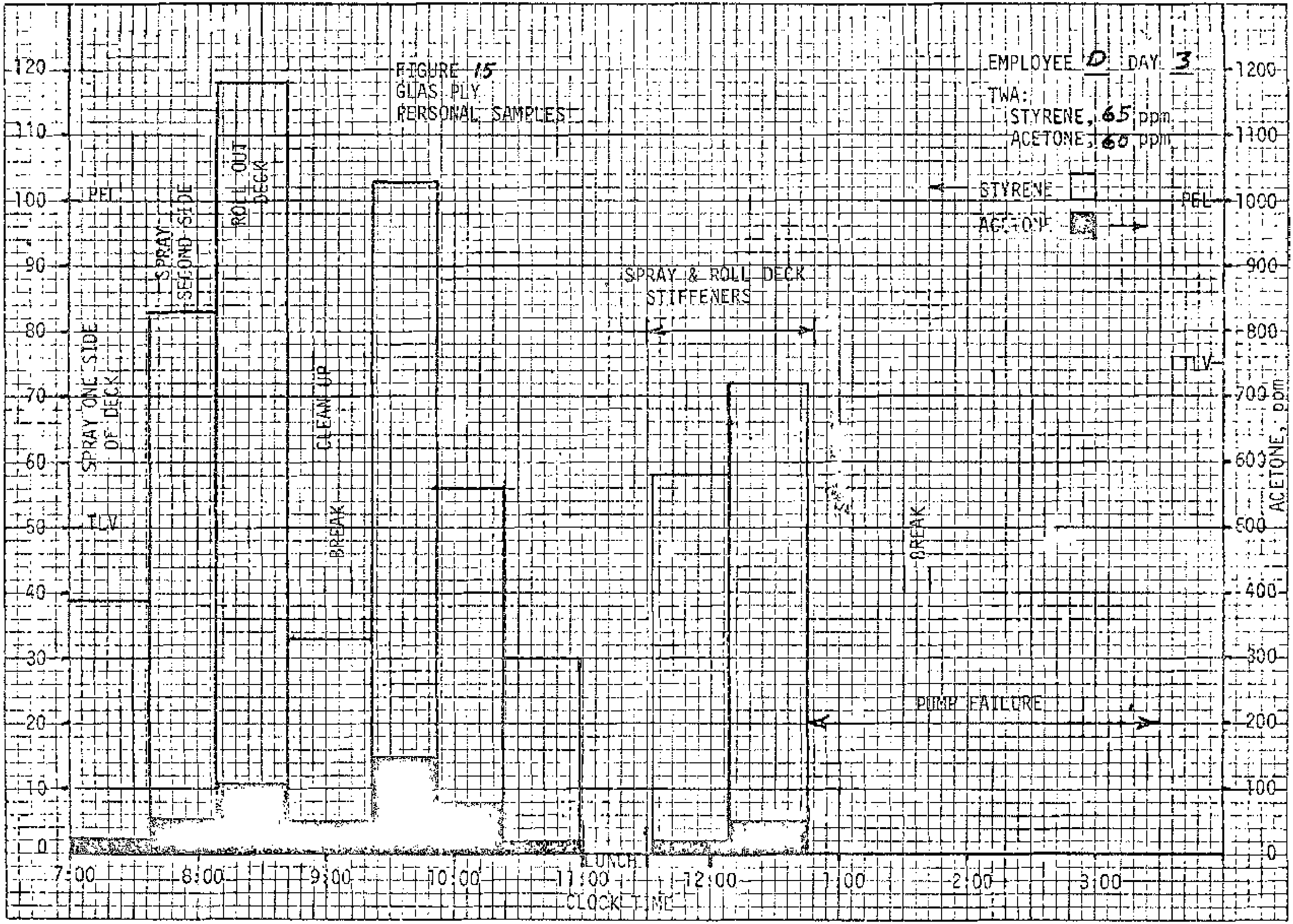


FIGURE 15
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE D DAY 3
TWA:
STYRENE, 65 ppm
ACETONE, 60 ppm
STYRENE
ACETONE
PEL
TLV
SPRAY ONE SIDE OF DECK
SPRAY SECOND SIDE
ROLL OUT DECK
CLEAN UP
BREAK
SPRAY & ROLL DECK STIFFENERS
LUNCH
PUMP FAILURE
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
0
10
20
30
40
50
60
70
80
90
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

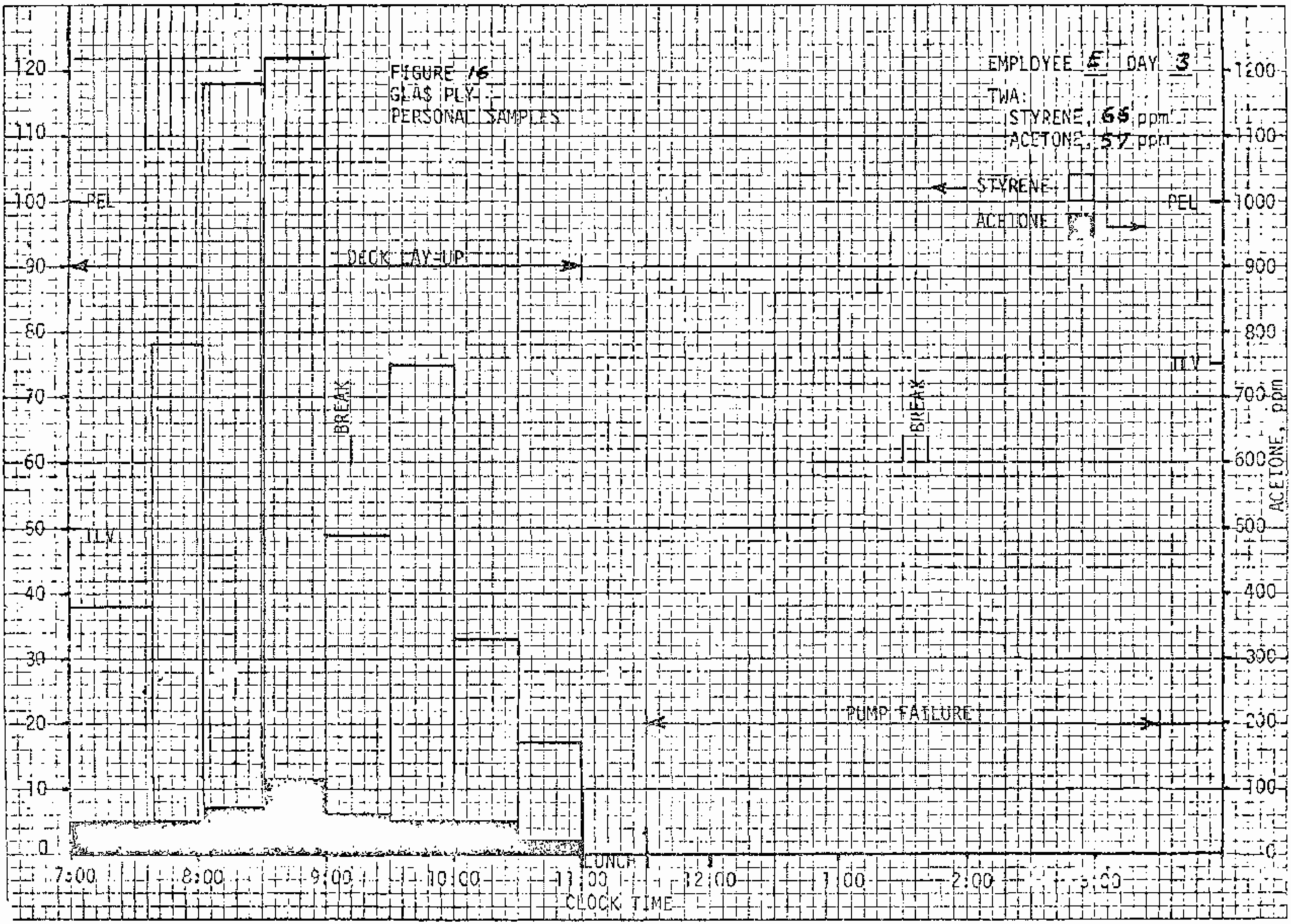


FIGURE 16
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE E DAY 3
TWA:
STYRENE, 65 ppm
ACETONE, 57 ppm
STYRENE
ACETONE
PEL
TLV
DECK LAY-UP
BREAK
BREAK
PUMP FAILURE
LUNCH
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
0
10
20
30
40
50
60
70
80
90
100
110
120
100
200
300
400
500
600
700
800
900
1000
1100
1200

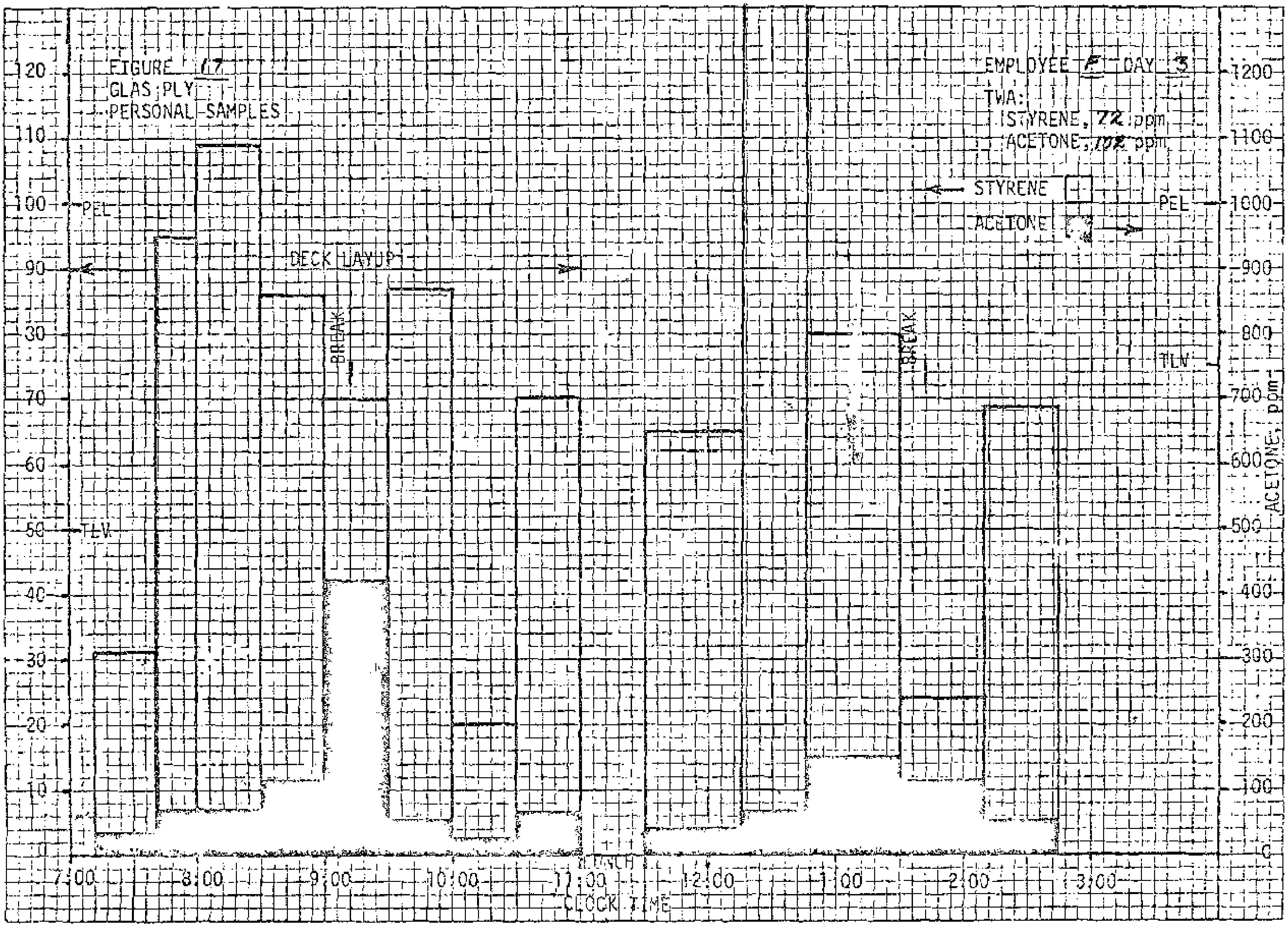


FIGURE 17
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE F DAY 3
TWA:
STYRENE, 72 ppm
ACETONE, 102 ppm
STYRENE
ACETONE
PEL
TLV
DECK LAYUP
BREAK
BREAK
LUNCH
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00

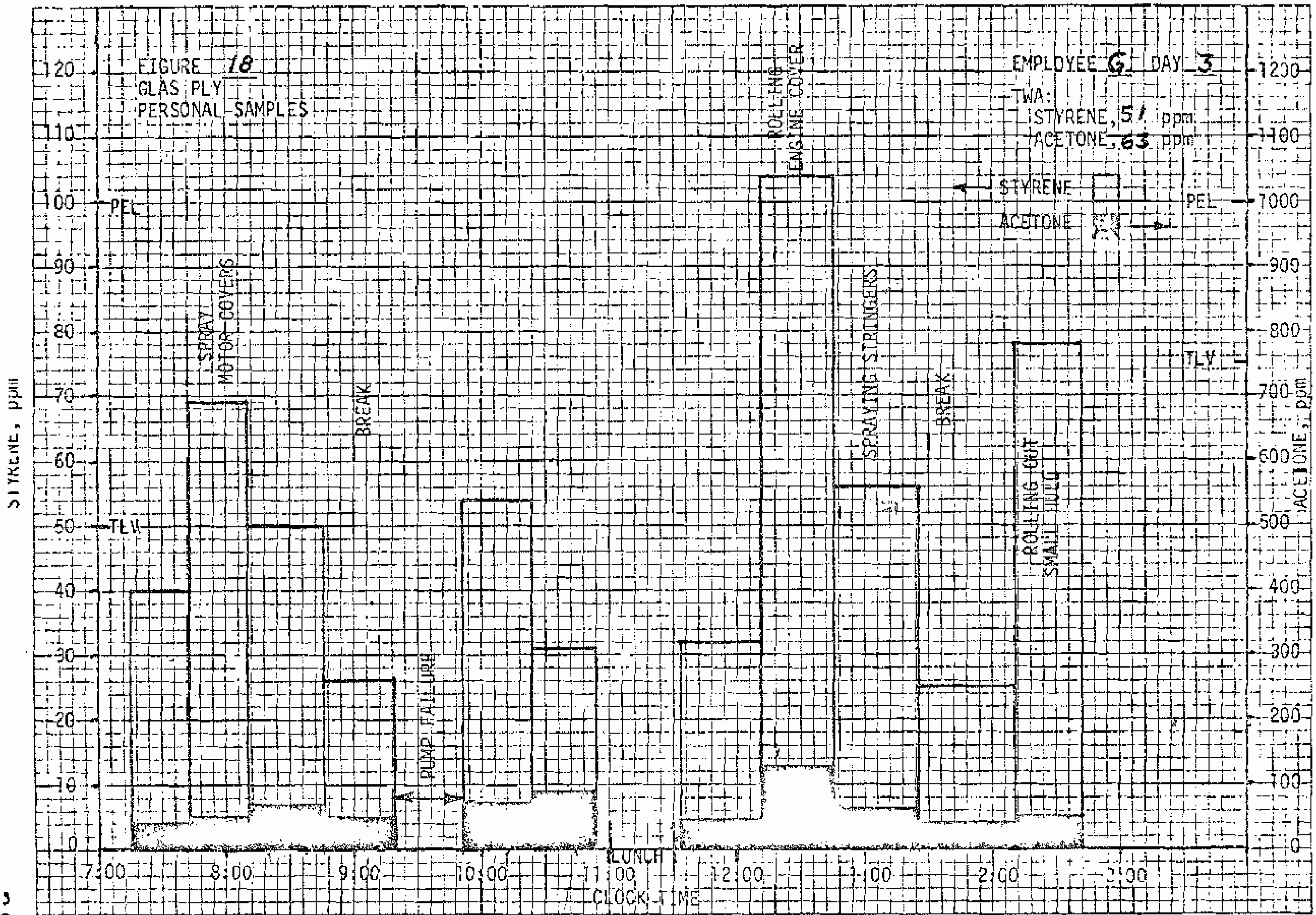


FIGURE 18
GLAS PLY
PERSONAL SAMPLES
EMPLOYEE G DAY 3
TWA:
STYRENE, 51 ppm
ACETONE, 63 ppm
STYRENE
ACETONE
PEL
TLV
SPRAY MOTOR COVERS
BREAK
PUMP FAILURE
LUNCH
ROLLING ENGINE COVER
SPRAYING STRINGERS
BREAK
ROLLING OUT SMALL HULL
STYRENE, ppm
ACETONE, ppm
CLOCK TIME
7:00
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00

Styrene concentration as measured by area samples is reported in Table II. Background concentration of styrene averaged 20 ppm (85 mg/m^3). A comparison of mean background levels with personal exposures yielded a significant difference in means (p of less than 0.1), leading to the conclusion that background levels from fugitive evaporation are the major cause of exposure. Visual examination of chart recorder tracings yielded no important temporal trends in background levels. The chart recorder revealed peaks of acetone and styrene related to near-by spraying or cleaning operations. These peaks were of short duration. An example of this peaking is shown in Figure 19.

TABLE II

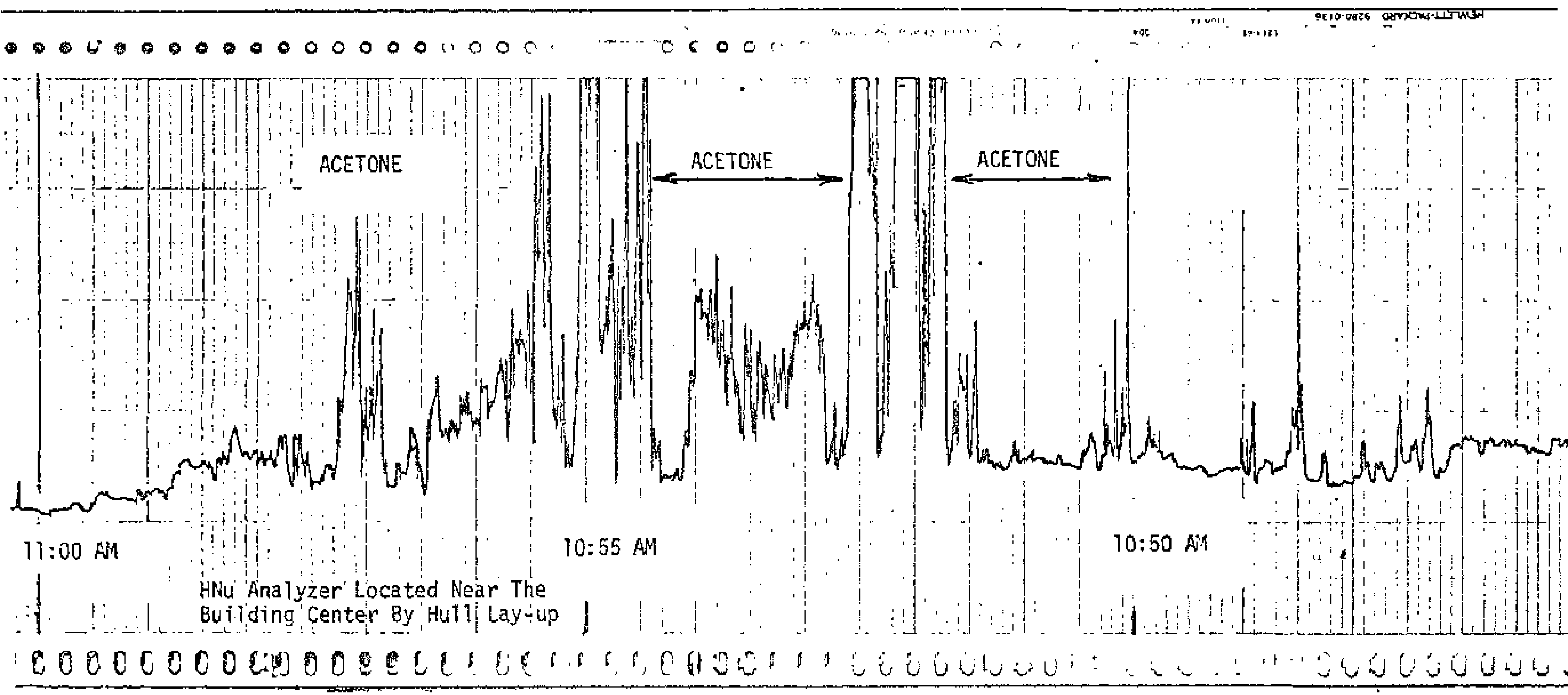
GLAS PLY, MARYSVILLE, WASHINGTON
AREA SAMPLE DATA*

Sample Location	ppm Styrene	ppm Acetone
December 2, 1981		
Bay D, Row 1, Hull lay-up and Gel Coat Area	25	24
	26	23
Bay B, Row 1	15	23
	12	8
Bay C,Row 3, Hull Lay-up	31	11
	24	17
Bay G, Row 2, Chopper Gun	28	27
	21	13
December 3, 1981		
Bay B, Row 1, Gel Coating Area	19	17
Bay F, Row 1	27	30
Bay F, Row 1, Deck Lay-up Area	21	22
	12	8
Bay D, Row 4	11	7
Bay F, Row 8.5, East Wall	9	4
Mean Value	20	16.7
PEL	100	1000
Standard Dev.	7.2	8.3

* By charcoal tube sampling

FIGURE 19

ACETONE PEAKS FROM CLEAN-UP PRIOR TO THE 11:00 AM
LUNCH BREAK. 12/1/81 GLAS PLY BOAT COMPANY, MARYSVILLE, WASHINGTON



Employees in this plant could be arbitrarily divided into low (less than 50 ppm) and high (greater than 50 ppm) exposure groups. Those in the low exposure category worked in the center bay of the building, directly under the fresh air louvers, which is an area of high turbulence and subsequent good mixing. Those in the high exposure category either worked in the side bay, an area of relatively static air, or worked in confined areas while installing hull bracings and while painting hull interiors.

DISCUSSION:

The use of dilution ventilation has four limiting factors:[1] (1) the quantity of contaminant generated must not be too great or air volume necessary for dilution will be impractical; (2) workers must be far enough from contaminant evolution, or evolution of contaminant must be in sufficiently low concentration so that workers will not have an exposure in excess of the extablished TLV or PEL value; and (3) the toxicity of the contaminant must be low; (4) the evolution of contaminants must be reasonably uniform.

The quantity of contaminant generated does not overwhelm the ventilation system at a PEL of 100 ppm styrene. The system reportedly has reserve capacity to increase the air changes per hour but this may generate excessive losses in the curing resin and would lead to higher heating costs.

The effectiveness factor is 2.2 when the average worker styrene exposure (45 ppm) is considered. This indicates the limitation of a dilution ventilation system when workers must work in close contact to a contaminant source. It is doubtful that an increase in air changes will alter this significantly.

The toxicity of styrene (PEL 100 ppm) is considered to be moderate. If the NIOSH recommendation for a 50 ppm TLV for styrene prevails it could be classified as highly toxic and the dilution ventilation approach will be hard pressed to meet the standard.

The evolution of styrene in a boat building plant is normally fairly uniform. This is because the resin is applied from a fixed number of spray nozzles which collectively will result in a uniform resin use rate. The peaks observed on the HNu™ chart are almost entirely attributable to acetone not styrene.

Acetone is used to clean styrene from parts, equipment and workers skin and clothing. Four of the nine observed acetone pots were open. Acetone used to clean the spray guns evaporates quickly into the room air. This cleaning activity preceeded each break and the end of the shift. The acetone exposure is well below the PEL of 1000 ppm but unnecessary exposure could possibly be avoided by cleaning parts just in front of the exhaust air inlet grills where the capture velocity is sufficient to overcome the eddy currents in the building. This could be accomplished within two feet of the exhaust air inlet grill where the air flow is steady and greater than 50 FPM.

Workers should be encouraged to wear organic vapor respirators while performing spray-on and roll-out tasks. The employees have the benefit of American Optical double cartridge organic vapor respirators but some choose not to use them.

Glas Ply is to be commended on the generally good housekeeping in the applications building. Kraft paper is placed on the floor to prevent the build-up of resin/fiber mats on the concrete. This paper is routinely replaced to provide a clean work surface and to prevent dusty air.

The 8 hour PEL of 100 ppm for styrene or the PEL of 1000 ppm for acetone was not exceeded nor was the acceptable ceiling concentration of 200 ppm styrene exceeded. If the NIOSH and ACGIH recommended TLV of 50 ppm and 100 ppm STEL for styrene is promulgated by OSHA, this plant would be in marginal compliance under its current operating procedures. A factor affecting the background styrene level could be the plant production, which was 1/3 the normal.

It is doubtful that significant changes in the exposure of the lamination workers could be made without significant changes in the ventilation system. The existing dilution ventilation system is however adequate to meet the current PEL of 100 ppm, under present production schedules.

Recommendations:

The ventilation system at Glas Ply performs well as a dilution ventilation system by keeping styrene levels generally well below the OSHA PEL of 100 ppm. There were a few workers whose styrene exposure was higher than the NIOSH (ACGIH) recommended TLV of 50 ppm styrene. These exposures occurred during spray-on and roll-out operations within laminated hulls which are not tilted, lamination of small parts, "taping up" a hull/deck and, dressing the inside of a boat with resin paint.

The dilution ventilation system does not assure an air supply to tight quarters such as inside a boat and within untilted hulls. Work areas along the walls do not always receive air at velocities sufficient to sweep styrene away or to cause rapid mixing. Observed air flow patterns indicate that air is eddying in a vertical plane at the walls and that styrene released in these areas will tend to linger. The area samples taken over 2 to 4 hour periods do not show styrene concentrations in excess of 31 ppm. Personal samples for styrene on lamination operators in these same areas indicate considerably higher exposures.

The following recommendations are made to aid in reducing exposures with the existing ventilation system.

1. Move all spray-on operation toward the center of the building to be within the turbulent air zone. The most turbulence occurred directly under the inlet air louvers but considerable mixing was observed in other areas except within twenty feet of the east and west walls.

2. Because of the confined spaces, auxiliary ventilation should be employed for deck/hull taping and interior boat hull painting operations

3. Grinding operations should be placed near the walls where low air turbulence will minimize the dispersion of the dust generated. It is very important that protective equipment be used to avoid inhaling the grinding dust.

4. Organic vapor respirators should be worn during spray-on and roll-out operations.

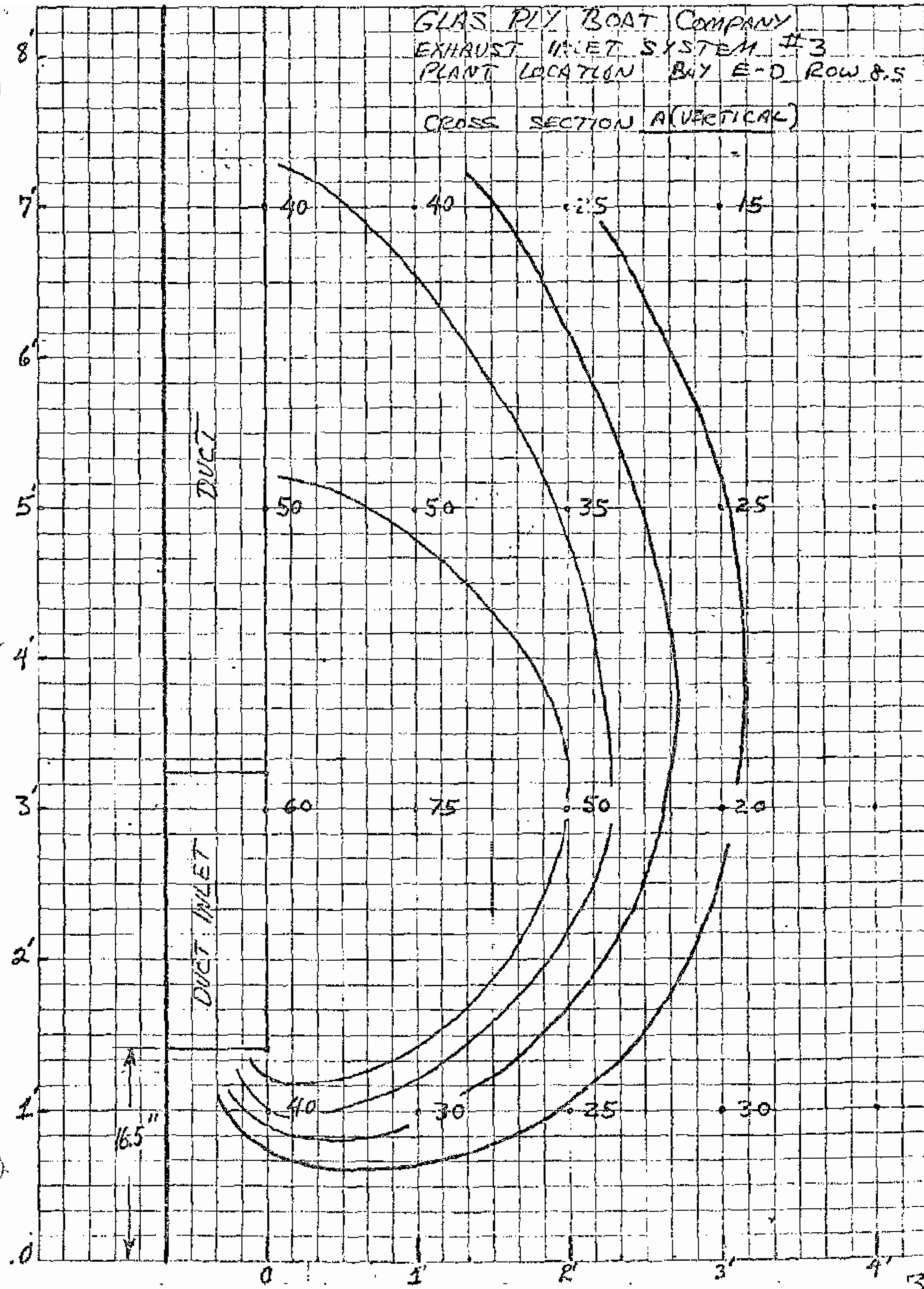
References:

1. Industrial Ventilation, 14th Edition, Section 2. Dilution Ventilation ACGIH, 1976, page 2-1

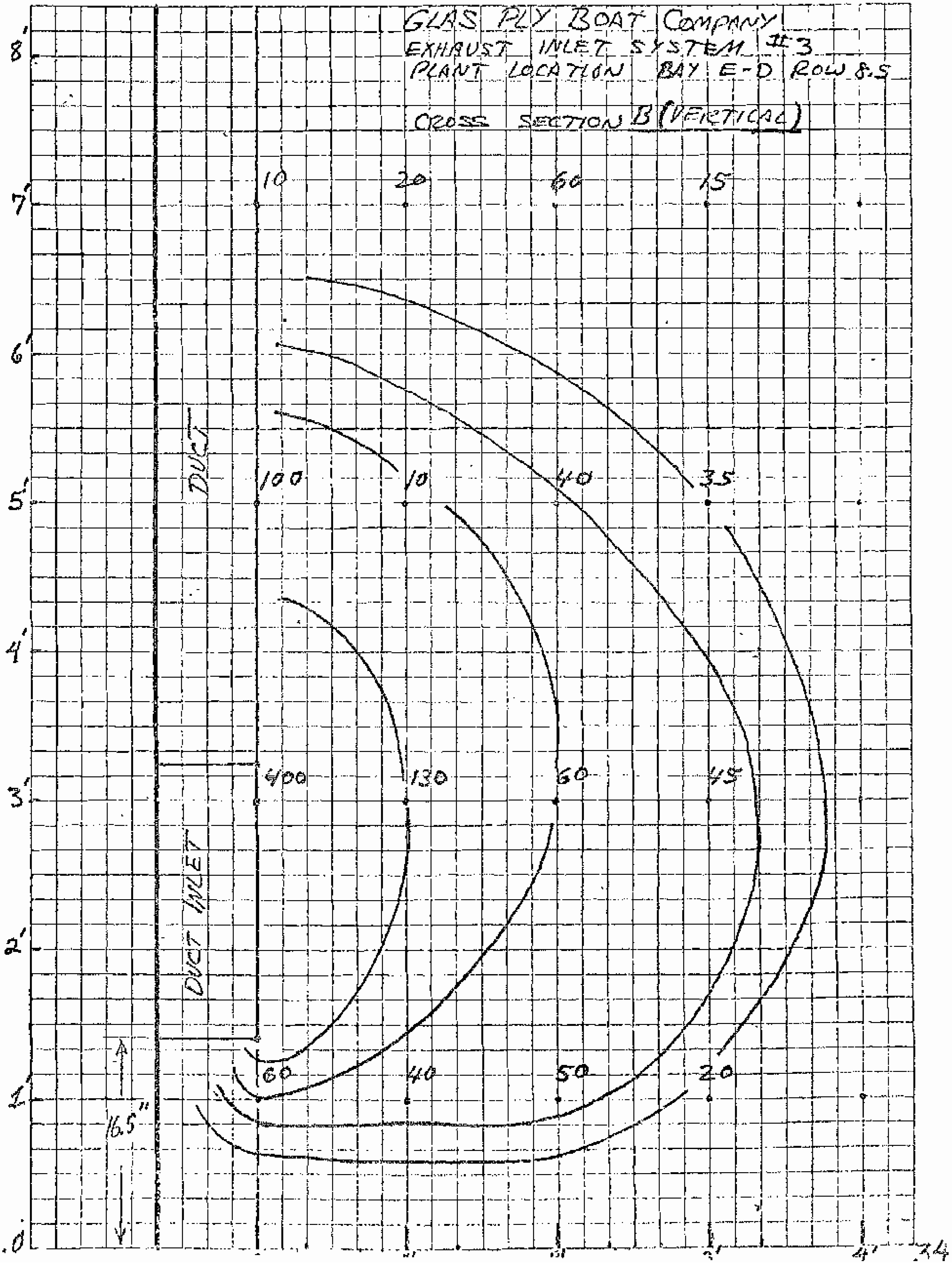
2. Ibid.

APPENDIX A

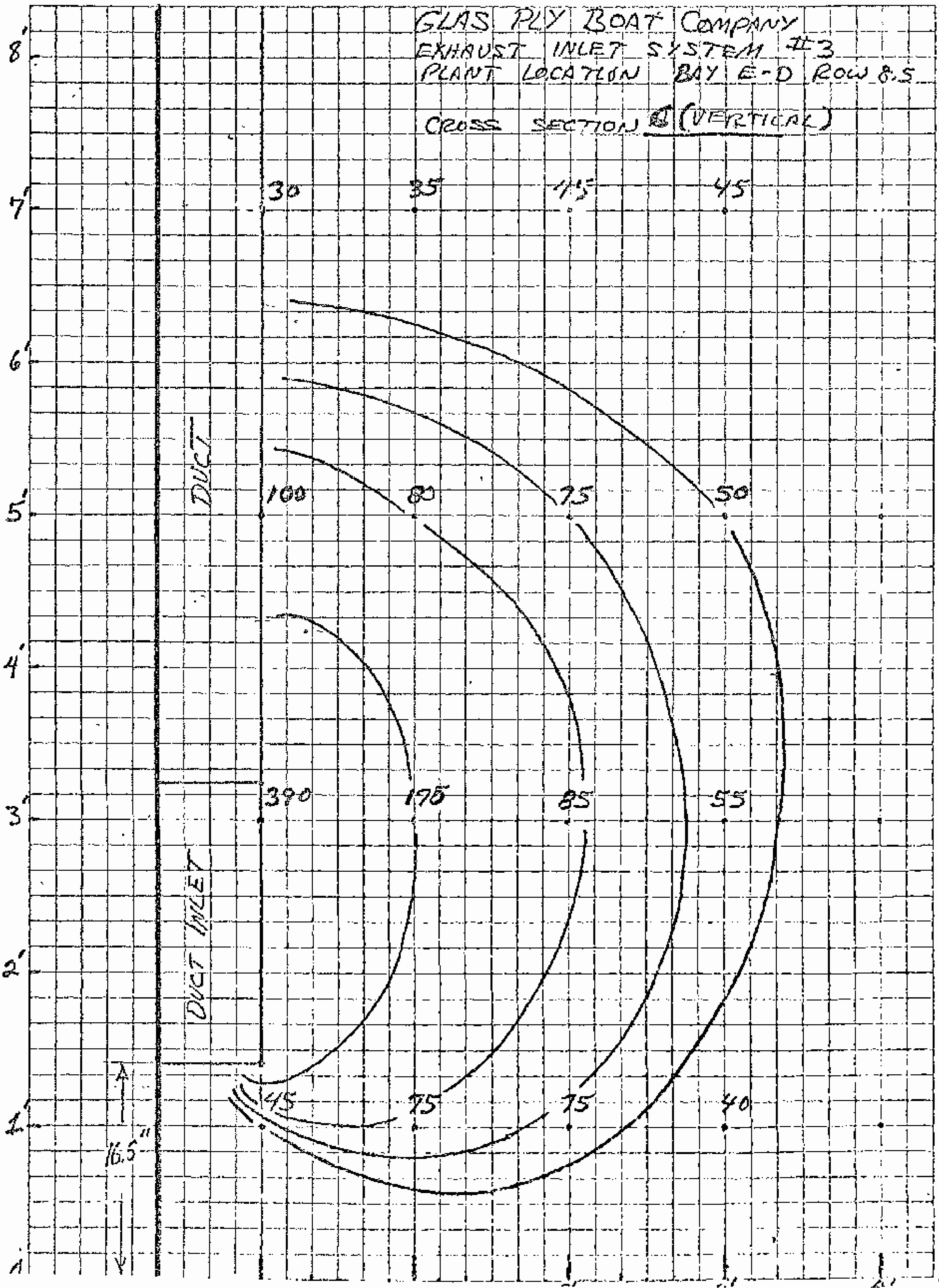
Exhaust Air Inlet Flow Patterns and Velocities


GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 8.5
CROSS SECTION A (VERTICAL)
DUCT
DUCT INLET
16.5"
40
40
25
15
50
50
35
25
60
75
50
20
40
30
25
30
8'
7'
6'
5'
4'
3'
2'
1'
0'
0
1'
2'
3'
4'

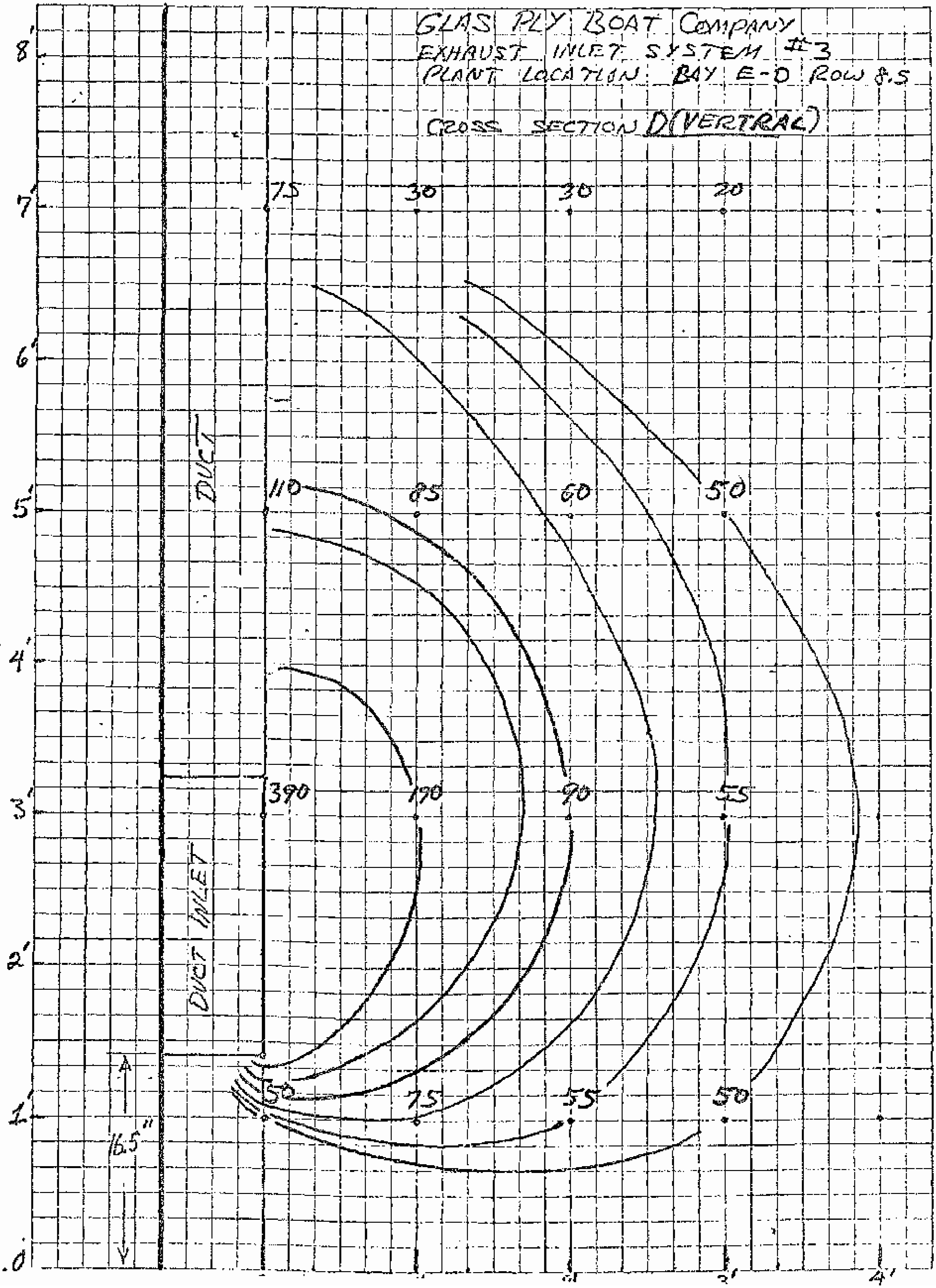
12-2-81


GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 8.5
CROSS SECTION B (VERTICAL)
8'
7'
6'
5'
4'
3'
2'
1'
0
10
20
60
15
DUCT
100
10
40
35
400
130
60
45
DUCT INLET
60
40
50
20
16.5"
4'

12-2-41

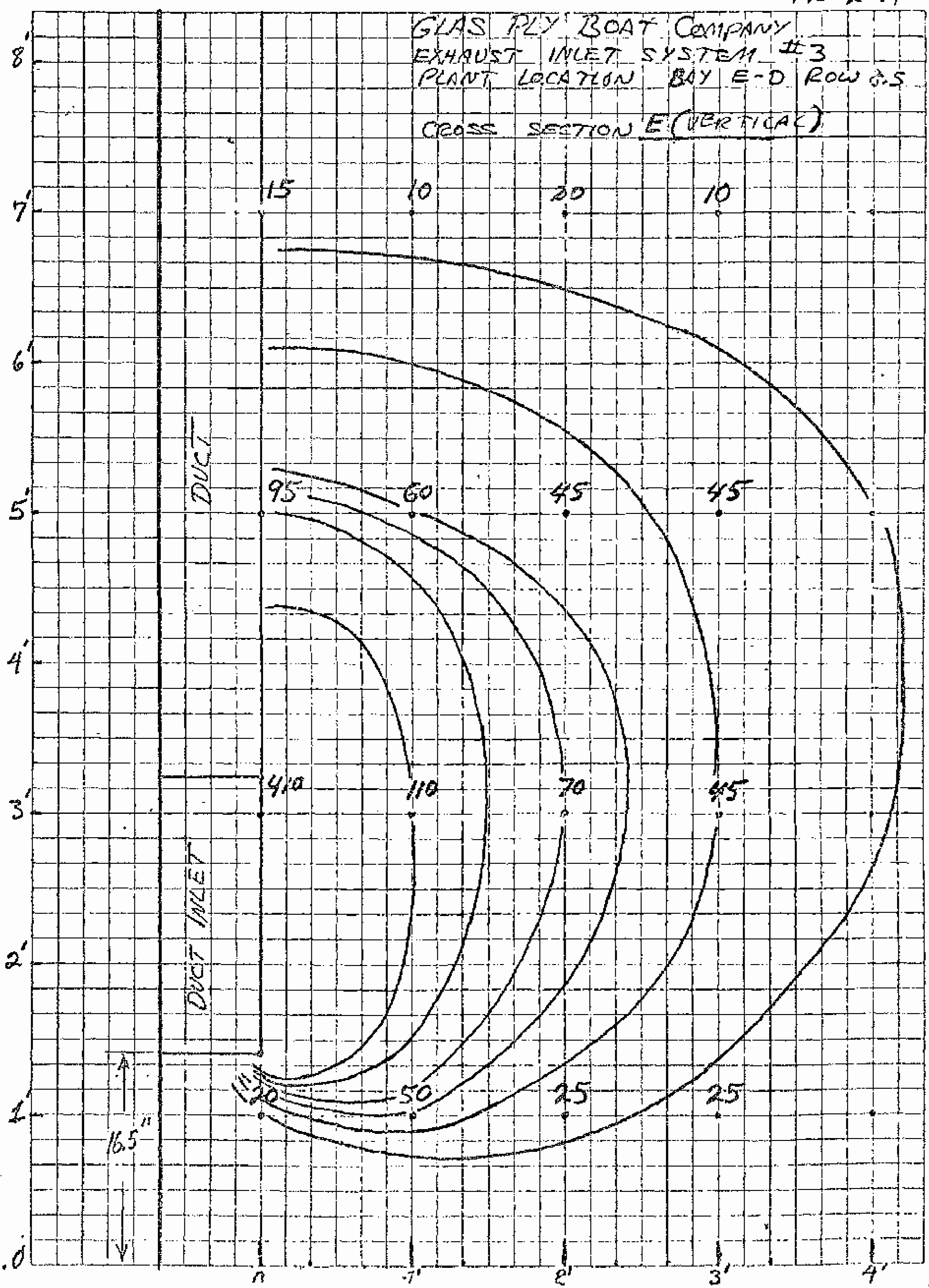

GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 8.5
CROSS SECTION (VERTICAL)
8'
7'
6'
5'
4'
3'
2'
1'
30
35
45
100
80
75
50
390
175
85
55
45
75
75
40
DUCT
DUCT INLET
16.5"

12-2-81


GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 8.5
CROSS SECTION D (VERTRAL)
DUCT
DUCT INLET
16.5"
8'
7'
6'
5'
4'
3'
2'
1'
0
75
30
30
20
110
85
60
50
390
190
90
55
50
75
55
50
3'
4'

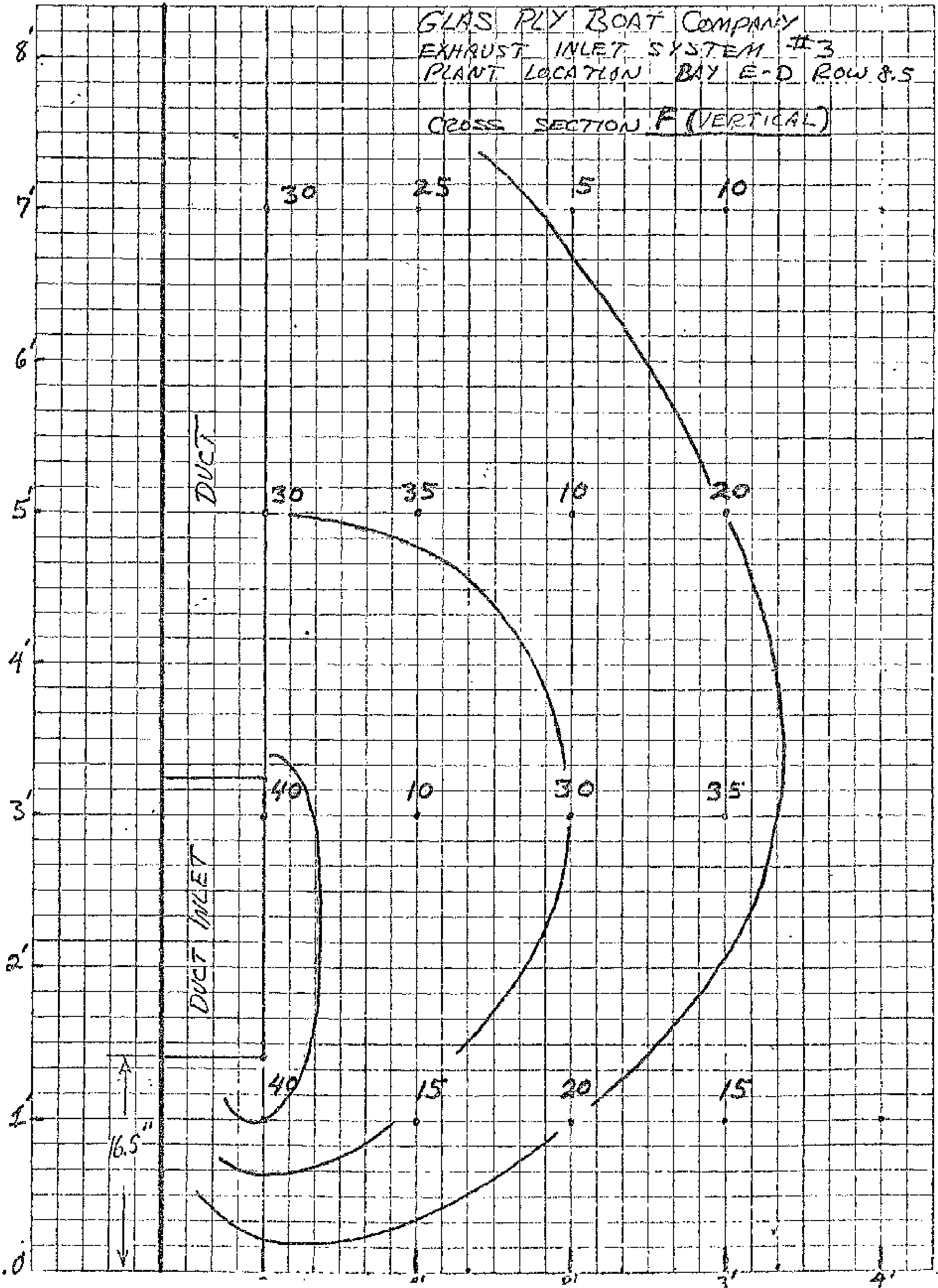
36

12-2-81


GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 3.5
CROSS SECTION E (VERTICAL)
DUCT
DUCT INLET
16.5"
15
10
20
10
95
60
45
45
410
110
70
45
20
50
25
25
8'
7'
6'
5'
4'
3'
2'
1'
0
1'
2'
3'
4'

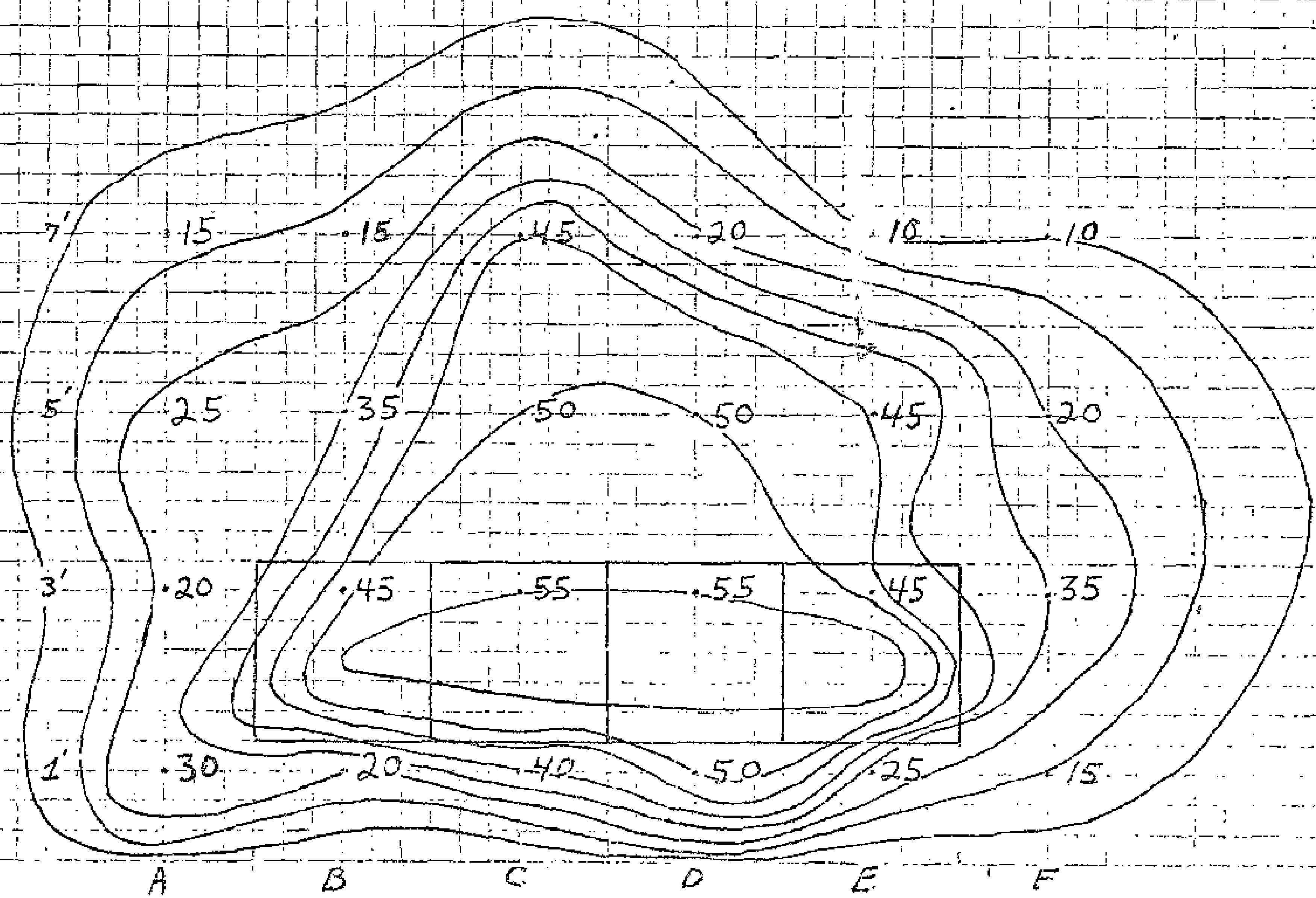
37

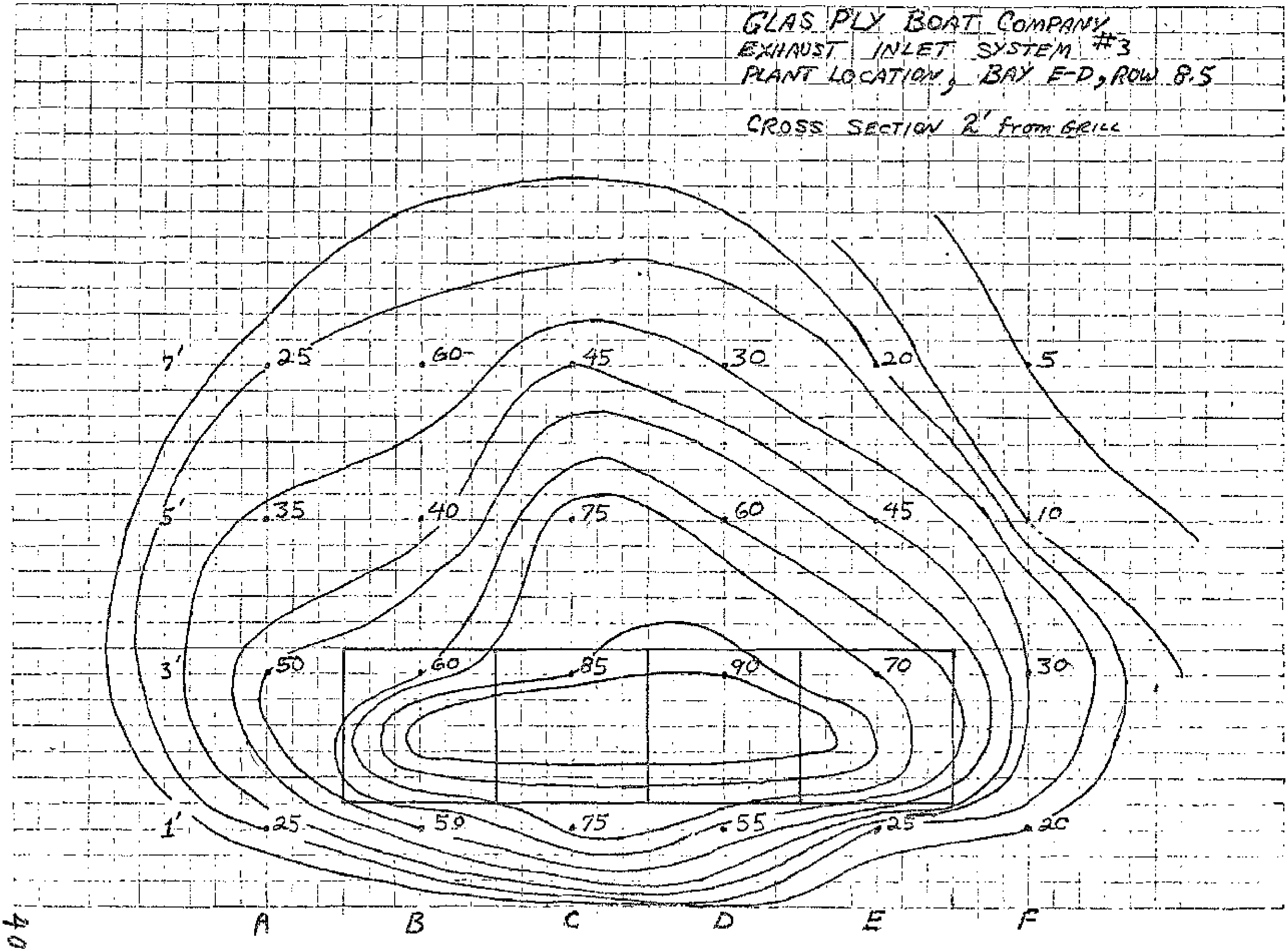
12-2-81


GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION BAY E-D ROW 8.5
CROSS SECTION F (VERTICAL)
DUCT
DUCT INLET
16.5"
8'
7'
6'
5'
4'
3'
2'
1'
0'
30
25
5
10
30
35
10
20
40
10
30
35
40
15
20
15
1'
2'
3'
4'

GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION, BAY E-D, ROW 8.5

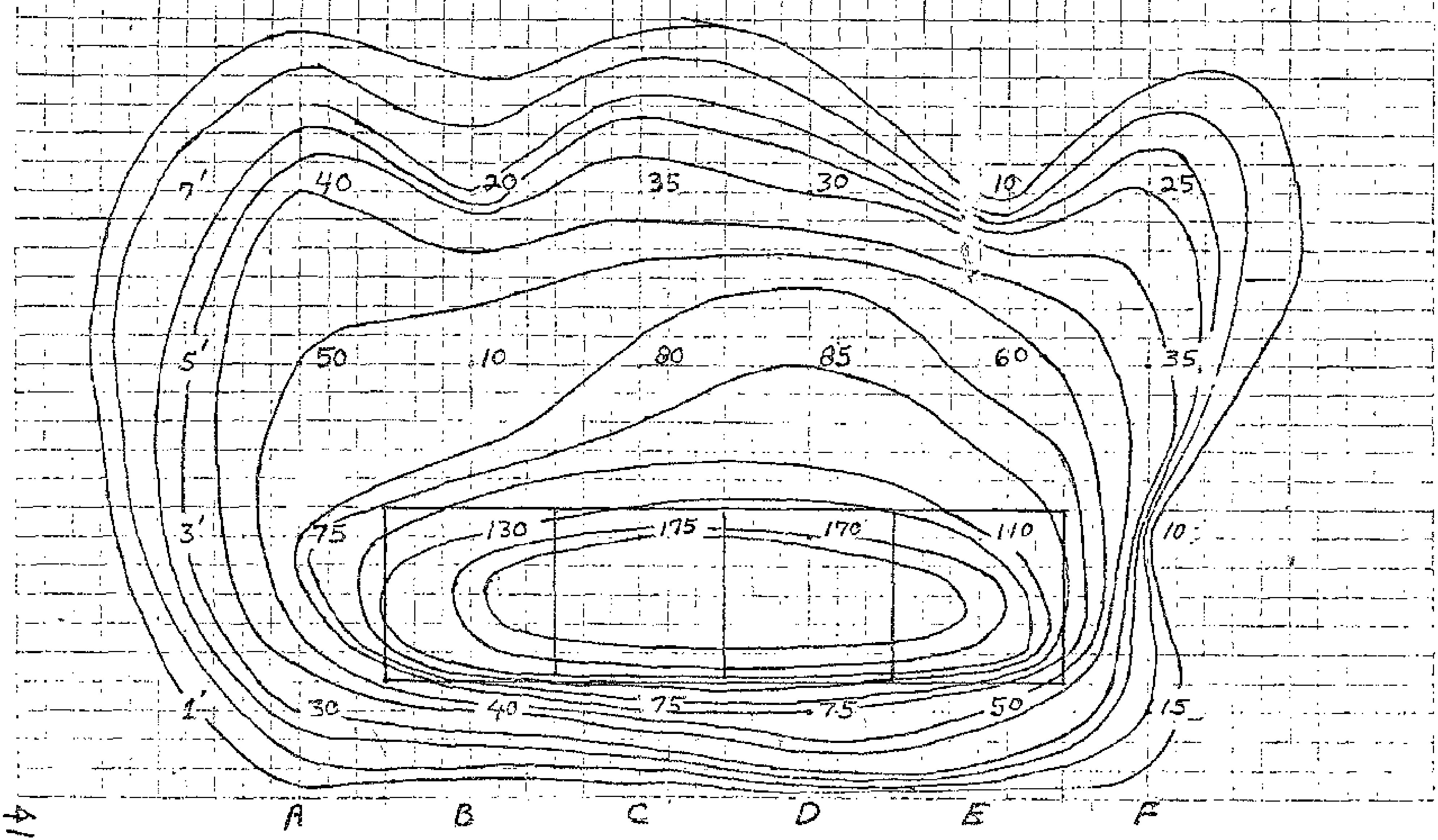
CROSS SECTION 3' FROM GRILL




GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION, BAY E-D, ROW 8.5
CROSS SECTION 2' from GRILL
7'
5'
3'
1'
25
60
45
30
20
5
35
40
75
60
45
10
50
60
85
90
70
30
25
59
75
55
25
20
A
B
C
D
E
F

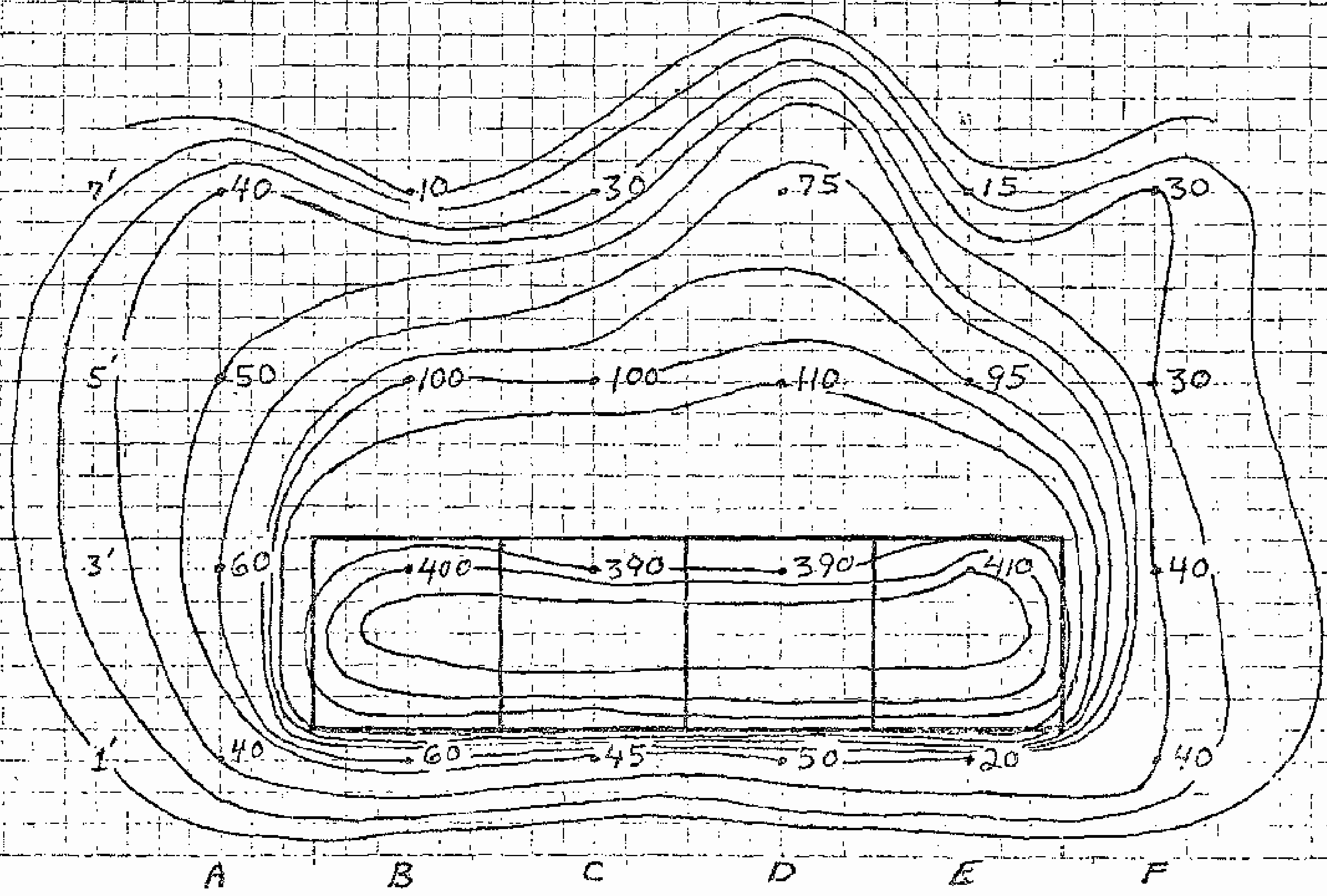
GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION, BAY E-D, ROW 8-5

CROSS SECTION 1' FROM GRILL



GLAS PLY BOAT COMPANY
EXHAUST INLET SYSTEM #3
PLANT LOCATION, BAY E-D, ROW 8.5

CROSS SECTION AT THE GRILL



APPENDIX B

Material Safety Data Sheets From Manufacturers Of Resin Products

GLIDDEN COATINGS & RESINS
DIVISION OF SCM CORPORATION

DWIGHT P. JOYCE RESEARCH CENTER
16651 SPRAGUE ROAD, STRONGSVILLE, OHIO 44136 (216) 771-5121

December 15, 1981

Mr. Bill Todd
Taft Labs., R-5
4676 Columbia Parkway
Cincinnati, Ohio 45226

Dear Mr. Todd:

Enclosed are the Material Safety Data Sheets that we talked about on December 10, 1981. Unfortunately my initial estimates for the styrene content were low. What is on the Material Safety Data Sheets is the correct amounts. I apologize for this error and hope that no inconvenience was caused.

760-W-15113-A	Off White Neo Gel-Kote
760-W-15118	Interior Kote

If we can be of further assistance, please let us know.

Very truly yours,

GLIDDEN COATINGS & RESINS
Division SCM Corporation

Robert L. Toth, Coatings Chemist
Technical Information Center

RLT:eac

enclosures

MATERIAL SAFETY DATA SHEET

NPCA 1
RL5740-30

SCM CORPORATION
Form 1001 Printed in U.S.A. 5/77

FOR COATINGS RESINS AND RELATED MATERIALS

(Approved by U.S. Department of Labor. Essentially Similar to Form OSHA 20)

DATE OF PREP 12/12/81

Section I

MANUFACTURER'S NAME
SCM - COATINGS AND RESINS DIVISION

STREET ADDRESS
900 UNION COMMERCE BLDG

CITY STATE AND ZIP CODE
CLEVELAND, OHIO 44115

EMERGENCY TELEPHONE NO
216-344-6000

PRODUCT CLASS
STYRENE POLYESTER

MANUFACTURERS CODE IDENTIFICATION
760 W19115 A

TRADE NAME OFF-WH NEO GEL-KOTE

Section II — HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT WGT.	TLV PPM	TLV mg/M³	% LEL	VAPOR PRESSURE mm Hg 20C
STYRENE-SOLVENT	38	50		1.1	4.5

Section III — PHYSICAL DATA

BOILING RANGE 293 F.

VAPOR DENSITY [X] HEAVIER [ ] LIGHTER THAN AIR

EVAPORATION RATE [ ] FASTER [X] SLOWER THAN ETHER

PERCENT VOLATILE BY VOLUME 52.2

WEIGHT PER GALLON 10.34

Section IV — FIRE AND EXPLOSION HAZARD DATA

DOT CATEGORY
FLAMMABLE LIQUID - CLASS I C

FLASH POINT
80 F. TCC

% LEL
1.1

EXTINGUISHING MEDIA
CO2, DRY CHEMICAL OR FOAM

UNUSUAL FIRE AND EXPLOSION HAZARDS

KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME. CLOSED CONTAINERS MAY EXPLODE WHEN EXPOSED TO EXTREME HEAT OR FIRE. DO NOT APPLY TO HOT SURFACES.

SPECIAL FIRE FIGHTING PROCEDURES

WATER MAY BE INEFFECTIVE ON FIRE BUT WATER SPRAY MAY BE USED TO COOL CLOSED CONTAINERS EXPOSED TO EXTREME HEAT OR FIRE TO PREVENT PRESSURE BUILD UP AND POSSIBLE AUTOIGNITION OR EXPLOSION.

I (Back) Printed in U.S.A. 5/77

Section V — HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE SEE SECTION II

EFFECTS OF OVEREXPOSURE
IRRITATION OF EYES, SKIN, AND RESPIRATORY TRACT. POSSIBLE DERMATITIS ON REPEATED # PROLONGED SKIN CONTACT. POSSIBLE HEADACHE, DIZZINESS AND EVENTUAL UNCONSCIOUSNESS OR COMA.

EMERGENCY AND FIRST AID PROCEDURES
FUMES - MOVE PERSON TO WELL VENTILATED AREA. RESTORE BREATHING. GET MEDICAL ATTENTION.
SKIN CONTACT - WIPE WITH CLEAN CLOTH, WASH THOROUGHLY WITH SOAP AND WATER.
EYE CONTACT - FLUSH THOROUGHLY WITH WATER, GET MEDICAL ATTENTION.

Section VI — REACTIVITY DATA

STABILITY [ ] UNSTABLE [X] STABLE CONDITIONS TO AVOID KEEP AWAY FROM SUN AND HEAT

INCOMPATABILITY (Materials to avoid) AVOID CONTAMINATION WITH FOREIGN MATERIALS.

HAZARDOUS DECOMPOSITION PRODUCTS
CO AND POSSIBLE ACRID FUMES ON IGNITION.

HAZARDOUS POLYMERIZATION [ ] MAY OCCUR [X] WILL NOT OCCUR

CONDITIONS TO AVOID MATERIAL MAY BECOME VISCOUS ON AGING AND BECOME UNUSEABLE

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
REMOVE ALL SOURCES OF IGNITION. VENTILATE AREA. MOP SPILLS WITH INERT ABSORBENT. BURN SWEEPINGS IN A SAFE AREA.

WASTE DISPOSAL METHOD DISPOSE IN ACCORDANCE WITH LOCAL REGULATIONS. DO NOT INCINERATE CLOSED CONTAINERS.

Section VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION
SPRAY APPLICATION
OPEN AREAS - USE PAINT SPRAY MASK, MECHANICAL FILTER RESPIRATOR
RESTRICTED VENTILATION AREAS - USE PAINT SPRAY MASK AND APPROVED CHEMICAL-MECHANICAL FILTER
CONFINED AREAS - USE AIR LINE RESPIRATORS OR HOODS

VENTILATION
PROVIDE DILUTION VENTILATION OR LOCAL EXHAUST TO KEEP VAPORS BELOW THRESHOLD LIMIT VALUES - SEE SECTION II

PROTECTIVE GLOVES SOLVENT RESISTANT GLOVES WHERE PROLONGED CONTACT IS INVOLVED

EYE PROTECTION SPLASH PROOF GOGGLES IN WORKING AREAS SUBJECT TO SPLASHING.

OTHER PROTECTIVE EQUIPMENT

Section IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
STORE BELOW 80 DEGREES F. KEEP CONTAINERS CLOSED # AWAY FROM HEAT AND OPEN FLAME

OTHER PRECAUTIONS
AVOID PROLONGED CONTACT WITH SKIN AND BREATHING VAPORS OR SPRAY MIST. DO NOT TAKE INTERNALLY.

760 W15115 A

MATERIAL SAFETY DATA SHEET

R157...-20

SCM CORPORATION
Form 3001 Printed in U.S.A. 5/77

FOR COATINGS, RESINS AND RELATED MATERIALS

(Approved by U.S. Department of Labor "Essentially Similar" to Form OSHA 20)

DATE OF PREP 12/12/81

Section I

MANUFACTURER'S NAME
SCM - COATINGS AND RESINS DIVISION

STREET ADDRESS
900 UNION COMMERCE BLDG

CITY, STATE, AND ZIP CODE
CLEVELAND, OHIO 44115

EMERGENCY TELEPHONE NO.
216-344-8000

PRODUCT CLASS
STYRENE POLYESTER

MANUFACTURER'S CODE IDENTIFICATION
760 W15118

TRADE NAME
INTERIOR KOTE

Section II — HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT WGT.	TLV PPM	TLV mg/M³	% LEL	VAPOR PRESSURE *
STYRENE-SOLVENT	39	50		1.1	4.5

* mm Hg 20C

Section III — PHYSICAL DATA

BOILING RANGE 293 F.

VAPOR DENSITY [X] HEAVIER [ ] LIGHTER THAN AIR

EVAPORATION RATE [ ] FASTER [X] SLOWER THAN ETHER

PERCENT VOLATILE BY VOLUME 53.5

WEIGHT PER GALLON 10.26

Section IV — FIRE AND EXPLOSION HAZARD DATA

DOT CATEGORY
FLAMMABLE LIQUID - CLASS I C

FLASH POINT
88 F. TCC

% LEL
1.1

EXTINGUISHING MEDIA
CO2, DRY CHEMICAL OR FOAM

UNUSUAL FIRE AND EXPLOSION HAZARDS
KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME. CLOSED CONTAINERS MAY EXPLODE WHEN EXPOSED TO EXTREME HEAT OR FIRE. DO NOT APPLY TO HOT SURFACES.

SPECIAL FIRE FIGHTING PROCEDURES
WATER MAY BE INEFFECTIVE ON FIRE BUT WATER SPRAY MAY BE USED TO COOL CLOSED CONTAINERS EXPOSED TO EXTREME HEAT OR FIRE TO PREVENT PRESSURE BUILD UP AND POSSIBLE AUTOIGNITION OR EXPLOSION.

Printed in U.S.A. 5/77

Section V — HEALTH HAZARD DATA

HOLD LIMIT VALUE SEE SECTION II

CTS OF OVEREXPOSURE
IRRITATION OF EYES, SKIN, AND RESPIRATORY TRACT. POSSIBLE DERMATITIS ON REPEATED & PROLONGED SKIN CONTACT. POSSIBLE HEADACHE, DIZZINESS AND EVENTUAL UNCONSCIOUSNESS OR COMA.

EMERGENCY AND FIRST AID PROCEDURES

FUMES - MOVE PERSON TO WELL VENTILATED AREA. RESTORE BREATHING. GET MEDICAL ATTENTION.
SKIN CONTACT - WIPE WITH CLEAN CLOTH, WASH THOROUGHLY WITH SOAP AND WATER.
EYE CONTACT - FLUSH THOROUGHLY WITH WATER. GET MEDICAL ATTENTION.

Section VI — REACTIVITY DATA

STABILITY [ ] UNSTABLE [ ] STABLE CONDITIONS TO AVOID KEEP AWAY FROM SUN AND HEAT

INCOMPATABILITY (Materials to avoid) AVOID CONTAMINATION WITH FOREIGN MATERIALS.

HAZARDOUS DECOMPOSITION PRODUCTS

CO AND POSSIBLE ACRID FO[illegible]

HAZARDOUS POLYMERIZATION [ ] MAY OCCUR [ ] WILL NOT OCCUR

CONDITIONS TO AVOID MATERIAL MAY BECOME VISCOUS ON AGING AND BECOME UNUSEABLE

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

REMOVE ALL SOURCES OF IGNITION. VENTILATE AREA. MOP SPILLS WITH INERT ABSORBENT. BURN SWEEPINGS IN A SAFE AREA.

WASTE DISPOSAL METHOD DISPOSE IN ACCORDANCE WITH LOCAL REGULATIONS. DO NOT INCINERATE CLOSED CONTAINERS.

Section VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION

SPRAY APPLICATION
OPEN AREAS - USE PAINT SPRAY MASK, MECHANICAL FILTER RESPIRATOR
RESTRICTED VENTILATION AREAS - USE PAINT SPRAY MASK AND APPROVED CHEMICAL-MECHANICAL FILTER
CONFINED AREAS - USE AIR LINE RESPIRATORS OR HOODS

VENTILATION

PROVIDE DILUTION VENTILATION OR LOCAL EXHAUST TO KEEP VAPORS BELOW THRESHOLD LIMIT VALUES - SEE SECTION II

PROTECTIVE GLOVES SOLVENT RESISTANT GLOVES WHERE PROLONGED CONTACT IS INVOLVED

EYE PROTECTION SPLASH PROOF GOGGLES IN WORKING AREAS SUBJECT TO SPLASHING.

OTHER PROTECTIVE EQUIPMENT

Section IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

STORE BELOW 80 DEGREES F. KEEP CONTAINERS CLOSED & AWAY FROM HEAT AND OPEN FLAME

OTHER PRECAUTIONS

AVOID PROLONGED CONTACT WITH SKIN AND BREATHING VAPORS OR SPRAY MIST. DO NOT TAKE INTERNALLY.

760 W15118

TECHNICAL BULLETIN

POLYLITE® POLYURETHANE RESIN

34-748
and 34-846 POLYLITE®
Urethane Pour-Froth
Foam System

TYPE

Two-component, rigid, closed-cell, polyether urethane foam system for pour or froth-in-place applications. Low viscosity with improved flow properties and low foaming pressures. Nominal free rise foam density is 1.9 lbs./ft.^{3} for pour-in-place and 1.6 lbs./ft.^{3} for froth-in-place.

MAJOR USES

For the foam-in-place insulation of refrigerated transportation equipment, industrial freezers, cold rooms, building panels, cavity walls and similar applications.

CONSTANTS OF THE RESIN AND PREPOLYMER

	Viscosity, cps.	Specific Gravity	Approx. Wt./Gal.
Component A: 34-846 Polylite	150-350 @ 77°F.	1.23-1.25 @ 77°F.	10.3 lbs.
Component B: 34-748 Polylite	500-700 @ 77°F.	1.20-1.22 @ 77°F.	10.1 lbs.

		Parts by Weight
Mix Ratio:	Component A: 34-846 Polylite	100
	Component B: 34-748 Polylite	100

REACTIVITY OF THE COMPONENTS (Observed @ 77°F.)

Cream Time (from start of mixing)	0'20"-0'30"
Rise Time (from start of mixing)	1'45"-2'15"
Tack-free Tiem (from start of mixing)	1'45"-2'15"
Control Core Density, Free Rise lbs./ft.^{3}	1.8-2.0

®Registered U.S. Patent Office

(over)

REICHHOLD CHEMICALS, INC. • RCI BUILDING, WHITE PLAINS, N.Y. 10602

APPLICATION INFORMATION

This Polylite foam system is designed for processing with commercial froth foam dispensing equipment provided with flow control systems for the continuous injection of fluorocarbon refrigerant 12. The R-12 injection rate should be adjusted to provide a froth foam free-rise core density of 1.6 to 1.7 lbs./ft.^{3} (approximately 4% or R-12 on total foam system weight).

The following is a suggested froth machine starting point ratio:

	Parts by Weight
Component A: 34-846 Polylite	48
Component B: 34-748 Polylite	48
Fluorocarbon R-12	4
	100

PHYSICAL PROPERTIES OF THE FOAM

Core density, lbs./ft.^{3}	1.8
% Closed Cells	92
K-Factor, Initial, 77°F., BTU/hr./ft.^{2}/in.°F.	0.12
Water Absorption, 10 ft. head, 77°F., 14 days ...... lbs./ft.^{2} of surface area	0.08
Compressive strength at 10% deflection paralled to rise, psi	35
Tensile Strength, parallel to rise, psi	42

SEE ATTACHED BULLETIN ON FLAMMABILITY

HANDLING PRECAUTIONS

34-748 Polylite contains a volatile fluorocarbon liquid which boils at 74.8°F. and volatilizes readily at room temperature. In confined areas it may displace enough air to be hazardous. Adequate ventilation must be provided when handling fluorocarbons.

34-846 Polylite contains a reactive isocyanate of the low volatility, minimal toxicity type, but is nevertheless classified as a toxic material. Avoid contact with skin, eyes, or clothing. Avoid breathing vapors. Foaming operations should be performed in well ventilated areas. Forced ventilation is recommended in confined areas to help keep vapors away from the workers. The use of a respirator is imperative in spraying operations. In case of contact with eyes, wash with plenty of water and get immeidate medical attention. Wash skin or clothing immediately with alcohol, then with plenty of soap and water.

Continued ....

STORAGE INSTRUCTIONS

34-748 Polylite contains a volatile fluorocarbon and should be stored at 75°F. or below; 60°F.-70°F. is recommended. When opening the container prior to use, partially unscrew the cap or vent bung to relieve any pressure before opening fully. Reseal the container as soon as required amount is withdrawn and return to cool storage.

34-846 Polylite should be protected from moisture contamination. For intermittent uses, the container or drum should be fitted with a dry air breather (a 9" pipe nipple filled with anhydrous calcium sulfate stopped on ends with cotton plugs and fitted into the vent bung). A storage temperature of 70°F.-90°F. is recommended.

All materials, when properly stored, are stable for at least six months.

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NPVLA 6

MATERIAL SAFETY DATA SHEET

(APPROVED BY U.S. DEPARTMENT OF LABOR "ESSENTIALLY SIMILAR" TO FORM LSB 005-4)

Section I

MANUFACTURER'S NAME	Reichhold Chemicals, Inc.
STREET ADDRESS	525 North Broadway
CITY, STATE AND ZIP CODE	White Plains, New York 10602
EMERGENCY TELEPHONE NO.	914-682-5700
CHEMICAL NAME AND SYNONYMS	
TRADE NAME	Polylite® 34-748
CHEMICAL FAMILY	Polyol
FORMULA	

Section II — HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS

PIGMENTS	%	TLV (Units)	SOLVENTS	%	TLV (Units)
NA			Trichloromonofluoromethane	>30	Group 5A
CATALYST			ADDITIVES		
Amines	<1		NA		
VEHICLE			OTHERS		
NA			NA		

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
NA		

Section III — PHYSICAL DATA

BOILING POINT (°F) (of the solvent)	77°F	SPECIFIC GRAVITY (H_2O=1)	1.22
VAPOR PRESSURE (mm Hg)		PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE (butyl ether	greater
SOLUBILITY IN WATER			
APPEARANCE AND ODOR			

Section IV — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) Flash Point Closed Cup 272°F (after evaporation of Freon)

FLAMMABLE LIMITS | Lel | Uel

EXTINGUISHING MEDIA Water, Chemicals CO_2

SPECIAL FIRE FIGHTING PROCEDURES None

UNUSUAL FIRE AND EXPLOSION HAZARDS Possible trichloromonofluoromethane breakdown to toxic gas in extremely high fire temperatures

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Section V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

EFFECTS OF OVEREXPOSURE
Possibly reduces the oxygen supply below the level necessary to support life.

EMERGENCY AND FIRST AID PROCEDURES

Section VI - REACTIVITY DATA

STABILITY	UNSTABLE	X	CONDITIONS TO AVOID High temperatures
	STABLE		

INCOMPATABILITY *(Materials to avoid)* None

HAZARDOUS DECOMPOSITION PRODUCTS
Possible thermal breakdown of fluorocarbon to toxic gas

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

Section VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Avoid breathing fumes - use adequate fresh air supply.

WATER DISPOSAL METHOD Flush with water

Section VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)* Fresh air supply

VENTILATION	LOCAL EXHAUST X	SPECIAL
	MECHANICAL *(General)* Down Draft-fumes heavier than air	OTHER

PROTECTIVE GLOVES X | EYE PROTECTION X

OTHER PROTECTIVE EQUIPMENT

Section IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
75oF or below - relieve pressure slowly when opening container.

OTHER PRECAUTIONS Reseal container well.

MATERIAL SAFETY DATA SHEET

(Approved by U.S. Department of Labor, Essentially Similar to Form LSB 005 4)

NPVLA 0-70

Section I

MANUFACTURER'S NAME	Reichhold Chemicals, Inc.
STREET ADDRESS	525 North Broadway
CITY, STATE AND ZIP CODE	White Plains, New York 10602
EMERGENCY TELEPHONE NO.	914-682-5700
CHEMICAL NAME AND SYNONYMS	Polymeric isocyanate
TRADE NAME	Polylite 34-846
CHEMICAL FAMILY	
FORMULA	

Section II — HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES & SOLVENTS

PIGMENTS	%	TLV (Units)	SOLVENTS	%	TLV (Units)
Not Applicable			Not Applicable		
CATALYST			ADDITIVES		
Not Applicable			Not Applicable		
[illegible]LE			OTHERS		
Not Applicable			Not Applicable		

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES

	%	TLV (Units)
Diphenylmethane diisocyanate	50	0.02 ppm
Higher polymers of similar structure	50	not established

Section III — PHYSICAL DATA

BOILING POINT (°F) @ 5 mm Hg	406 (208°C)	SPECIFIC GRAVITY (H_2O=1)	1.24
VAPOR PRESSURE (mm Hg) @ 25°C	1 x 10[illegible]	PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE	
SOLUBILITY IN WATER	Insoluble		
APPEARANCE AND ODOR	Brown viscous liquid, odor very slightly aromatic		

Section IV — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) Pensky-Martens Closed Cup 383°F	FLAMMABLE LIMITS	Lel	Uel

EXTINGUISHING MEDIA CO_2, dry chemical foam or water fog may be used

SPECIAL FIRE FIGHTING PROCEDURES The usual fireman's body protection should be worn as well as self-contained breathing apparatus to protect from vapors formed from the product

UNUSUAL FIRE AND EXPLOSION HAZARDS

This information is furnished without warranty, representation, inducement or license of any kind, except that it is accurate to the best of Reichhold Chemicals, Inc.'s knowledge, or obtained from sources believed by Reichhold Chemicals, Inc. to be accurate, and Reichhold Chemicals, Inc. does not assume any legal responsibility for use or reliance upon same. Customers are encouraged to conduct their own tests. Before using any product, read its label.

Section V — HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE 0.02 ppm for Diphenylmethane diisocyanate

EFFECTS OF OVEREXPOSURE
ucous membrane irritation and tightness of the chest. Irritation of the resp
tory tract, coughing, headache, and shortness of breath. Exposure can lead
allergenic sensitivity.

EMERGENCY AND FIRST AID PROCEDURES
Skin - Wash with soap and water for at least 5 minutes.
Eyes - Wash with large amounts of water for a minimum of 15 minutes and consu eye physician.
Internal Inhalation. Induce vomiting and consult physician. Remove to uncontaminated area, administer oxygen by authorized person if necessary. Call a physician.

Section VI — REACTIVITY DATA

STABILITY			
	UNSTABLE		CONDITIONS TO AVOID Avoid temperatures above 50°C (121°F) or below (32°F)
	STABLE	X	

INCOMPATABILITY (Materials to avoid) Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION			
	MAY OCCUR		CONDITIONS TO AVOID Contact with moisture and other materials which react with isocyanates.
	WILL NOT OCCUR	X	

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Absorb in an absorbent sweeping/cleaning compound (e.g. "oil dry"), remove f
area in open drums and treat with water containing 1% ammonia before dispos
Wear respiratory protection when cleaning up all spills.

WASTE DISPOSAL METHOD Disposal of waste should be in accordance with Federal, State, and Local regulations regarding environmental control.

Section VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) Canister type gas masks equipped for organic vapors; mask supplied from an external air source self-contained breathing equipment

VENTILATION		
	LOCAL EXHAUST To maintain vapor concentration below TLV	SPECIAL
	MECHANICAL (General) yes	OTHER

PROTECTIVE GLOVES Chemically resistant rubber or plastic | EYE PROTECTION Chemical safety goggles

OTHER PROTECTIVE EQUIPMENT Safety showers and eye wash stations should be available.

Section IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
This isocyanate should be protected from water by a dry atmosphere (-40°F Dew Point) (-40°C) and maintained at 65-75°F (18-20°C)

OTHER PRECAUTIONS

TECHNICAL BULLETIN

33-096

POLYLITE® POLYESTER RESIN

TYPE OF POLYESTER

Rigid, thixotropic resin, promoted for room temperature cure. Formulated for the production of large reinforced plastic parts by spray-up technique.

MAJOR FEATURES

1. Provides fast wetting of fiber reinforcement while minimizing drain-out tendency.
2. Provides fast cure rate with minimum peak exotherm temperature.
3. Non-wax properties provide excellent interlaminar adhesion.

PROPERTIES OF LIQUID POLYLITE® 33-096

Viscosity, Brookfield LVF No. 3, 60 RPM @ 25°C.	450 ± 100 cps.
Color	Pink - Purple
Specific Gravity	1.09 ± 0.03
Weight per Gallon	9.1 ± 0.2 lbs.

(Additional information below)

PROPERTIES OF CURED UNFILLED POLYLITE® 33-096

Tensile Strength, psi	8-10,000
Flexural Strength, psi	12-15,000
Flexural Modulus, psi x 10^5	5.5-6.0
Compressive Strength, psi	20-25,000
Barcol Hardness (934-1)	45-50

GEL TIME

100g 33-096 POLYLITE® @ 25°C, 1.0cc SUPEROX® 709	12 ± 2 min.

®Reg. U. S. Pat. Office

REICHHOLD CHEMICALS, INC • P. O. BOX 1482, TACOMA, WASHINGTON 98401

MATERIAL SAFETY DATA SHEET

(APPROVED BY U.S. DEPARTMENT OF LABOR "ESSENTIALLY SIMILAR" TO FORM LSB 005-4)

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DMA-9/75

Section I

MANUFACTURER'S NAME
REICHHOLD CHEMICALS, INC.

STREET ADDRESS
525 North Broadway

CITY, STATE AND ZIP CODE
White Plains, New York 10603

EMERGENCY TELEPHONE NO.
914 682-5700

CHEMICAL NAME AND SYNONYMS	TRADE NAME
Unsaturated Polyester or Polyester Resin	POLYLITE® 33-096
CHEMICAL FAMILY	FORMULA
Organic Synthetic Resin	Unsaturated Polyester in Monomer

Section II — HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS

PIGMENTS	%	TLV (Units)	SOLVENTS	%	TLV (Units)
CATALYST			ADDITIVES		
VEHICLE			OTHERS		
Unsaturated Polyester	>50		Styrene Monomer	<50	100p
			Dimethyl Aniline	<0.2	5 p sk.

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS OR GASES	%	TLV (Units)
STYRENE HAZARDS: SEE MCA CHEMICAL SAFETY DATA SHEET SD-37		
DIMETHYL ANILINE: SEE MCA CHEMICAL SAFETY DATA SHEET SD-17		
The quantity of Dimethyl Aniline contained in this resin is not sufficient to		
constitute a serious hazard. Follow procedures in Section V.		

Section III — PHYSICAL DATA

BOILING POINT (°F)	Above 145°C (293°F)	SPECIFIC GRAVITY (H_2O=1) (product)	1.1 - 1.2
VAPOR PRESSURE (mm Hg) @20°C (styrene)	<5	PERCENT VOLATILE BY VOLUME (%) (product)	<50
VAPOR DENSITY (AIR = 1) (styrene)	3.6	EVAPORATION RATE (n butyl acetate = 1)	<1
SOLUBILITY IN WATER (product)	N.A.		
APPEARANCE AND ODOR	Clear liquid with typical styrene odor.		

Section IV — FIRE AND EXPLOSION HAZARD DATA

Typical Flash POINT (METHOD USED) 96°F Tag Open Cup
65°F Pensky-Martin Closed Cup

FLAMMABLE LIMITS (Vol. % in air styrene) | Lel 1.1 | Uel 6.1

EXTINGUISHING MEDIA
Foam, carbon dioxide or dry chemical, per National Fire Protective Assn. Class "B" extinguish

SPECIAL FIRE FIGHTING PROCEDURES
None - fight like a fuel oil fire

Unusual Fire and Explosion Hazards: Styrene will polymerize readily at elevated temperatures such as fire conditions. If this occurs in a closed container, there is a possibility of violent rupture.

Section V — HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE
Styrene 100 ppm (See Section II)

EFFECTS OF OVEREXPOSURE
Styrene @ 400 ppm or in strong concentration is irritating to all of the respiratory tract and eyes. May be fatal @ 10M ppm. Somewhat anesthetic.
(N.B.) Styrene vapor generation of polyester resins will rarely exceed 200 ppm.

EMERGENCY AND FIRST AID PROCEDURES
Remove victim from exposure to well-ventilated area - make comfortably warm but not hot - use oxygen or artificial respiration as required. In case of skin contact, wash thoroughly with soap and water. In case of ingestion, consult physician. In case of eye contact, flush promp with copious amounts of water for 15 minutes and consult a physician.

Section VI — REACTIVITY DATA

STABILITY			CONDITIONS TO AVOID
	UNSTABLE		Sunlight, open flames, contamination
	STABLE	XX	and prolonged storage above 100°F.

INCOMPATABILITY (Materials to avoid)
Strong acids, peroxides and other oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS
Carbon monoxide and dioxide, low molecular weight hydrocarbons and organic acids.

Hazardous Polymerization may occur.
Conditions to Avoid: Improper addition of promoter and/or catalyst. Consult product bulletin. A promoter (metal organic such as cobalt or aniline type) and catalyst (organic peroxide type) used with this product should always be mixed separately with the product and should never be mixed directly together. Also, sunlight, open flames, contamination and prolonged storage above 100°F.

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Remove saturated clothing promptly and wash affected skin areas with soap and water. Remove all sources of ignition (flames, hot surfaces, and electrical static, or frictional sparks). Ventilate area. Use protective measures outlined in Section VIII below. Absorb with inert materials such as Vermiculite or sand and place in closed container for disposal as solid waste. Wash area well with trisodium phosphate and water.

WASTE DISPOSAL METHOD
Resin that may have been mixed with peroxide initiators prior to spillage should be mixed with inert filler and removed to an open area. Allow time to gel and cure. Use either approved sanitary land fill or incineration. Do not incinerate closed containers. Disposal must be carried out in accordance with local, state, and federal regulations.

Section VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)
Up to 100 ppm: none. 100 ppm and above: U. S. Bureau of Mines approved air line mask or self-contained breathing apparatus.

Ventilation: Provide general dilution or local exhaust ventilation to comply with Sections II and IV (styrene vapor is heavier than air). Use explosion-proof motors.

PROTECTIVE GLOVES	EYE PROTECTION
Neoprene or non-soluble plastic	Use safety eye wear designed to protect against splash or liquids.

OTHER PROTECTIVE EQUIPMENT
Frequently clean protective clothing, shoes, etc., to avoid skin contact with styrene. Safety showers and eye wash stations should be available.

Section IX — SPECIAL PRECAUTIONS

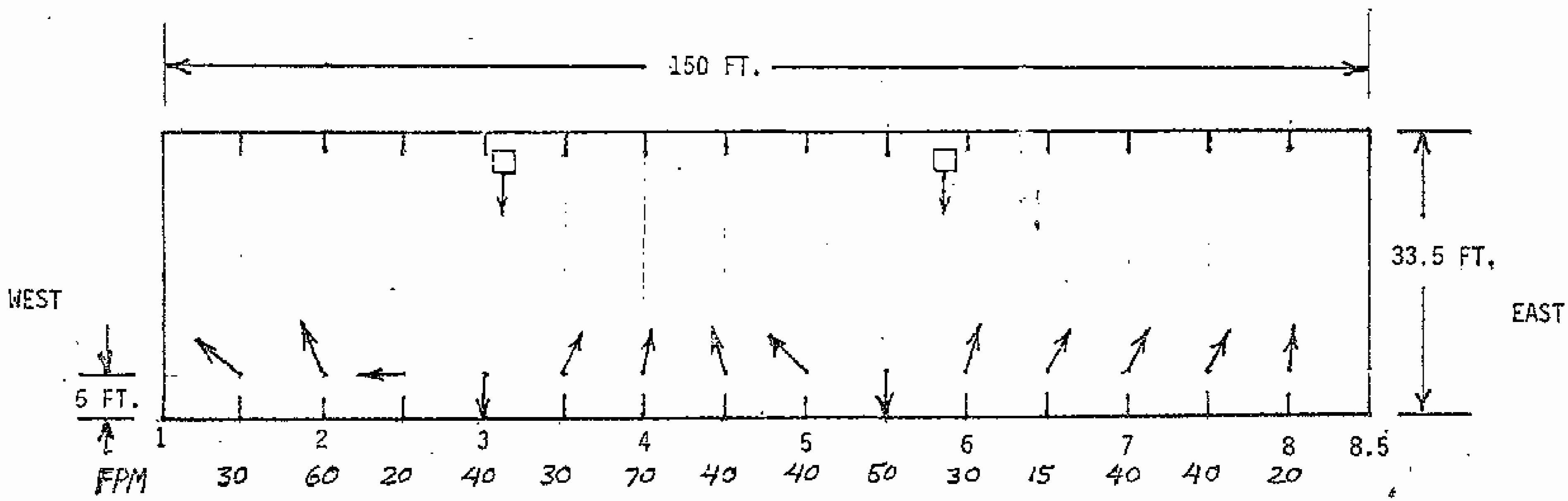
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Store and handle as National Fire Protective Association Class 1-C flammable liquid. Store below 27°C. (80°F.) in a closed container and dry area to avoid spoilage. Open drums slowly to relieve any internal pressure. In bulk storage check vents and flame arrestors for plugging by the formation of polymer. Ground all connections, containers, etc. when using.

APPENDIX C

Air Flow Patterns in Application Building

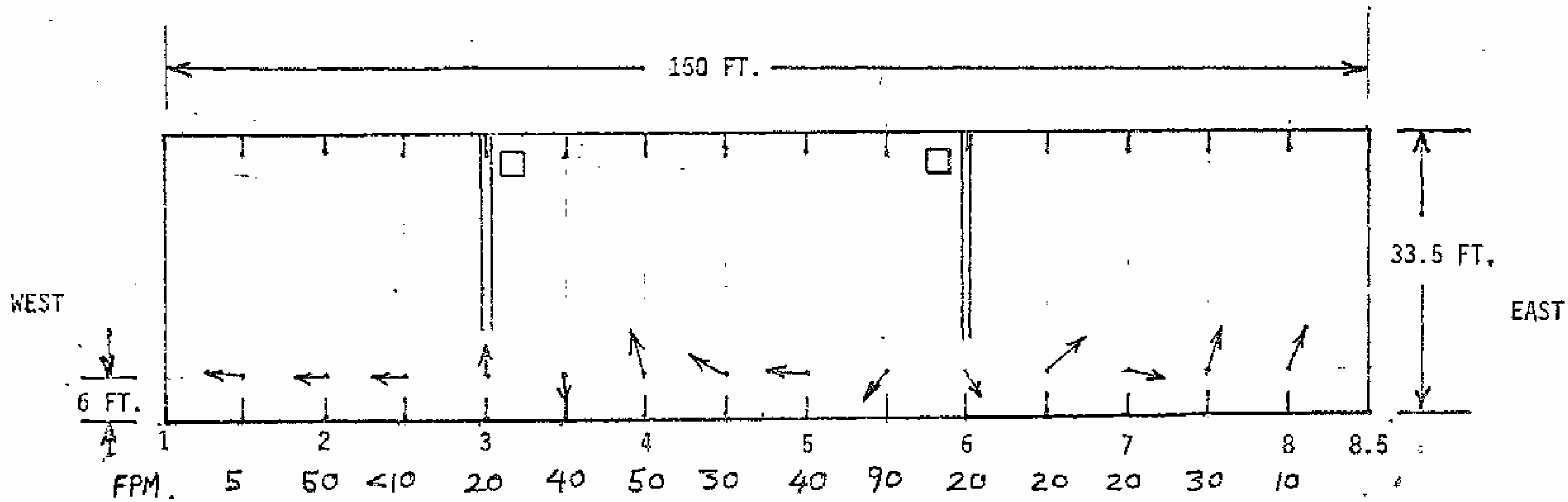
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY A.5, 12-3-81



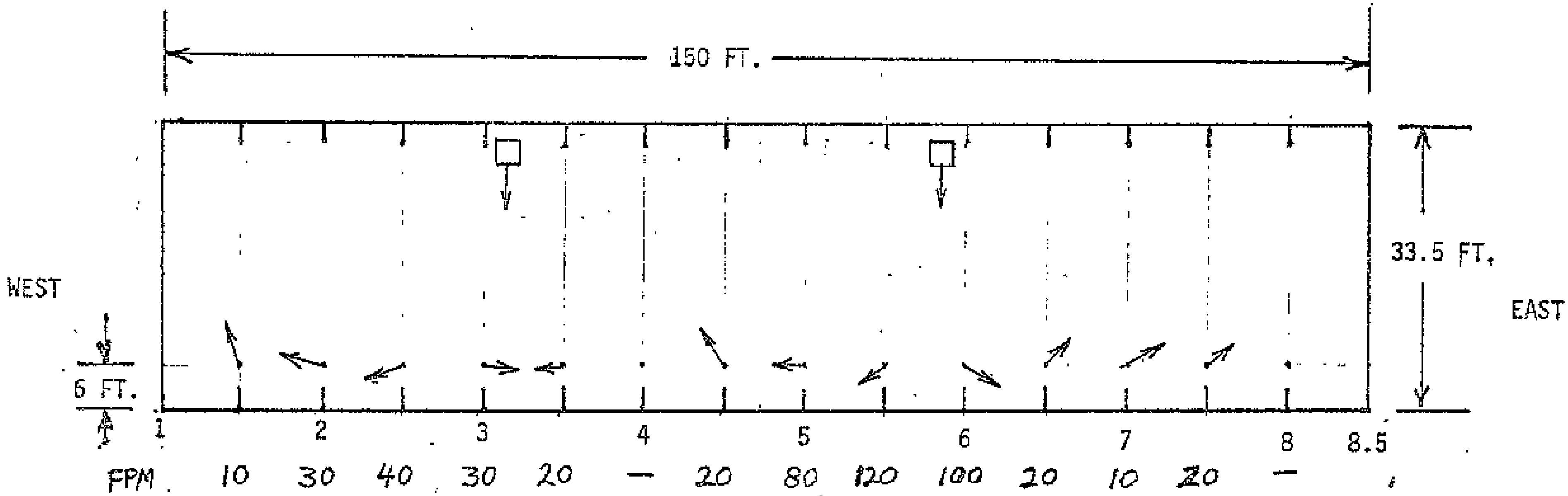
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY B, 12-3-81



GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY 8.5, 12-3-81



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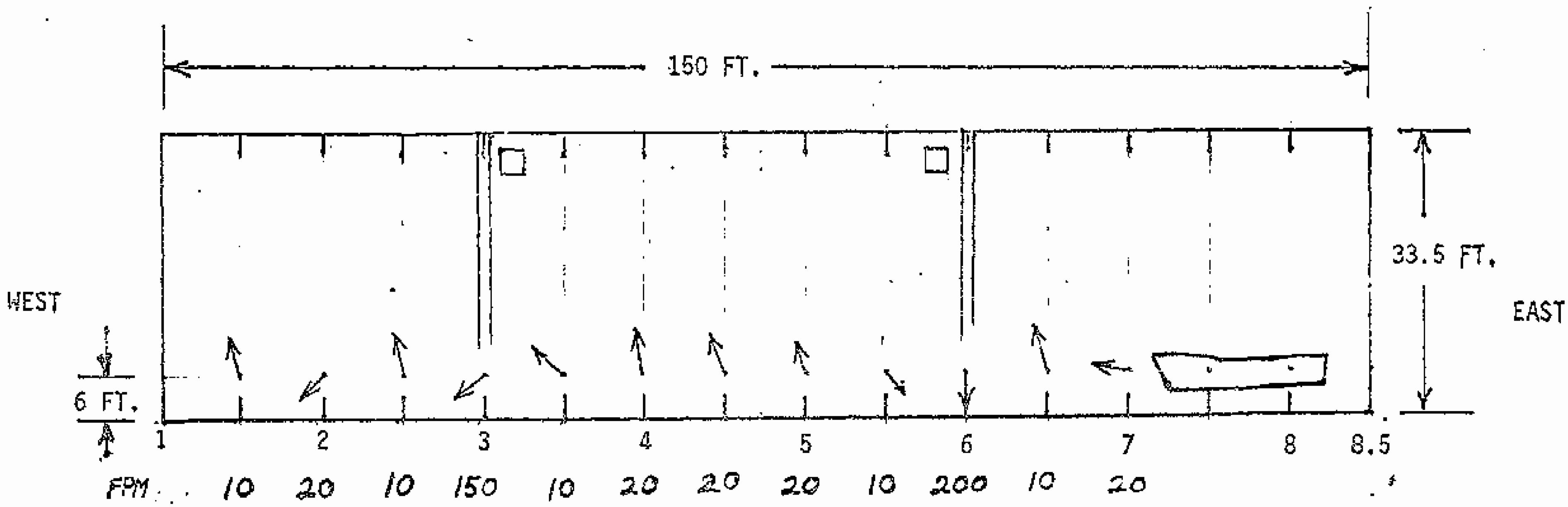
AIR MOVEMENT IN CROSS SECTION BAY C, 12-3-81



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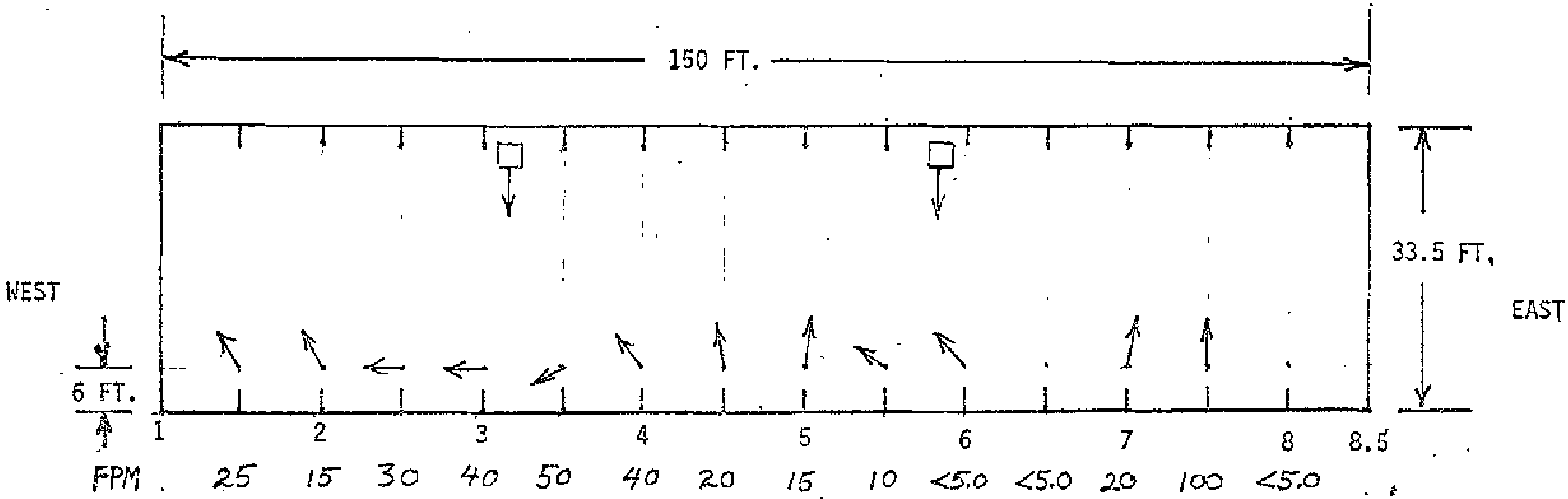
AIR MOVEMENT IN CROSS SECTION Bay C.5, 12-3-81



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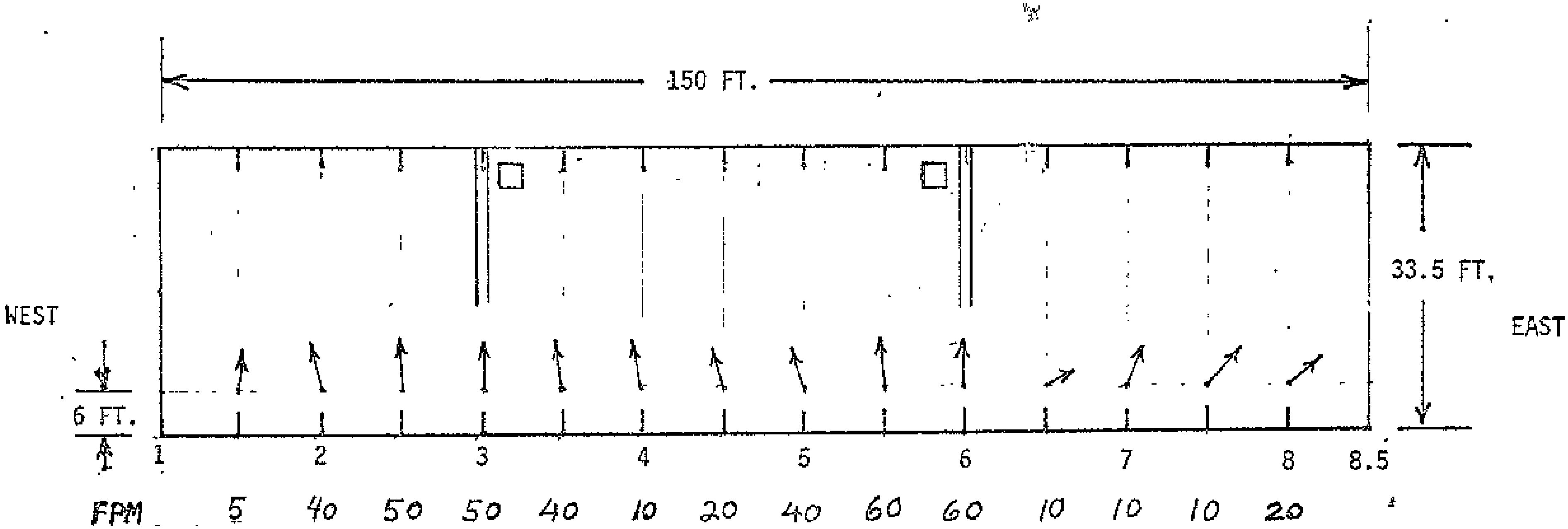
AIR MOVEMENT IN CROSS SECTION BAY D, 12-3-81



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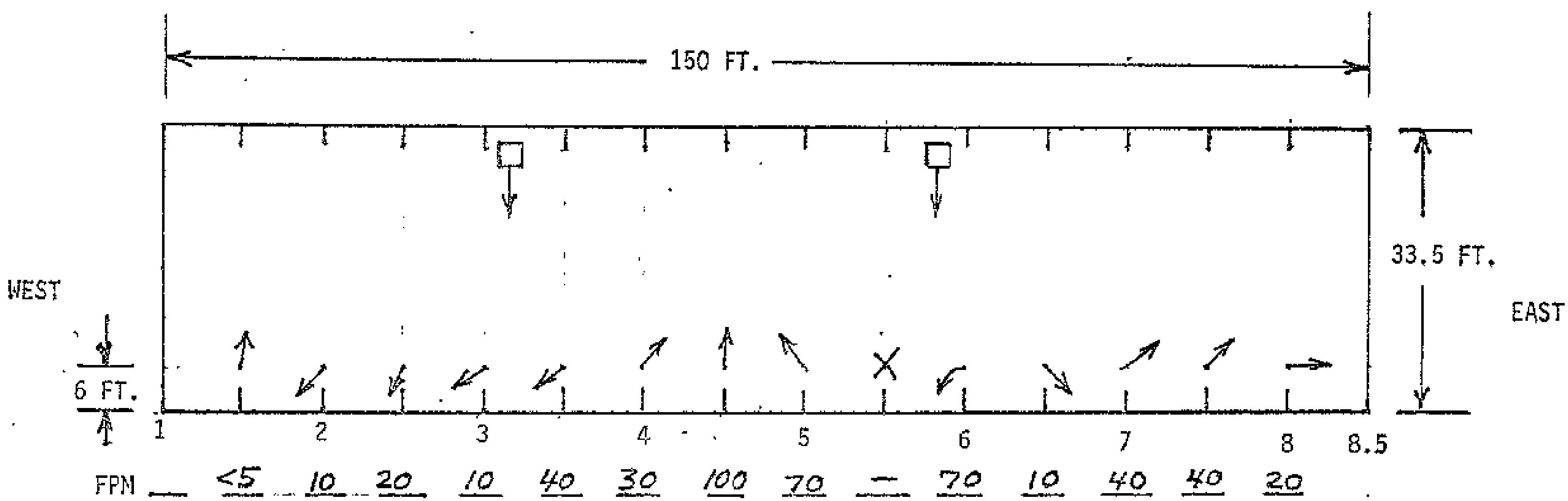
AIR MOVEMENT IN CROSS SECTION $_{D.5}^{BAY}$, 12-3-81



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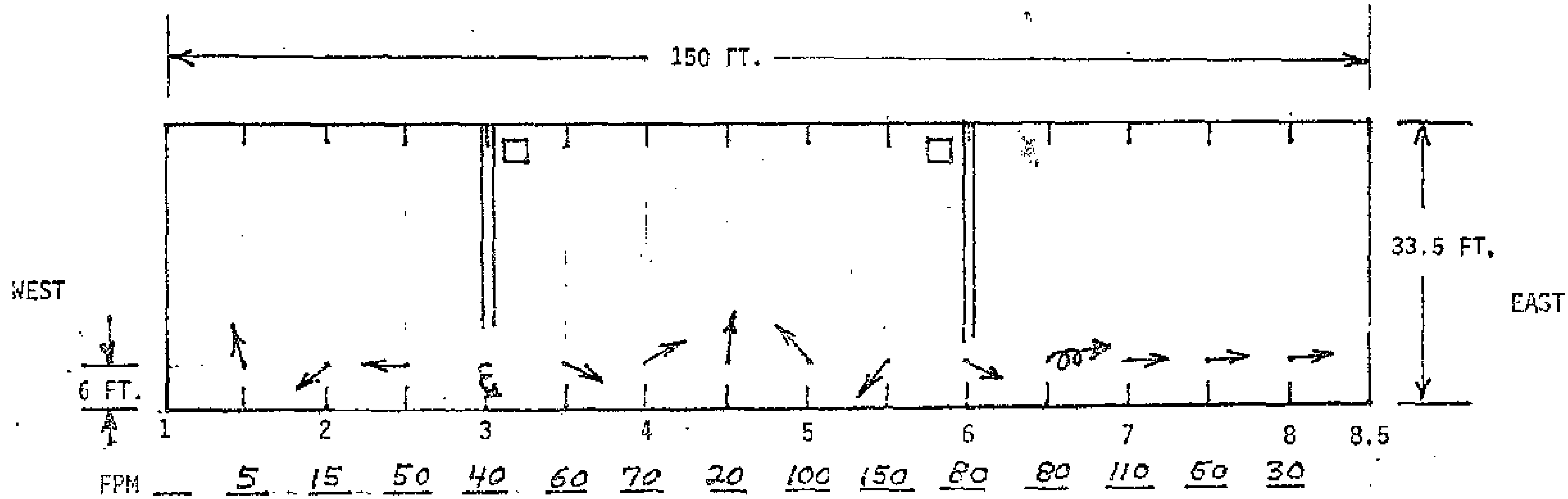
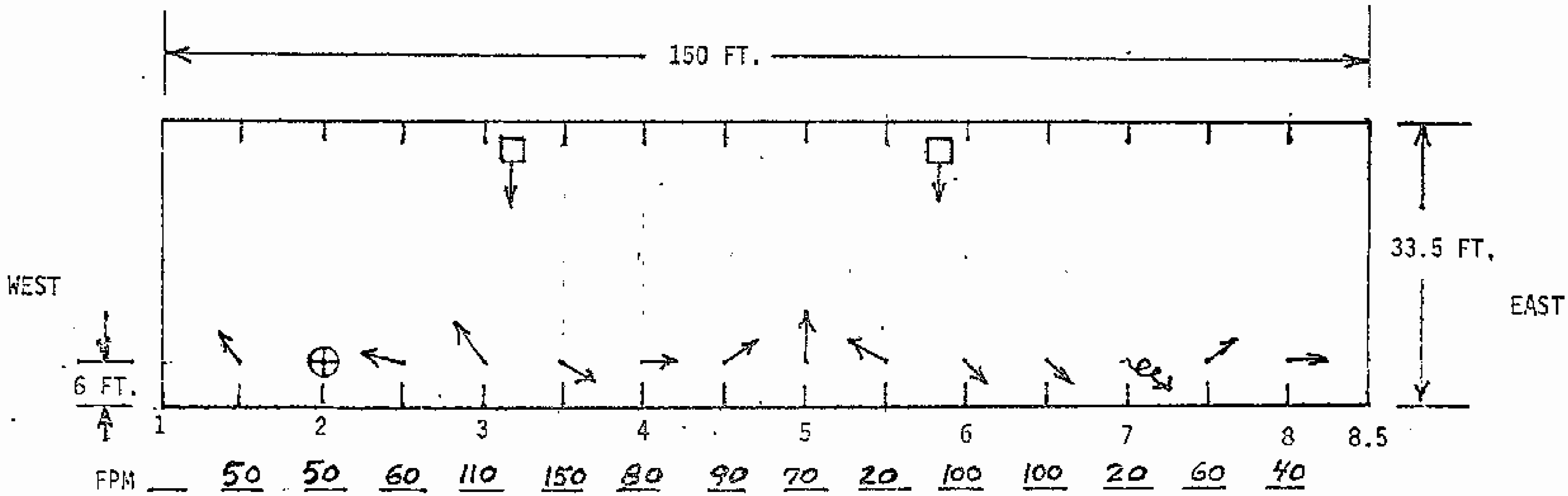
AIR MOVEMENT IN CROSS SECTION BAY E, 12-3-81



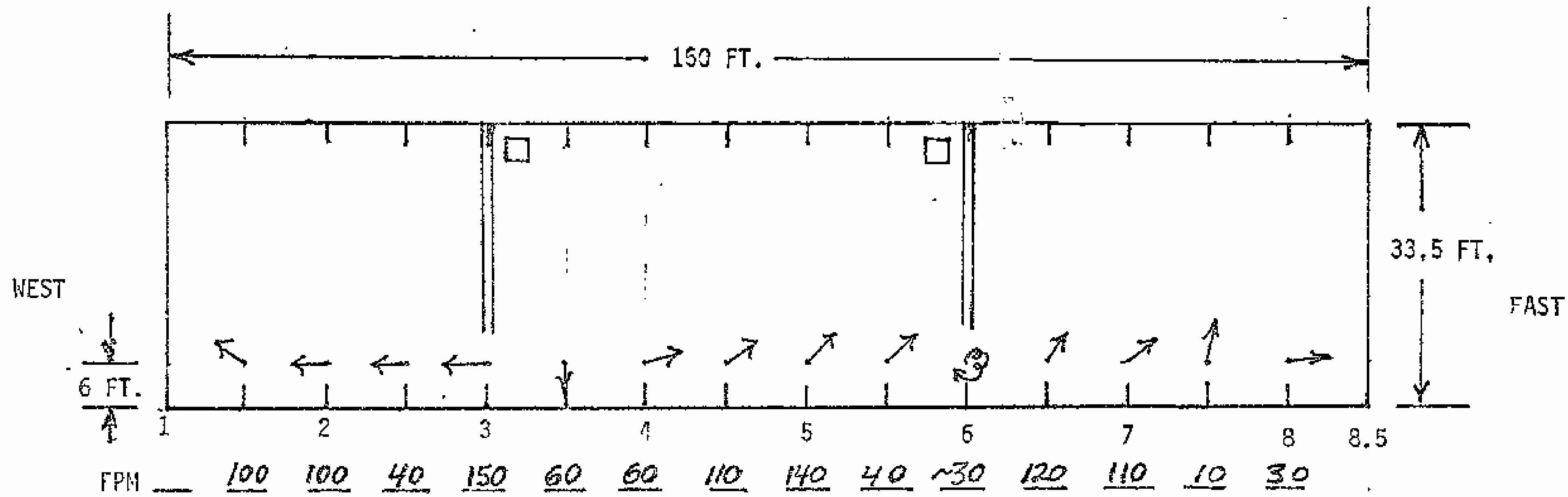
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY E.5, 12-3-81



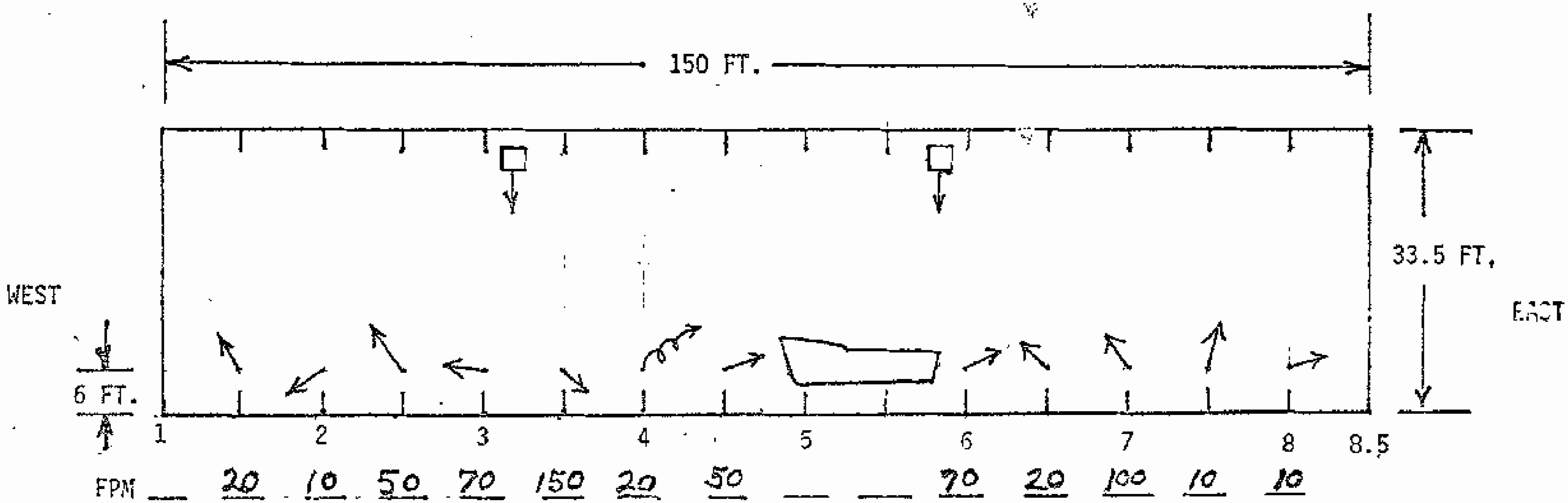
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY F, 12-3-81



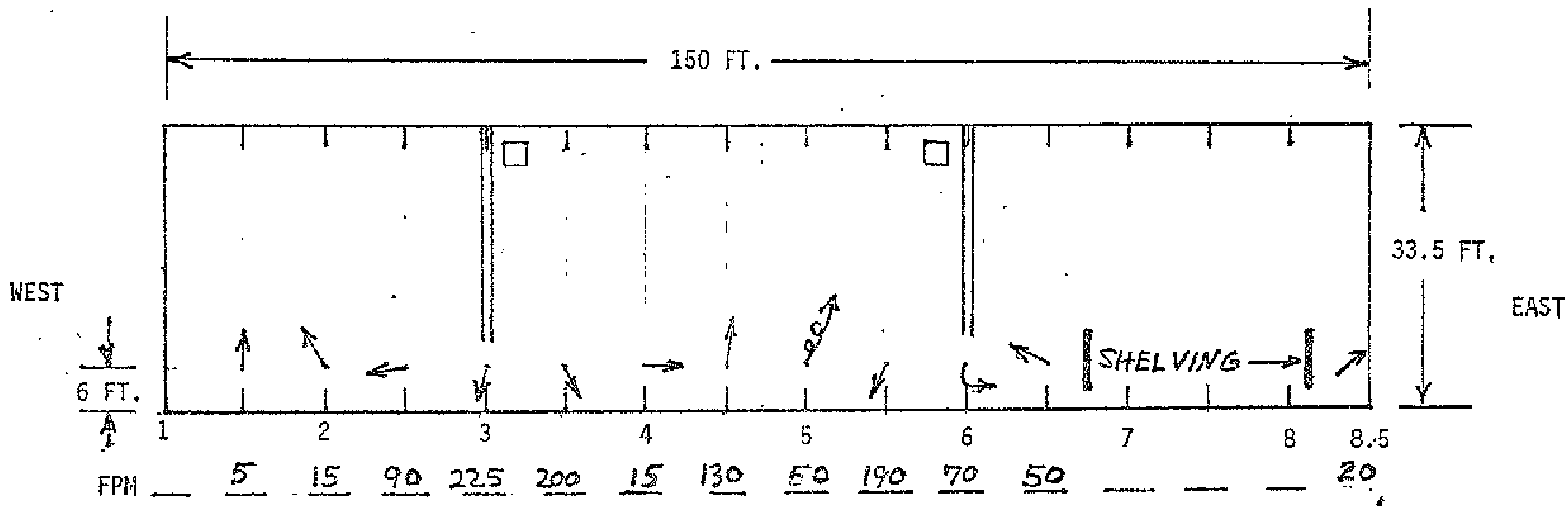
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY 1.5, 12-3-81



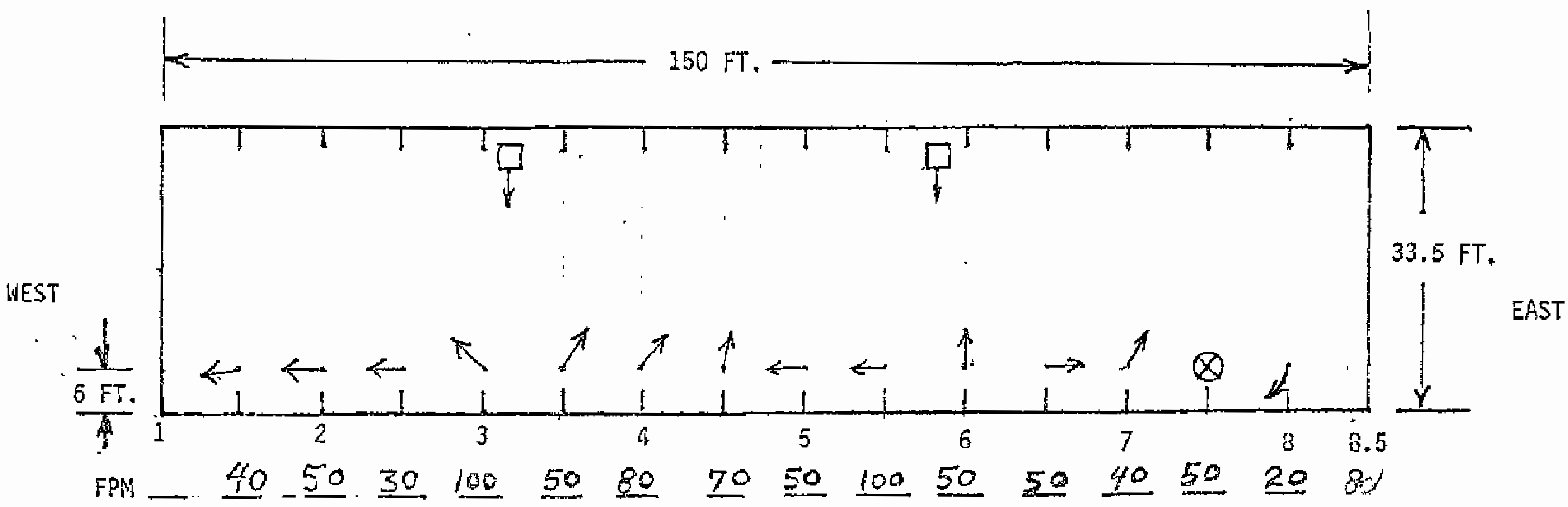
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY G, 12-3-81



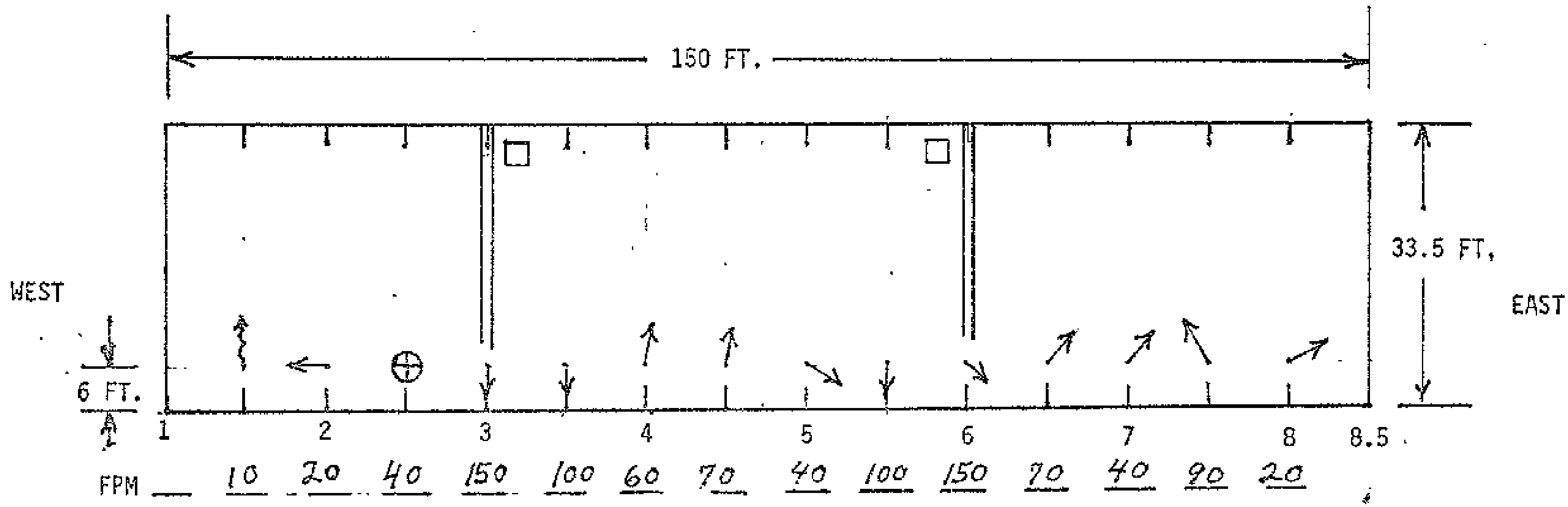
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY 8.5, 12-3-81



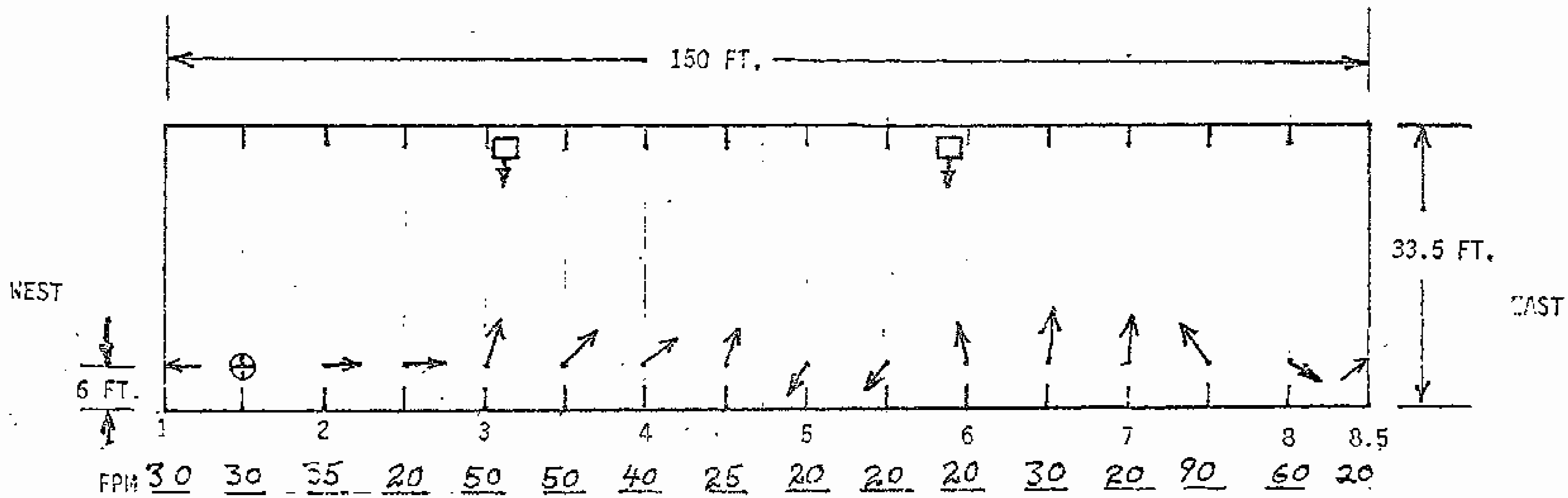
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION $\frac{BAY}{H}$, 12-3-81



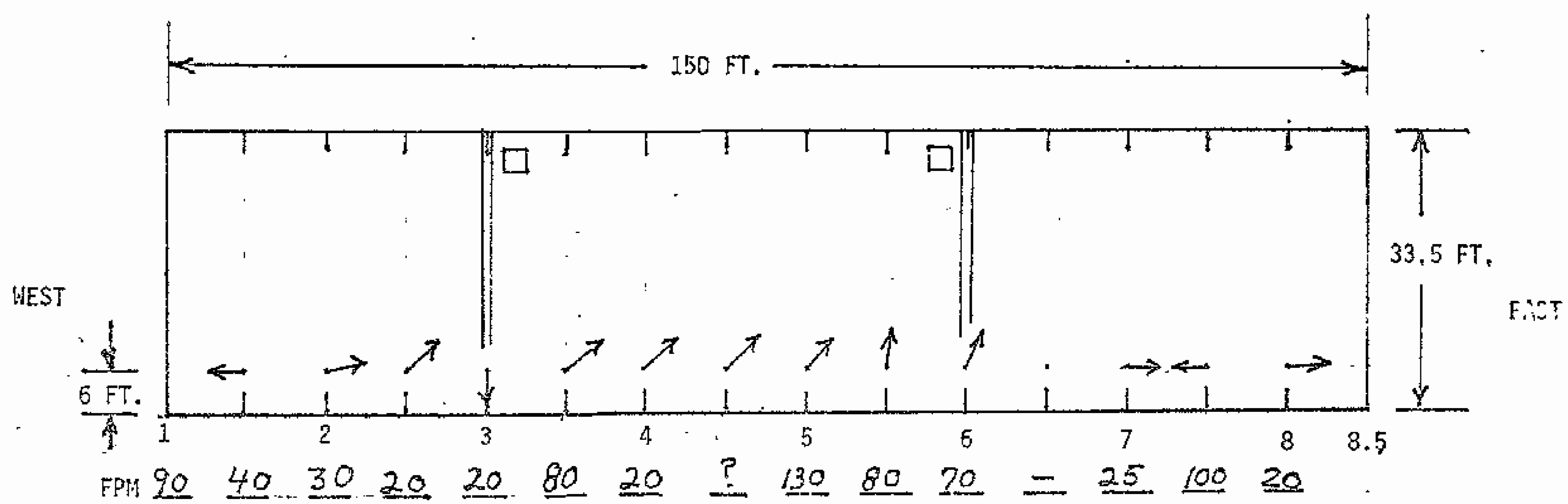
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION   BAY H.5, 12-3-81



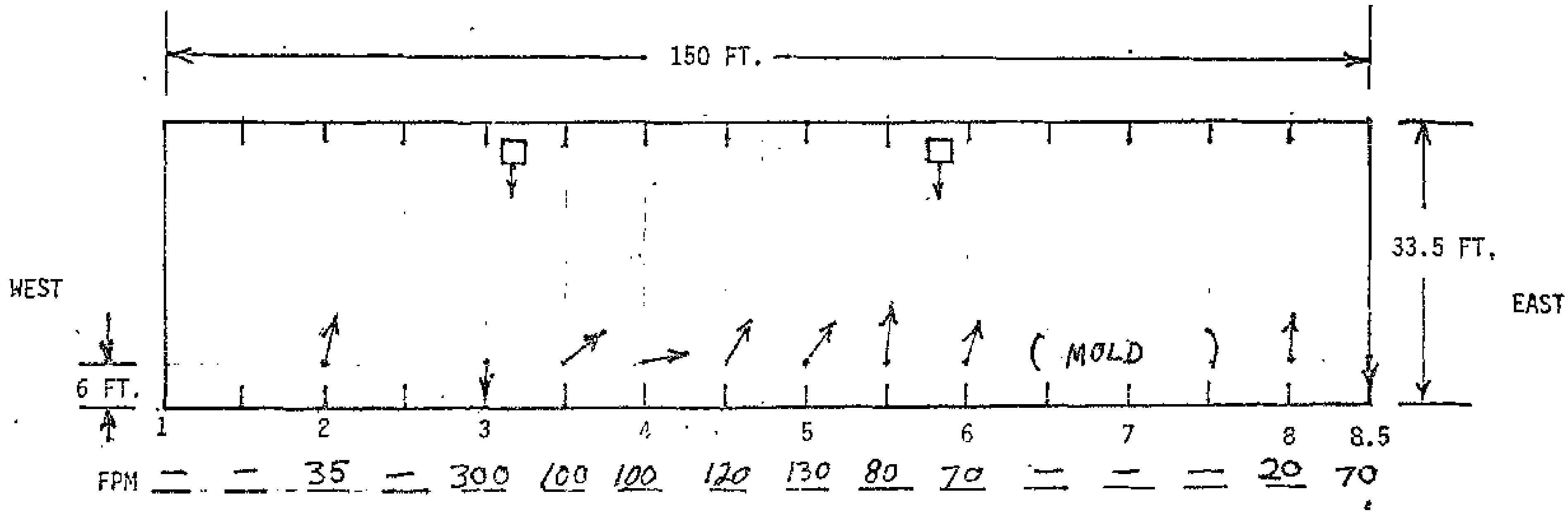
GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY I , 12-3-81



GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY 1.5, 12-3-81



GLAS PLY BOAT COMPANY APPLICATION BUILDING

AIR MOVEMENT IN CROSS SECTION BAY J, 12-3-81