U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
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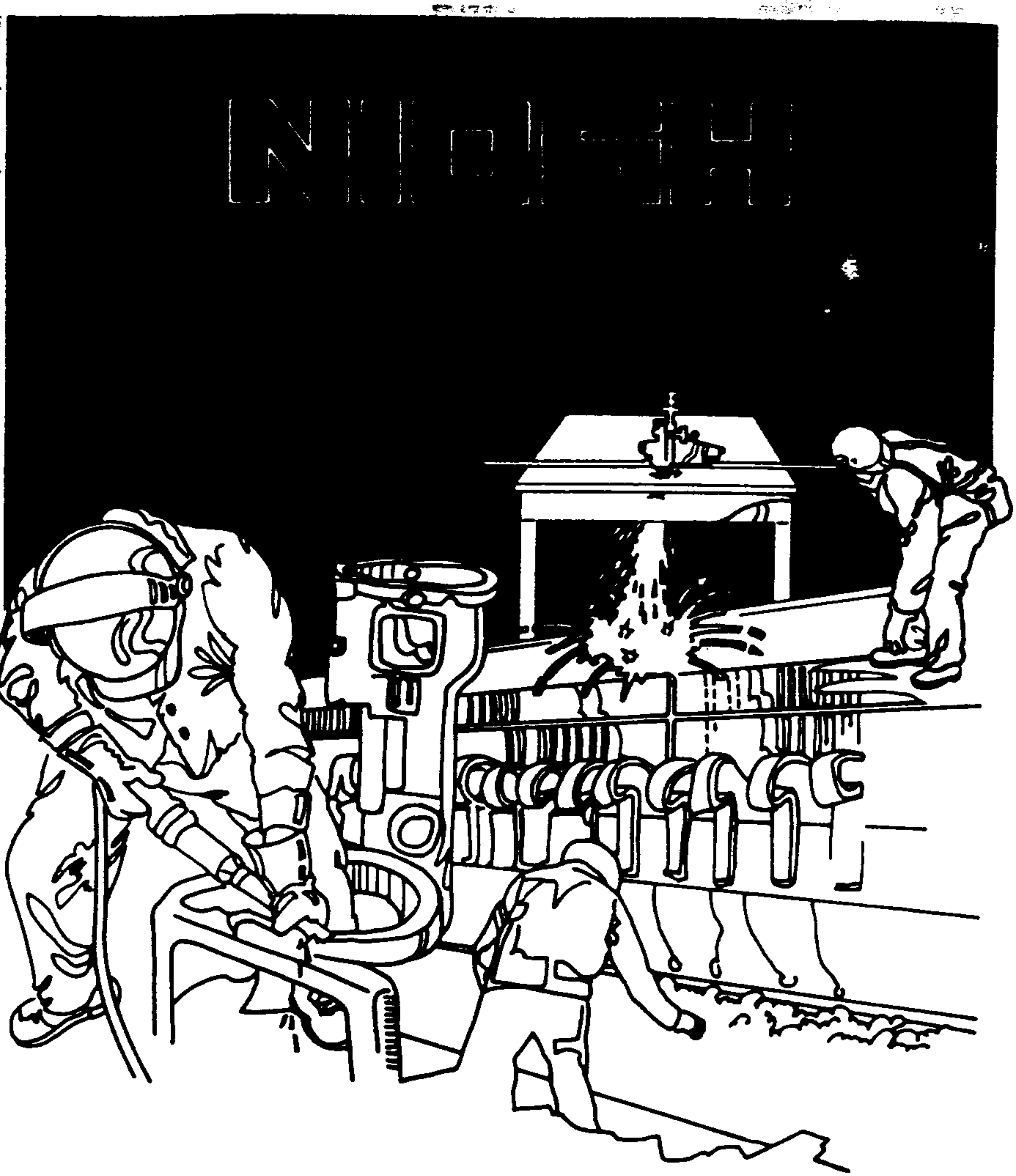

Health Hazard Evaluation Report

HETA 88-299-2028
LOUIE GLASS FACTORY
WESTON, WEST VIRGINIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 88-299-2028
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LOUIE GLASS FACTORY
WESTON, WEST VIRGINIA

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I. SUMMARY

On October 11-13, 1988, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted an investigation at the Louie Glass Company in Weston, West Virginia. This investigation was performed in response to a management request received on June 21, 1988, concerning the appropriate eye wear to protect workers from optical radiation emitted by the glass furnace. Since heat stress was identified by the NIOSH investigators as a potential problem, it was also evaluated as part of the investigation.

Optical radiation measurements were made in the furnace room under normal work conditions over several shifts. The maximum levels of far ultraviolet, near ultraviolet, visible, and infrared radiation were found to be non-detectable, 8 microwatts per square centimeter, 0.93 candela per square centimeter, and 173 milliwatts per square centimeter, respectively. Only the infrared radiation levels exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) guideline value of 10 milliwatts per square centimeter.

The heat stress measurements made near the furnace yielded Wet Bulb Globe Temperature (WBGT) values ranging from 61 to 116 degrees Fahrenheit. Results of the medical questionnaire, given to furnace room personnel, revealed the occurrence of shortness of breath, heat sickness, burns, cuts, eye injuries, dry eyes, itchy nose, and ergonomic problems.

Based on the data collected in this survey, NIOSH investigators have concluded that under certain conditions workers would be exposed to excessive levels of infrared radiation from both the furnace and certain glass making procedures. Recommendations are made in Section VIII for reducing these exposures and selecting appropriate personal protection equipment.

KEYWORDS: SIC 3229 (Pressed and Blown Glass and Glassware), infrared radiation, heat stress, ergonomics, personal protective equipment.

II. INTRODUCTION

On June 21, 1988, NIOSH received a request for a health hazard evaluation at the Louie Glass Company, Inc., Weston, West Virginia. The request was submitted by management and expressed concern about the proper eye wear necessary to protect plant workers from optical radiation produced from glass melting furnaces. Two on-site surveys were conducted on August 18, 1988, and September 8, 1988, with a follow-up survey performed on October 11-13, 1988. Measurements of heat stress levels were made, optical radiation levels were recorded, and a health questionnaire was administered.

III. BACKGROUND

Louie Glass Company is the largest manufacturer of handmade glass in the United States. The Louie Glass Company ships about six million pieces of handmade crystal annually. In 1972 Louie Glass became a subsidiary of Princess House, Inc. Today, both Louie Glass and Princess House are subsidiaries of the Colgate-Palmolive Corporation.

The heart of the glass making operations at Louie Glass is the large furnace (Figure 1) which melts batches of uniquely blended raw materials selected to enhance the glass crystal products at approximately 2200°F. Since there are many different glass pieces, the work is performed by groups of four to eleven workers called teams. Each team or shop, is comprised of workers who have experience in various phases of glass making and who have been working together for many years.

Glassworkers stand near a semi-enclosed furnace as they form various glass products. After the piece is formed, it can be modified to receive a crimped or folded rim, a lip, or a stemmed foot by other glassworkers located at several finishing stations further away from the furnace. The time to make the various pieces generally ranges from 1 to 3 minutes. After the piece is finished it is placed in an annealing oven for about 90 minutes. Following the annealing process, the glass products are inspected for scars, faults, or other defects.

The furnace room is built with a raised platform surrounding all the port holes. The platform is about 12 inches high and about 10 feet wide. All of the glass gathering is accomplished while standing on the platform, while all the glass forming occurs beyond the platform.

Louie Glass Company maintains hourly logs of the furnace temperature at each window port using a calibrated pyrometer (Figure 2). The data obtained from these logs over the days of measurements are shown in Table I. Over the 5-day evaluation cycle the temperature ranged from 2202 to 2225°F. This small temperature increment of 23°F over 5 days suggests the furnace is a relatively constant hot source.

After quality control (QC) inspection, the accepted glass products are transported to the final finishing department where all excess glass is removed. This removal process takes place manually (a process known as "crack-off") or can be performed with modern 20-head polishing units. After the removal process is completed, the glass products go to the engraving area where unique floral designs (such as stems, leaves, and flower petals) are inscribed manually by engravers.

Due to the nature of the glass making process the facility runs continuously four shifts total, rotating three shifts per day, seven days per week. The facility employed, at the time of this evaluation, about 550 employees, the majority (93%) of which are male hourly employees.

Broken glass is an obvious undesired by-product from the operations. Normally at the end of a workshift, employees dry sweep the floors and either remelt or dispose of the sweepings. All personnel are required to wear safety glasses for eye protection and about half of the workers wear some form of tinted lenses.

IV. METHODS AND MATERIALS

A. Environmental

The following equipment was used to measure levels of radiant energy produced by the various processes:

1. Luminance or brightness levels were measured with a Spectra Mini-Spot photometer having a one degree field of view. The measurements were obtained in units of footlamberts (fL) which were converted to candela per square centimeter (cd/cm^2). The luminance of a source is a measure of its brightness when observed by an individual without eye protection, regardless of the distance from source.

2. An International Light radiometer, model 700, with specially calibrated detectors was used to evaluate the ultraviolet (UV) radiation levels. One detector was designed to read the actinic UV radiation (200 to 315 nm) in biologically effective units of microwatts per square centimeter (uW/cm^2), while the other detector measured near UV (320-400 nm) in units of milliwatts per square centimeter (mW/cm^2) with no biologic weighting factor.

3. A Solar Light Sunburn meter was used to document the presence of any erythema-producing radiation in the 290 to 320 nm wavelength region. This meter reads in sunburn units per hour.

4. An Eppley model 901 calibrated thermopile with a quartz window was used to measure irradiance in units of mW/cm^2 over the wavelength range from 200 to 4500 nm.

All equipment used to document exposure to optical radiation fields had been calibrated within six months either by NIOSH or the respective manufacturer.

Heat stress measurements were obtained using a Reuter-Stokes heat stress monitor, model RSS-211D at locations within the furnace room where glass workers spent the majority of their time (Figure 3). The instrument provided wet bulb globe temperature (WBGT) values for comparison to various WBGT evaluation criteria applicable to working in hot environments. The WBGT readings incorporate air temperature, natural wet-bulb temperature, and globe temperature measurements to assess the parameters that can contribute to heat stress such as the convective heat load, the radiant heat load, and the ability of the body to eliminate heat through perspiration and vasodilation. The monitors were mounted on tripods at a height of about four feet from the floor and allowed to equilibrate for a period of time at each measurement site prior to obtaining instrument readings.

B. Medical Questionnaire

From October 11-13, 1988, NIOSH investigators administered a medical questionnaire, including job history (Appendix I). Furnace room personnel from all shifts were invited to participate.

The study questionnaire was administered during the working hours of each of four shifts. Employees were scheduled (by shop) to report to a break room where a self-administered questionnaire was distributed. NIOSH investigators were available to answer questions and to assist those who were unable to read. The voluntary and confidential nature of the survey was explained both verbally and in writing. The questionnaire contained questions designed to gather information on job history, use of protective devices (spectacles), and medical conditions and symptoms (particularly ocular, upper and lower respiratory, and dermatologic).

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity allergy.

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information about chemical and physical agents become availab!-

The primary sources of environmental evaluation cri'eria for the workplace are: 1) NIOSH criteria documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational diseases. In evaluating the exposure levels and the recommendations for reducing these levels found in these reports, it should be noted that industry is legally required to meet those levels specified by an OSHA standard. However, at present, there is limited information from OSHA on exposure criteria for workers exposed to physical agents. Criteria for physical agents not covered b· OSHA come from either ACGIH, NIOSH, or in some cases from consensus standards promulgated by the American National Standards Institute (ANSI).

A. Optical Radiation

1. Infrared Radiation [1-5]

All objects having temperatures above absolute zero emit infrared radiation (IR) as a function of temperature. In biological systems, the major insult of IR exposure appears to be a rise in the temperature of the absorbing tissue.

Some of the physical factors which influence this temperature rise are the wavelength, heat conduction parameters, exposure time, and total amount of energy delivered to the exposed tissue. Since IR photons are low in energy, they would not be expected to enter into photochemical reactions with biological systems. Molecular interactions with radiation in the IR regions are characterized by various vibrational-rotational transitions resulting in an increase in thermal energy of the molecule.

Since the primary effect of IR on biological tissues is thermal, the skin provides its own warning mechanism by having a pain threshold below that of the burn threshold. However, there is no such adequate warning mechanism in the eye therefore, additional protective equipment is often necessary. Traditionally, safety personnel consider IR to be a cataractogenic agent, but recent literature has cast serious questions about whether IR cataracts can be produced in the workplace from non-coherent optical sources, such as glass furnace operations.

IR radiation beyond 1400 nm can produce corneal and eyelid burns, as well as dry eye and skin. The primary biological effect of IR on the retina and choroid is thermal in nature, with the amount of damage being proportional to the length of exposure. If the radiation intensity is low enough, however, normal retinal blood flow may be sufficient to dissipate any heat generated. Nevertheless, due to the focusing effect of the anterior ocular components, small amounts of IR can produce a relatively intense point energy distribution on the retina, resulting in a lesion.

2. Visible Radiation [1,5,7,8-10]

Visible radiation, from either the sun or artificial sources, is an important occupational health consideration because of its major role in our daily life. When light levels are high at unique wavelength regions, retinal hazards arise that require the wearing of protective eye wear devices. These types of direct retinal effects from excessive light levels have been well known and documented for many years (i.e., staring at welding arcs or the sun).

Indirect effects of light, however, can occur not only from absorption of light energy in tissues but from the action of chemical substances liberated by cells in the body. In many cases such indirect effects occur at much lower intensities than those required to produce the direct effects. As a result, such effects often are not recognized as a major occupational health hazard. Examples of this relationship of light to biological rhythms include effects on physical activity, sleep, food consumption, etc. Another well-known indirect effect is the inhibition of melatonin synthesis by the pineal gland, which in turn affects the maturation and activity of the sex organs. Only within the last few years have investigators begun to discover the various subtle physiological and biochemical responses to light.

Another issue which often arises is that associated with poor room or task lighting conditions. Such conditions may cause asthenopia (eye strain). Although the etiology of eye strain is debatable, it appears that repeated occurrences probably do not lead to any permanent eye damage. Workers over 40 years of age will probably develop more symptoms of eye strain (headache, tired eyes, irritation) since they require more light to perform a similar job than younger workers.

The ACGIH TLVs for visible radiation are intended to offer protection from retinal thermal injury and from photochemical injury that can occur from exposure to wavelengths in the region from 400-500 nanometers.

3. Ultraviolet Radiation [1,6,7,9]

UV radiation is an invisible radiant energy produced naturally by the sun and artificially by arcs operating at high temperatures. Examples of these sources include germicidal and blacklight lamps, carbon arcs, welding and cutting torches, electric arc furnaces, and various laboratory equipment.

Since the eyes and skin readily absorb UV radiation, they are particularly vulnerable to injury. The severity of radiation injury depends on factors which include exposure time, intensity of the radiation source, distance from the source, wavelength, sensitivity of the individual, and presence of sensitizing agents.

Sunburn is a common example of the effect of UV radiation on the skin. Repeated UV exposure of lightly pigmented individuals may result in actinic skin: a dry, brown, inelastic, wrinkled skin. Actinic skin is not normally debilitating, but is a warning that conditions such as actinic keratosis, squamous cell epithelioma, and basal cell epithelioma may develop.

Since UV is not visible, the worker may not be aware of an exposure at the time it is occurring. Absorption of the UV radiation by the eye and eyelids can cause conjunctivitis. Lesions may also be formed on the cornea as a result of high exposure levels (photokeratitis). Such injuries usually manifest themselves 6 to 12 hours after exposure. The injuries may be very painful and incapacitating, but impairment is usually temporary. Workers also need to be aware that the presence of certain photosensitizing agents on the skin can produce exaggerated sunburn when exposed to certain UV radiation wavelengths.

B. Hot Work Environments [3, 11-12]

NIOSH originally defined hot environmental conditions as any combination of air temperature, humidity, IR radiation, and wind speed that exceeds a WBGT value of 79° Fahrenheit (F) or 26° Celsius (C). NIOSH, in its revised criteria for occupational exposure to hot environments, presents maximum recommended heat stress levels on a sliding scale of WBGT values for various metabolic heat levels (work effort). The recommended heat stress limits are presented as a series of five curves on a graph. Four curves represent different work-rest regimens, while the fifth curve is a ceiling limit which is not to be exceeded at any time for any work level without the workers being provided with and properly using appropriate and adequate heat-protective clothing and equipment. In order to use the criteria one must compute 1-hour time-weighted average WBGT values for the work area and estimate the work effort (metabolic heat) produced by the tasks performed by the worker in the hot environment. Figures 3 (recommended Heat-Stress Alert Limits (RALs) for heat-unacclimatized workers) and 4 (recommended Heat-Stress Exposure Limits [RELs] for heat-acclimatized workers), shown in reference 11, present this information.

These criteria assume the worker is clothed in the customary one-layer work clothing ensemble, is physically and medically fit, has good nutrition, and has adequate salt and water intake. Additionally, the worker should not have any preexisting medical conditions which might impair the body's thermoregulatory mechanisms. Alcohol use and certain therapeutic or over-the-counter medications can also impair the body's heat tolerance and may increase the risk for heat injury or illness. The NIOSH evaluation criteria may not be applicable if the worker or conditions do not meet the above requirements.

C. Heat Stress [12,13]

Heat stress is defined as the total net heat load on the body, which is comprised of contributions from exposure to external environmental sources and from metabolic heat production.

Four factors influence the interchange of heat between the human body and the environment. These are: (1) air temperature, (2) air velocity, (3) moisture content of the air, and (4) radiant heat sources. Industrial heat problems involve a combination of these factors which produce a working environment that may be uncomfortable or even hazardous because of an imbalance of metabolic heat production and heat loss.

The fundamental thermodynamic processes involved in heat exchange between the body and its environment may be described by the basic equation of heat balance:

$$S = M - E \pm R \pm C$$

where S = change in body heat content (heat gain or loss); M = rate of metabolism (associated with body function and physical work); E = heat loss through evaporation of perspiration); R = heat loss or gain by radiation (infrared radiation emanating from warmer surfaces to cooler surfaces); and C = heat loss or gain through convection (passage of a fluid [air] over a surface with the resulting gain or loss of heat). Under conditions of thermal equilibrium (essentially no heat stress) heat generated within the body by metabolism is completely dissipated to the environment and deep body (core) temperature remains constant at about 98.6°F (37°C).

When heat loss fails to keep pace with the heat gain, the core temperature begins to rise. At this point certain physiologic mechanisms begin to function in an attempt to increase heat loss from the body. First, there is dilation of the blood vessels of the skin and subcutaneous tissues with diversion of a large part of the body's blood supply to the body surface and extremities. An increase in circulating blood volume also occurs through the withdrawal of fluids from body tissues. These circulatory adjustments enhance heat transport from the body core to the surface. Simultaneously, the sweat glands become active, spreading fluid over the skin, which removes heat from the skin surface by evaporation. Evaporative cooling must balance the combined effects of metabolic and environmental heat load to maintain thermal equilibrium. If this fails, heat storage begins with the resultant strain of increased body temperature.

Prolonged exposure to excessive heat may cause increased irritability, lassitude (weariness), increased anxiety, and inability to concentrate. The results are mirrored by a general decrease in the efficiency of production and the quality of the finished product.

The acute physical disabilities caused by excessive heat exposure are, in order of increasing severity: heat rash, heat cramps, heat exhaustion, and heat stroke.

Chronic heat illnesses are those occurring as after-effects of acute heat illnesses; those brought on by working in excessive hot jobs for a few weeks, months, or years but without the occurrence of acute heat illness; and those associated with living in climatically hot regions of the world. Chronic after effects associated with acute heat illnesses can include reduced heat tolerance, dysfunction of sweat glands, reduced sweating capacity, muscle soreness, stiffness, reduced mobility, chronic heat exhaustion, and cellular damage in different organs, particularly in the central nervous system, heart, kidneys, and liver.

Chronic heat illnesses not associated with an acute incident of heat illness can fall into one of two categories based upon the duration of exposure. After several months of exposure to a hot working environment chronic heat exhaustion may be experienced. Symptoms which may develop include headache, gastric pain, sleep disturbance, irritability, vertigo, and nausea. After many years in a hot job, cumulative effects of long-term exposure which may develop are hypertension, reduced libido, sexual impotence, myocardial damage, and nonmalignant diseases of the digestive organs.

VI. RESULTS

The evaluation performed by NIOSH at Louie Glass Company included measurements of optical radiation produced by the furnace, determination of heat stress, and administration of a medical questionnaire.

A. Optical Radiation

1. Luminance

Luminance levels associated with the 13 open port holes ranged from 0.80 to 0.93 candela per square centimeter (cd/cm^2). These measurements were made with the photometer aimed at the furnace where the gatherer was positioned during his work cycle. Measurements were made daily on the same open port holes, and all were found to be within the above luminance range. The recorded levels are below the ACGIH TLV of 1 cd/cm^2.

2. Ultraviolet Radiation

Levels of both near and actinic UV radiation, produced by the furnace, were documented daily during the evaluation. The actinic radiation levels (200 to 315 nm) were non-detectable at all port holes. The maximum level of near UV radiation (315 to 400 nm) was 8 microwatts per square centimeters at the edge of the port hole. These levels of near and actinic UV radiation are below the TLV and are not considered to be an optical or skin hazard.

The sunburn meter indicated non-detectable levels everywhere in the facility, except outside. The maximum reading obtained at noon outside (overcast day) was 0.5 SBU per hour.

3. Infrared Radiation

During the initial plant walkthrough it was observed that worker exposure to IR could occur from two different situations. One was exposure to the IR emitted from the furnace through the port holes and the second was from handling the hot glass as it was processed. While the furnace irradiance was higher than the irradiance from the glass processing, the exposure time from the glass processing was longer than the total exposure time spent in the immediate area of the furnace. The irradiance of the glass product after removal from the furnace constantly decreases as it undergoes shaping. These variations in workers' IR exposure due to source differences are an important consideration in developing an appropriate eye protection program.

At close vicinity (2 feet from the furnace port hole) measurements of IR as high as 173 mW/cm^2 were obtained. This level is about 17 times the TLV of 10 mW/cm^2. Additional measurements were made at selected port holes of the furnace at varying distances. These results are shown in Figure 4. While some slight differences exist in the magnitude of IR levels at different port holes, it is obvious that the IR levels decrease as the distance from the furnace is increased.

After gathering, the glass material was brought to the blower by the gatherer for further shaping and processing. The highest IR level measured while workers were processing the glass was 140 mW/cm^2. This result was obtained at a distance of one foot from a glass blower who was shaping the hot glass.

B. <u>Heat Stress</u>

The heat stress measurements revealed a high level of heat at the porthole openings of the furnace, but these levels quickly decreased as the distance from the furnace was increased. This is shown in Table II. The WBGT readings obtained at two feet from three of the five porthole openings exceeded the NIOSH heat stress ceiling limit of 101°F. The highest level obtained was 116°F at porthole #1. It is observed that the measured IR radiation levels followed the same pattern as heat stress levels. This finding clearly illustrates the radiative component associated with the measured heat stress levels.

Due to the short time period gatherers stood at two feet from the portholes, the investigators do not believe these WBGT levels represent actual increases in body core temperature and, therefore, do not represent a heat stress condition. At best, the thermal insult sensed by the gatherers would be a slight rise in body surface temperature when close to the portholes. As the gatherers move away, this "warmth" effect would decrease until the they returned to the porthole area.

The heat levels were lower at the other end of the furnace. Measurements made at the edge of the platform (6 to 9 feet from the furnace) fell to a range of 67° to 73°F. The company had installed several fans (see Figure 5) throughout the furnace area for additional cooling.

Other WBGT measurements made at the work stations on the periphery of the furnace were found to be in the 60° to 70°F range. It is noted that all WBGT measurements made for this evaluation were made in the fall season, on a day when the outside ambient air temperature was 62°F with a relative humidity of 61%. These measurements should be repeated during the summer months when the heat load from the environment is at its highest to determine the maximum heat stress factors in the furnace room.

C. Medical Questionnaire

1. Characteristics of the Worker Population

Of the 315 hourly furnace room employees on the payroll, 264 were present during the questionnaire administration and 233 (74% of hourly employees, 89% of those present) completed questionnaires. Participation rates varied little by shift. Almost all participants were male, with a median age of 36; one-fourth of the workers were 44 years of age or older.

Experience in the glassmaking industry varied from less than one year to 52 years, with a median of 11 years. Twenty-five percent of the group had worked five years or less in glassmaking. The number of years spent in furnace room jobs was somewhat less (median 9 years, range <1 - 31 years; 28% of the workers worked in furnace room jobs for five or less years.) Workers were in their current job for a median of 2.9 years (range <1 - 31 years); 25% worked at their current job for half a year or less.

2. Categorization of Exposure

There are 22 specific jobs in the furnace room, and workers typically progress from the least skilled "spare" to the highest-skilled and highest paying jobs of blower and bit-person. The jobs that were recorded from the survey of furnace room employees were grouped for analysis into high and low exposure groups, based on the IR measurements taken for each job during the industrial hygiene survey of the furnace room and the description of job activities. Additionally, exposure was dichotomized into "platform" and "non-platform", with the former group considered highly exposed. Both current and cumulative IR exposures were considered in the analyses.

From the job history, we were able to calculate the number of years worked, per individual, in each exposure category (high, low, platform, non-platform). A substantial number of workers had held jobs in other glass factories in the past. Workers reported that job practices and exposures were similar for the same job title in different plants, so these jobs were classified into the same exposure categories as the Louie jobs. Cumulative exposures were computed using just the reported Louie exposure and also summarizing over all jobs, Louie and non-Louie. Current exposure categories were based on the present job classification. After examination of a number of different groupings, blowers and bit-persons were chosen for the analysis as the high IR exposure group. Prevalance rates of medical conditions and symptoms were calculated for the high exposure group and for the rest of the workers (the "non-exposed"). The ratio of these rates was calculated (RR), as well as its 95 percent confidence interval (CI). Confidence intervals which exclude 1.00 indicate a statistically significant RR.

3. Survey Findings

Regarding conditions affecting the eye: three workers reported a diagnosis of cataract, four reported glaucoma, one reported diabetes, and none reported retinal disease. Five workers reported carpal tunnel syndrome. Nineteen workers reported a diagnosis of bronchitis, and 15 reported "white lung", which we believe is a local term for silicosis.

a. Visual Effects

Those with and without symptoms did not significantly differ by any of the cumulative exposure indices. When analyzed by current exposure categories, blowers and bit-persons (a high current IR exposure group) reported somewhat higher rates of hazy and blurry vision, as compared to the other workers (Table III). This elevation lessened but persisted after adjustment for the use of green spectacles at work (Table III). Age did not affect this relationship.

All but six of the furnace room workers reported wearing some type of safety glasses at work. The majority wear green spectacles at work, either full-time (149/234, 64%) or part-time (13/234, 6%); next most common glasses are colorless (57/234, 24%); other types are rose-colored, photogrey, or various combinations of lenses. About half (123/234) wear prescription lenses to improve their vision at work, while 44% (102/234) never wear any corrective lenses. Blowers and bit-persons are significantly more likely to wear prescription lenses at work (Table III); they are also more likely than other workers to have had two or more prescription changes within the past two years (Table III).

When asked whether they thought their job had affected their vision, 21% (48/234) of the workers answered affirmatively. Light sensitivity or glare; pain, itching or burning; and blurry, distorted vision accounted for 38% of all reported effects. Blowers and bit-persons had higher rates of reported visual effects than the other workers. Those that wear green safety glasses also had higher prevalance rates than other workers for reported effects (RR=1.92, CI=1.03-3.56); after adjustment for use of green-colored spectacles, there was no association of these reported eye effects with current job.

b. Respiratory Effects

Mean cumulative exposure indices did not differ between those with and without respiratory symptoms. However, shortness of breath was reported significantly more often from blowers and bit-persons than other workers, even after adjustment for smoking (Table IV). Shortness of breath is highly associated with "white lung". (RR=3.81, CI=2.66-5.46). White lung was a self described medical condition written in by 15 workers under Question 12, part j. Even after removal of those with "white lung", the blowers and bit-persons still showed significantly elevated rates of shortness of breath (Table IV).

"White lung" workers were significantly older than the other workers (45 vs. 37 yrs, $p=0.002$), and worked longer in glassmaking than the others (26 vs. 12 yrs, $p<0.001$).

c. Other Health Effects

Blowers and bit-persons reported higher rates of tingling of the hands (a symptom of possible carpal tunnel syndrome) than the other workers (Table IV). This finding is consistent with the type of hand movements their jobs require, i.e. repetitive wrist rotations, wrist flexions and extensions, and rolling of glassblowing tools with the fingers.

Dry eyes were more common among blowers and bit-persons, as was itchy nose. The RR for both decreased with age and itchy nose was significant only for those age 30 and under (Table IV). These results are probably due to a general drying of the cornea surface and tissues near the nose. The higher reported rate for younger workers may represent an adaptation to drying conditions in older exposed workers.

Thirty percent (70/234) of the furnace room workers reported at least one incident of heat sickness within the past year. Of the 143 who reported being in their present job at least one year, 47 (33%) reported at least one episode of heat sickness. The highest rates of heat sickness (40% or higher) were from workers in the following jobs: blockers (4/9, 44%), crack-offs (8/19, 42%), and bit-persons (4/10, 40%).

4. Injuries

The overall rate for all injuries over the past year was 47% (109/234). Burns were most common at 37% (86/234), followed by cuts at 25% (59/234), eye injuries at 11% (26/234) and all other types at 7% (16/234).

For those employed at least one year in their present job, the injury rate was 45% (64/143). Forty-one percent of these injuries (23/64) occurred among workers in the following jobs: spares, core/ball holders, handle stickers, burn-offs and crack-offs. In all these groups the injury rates were above 50%. When examined by type of injury the following high risk groups were identified: (1) 43% of all burns occurred among holders, handle stickers, spares, burn-offs and crack-offs; burn rates in these groups ranged from 42-100%, (2) 44% of cuts occurred among spares, handle stickers, burn-offs and crack-offs; cut injury rates in these groups ranged from 36-67% and (3) 71% of eye injuries occurred among gatherers, burn-offs, crack-offs, and footers; eye injury rates ranged from 15-19% in these groups.

VII. DISCUSSION

A. Eye Wear Concerns

While making the optical radiation measurements, it was observed that many of the furnace room personnel were wearing some sort of eye protection, but it did not appear there was a uniform policy regarding the type of required eye protection. One of the major issues to be determined was the value of the appropriate filter shade number for eye wear use in the furnace room. Eye protection can be specified in terms of shade number which is a logarithmic notation of visual transmittance. The ANSI standard Z 87.1 (1989) sets transmission specifications in the visible, UV, and IR radiation regions [15]. Measurement at Louie Glass demonstrated that UV and visible occupational radiation exposures did not exceed the applicable standards and guidelines at the time of this investigation. Therefore, the proper selection of a furnace room filter depends on controlling the occupational IR radiation exposure.

Table 5 shows the maximum IR transmittance percent permitted by selected filter shades. Using these values and the maximum IR levels measured in the furnace room one can calculate the IR levels transmitted by different shades. If the maximum values of 173 mW/cm^2 and 140 mW/cm^2 for platform and non-platform personnel, respectively, are used (as reported earlier), then a filter shade of #3/#4 affords reasonable IR ocular protection based on the ACGIH TLV of 10 mW/cm^2. The relative spectral transmission of a typical shade #3 filter is shown plotted against the relative furnace spectral irradiance in Figure 6. This figure shows how a filter controls the level of IR irradiance incident upon the eye.

The use of a shade #3/#4 filter offers sufficient ocular protection from the IR exposure and still permits sufficient luminous transmittance for workers to view the majority of work tasks (see Figures 7-10). While one can use higher filter shades to reduce the ocular exposure, it should be noted that the higher the shade number, the darker the tint, and the more difficult to see.

Platform personnel, such as gatherers and blowers, definitely should wear these eye protectors. In addition, other furnace room personnel should be offered eye protectors if, in the opinion of the safety office, their job tasks require them to work with hot objects emitting excessive levels of IR. All workers must continue to wear some form of safety eye wear protection while in the glass production area, including engraving, QC, and furnace stations.

From the medical survey it was not possible to identify any visual effects related to cumulative exposure to IR radiation among this group of workers. It must be noted, however, that an ophthalmic or visual acuity examination was not performed.

The questionnaire revealed some visual symptoms which seemed related to current job. Hazy and blurry vision, the use of prescription lenses and more frequent changes in prescription were reported more frequently by blowers and bit-persons than other workers. These findings persist after adjustment for age and type of safety glasses and may reflect the high visual demands of these jobs rather than an acute effect of exposure. Workers who wore green safety glasses were more likely to report that they believe their job is affecting their vision. This may reflect the discomfort caused by wearing the lenses. Some of the discomfort might be eliminated by the use of different frame types.

B. Ergonomic Issues

Higher prevalance rates of hand tingling and numbness in the blowers and bit-persons, along with the reports of five cases of carpal tunnel syndrome, indicate the need for an ergonomic evaluation of these furnace room jobs.

The Princess House company (which now owns Louie) contracted for an ergonomic study of their Massachusetts facility, which also produces engraved glassware. Their preliminary conclusions were that better seating, armrests and lowering of the machines would improve comfort of the engravers. These improvements had not been implemented at the Louie Glass facility at the time of our visit.

Three locations were observed within the facility where work was performed which required high demand visual tasks. The first location was in the furnace room where it was necessary for the blowers to shape the glass with the aid of a floor mounted mold (Figure 11). The blowers would attempt to place the molten glass glob into the mold (a distance of about 6 feet) while blowing through the gather pole. This task was hard to perform for the blower due to insufficient task illumination. The proposed solution is to increase the illumination within the mold so that the blower can better observe placement of the hot glowing glass glob into the mold. This approach was tested on several molds by using a flashlight to provide additional illumination of the bottom and sides of the mold. All the blowers agreed that the additional illumination was helpful.

The second location was in the engraving area located at the other end of the building from the furnace area. There were 24 work stations set up in the engraving area on the days of this survey, but only 10 were occupied (Figures 12-14). The workers, all of whom were women, were responsible for engraving various decorative patterns, such as leaves and flowers, into the crystal glass. Women sat at the work stations and used a rotating wheel for a scribing tool. The chairs used had no arm rests, few had any back rests, and none of the chairs were adjustable in any direction. As a result, the women were forced to adopt awkward postures at their worktable for most of the day. Many of the women were using table lamps for additional task lighting since the room light fixtures did not provide appropriate illumination. Unfortunately the table lamps used very low wattage bulb, and were therefore only marginally effective.

It was also noticed that glassware would occasionally break during the engraving process from the pressure exerted by the scribing tool, yet none of the women used gloves or finger protection while performing the engraving, and only a few wore safety glasses. Most of the women, however, did wear prescription glasses.

The third location was the QC inspection station located at the end of a 40-foot heating oven. The glassware made in the furnace room was carried to the heating oven and slowly moved to the inspection area via a conveyor system. During this transit, the glass would undergo further annealing. At the end of the oven, two inspectors would physically inspect each piece, noting the color, quality of glassware, breakage, and defects. Each piece was observed in the light of opaque-filtered fluorescent lamps such as are used in an radiology department. It was noted that fluorescent lamps in the light fixture were of different bulb types and ages. Different light sources might pose problems for consistent quality assurance. Some suggestions were also made about installing additional lights along the side of the QC area so the inspectors would not have to pick up each glass piece. Such an arrangement would minimize the potential for cuts and abrasions to inspectors and also permit a faster process.

C. Other Observations

While the environmental measurements did not support heat stress findings, the medical symptoms reported by the furnace room personnel did indicate reports of heat sickness. Since the measurements were made in the fall and not the summer, perhaps some of the symptoms reported were either a result of summer time exposures or insufficient ventilation. Since it is not known what exposures situations caused the heat sickness symptoms, then it is recommended that heat stress measurements be repeated during summer months.

This evaluation clearly indicated that high levels of IR exist in the furnace room at Louie Glass Company. Previous reports on IR radiation suggest that workers exposed to high levels of IR can experience drying of the mucous membranes, shortness of breath, upper respiratory symptoms, and general drying out of moist tissues.[4,15] These types of symptoms were reported in the medical questionnaire.

Symptoms of dry eyes and itchy nose were associated with the furnace room jobs of blower and bit-person and may reflect the acute drying effects of IR exposure. The association of these jobs with shortness of breath is not explained by the respiratory demands on the glassblowers, but may be a reflection of discomfort due to the dryness of the air or the increased heat load on the body.

As a result of the environmental measurements and the reported medical symptoms, there exists a need to reduce IR exposure to furnace room personnel. One approach for reducing these exposures without altering job productivity is to reduce the effective porthole dimensions. A smaller porthole would reduce the IR flux emitted from a given site. A second approach would be the use of a high transparent material, such as 1/4 inch clear cast acrylic or polycarbonate, mounted a few inches in front of the porthole to reduce the worker's facial thermal load as well as permit visibility of the gathering process. A third approach might employ the use of tinted eye wear in conjunction with a plastic face shield cut so that it comes to the vicinity of the upper lip. Elimination of the IR thermal load by these and other methods would, in the opinion of the investigators, help reduce the observed effects as well as aid in ocular protection requirements.

Methylene chloride was present in the conveyor belt dressing compound. NIOSH considers this chemical to be a suspected human carcinogen and recommends that exposures be maintained at the lowest feasible level.

Industrial hygiene services are provided by an outside consulting group. The results from previous sampling periods over several years for silica and respirable dust were provided to NIOSH. These results, from an accredited laboratory, indicated that all exposures were below the applicable occupational exposure standard. Since evaluation of the optical radiation was the focus of the NIOSH evaluation, NIOSH did not repeat these environmental evaluations. A bulk sample which had been removed from the firebrick in the furnace was analyzed by NIOSH for free silica and none was detected.

At the time of the first site visit that there was no baseline ophthalmological information available on any of the glassworkers. Following a suggestion by NIOSH, a program to obtain such information had been initiated by the time of the second visit.

VIII. RECOMMENDATIONS

The following recommendations are offered to reduce potentially significant occupational exposures and safety risks at Louie Glass:

1. It is recommended that shade #3/4 tinted eye wear be used by the platform personnel. Other furnace room personnel should be offered eye protectors (probably at a lower shade number) depending on type of work performed.

2. There needs to be a clear and understandable company policy on the need for tinted eye protectors and who should wear them. This policy should be developed by the safety personnel as soon as possible.

3. Pre-placement visual acuity screening should be improved and expanded for all personnel involved with glass production at the company.

4. Furnace room workers who experience persistent ocular symptoms (such as irritation, difficulty seeing clearly, etc.), should be referred to an appropriate health care provider for further evaluation.

5. Area fans and general ventilation outlets should be placed near furnace room personnel to aid in reducing the thermal load.

6. It is recommended that the facility consider the possibility of reducing the effective porthole area and installation of transparent material in front of the porthole as potential methods to reduce the IR exposure level, as well as to minimize the number of reported medical symptoms.

7. More emphasis on wearing protective gloves is needed at the facility to reduce the large number of reported cuts and burns. The safety office should further identify those areas where high number of cuts and burns occur.

8. It is suggested that the company adopt a no smoking policy for all workstations.

9. Heat stress measurement should be repeated in the furnace area during summer months.

10. Furnace room workers should maintain a liberal fluid intake. In general, salt supplement should not be necessary. If salt supplementations is provided it should be in the form of salt solutions or sodium-containing beverages.

11. More emphasis needs to be placed on solving some of the ergonomic and illumination problems seen in the engraving and quality control areas. The molds used in the furnace area should have additional task lighting to aid the glassmakers in placing the hot glass into the molds.

12. Workers reporting numbness and tingling of hands are possible cumulative trauma cases. Those with persistent symptoms should be referred for medical evaluation. An ergonomic evaluation of the workplace (furnace room and engraving areas) should be undertaken.

13. Louie Glass should attempt to obtain conveyor belt dressing compounds that do not contain methylene chloride or other hazardous ingredients. The company should complete the collection of all material data safety sheets (MSDS) for chemicals used in the facility.

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Maximum and Minimum Furnace Temperature Values (in degrees Fahrenheit) Recorded at Holes #1, #7, and #13 by Plant Personnel During the NIOSH Evaluation.

Louie Glass Plant
Weston, West Virginia
HETA 88-299
October 11-13, 1988

Date	No. Hole Measurements	Hole #1		Hole #7		Hole #13	
		Max	Min	Max	Min	Max	Min
10/9	1	2220	2220	2225	2225	2218	2218
10/10	11	2218	2206	2225	2216	2220	2211
10/11	11	2215	2210	2220	2210	2216	2209
10/12	11	2223	2209	2223	2211	2219	2207
10/13	4	2214	2202	2220	2218	2214	2212

TABLE II

Heat Stress Measurements

Louie Glass Company
Weston, West Virginia
HETA 88-299
October 11-13, 1988

Measurement Location	Measurements in °F WBGT	GT	WB	%RH
Furnace room				
Port #1:				
2 ft. from opening	116	186	86	28
9 ft. from opening edge of stage	73	92	65	49
19 ft. from opening at blow mold position	64	76	59	58
31 ft. from opening; aisle behind work station	61	72	56	58
Port #2:				
2 ft. from opening .	115	192	82	22
9 ft. from opening; edge of stage	67	83	60	62
Port #4:				
2 ft. from opening	95	150	72	24
7 ft. from opening; edge of stage	71	97	60	34
17 ft. from opening; gas-fired cutting station	68	84	61	48
Port #10:				
2 ft. from opening	92	140	72	26
6 ft. from opening; edge of stage	71	88	64	48
Port #13 (2nd shift):				
2 ft. from opening	105	178	74	20
7 ft. from opening; edge of stage	69	86	62	44
Port #13 (3rd shift):				
2 ft. from opening	110	192	75	20
7 ft. from opening; edge of stage	67	87	58	52
Outside of Building	61	78	54	61

GT, DB, and WB = Globe, Dry Bulb, and Natural Wet Bulb Temperature, respectively

TABLE III

Prevalence Rates of Selected Visual Symptoms in Blowers
and Bit-Persons as Compared to Other Workers

Louie Glass Plant
Weston, West Virginia
HETA 88-299
October 11-13, 1988

Symptom	Rate In Exposed	Rate In Non-Exposed	Rate Ratio	95% Confidence Interval
Hazy vision	14/52(27%)	23/182(13%)	2.13	(1.18-3.84)
adjusted for green glasses			1.82	(0.99-3.36)
Blurred vision	18/52(35%)	35/182(24%)	1.80	(1.07-4.63
adjusted for green glasses			1.73	(1.05-2.86)
Use prescription lenses at work	37/52(71%)	86/182(47%)	1.51	(1.19-1.90)
Had 2+ prescription changes over last 2 years	6/52(12%)	4/82(2%)	2.92	(1.66-5.16)
Believe job affected vision	16/52(31%)	32/182(18%)	1.75	(1.05-2.93)
adjusted for green glasses			1.49	(0.89-2.50)

TABLE V

Maximum Infrared Transmittance of Various Shade of Filter Lenses*

Louie Glass Plant
Weston, West Virginia
HETA 88-299
October 11-13, 1988.

Shade Number	Maximum IR Transmittance (%)**	Calculated IR Exposure (mW/cm^2) Platform	Non-Platform
1.5	25	43	35
1.7	20	35	28
2.0	15	26	21
2.5	12	21	17
3.0	9	16	13
4.0	5	9	7
5.0	2.5	4	4
6.0	1.5	3	2
7.0	1.3	2	2
8.0	1.0	2	2

* Modified from ANSI Z87.1 (1989)
** IR is defined to cover wavelengths from 780 to 2000 nanometers

TABLE IV

Prevalence Rates of Selected Other Symptoms in Blowers and Bit-Persons as Compared to Other Workers

Louie Glass Plant
Weston, West Virginia
HETA 88-299
October 11-13, 1988

Symptom	Rate In Exposed	Rate In Non-Exposed	Rate Ratio	95%Confidence Interval
Shortness of breath	27/52(40%)	37/182(20%)	1.99	(1.28-3.08)
(adjusted for smoking)			1.99	(1.29-3.05)
excluding "white lung" cases			1.82	(1.08-3.07)
Tingling/numbness of hands	23/52(44%)	43/182(24%)	1.87	(1.25-2.80)
Dry eyes	21/52(40%)	44/182(24%)	1.67	(1.10-2.54)
Itchy nose (age <=30)	23/52(44%)	57/182(31%)	1.41	(0.97-2.05)
age <=30	7/11(64%)	17/55(31%)	2.06	(1.13-3.74)
age 31+	16/41(39%)	40/127(31%)	1.24	(0.78-1.96)

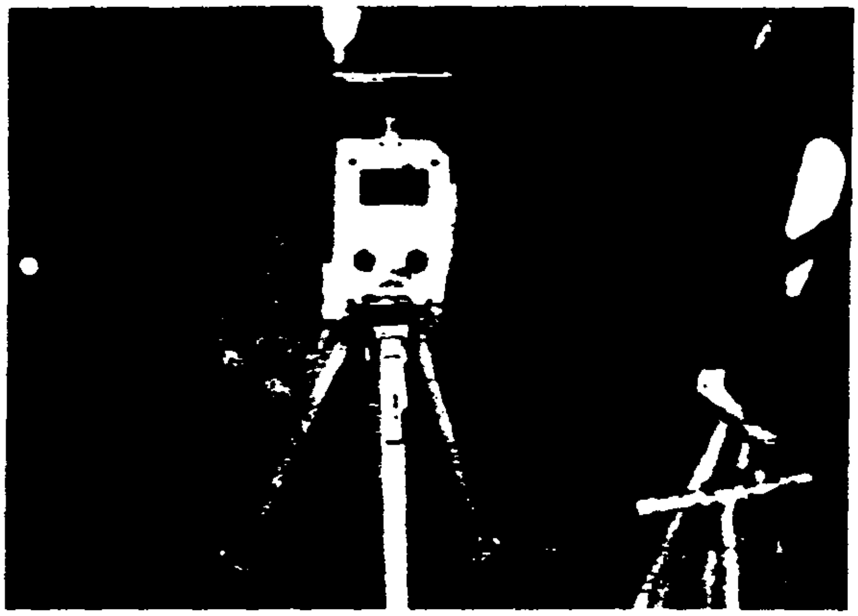


Figure 2. Heat stress measurements performed at furnace porthole.

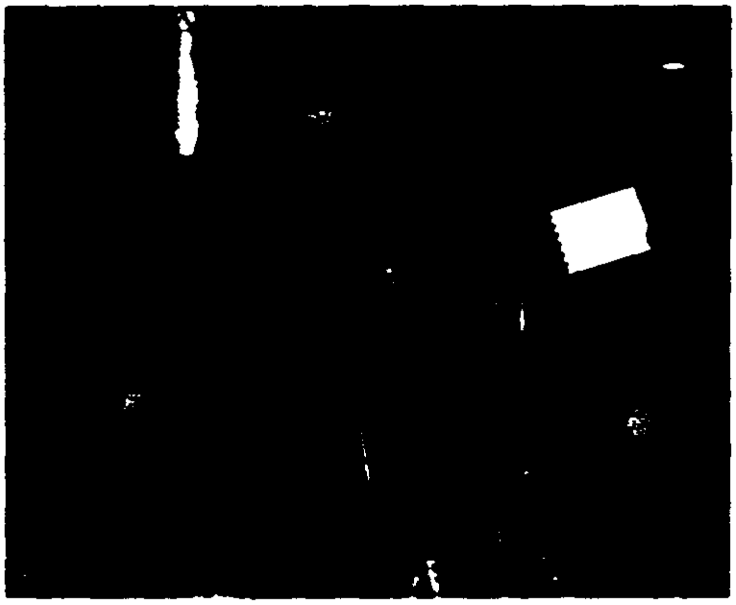


Figure 3. Furnace temperature being measured by pyrometer.

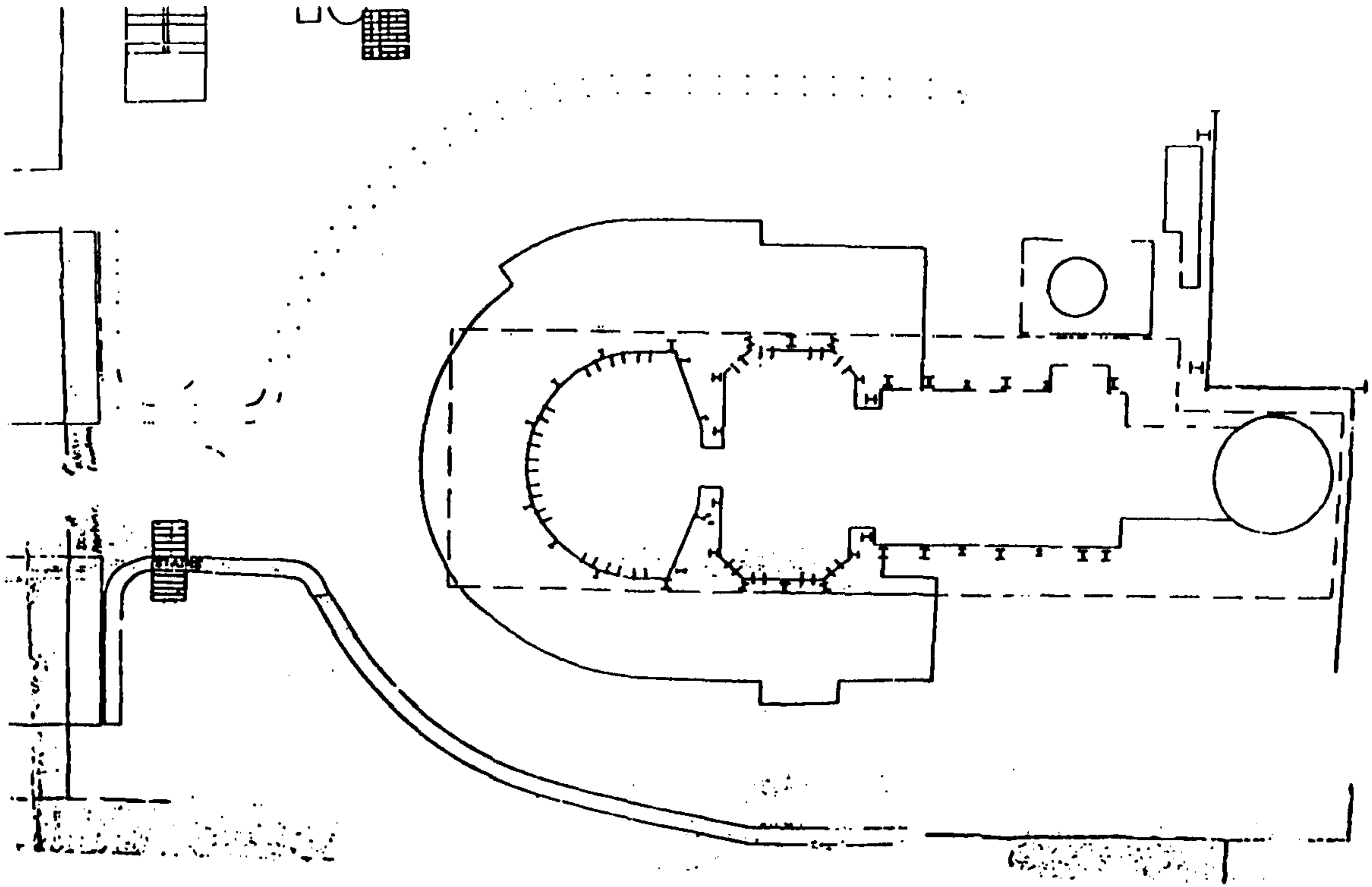


FIGURE 1. Schematic of Louie Glass Company furnace. Cross-hatched area represents platform on which the gatherers worked.

Figure 5. Fans mounted in furnace area to provide additional cooling.

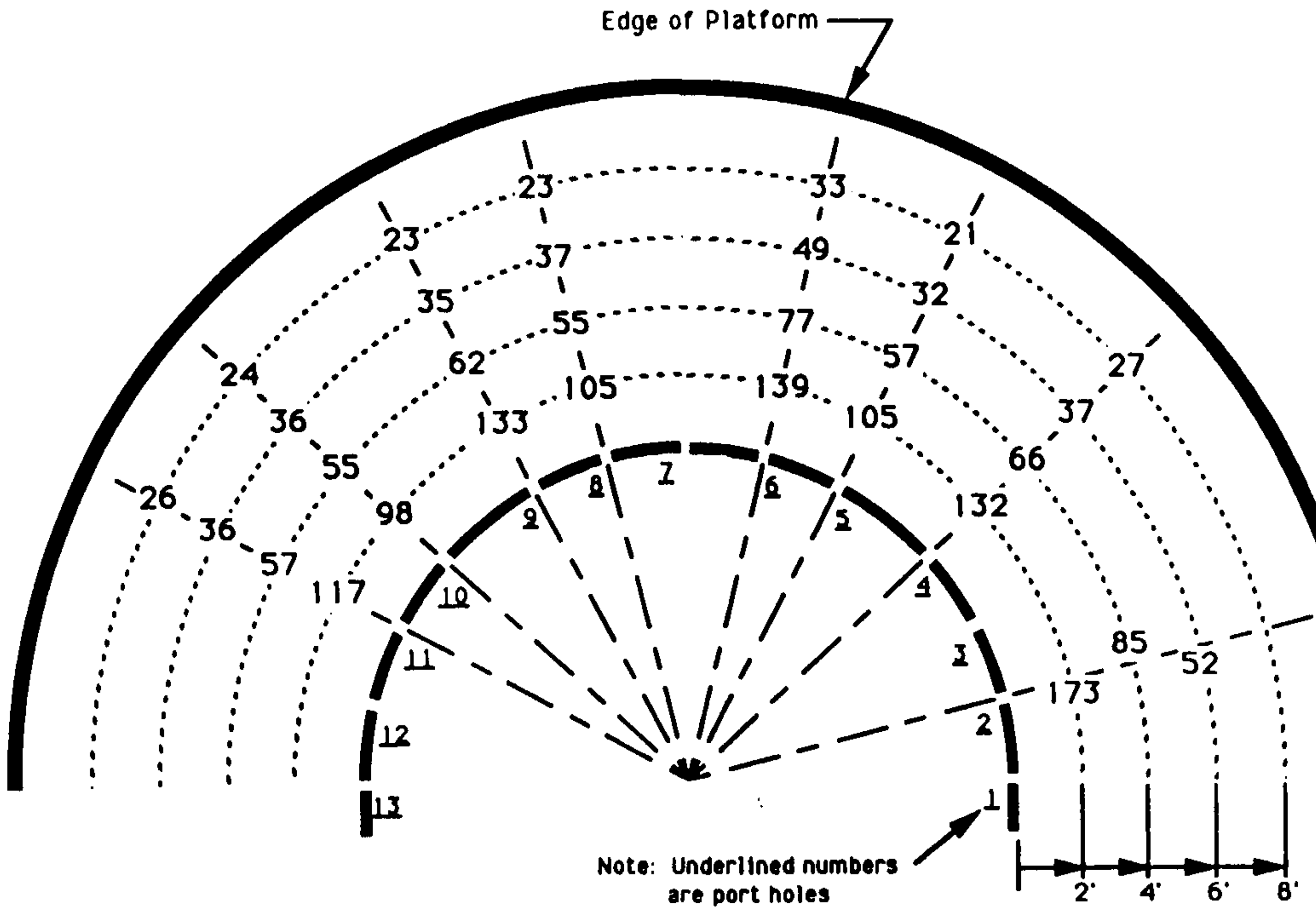


Figure 4. Distribution of IR irradiance (in mW/cm^2) on the platform as a function of distance from the center of the furnace.

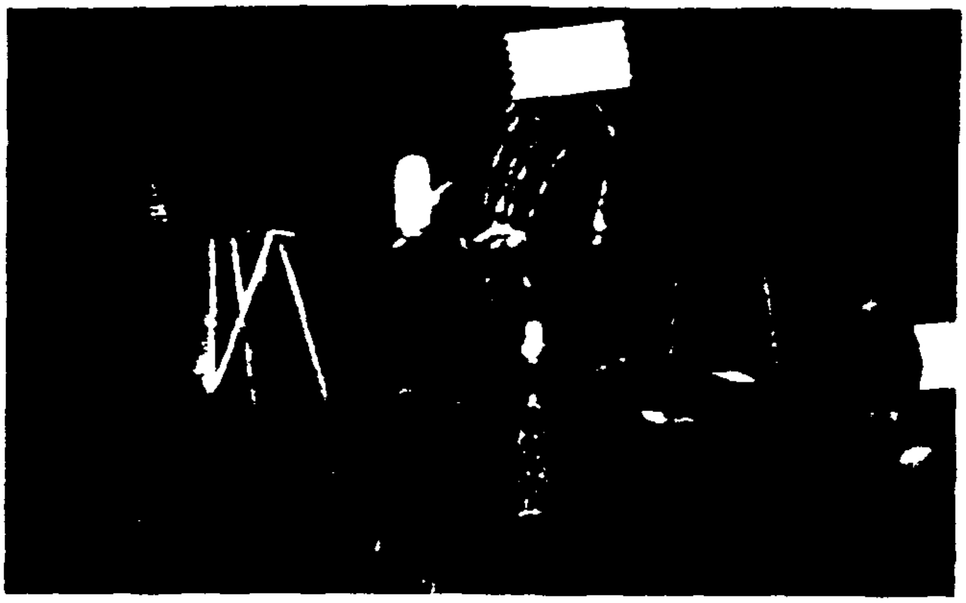


Figure 7. Foot-setter attaching material to glass product.

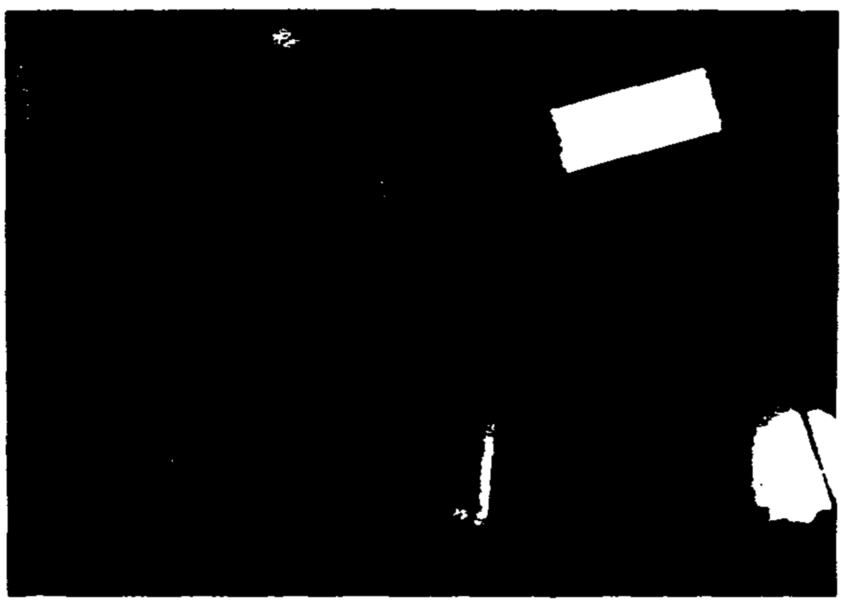
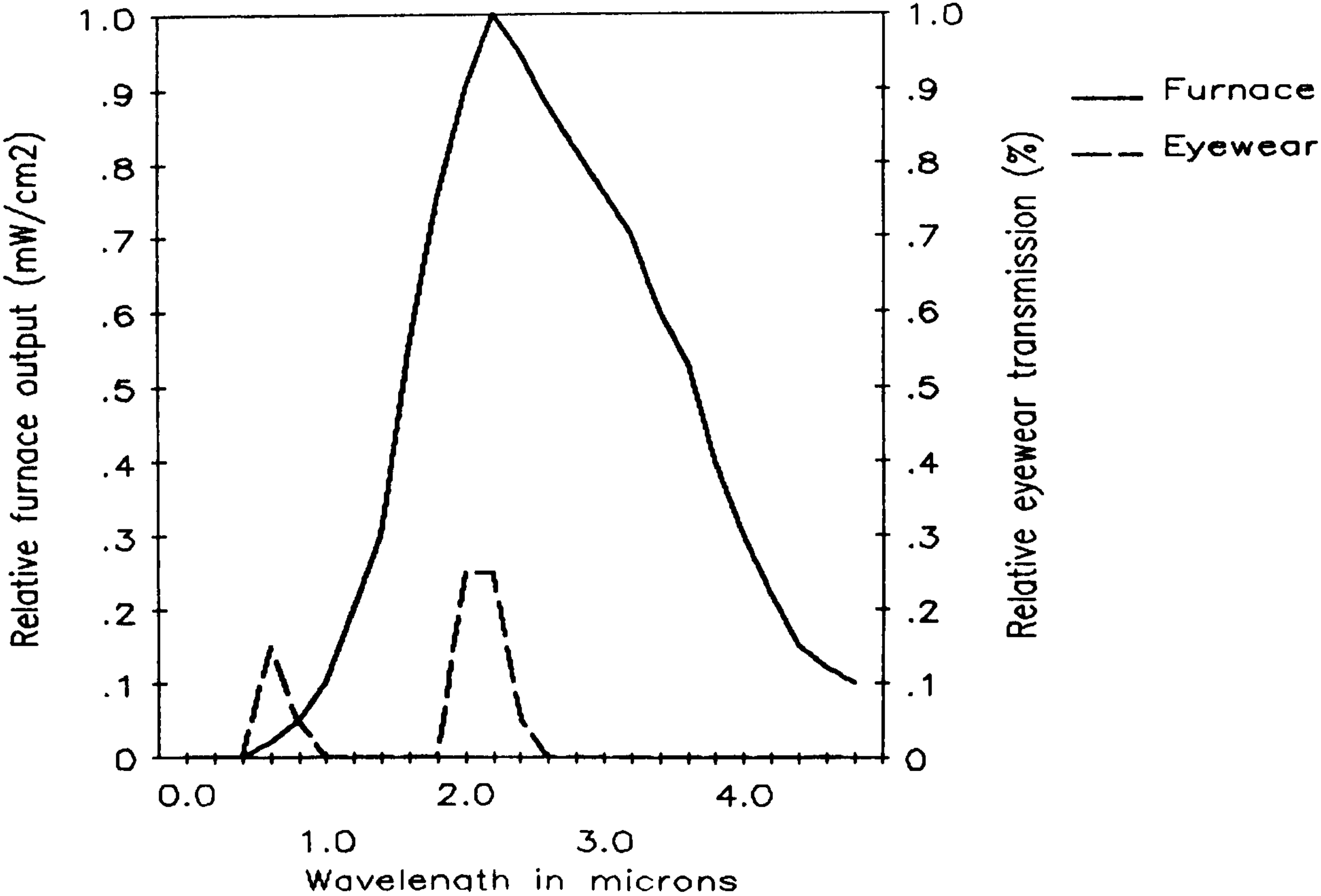


Figure 8. Two Gatherers obtaining material from the furnace.

Figure 6. Relative furnace irradiance versus spectral transmission of typical eye protector.



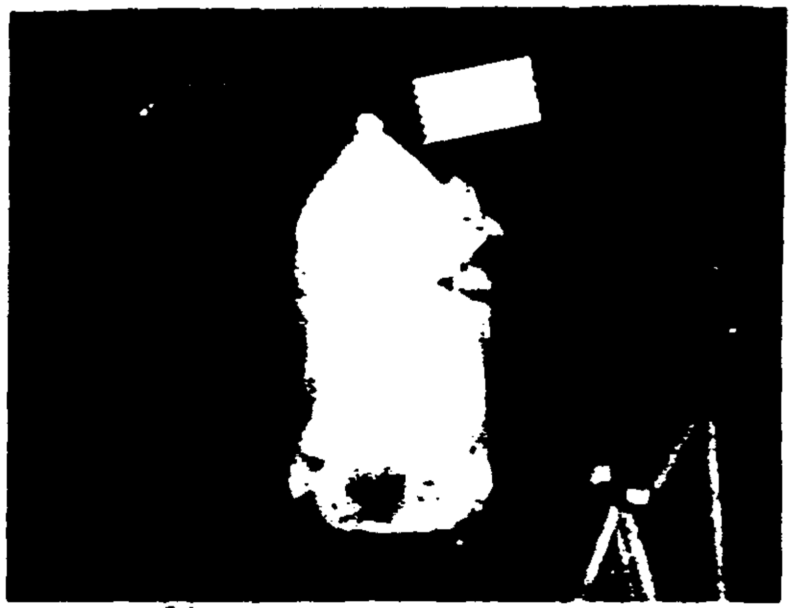


Figure 9. Gatherer at work. Notice bandaged area on arm from burn.

Figure 10. Up-close work being performed on hot glass by team member.

Figure 11. Glassblower using mold.

Figure 12. Glass polisher making final runs.

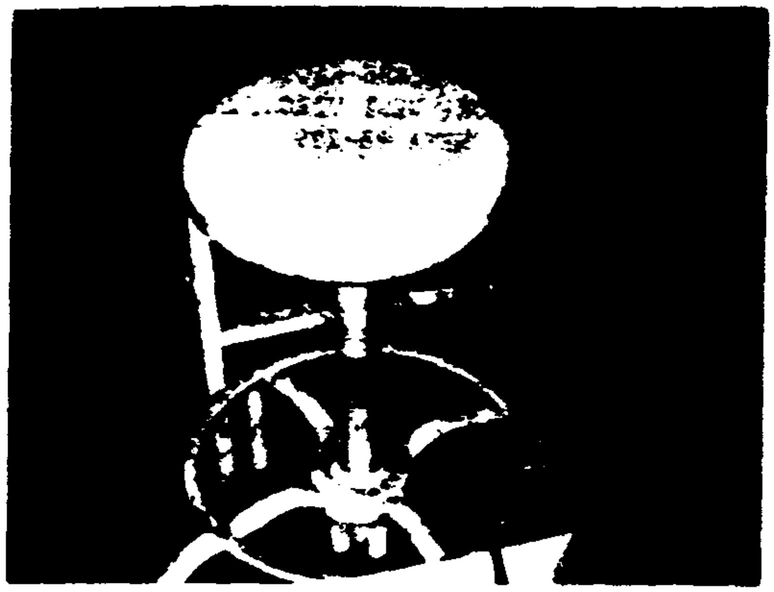


Figure 13. Typical chair used by engraving personnel

Figure 14. Typical engraver's work station.

APPENDIX I.

LOUIE GLASS FACTORY
WESTON, WEST VIRGINIA
HETA 88-299

Personnel from the National Institute for Occupational Safety and Health (NIOSH) are conducting a study of possible health and safety hazards in the furnace room of the Louie Glass Factory. The study consists of two parts:

1. Collection of health information and work history from questionnaires filled out by employees who work in the furnace room.

2. Industrial hygiene sampling of the furnace room work environment.

Since you work in the furnace room, we would like you to fill out the questionnaire. This questionnaire takes about 15 minutes to fill out. It will ask you a few background questions about yourself (age and sex), about your present and past jobs in glass-making, and whether you have had certain medical conditions or symptoms, either at work or away from work.

Your participation is voluntary. You can refuse to participate at all or refuse to answer any questions you wish. All personal information provided will be considered confidential in accordance with the Privacy Act of 1974 (Public Law 93-579).

WORK AND HEALTH HISTORY

FOR OFFICE USE ONLY	
ID# ______	(1-3)
	(4-9)
	(10)
	(11-12)

Today's date: ______ / ______ / 19 ____
(month) (day) (year)

I. GENERAL INFORMATION

1. Name ____

2. Address ____

____

3. Sex (please check): 1____male
2____female

4. Age last birthday: _____
(years old)

II. WORK HISTORY

FOR OFFICE USE

5. What is your present job? (please check): (13)

1___blower

2___bit person

3___gatherer

4___core gatherer

5___footer

6___blocker

7___other (describe below):

6. What shop do you work with now? (describe below): | | | (14-15)

7. What shift do you usually work? (please check one): (16)

1___~~day~~ A

2___~~afternoon~~ B

3___~~night~~ C

4___~~swing or fourth~~ D

5___~~other (describe below):~~

8. How long have you worked this job at Louie Glass? (17-20)

| | | (# mos) or | | | (# yrs)

III. HEALTH HISTORY

OFFICE USE

12. Were you ever told by a medical doctor that you had any of the following medical conditions? (Please check all that apply and give year of diagnosis).

Medical Condition		Year of diagnosis	OFFICE USE
a. Cataracts	1___Yes	19 |_|_|_|	(4-6)
b. Glaucoma	1___Yes	19 |_|_|_|	(7-9)
c. Retinal disease	1___Yes	19 |_|_|_|	(10-12)
d. Diabetes	1___Yes	19 |_|_|_|	(13-15)
e. Eczema	1___Yes	19 |_|_|_|	(16-18)
f. Carpal tunnel syndrome	1___Yes	19 |_|_|_|	(19-21)
g. Asthma	1___Yes	19 |_|_|_|	(22-24)
h. Bronchitis	1___Yes	19 |_|_|_|	(25-27)
i. Emphysema	1___Yes	19 |_|_|_|	(28-30)
j. Other lung disease (describe below): ..	1___Yes	19 |_|_|_|	(31-33)

OFFICE USE

13. Do you get the following symptoms either at work or away from work on a regular basis? (Please check all that apply).

Symptom	At Work	Away From Work	
a. Dry skin	1___Yes	1___Yes	(34-35)
b. Itchy or irritated skin	1___Yes	1___Yes	(36-37)
c. Dry eyes	1___Yes	1___Yes	(38-39)
d. Itchy, irritated or watery eyes	1___Yes	1___Yes	(40-41)
e. Nosebleeds	1___Yes	1___Yes	(42-43)
f. Itchy or irritated nose	1___Yes	1___Yes	(44-45)
g. Stuffy or runny nose	1___Yes	1___Yes	(46-47)
h. Sinus congestion	1___Yes	1___Yes	(48-49)
i. Sore or scratchy throat	1___Yes	1___Yes	(50-51)
j. Difficulty breathing	1___Yes	1___Yes	(52-53)
k. Tightness of chest	1___Yes	1___Yes	(54-55)
l. Wheezing/whistling breath	1___Yes	1___Yes	(56-57)
m. Shortness of breath	1___Yes	1___Yes	(58-59)
n. Cough	1___Yes	1___Yes	(60-61)
o. Headache	1___Yes	1___Yes	(62-63)
p. Blurred vision	1___Yes	1___Yes	(64-65)
q. Hazy vision	1___Yes	1___Yes	(66-67)
r. Double vision	1___Yes	1___Yes	(68-69)
s. Tingling or numbness of hands	1___Yes	1___Yes	(70-71)
t. Other (describe below)	1___Yes	1___Yes	(72-73)

CARD |0|2| (79-80)

OFFICE USE

14. In the PAST YEAR, how many times have you had any of the following injuries during work at Louie Glass and were you hospitalized?

Injuries	# of times	Hospitalized		OFFICE USE
a. Gotten sick from the heat	|__|__|__|	1___Yes	2___No	(4-6)
b. Burned by hot glass or metal	|__|__|__|	1___Yes	2___No	(7-9)
c. Cut by broken glass	|__|__|__|	1___Yes	2___No	(10-12)
d. Injury to eye	|__|__|__|	1___Yes	2___No	(13-15)
e. Other injuries (describe below):	|__|__|__|	1___Yes	2___No	(16-18)

15. Do you smoke cigarettes? (19)

1____no, never did

2____no, quit more than a year ago

3____no, just quit

4____yes, less than one pack per day

5____yes, one or more packs a day

IV. VISION

OFFICE USE

16. Do you wear eyeglasses or contact lenses to improve your vision AT WORK? (20)

1____yes, eyeglasses

2____yes, contact lenses

3____yes, both

4____no

17. Do you wear eyeglasses or contact lenses to improve your vision AWAY FROM WORK? (21)

1____yes, eyeglasses

2____yes, contact lenses

3____yes, both

4____no

18. What kind of safety glasses do you now wear at work? ( )

1____colorless

2____rose-colored

3____green

4____do not wear safety glasses

5____other (describe below):

Questions 19-23 are about how well you can see. If you wear eyeglasses or contact lenses, answer the questions describing how you see WITH YOUR GLASSES OR CONTACT LENSES. (Please check one answer per question)

19. How much trouble do you have seeing with your LEFT EYE? (23)

1____cannot see

2____some trouble

3____no trouble

OFFICE USE

20. How much trouble do you have seeing with your RIGHT EYE? (24)

1____cannot see

2____some trouble

3____no trouble

21. How much trouble do you have seeing with BOTH EYES TOGETHER? (25)

1____cannot see

2____some trouble

3____no trouble

22. Do you have any problem seeing distant objects? (26)

1____yes (describe below)

2____no

3____don't know

IF YES: What kind of problems? (Please describe):

23. Do you have any problems seeing that can't be helped by eyeglasses? (27)

1____yes (describe below)

2____no

3____don't know

IF YES: What are they? (Please describe):

OFFICE USE

24. Do you have any restrictions on your driver's license?

1____yes (describe below) (28)

2____no

3____do not have driver's license

IF YES: In what way? (Please describe):

25. Do you have problems driving at night because of glare from other cars' headlights?

1____yes (29)

2____no

3____do not drive

26. Do you have problems with blurry vision when you read or do close work?

1____yes (30)

2____no

27. What year did you last have your vision tested? 19 | | | (year)

(31-32)

OR IF NEVER TESTED, CHECK HERE........................99____

28. During the past two years, how many times have you had your glasses or contact lenses prescription changed? | | (# times)

(33

OR IF YOU NEVER WORE GLASSES OR CONTACT LENSES, CHECK HERE..9____

29. Do you think your job has had any effect on your vision?

1____yes (describe below) (34

2____no

3____don't know

IF YES: In what way? (Please describe):

CARD |0|3| (79-80

THANK YOU FOR YOUR COOPERATION.