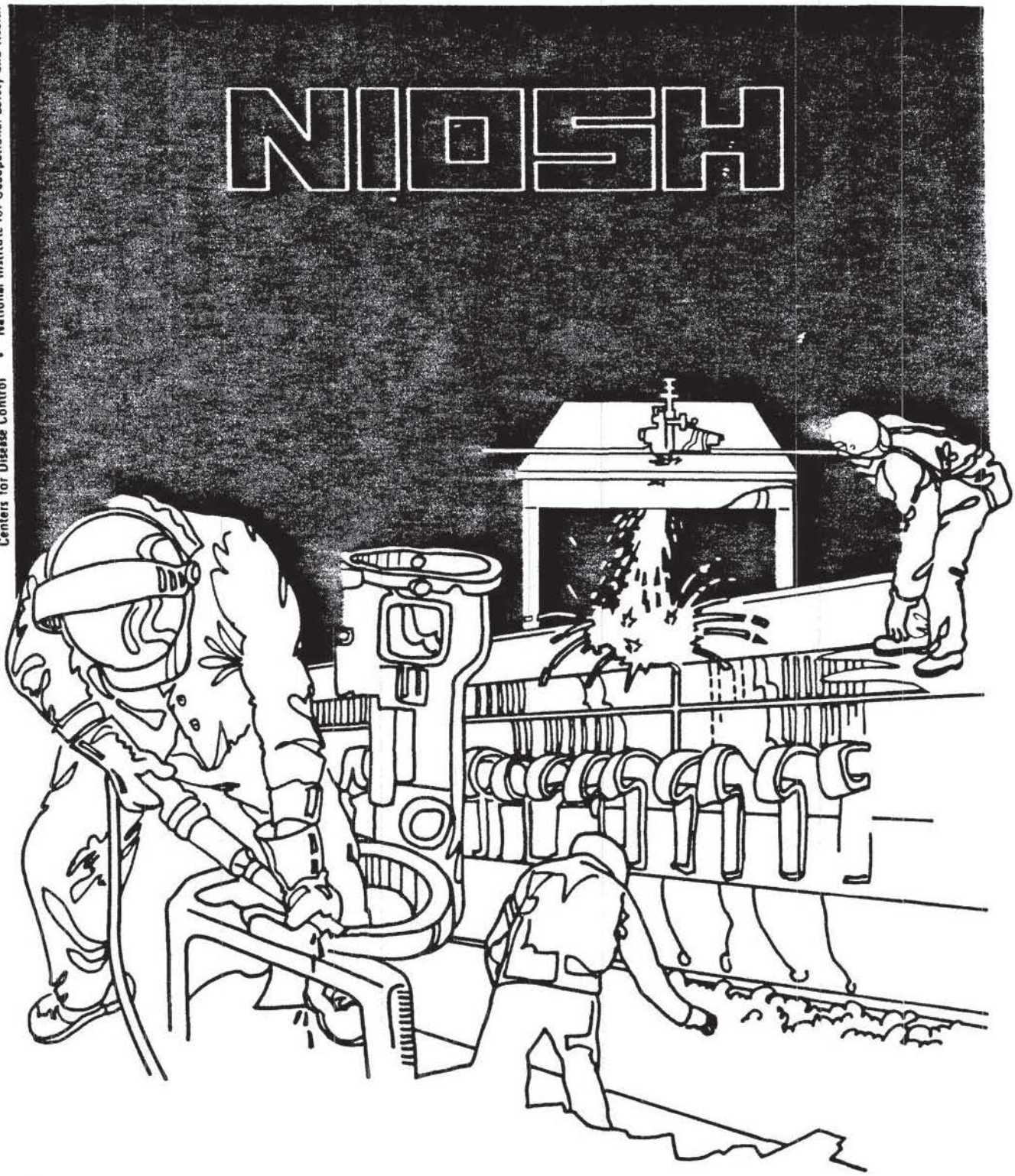
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
Centers for Disease Control • National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

79-149-758

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. 699(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.

HE 79-149-758
October, 1980
American Can Company
Chambersburg, Pennsylvania

NIOSH INVESTIGATORS:
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SUMMARY

On September 20, 1979, NIOSH received a request from the Chambersburg Printing Specialties and Paper Products Union for a health hazard evaluation in the pressroom at the American Can Company in Chambersburg, Pennsylvania. The request alleged that the infrared (IR) dryers were burning off layers of their eyes and lips. The request also expressed concern about the heat and fumes the dryers emit while drying the ink.

A walk-thru evaluation was conducted on October 9, 1979. At that time non-directed medical interviews were conducted with the affected workers. Thirteen of the twenty employees interviewed complained of eye problems and the causative agent to be the infrared dryers. Three employees complained about the kerosene-air clean-up of the presses causing them to be sick in the stomach. Six employees were concerned about the dust from the offset. From the conditions of use and responses to the interviews it was determined that environmental sampling would be performed for offset press dust, aldehydes, infrared radiation and kerosene.

On March 11-13, 1980, NIOSH personnel evaluated the IR dryers and the work atmosphere for vegetable dust (nuisance) and for isopropanol and aldehyde vapors.

Analysis of the environmental air samples for nuisance dust, isopropanol and aldehyde vapors collected at the printing presses indicated that they are below NIOSH and OSHA permissible levels. The press cleaning operation by spraying kerosene was to be evaluated, however, the operation was changed and machines are cleaned manually with rags and kerosene and there are no employee complaints.

The IR irradiance levels were below 10 mW cm^{-2} which is the proposed American Conference of Governmental Industrial Hygienists guideline for cataract production. The irradiance levels, however, were of sufficient magnitude to perhaps produce drying of the lips and eyes from the unshielded IR lamps.

On the basis of the data collected in this investigation NIOSH determined that no hazard existed as a result of exposure to nuisance dust, isopropyl alcohol and aldehydes. However, there is a real potential for the infrared dryers to cause adverse health effects such as dry lips and dry eyes. Recommendations are made for additional shielding of the IR dryers and provision of eye protection and a vision examination program for exposed workers.

KEYWORDS: SIC 2654 (Sanitary Food Containers), nuisance dust (vegetable), aldehydes, isopropanal, infrared radiation, burning of lips and eyes.

I. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates adverse health effects of substances found in the workplace. The Chambersburg Printing Specialties and Paper Products Union requested such an investigation from NIOSH on September 20, 1979, alleging that the infrared dryers, are burning off layers of their eyes and lips. This request also expressed concern about the heat and fumes the dryers emit while drying the ink.

III. BACKGROUND/CONDITIONS OF USE

On October 9, 1979, a NIOSH industrial hygienist visited the plant to conduct a walk-thru survey to observe the conditions of use and to administer non-directed medical questionnaires to the employees.

During the meeting, it was brought out that the reason the health hazard request was initiated was that the employees at the presses where infrared dryers are used were complaining of health problems. These problems began shortly after the first of the year following the installation of the initial unit. Later two more units were installed and additional complaints were received.

American Can Company manufactures cardboard food containers at this site utilizing offset printing techniques.

There are five Moon and Inor infrared dryers at the facility that are used to cure specially-prepared inks. Each dryer has about 30 quartz IR heat lamps in a 0.46 m by 3.1 m area. Some of the dryers used combinations of 1 and 2 kilowatt (kW) lamps, while other dryers used only 2 kW lamps. In general, most of the dryers operate at a maximum of 60 kW. The dryers were positioned on the west side of the building as shown in Figure 1.

Each press was about 15 m long, 4 m wide and 5 to 6 m high. Each press had a catwalk around its perimeter. Figure 2 shows a schematic of how the curing process works. The material to be cured passes within 0.3 m of the lamps. Since the lamps remain on during the curing time, the passage of the material under the bank of lamps produces a light-cycling effect (i.e., increase and decrease of light intensity).

The literature sent with the dryers states several times that in normal operation lamps must be mounted so that it is impossible to directly observe the lamps. During the initial walk-thru survey of October 9, 1979, no shielding was present, necessitating the press operator to be exposed to the direct radiation from the infrared dryer lamps. Direct radiation was still observable on March 11, 1980, however, it must be noted that some attempt was made to shield the source, but this effort did not eliminate all direct radiation exposure to workers.

The dryers at the facility use 1 and 2 kW quartz infrared heat lamps manufactured by Philips (model number 13713z/98). These lamps work at

a filament temperature of 2400 K. The relative spectral emission of this type of lamp, as indicated in Philips sales literature, is shown in Figure 3. This figure demonstrates several facts. First, little, if any, ultraviolet radiation (i.e., wavelengths less than 400 nm) is produced. Second, the peak wavelength occurs around 1200 nm. Third, visible radiation is produced by the lamp. Fourth, the lamp produces far infrared (i.e., wavelengths greater than 3000 nm) radiation which may present heat stress problems.

A vegetable type offset powder is used for drying. An aqueous isopropyl alcohol solution is used as a roller wash.

Weekly the presses were cleaned utilizing a kerosene-air mixture. The process was changed to a manual method during the atmospheric evaluation period of March 11-13, 1980.

Non-directed medical interviews were conducted with twenty pressmen on all three shifts. Three pressmen who either had no exposure to the infrared dryers or who took special precautions in not looking into the light had no problems. The remainder of the employees complained of headaches, tiredness, dryness of the face and lips, dryness of the eyes, nasal problems, breathing problems and watering of the eyes. The agents which the employees claimed caused these symptoms were kerosene, plate wash, infrared dryers, offset dust, and fumes from the curing of the inks.

Thirteen of the twenty employees interviewed complained of eye problems and the causative agent to be the infrared dryers. Three employees complained about the kerosene-air clean-up of the presses. Six employees were concerned about the dust from the offset.

A preliminary report was sent in October, 1979, to Union and management which contained the findings from medical questionnaires and toxicity of materials which could contribute to the symptoms which the employees were complaining about.

IV. EVALUATION DESIGN

a) Infrared Radiation

The following equipment was used to document levels of radiant energy produced by the infrared lamps:

1. An EG&G model 555 spectroradiometer was used to measure the spectral irradiance in the wavelength region from 280 to 1100 nm. The unit of measurement is the watt per square centimeter per nanometer ($W \cdot cm^{-2} \cdot nm^{-1}$). The values obtained are summed to give the total irradiance in a particular optical region in units of $W \cdot cm^{-2}$.

The spectroradiometer operated at a 10 nm bandpass, with 10^{o} acceptance angle, and recorded cosine-corrected irradiance values.

2. Luminance or brightness levels were measured with a Spectra Mini-Spot photometer having a 1^{o} field of view. The values were obtained in terms of footlamberts (fL) which are converted to candelas per square centimeters ($cd \cdot cm^{-2}$). 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.

3. An International Light Model 730A radiometer with specially calibrated detectors was used to evaluate the ultraviolet radiation levels. One detector was designed to read the actinic UV radiation (200 to 315nm) in biologic effective units of microwatt per square centimeter ($uW \cdot cm^{-2}$), while the other detector measures near UV (320-400 nm) in units of milliwatt per square centimeter ($mW \cdot cm^{-2}$) with no biologic weighting function.

All optical radiation instruments used in this evaluation had been calibrated by the respective manufacturer within six months and were checked by NIOSH before and after field measurements for compliance with calibrations.

All measurements were performed in the press room during regular working hours (which covered at least 2 workshifts) on March 11-12, 1980. The presses were claimed to be operating normally at 70% of their output. Since complaints had been voiced by workers around these presses, radiation levels were documented at positions on the floor and catwalk. Figure 4 is a schematic of the measurement locations with reference to the lamp bank. It is important to note that workers on the catwalk are exposed to reflected radiation as compared to the direct radiation exposure to the floor workers.

Measurements at floor level were performed at 4.8 m and 2.5 m (horizontal) from the lamp bank with the detectors at angles of 17^{o} and 31^{o} respectively. Measurements at the catwalk location were performed with the detector aimed at the lamp bank (56^{o} below the vertical) at a straight line distance of 10 meters. Results are reported for presses #2 and #5.

b) Nuisance Dust

Six personal dust samples were collected on March 12-13, 1980 utilizing personal air sampling pumps and 0.8 micron membrane filters. These samples were subsequently analyzed gravimetrically The results are presented in Table I.

c) Aldehydes

Two general air impinger samples were collected at the #3 and #5 presses in a solution containing one percent $NaHSO_3$. These samples were subsequently analyzed for formaldehyde by NIOSH Method P&CAM 125. Subsequently these samples were analyzed for C_2 to C_5 aldehydes using a Hewlett-Packard 5731A gas chromatograph equipped with a flame ionization detector. A 12' x 1/8" glass column packed with 4% Carbowax 20M and 1% PPI on 60/80 mesh Carbopack B was used with a temperature program from 120°C to 150°C changing at a rate of 8°C/minute.

d) Isopropyl Alcohol

Three general and personal air samples were collected at 100 ml per minute on charcoal tubes.

The A and B sections of the charcoal tubes were analyzed separately following a modification of NIOSH method S-65. As is specified in the method, samples were desorbed each in 1 ml carbon disulfide which contained 1% (by volume) 2-butanol, as an aid in desorbtion. The analysis was carried out on a Hewlett-Packard 5731A gas chromatograph with flame ionization detection using a 3' x 1/8" stainless steel column packed with 80/100 mesh Chromosorb 108. Temperature programming between 130°C and 160°C at a rate of 16°C/minute was used to insure a clean separation of the isopropanol from other constituents present.

Each bulk was analyzed for the contents of possible interfering compounds which could have affected the quantitation of the isopropanol on the charcoal tubes. Very little besides isopropanol was detected in the bulk samples.

The results are presented in Table II.

V. EVALUATION CRITERIA

a) Infrared Radiation[1]

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

The physical factors associated with 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 probably do not enter into photochemical reactions with biological systems. Molecular interaction with radiation in the IR regions are characterized by various vibrational-rotational transitions resulting in an increase in thermal energy of the molecule.

Harmful Effects

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.

In the eye, however, there is no adequate warning mechanism to protect against lenticular damage. Cataracts may be produced by prolonged exposure to wavelengths at energy levels that do not normally burn the skin. Recent reports, however, tend to cast serious questions of etiology of cataracts by IR.[2,3]

The present etiology of IR-induced cataracts is thought to be directly correlated with the amount of energy initially absorbed by the iris and then transferred to the lens. The threat of cataract formation is primarily from wavelengths below 1400 nanometers. Longer wavelengths may produce corneal damage, the difference being due to the site of energy absorption.

The primary biological effect of IR on the retina and choroid is thermal in nature, with the amount of damage being proportionate to the length of exposure. If the radiation intensity is low enough, however, the 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 radiation can produce a relatively intense point energy distribution on the retina resulting in a lesion. The effects of IR on the lid and cornea can be considered as ordinary cutaneous burns.

b) Nuisance Dust [4]

Offset dusts are vegetable in nature and are considered as inert or nuisance dusts. Nuisance dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance aerosols have also been called biologically "inert", but the latter term is inappropriate to the extent that there is no particulate which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts has the following characteristics:

1. The architecture of the air spaces remains intact.
2. Collagen (scar tissue) is not formed to a significant extent.
3. The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility or may cause unpleasant deposits in the eyes, ears and nasal passages.

See Table I for evaluation criteria.

c) Formaldehyde - Aldehydes (3)

Aldehydes are strongly irritating to the skin, eyes, and respiratory tract. Acute exposure may result in pulmonary injuries such as edema, bronchitis, and bronchopneumonia. Skin and pulmonary sensitization may develop in some individuals and result in contact dermatitis and, more rarely, asthmatic attacks. After hypersensitivity develops, individuals may develop symptoms due to other aldehydes.

d) Isopropyl Alcohol

The vapors of isopropyl alcohol are mildly irritating to the conjunctiva and mucous membranes of the upper respiratory tract. It is potentially narcotic in high concentrations causing atoxia, prostration, deep narcosis and death.

See Table II for evaluation criteria.

VI. RESULTS AND DISCUSSION

a) Infrared Radiation

Figure 5 shows a plot of spectral irradiance values versus wavelength for the lamp bank of press #2 taken at a distance of 4.8 m. The spectral irradiance values cover the wavelength range from 280 to 1100 nm and the graph of these values generally support the manufacturer's results over the same spectral region. The summed spectral irradiance values of Figure 5 is 1.5 $mW \cdot cm^{-2}$, with approximately 72% of the irradiance in the irradiance in the IR region beyond 760 nm. At 2.5 m the total irradiance (280 to 1100nm) increases to about 3 $mW \cdot cm^{-2}$. It is noted that the value at 2.5 m was made under different geometrical conditions than at 4.8 m due to loading of items to be used. There was not any actinic UV detected and the near UV irradiance was 2-3 $uW \cdot cm^{-2}$ using both the IL-730A and EG&G 555 systems. The luminance value measured was almost 1000 fL at 4.8 m.

Measurements were performed on the catwalk of press #2 and #5 with the EG&G 555 detector positioned at the eye level of the operators on duty. On press #2 the total irradiance was over 3 times greater than the values recorded at 4.8 on the floor. The total irradiance on the catwalk of press #5 was 5.9 $mW \cdot cm^{-2}$. The maximum luminance value recorded on the catwalk was 10,000 fL.

The IR irradiance levels were below 10 $mW \cdot cm^{-2}$ which is the proposed ACGIH guideline for cataract production, however, the IR irradiance levels were of sufficient magnitude to perhaps produce the drying of the eyes and lips from the unshielded lamps.

Table III gives values for the maximum optical radiation levels produced at various locations.

b) Nuisance Dust

Employee exposure to nuisance dust (6 samples collected) ranged from 0.22 to 0.84 milligram per cubic meter (mg/M^3) of air on March 12-13 at presses Nos. 2, 3, 5, 6 and 7. These values were well below the criteria for nuisance dust of 10 mg/M^3 (Table I).

c) Aldehydes

Two general air samples were collected and subsequently analyzed for formaldehyde, and the C_2-C_5 aldehydes viz., acetaldehyde, propionaldehyde, bytraldehyde and valeraldehyde. The limit of detection for formaldehyde was 1 microgram per sample. For the C_2 to C_5 aldehydes the limit of detection was 0.03 mg/M^3. These values did not exceed the criteria proposed by NIOSH (1.2 mg/M^3 of air sampled).

d) Isopropyl Alcohol

One general and two personal air samples for isopropyl alcohol were collected. Concentrations ranged from 193 to 422 mg/M^3 of air sampled. These values are below the criteria set by NIOSH and the American Conference of Governmental Industrial Hygienists of 980 mg/M^3 of air sampled (Table II).

e) Kerosene

Air sampling was not done for kerosene vapor and mist although originally plans were made to evaluate this operation due to complaints from the employees. Cleaning of machines was done by air-kerosene spraying of the offset presses. Following the initial visit, this practice was discontinued. Press cleaning is now done manually and employee complaints have subsided. No benzene contamination was found in a bulk sample.

VII. RECOMMENDATIONS AND CONCLUSIONS

a) Infrared Radiation

The dryers were installed on November 1978 and complaints started in early 1979. Most of the complaints centered around dry eyes and lips. Very few workers wore any protective IR glasses during the visit on March 11-12, 1980. The known biological effects associated with IR are shown in Figure 6 as a function of various wavelength regions. One of the effects reported by the workers, that of dry lips, can be partially explained by Figure 7. It is obvious that the heat lamps produced IR at wavelengths that are not reflected by the human skin. Hence the energy can be absorbed and produced a dry skin (lip) condition. Another worker effect, that of dry eye, can be demonstrated by viewing Figure 8. Optical radiation beyond 2500 nm is not transmitted by the cornea and therefore, has to be absorbed or reflected which will increase evaporation of tear film causing a dry-eye condition.

Other effects such as inflammation of eye lids, chronic rhinitis, laryngitis, and sinus difficulties have been reported in the literature as being associated with IR exposure.

As a result of the measurements performed, the following recommendations are offered:

1) Due to the presence of high IR irradiance levels, high percentage of IR in the heat stress region, excessive luminance levels, and the types of complaints voiced it is recommended that the dryers be shielded in the manner suggested by the manufacturers. Also to be noted is the fact that workers are located in the area between presses. This means that exposure levels will be increased over what is shown in this report since contribution of radiant energy to the worker will come from both presses. The measurements in this report reflected only the contribution from one press (i.e. #2).

2) Consideration should be given to require that appropriate IR reflecting/absorbing goggles be worn by press personnel. Not only would such goggles aid in reducing IR ocular exposure levels but also improve visual acuity related to quality control tasks.

3) All mirrors in the area should be repositioned such that they do not focus the high luminous levels into areas not desired (workers eye). If that is not possible, the mirrors should be removed.

4) Attention should be given to the posting of the area with caution signs indicating potential eye damage area - wear IR glasses.

5) Consider instituting detailed vision examination program for pressmen.

b) Air Contaminants

No recommendations are made for air contaminants as the concentrations found were well within the prescribed limits.

Experience has shown that air-kerosene spray cleaning of machinery would cause excessive overspray and would be a cause for complaints The present policy of manual cleaning takes more time and would be more difficult, however, exposure to kerosene is minimized and from talks with the employees, on March 12, 1980, the complaints are non-existant.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Hazard Evaluation and Technical Assistance Branch

IX. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

Plant Manager, American Can Company, Chambersburg, Pennsylvania

Vice President, Chambersburg Printing Specialties and Paper Products Union

NIOSH, Region III

OSHA, Region III

For the purpose of informing the approximately 45 employees of the results of the American Can Company, Chambersburg Plant, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) for their perusal.

X. REFERENCES

1. Occupational Diseases: A Guide to Their Recognition, USPHS, CDC, NIOSH, Publication #77-181, Revised June 1977.

2. Infrared Radiation, in Manual on Health Aspects of Exposure to Nonionizing Radiation by Moss, C.E. (et. al) World Health Organization, Regional Office, Copenhagen, Denmark, 1980.

3. Determination of Ocular Threshold Levels for Infrared Radiation Cataractogenesis, by Pitts, D.G. (et. al) NIOSH, Publication #80-121, June 1980.

4. An analysis of a reported occupational exposure to infrared radiation by Sensintaffar, E.L., Sliney, D.L., and Parr, W.H. Am. Industrial Hyg. Assoc. Journal V39 (1): 63-69, 1978

5. American Conference of Governmental Industrial Hygienists (ACGIH), Documentation of the Threshold Limit Values, 197[illegible].

6. ACGIH, TLV's Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1979.

Table I
American Can Company
Chambersburg, Pennsylvania
HHE 79-149
March 12-13, 1980
Results of Personal Air Samples for Offset Powder Dust (Vegetable)

Date	Sample Number	Job Description	Sampling Period	Concentrations mg/M^3(a) (Total Particulate)
March 12	4815	No. 2, Pressman	7:25-14:50	0.74
	4807	No. 6, Pressman	7:30-14:50	0.84
	4820	No. 3, 2nd Pressman	7:27-14:50	0.27
March 13	4813	No. 2, 2nd Pressman	7:17-14:43	0.44
	4827	No. 5, Pressman	7:18-14:45	0.22
	4821	No. 7, Pressman	7:20-14:40	0.59

(a) mg/M^3 - milligram of substance per cubic meter of air sampled.

Evaluation Criteria

(OSHA) Inert	15 mg/M^3
(ACGIH) Nuisance	10 mg/M^3

TABLE II

American Can Company
Chambersburg, Pennsylvania

HHE 79-149

March 12-13, 1980
Results of General Air and Personnel Air Samples for Isopropyl Alcohol

Sample No.	Date	Area/Operation	Sample Period	Concentration mg/M^3*
1	3/12/80	General Air, No. 6 Press	11:29-15:44	422
2	3/13/80	Press Helper No. 6 Press	7:13-14:40	283
3	3/13/80	Pressman No. 6 Press	7:12-14:43	193

* mg/M^3 denotes milligrams of isopropanol per cubic meter of air sampled.

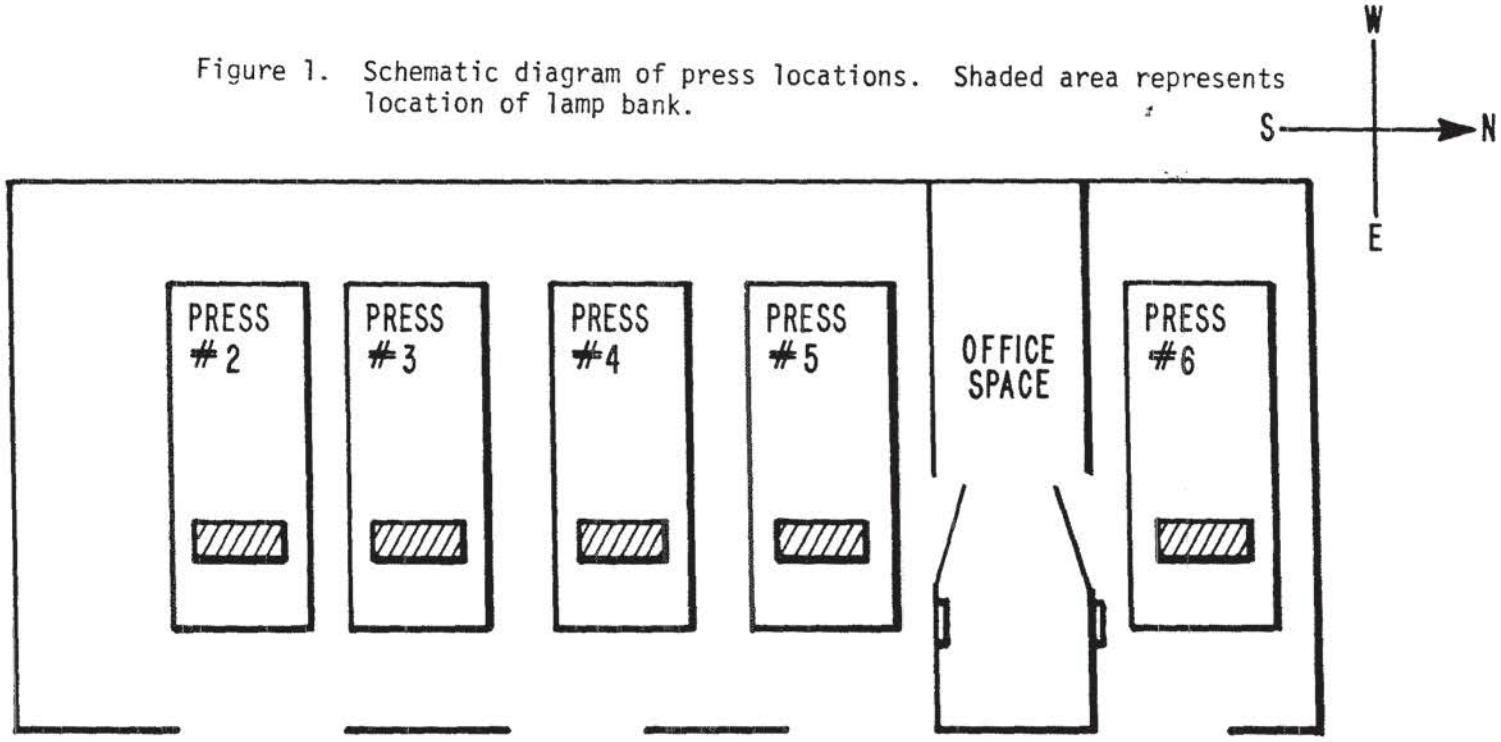
Evaluation Criteria

	OSHA	NIOSH	ACGIH
Isopropyl Alcohol mg/M^3	980	980 1960/15 min ceiling	980 (Skin) 1225/15 min ceiling

TABLE III
American Can Company
Chambersburg, Pennsylvania
HHE 79-149
March 12-13, 1980
Maximum Recorded Optical Radiation Levels

Type of Radiation Measured and Wavelength Region in nm	Press Location and Distance from Source (m)	Measured Radiation Level	Optical Radiation Guideline Values (6)
Actinic UV (200-315)	Press # 2 and # 5 at 2,5 m and 4.8 m (floor)	Not Detectable	0.1 $\mu W \cdot cm^{-2}$
Near UV (320-400)	Press # 2 at 4.8 m (floor)	3 $\mu W \cdot cm^{-2}$	1.0 $mW \cdot cm^{-2}$
Luminance (400-760)	Press # 2 at 5.0 m (catwalk)	10,000 fL	2920 fL
Infrared (760-1100)	Press # 5 at 4.0 m (catwalk)	4.1 $mW \cdot cm^{-2}$	10.0 $mW \cdot cm^{-2}$
TOTAL (310-1100)	Press # 5 at 4.0 m (catwalk)	5.9 $mW \cdot cm^{-2}$	----

Figure 1. Schematic diagram of press locations. Shaded area represents location of lamp bank.



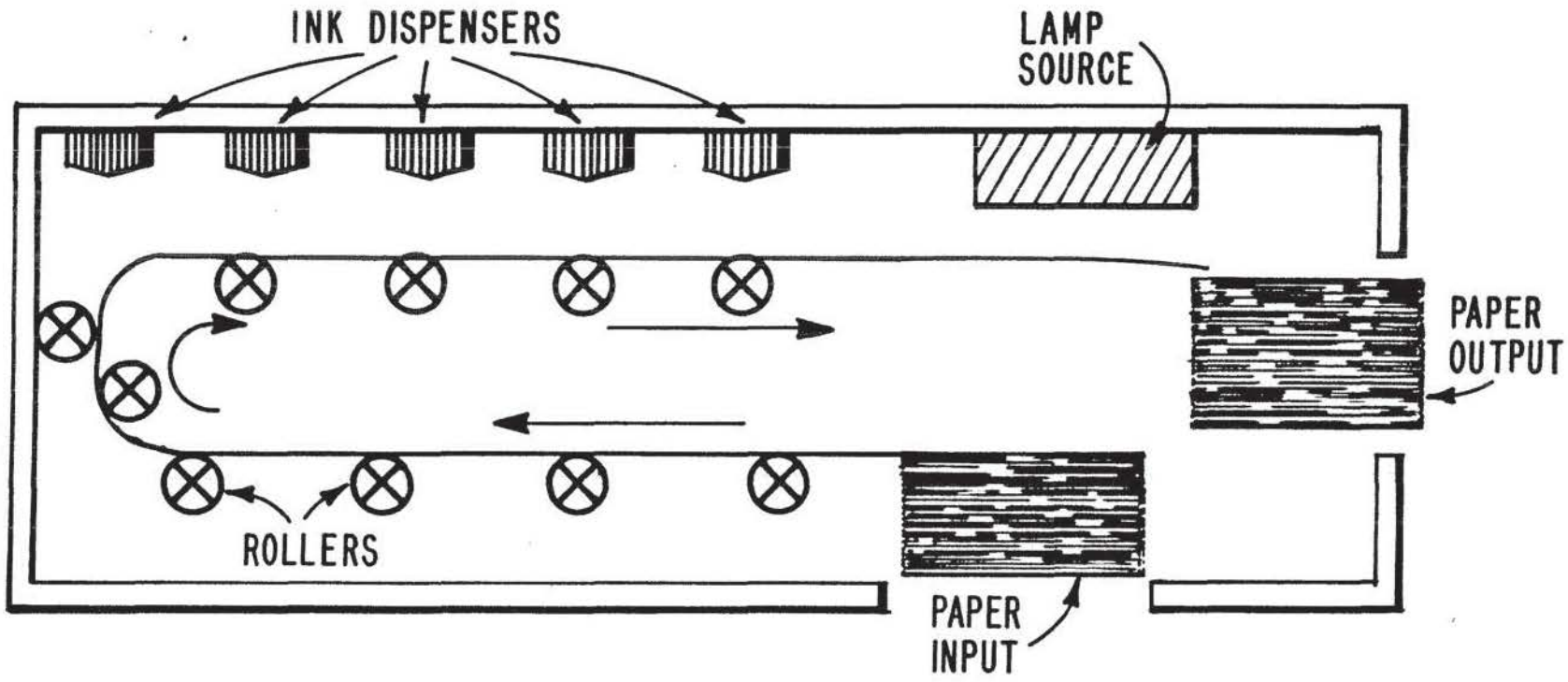


Figure 2. Side view of curing process.

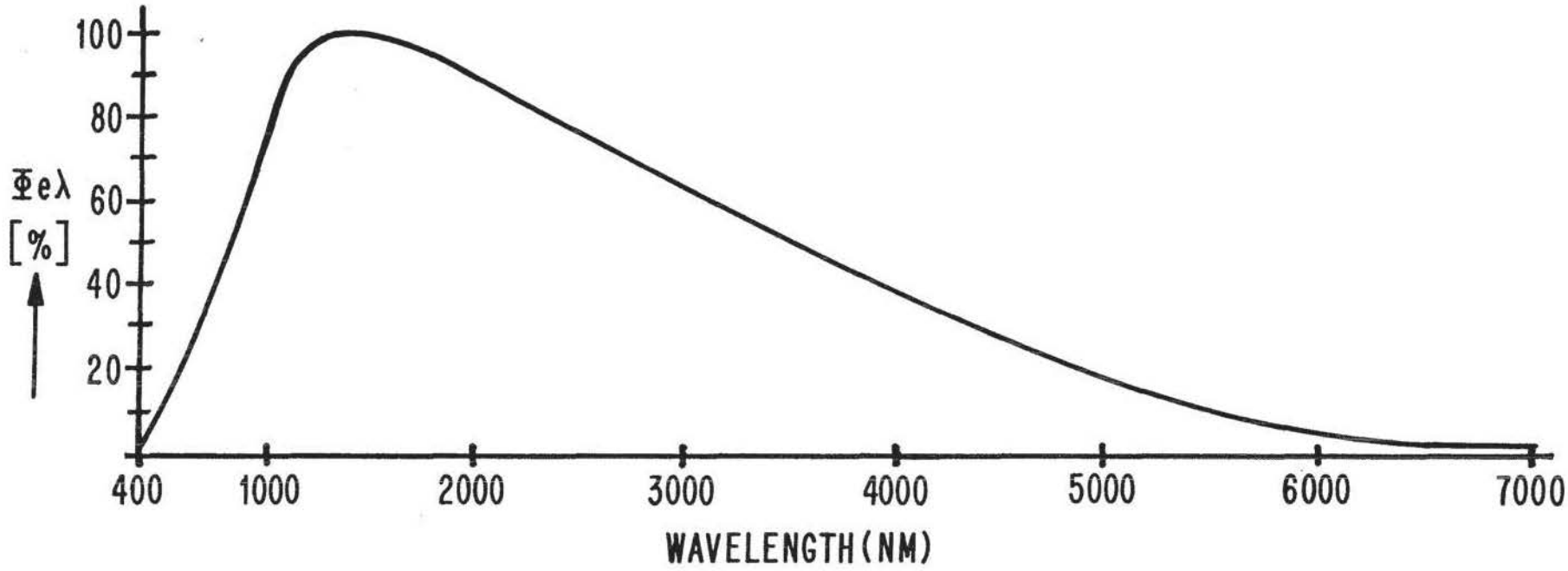


Figure 3. Relative spectral radiation distribution of heat lamp used in the dryer according to manufacturers.

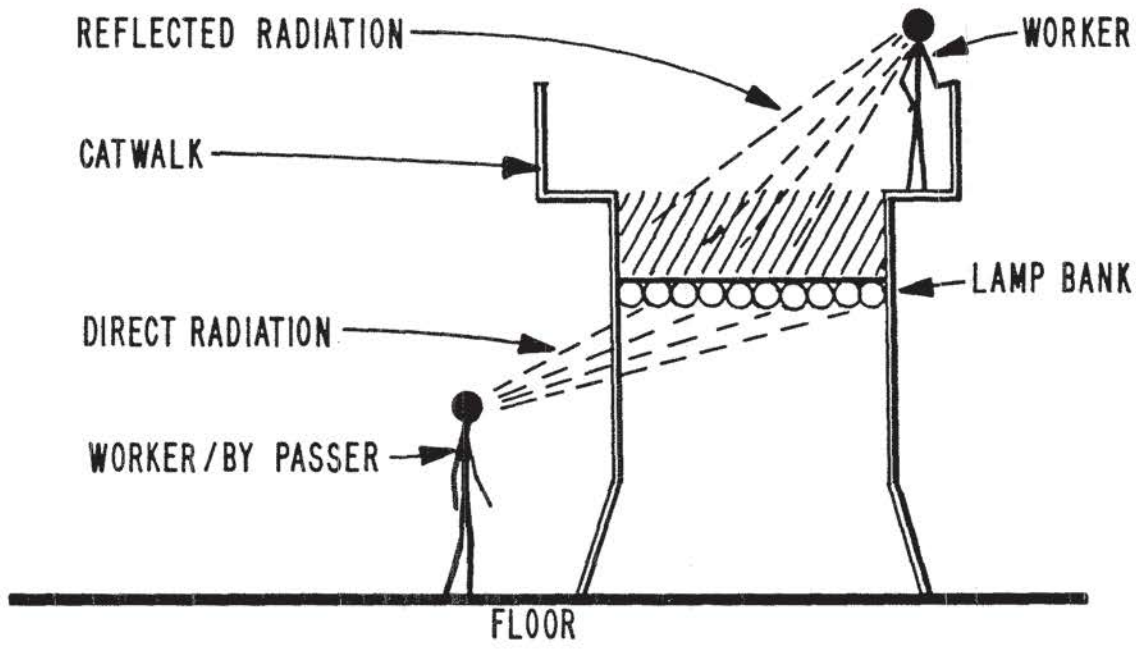


Figure 4. Conceptual difference in worker's exposure to direct and reflected radiation.

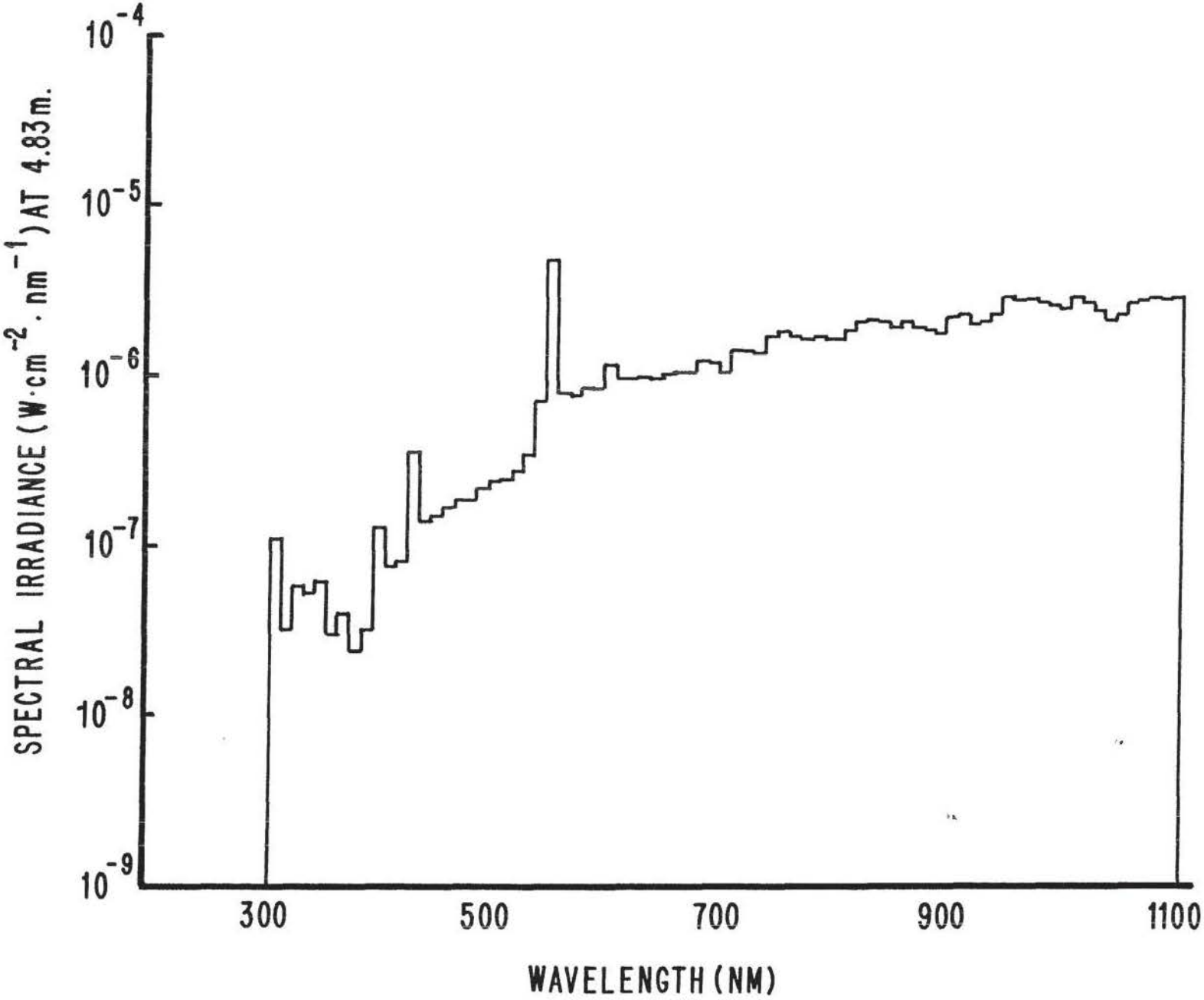


Figure 5. Spectral irradiance of lamp bank on press 2 at 4.8 m.

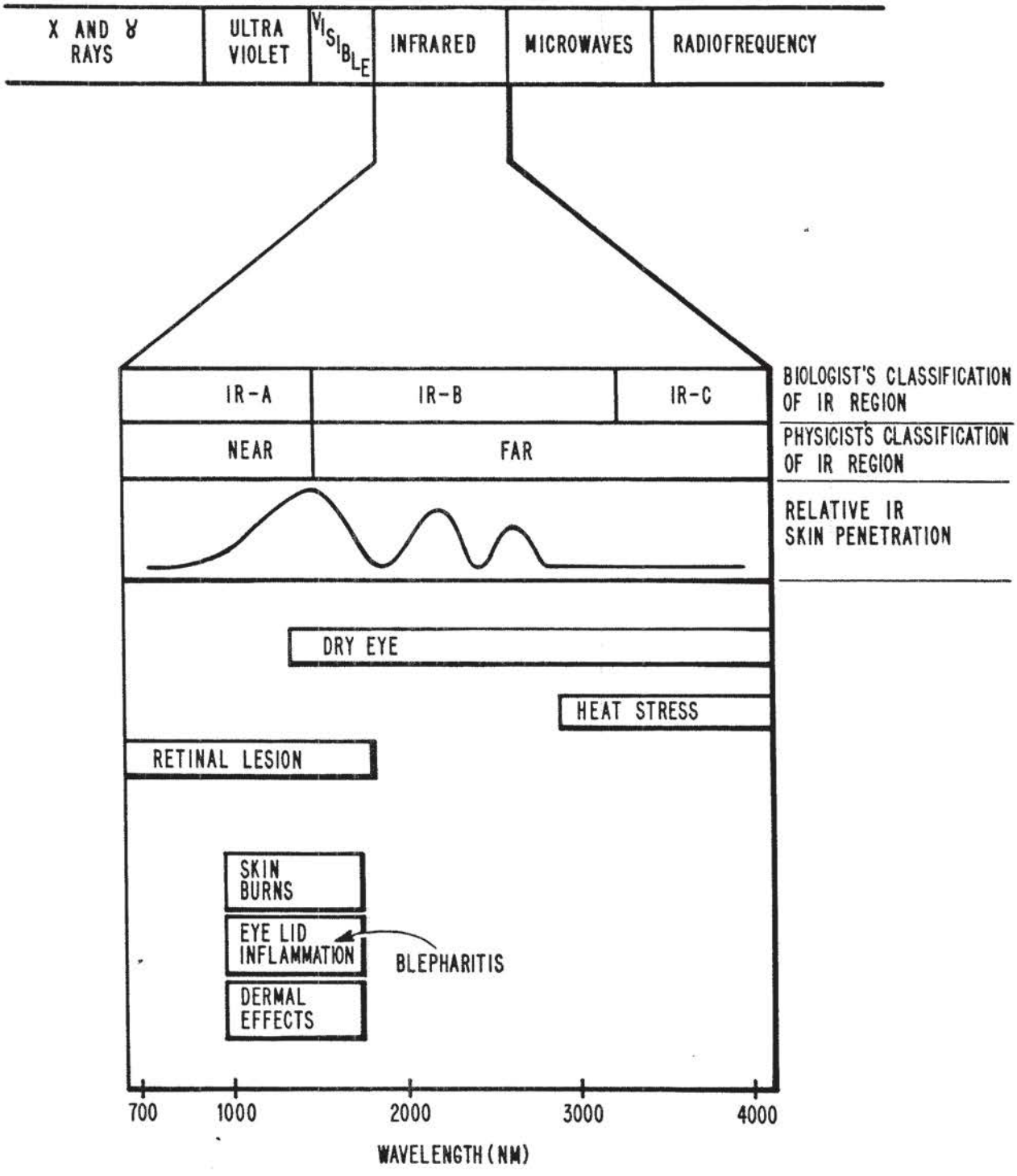


Figure 6. Classification of IR spectral region and their potential associated biological effects.

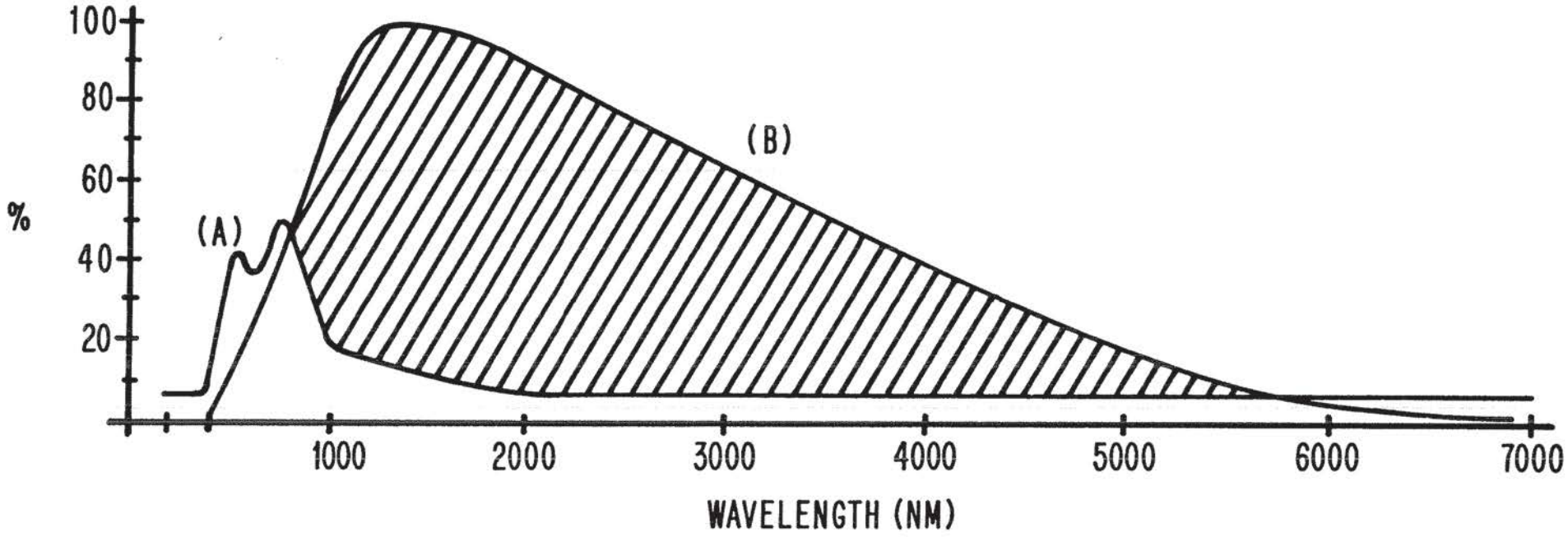


Figure 7. Conceptual exploration of dry skin. Curve (C) is the corneal transmittance and curve (B) is the lamp spectral distribution. Shaded area represents optical energy that is incident upon cornea that leads to dry eye condition.

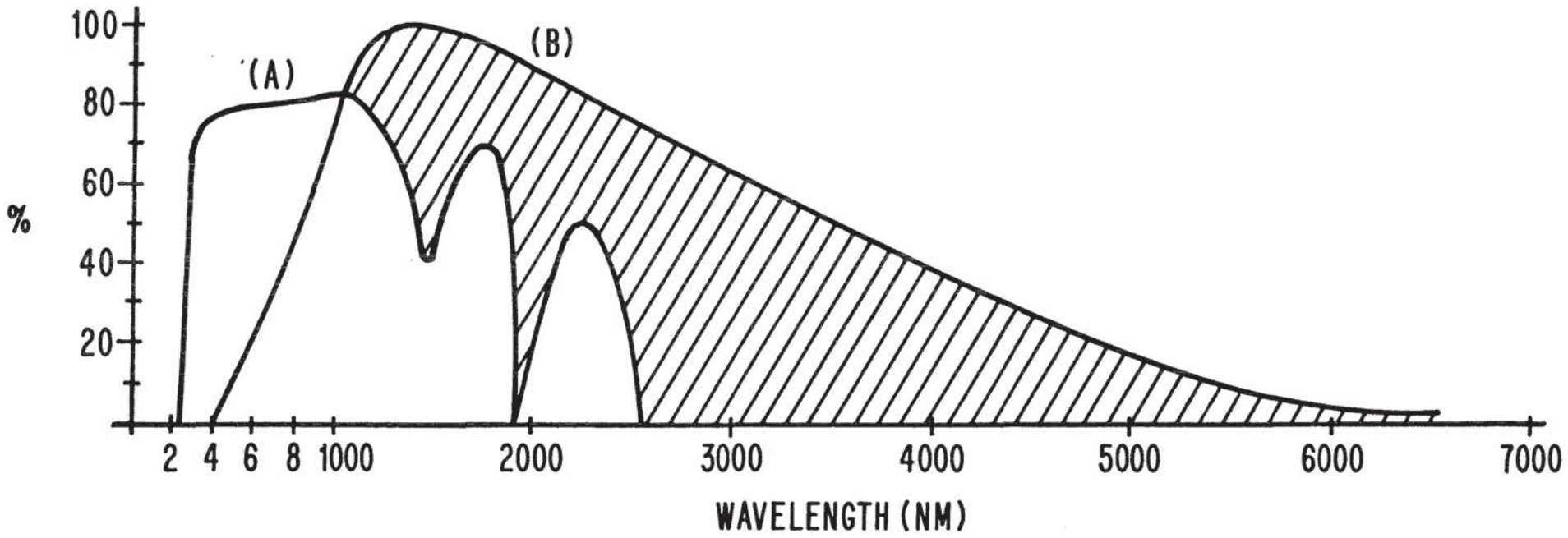
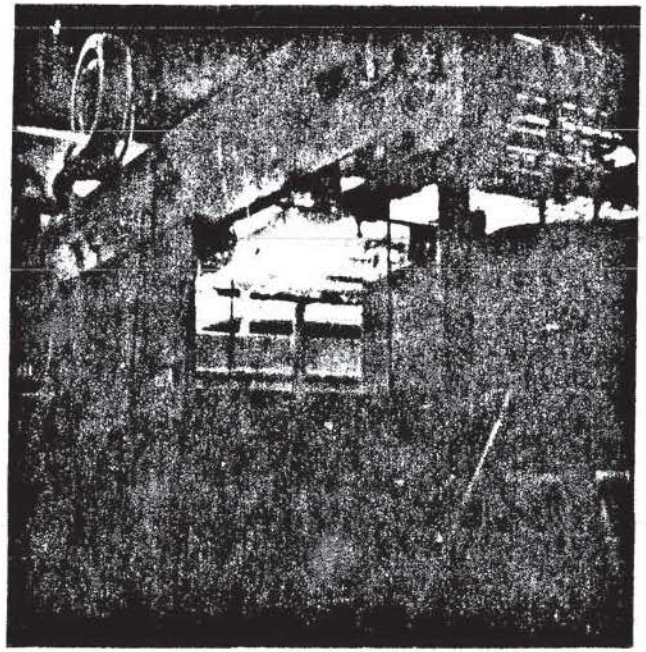
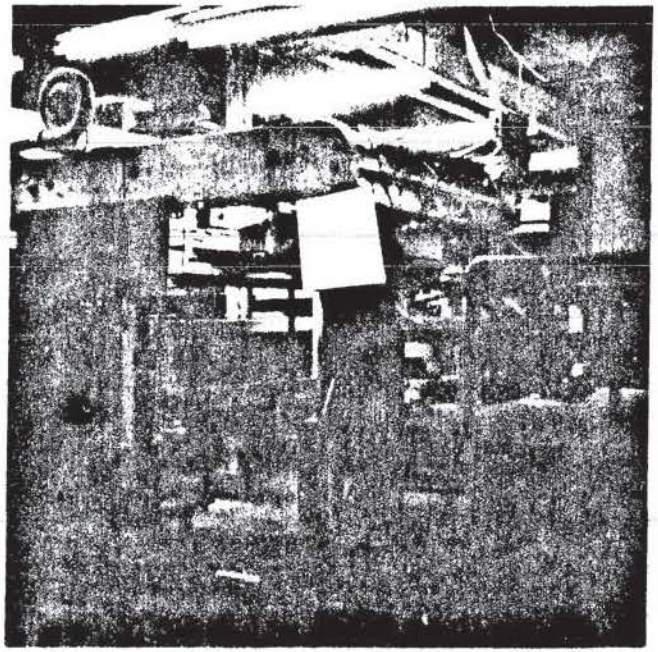


Figure 8. Conceptual exploration of dry eye. Curve (C) is the reflection of human skin and curve (B) is the lamp spectral distribution. Shaded area represents optical energy that is not reflected by skin and hence can be absorbed and produce dry skin.

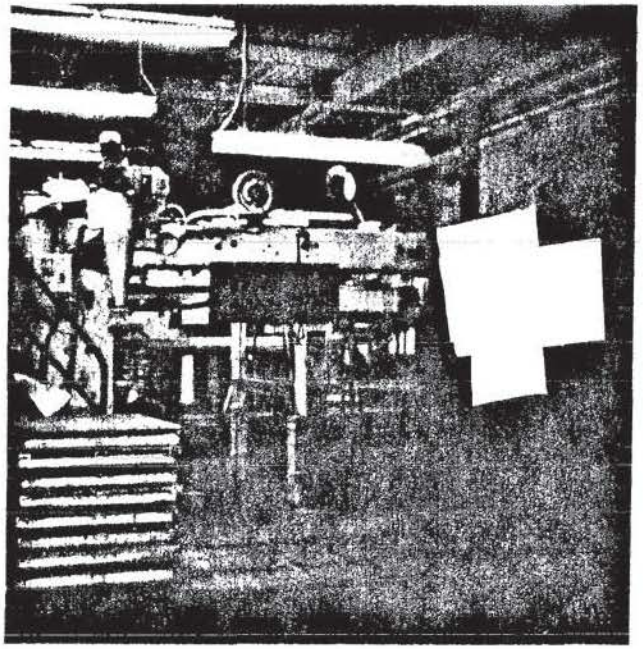
APPENDIX



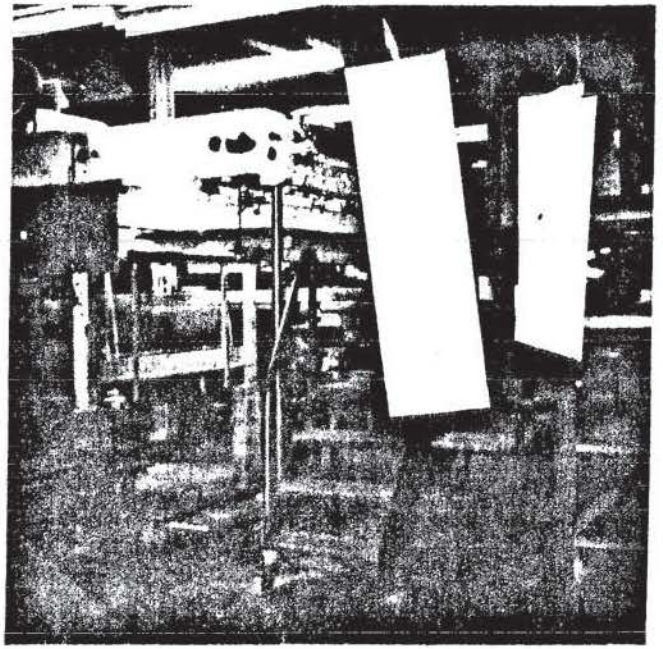
(1) Press #2 - LOOKING UP AT LAMP BANK ON FLOOR. NOTE SHIELDING STRIP.



(3) Press #2 - MAN-WORKING POSITION, NO GLASSES, HE CAN VIEW PART OF WHAT IS SHOWN IN (1)

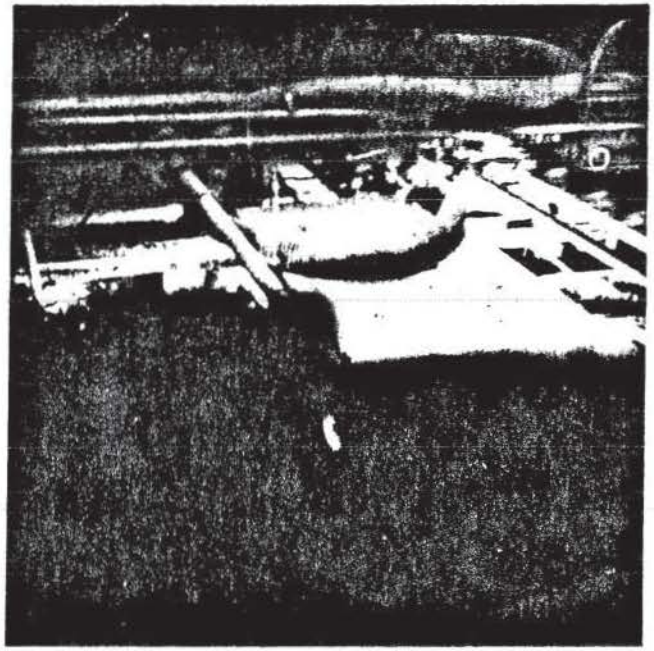


(2) Press #2 - SIDE VIEW OF SHIELDING STRIP. NOTE Q.A. CHECK STATION & MIRROR.

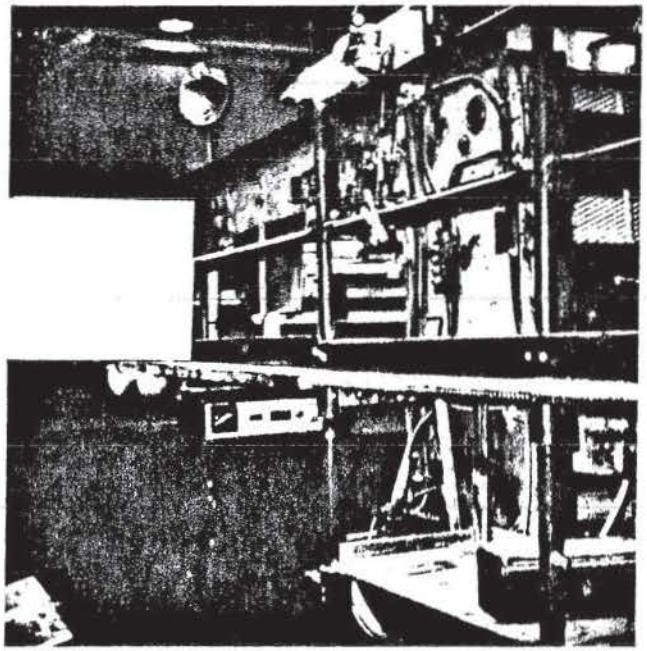


(4) Press #2, MAN ON CAT-WALK.

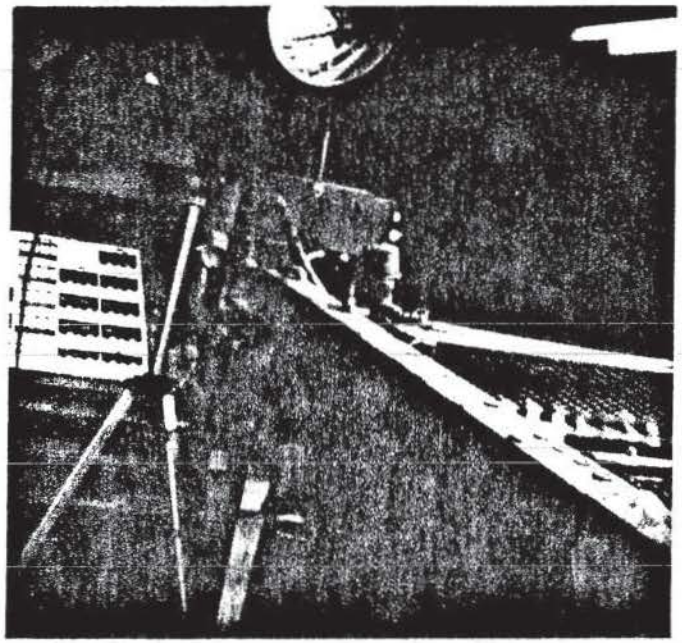
APPENDIX



(5) PRESS #6 — ON CATWALK LOOKING DOWN ON LAMP BANK, REFLECTED LIGHT.



(6) PRESS #2 - BACK SIDE, NOTE MIRROR



(7) PRESS #2 - CLOSE UP of MIRROR ABOVE CATWALK.