REGION-5

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT NO. TA 77-65

DEARBORN SPECIALTY FOUNDRY
FORD MOTOR COMPANY
DEARBORN, MICHIGAN 48121

OCTOBER 1977

Study Requested By:
Area Director
OSHA Area Office
Detroit, Michigan

NIOSH Project Officer:
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Study Date:
July 15, 1977

I. SUMMARY

A recent survey (July 15, 1977) concentrated on heat stress exposures of the Mold Blow-Off (Vacuum) Operator, North Crankshaft Line. Environmental measurements showed a Wet Bulb Globe Temperature (WBGT) index which ranged from 89 to 99 and a Belding and Hatch Heat Stress Index (HSI) which ranged from 50 to 98 for the Vacuum Operator on the day of the survey. Spot checks (environmental measurements) were made at several other work positions on the crankshaft line. A physiological study of the Vacuum Operator showed an oral temperature rise of 1.8^{o}F across the work shift and a sweat loss of 2.89 liters for the shift. The operator's water deficit was 1.59 liters (2 percent of initial body weight) for the shift. His pulse rate increased, and his blood pressure decreased during the shift. On the basis of these findings, it must be concluded that a severe thermal insult to some employees does exist on at least certain days.

On July 6, 1977, the Mold Blow-Off Operator collapsed (about 40 minutes after getting off work) and was taken to a hospital. He expired about 9 hours later (July 7, 1977). A careful review of the employee's activities on July 6th, of hospital records, and of autopsy findings, leads to the conclusion that the diagnosis of heat stroke by the attending physician and the coroner's office is appropriate. Further, considering the physiological study and environmental survey findings of July 15, 1977, it is concluded that this employee's exposure to heat stress on the job, was a contributing factor to his death by heat stroke.

II. INTRODUCTION

On July 15, 1977, the National Institute for Occupational Safety and Health (NIOSH) assisted the Occupational Safety and Health Administration (OSHA) in an environmental survey/physiological study at the Ford Motor Company, Dearborn Specialty Foundry (DSF), North Crankshaft Line. This effort was made at the request of Ms. Mary Fulmer, Area Director, Detroit Area Office, OSHA, during the late afternoon of July 12, 1977. The event which precipitated this request was the death on July 7, 1977, of a 21 year old crankshaft line employee (Mold Blow-Off Operator) reportedly of heat stroke. About 40 minutes after getting off work (day shift) the employee collapsed, was admitted to a hospital, and expired about nine hours later.

III. TECHNICAL ASSISTANCE

A. Scope of Activity

It became apparent quite early that the investigation would have to be limited in scope. Contributing factors were: 1) the short time in which to prepare for the study, 2) the foundry was too large to study in its entirety, 3) the field time available for the study was short, and 4) the NIOSH investigators were unacclimatized to heat - - consequently, the investigators' exposure times were limited. It was therefore decided to restrict the investigation to the immediate vicinity of the Mold Blow-Off (Vacuum) Operator on the North Crankshaft Line. Psychrometric data was obtained during the work shift for the Vacuum Operator; spot checks (psychrometric data) were made at several other work locations in the vicinity of the Vacuum Operator: and the Vacuum Operator was monitored during the work shift to determine his physiological response to the thermal environment at his work site.

During the investigation, NIOSH and OSHA representatives met with the following officials:

1. Manager, Industrial Relations, Dearborn Specialty Foundry
2. Production Manager, Dearborn Specialty Foundry
3. Safety Engineer, Dearborn Specialty Foundry
4. North Line Foreman, Dearborn Specialty Foundry
5. Supervisory Industrial Engineer, Dearborn Specialty Foundry
6. Division Safety Engineer, Ford Motor Company
7. Rouge Complex Medical Director, Ford Motor Company
8. Corporate Industrial Hygiene Director, Ford Motor Company
9. Industrial Hygienist, Ford Motor Company
10. Building Union Chairman, U.A.W.
11. Union Health & Safety Representatives, U.A.W.
12. Union Committeeman, U.A.W.
13. Engineer, Michigan Department of Public Health

B. Process Description

The North Crankshaft Core and Mold Line (Dept. 5984) embraces several operations relative to the casting of crankshafts for Ford Motor Company products. The assembly line process consists of using a urea-formaldehyde resin to build up a casting shell upon heated metal dies. After baking, the shells are removed from the dies and two shell halves are clipped together to form a shell mold. The shell molds are placed in flasks and hot metal shot is poured around the molds to prevent them from cracking or breaking when filled with molten metal. At this stage the Vacuum Operator removes metal caps from the mold pouring cups, vacuums the necks of the pouring cups, and pours a small cupful of aluminum chips into the flasks. At the pouring stations, molten casting alloy is poured into the molds. After solidification occurs, the contents are dumped from the flasks. The crankshafts are conveyed to another area for finishing, the broken shell assemblys are discarded, and the steel shot is recycled.

Forty men per shift are normally employed on the North Crankshaft Line on basically a two shift per day basis. For the hot weather relief season (June 1 to September 15) two extra men are assigned to the North Crankshaft Line for relief purposes. The amount of relief time for the hot weather relief season (not including lunch) varies from 68 minutes per shift to 240 minutes per shift. The Vacuum Operator receives 68 minutes of relief (two 34 minute breaks) during the shift. Normal work attire consists of long sleeve coveralls with dust caps. Some of the men wear nuisance dust respirators which are provided by the company.

C. Environmental Study - July 15, 1977

The data relative to the Wet-Bulb Globe Temperature Index (WBGT) was obtained using the instrumentation and methodology as described in the NIOSH Criteria Document for Occupational Exposure to Hot Environments and the ACGIH Threshold Limit Value (TLV) for heat stress. At the times of taking the WBGT data readings, air velocities and aspirated dry- and wet-bulb temperatures were recorded so that the Belding and Hatch Heat Stress Index (HSI) could be calculated. "Botsball" readings were also taken. These data, along with the corresponding WBGT and HSI values are presented in Table 1.

The sample location on the right side of the Vacuum Operator is judged to be most representative of the Vacuum Operator's exposure at his work station. The WBGT representing the operator's exposure (at his work station) then ranged from 89°F to 99°F on the day of the survey. The time-weighted average WBGT at the Vacuum Operator's work station is calculated to be 94°F (93.7). A straight arithmetic average of the five data points (Vacuum Operator's right side) also yields 94°F (93.8). Considering the work load to be "light" (less than 200 kcal/hour) the TLV would have allowed for a maximum of 25 percent work each hour, on the day of the survey (see Figure 1).

The HSI for the Vacuum Operator (right side) ranged from 50 to 98. For an interpretation of these values, Table 2 is attached to this report. A HSI of 40 to 60 would represent "severe heat strain" while a HSI of 100 would represent the maximum strain tolerated daily by fit, acclimatized young men. The very short HSI Allowable Exposure Times (AET) should not be interpreted literally. Rather, they should be judged to mean that the work situation is extremely stressful and that a comprehensive and effective good work practices program is well-advised.

There are "man coolers" at the hotter work stations whereby outdoor air is blown on the workers. This air is not conditioned and in actuality rises to several degrees warmer than the outdoor air. At 12:50 p.m., the temperature of the air blown on the Vacuum Operator was 104°F (dew point 73°F). At the same time, the U.S. Weather Service official temperature at the Wayne County Metropolitan Airport was 99°F (dew point 73°F).

It should be noted that July 6th and 15th were unusually hot days. U.S. Weather Service data for the day shift on these two days is shown on Table 3. These temperature determinations were made at about ten minutes before the hour at the Metropolitan Airport which is about eleven miles to the southwest of the DSF.

D. Physiological Study - July 15, 1977

1. Work Load

The worker stands on a metal grated platform elevated approximately 18 inches above floor level. As molds pass along a conveyor line in front of him, he removes a cap, vacuums the pouring cup, and adds a small quantity of aluminum chips to each mold. The body position during this operation was primarily erect with little leg movement. A stool was available. However, it was used mainly when the line was down.

The normal work schedule for this job is from 6:00 a.m. to 2:30 p.m. There is a lunch break from 10:00 - 10:30 a.m., and a 34 minute relief break during each half of the shift.

The worker that was observed reported to the main medical center before the shift started instead of the first-aid room located in the foundry. Consequently, he did not start working at his job until 6:40 a.m. During the first half of the shift, three breaks were taken of 32, 22 and 8 minute duration. During the second half of the shift, two breaks were taken of 25 and 55 minutes duration.

On July 15, for short intervals, there was "down" time during the first half of the shift. However, there was a great deal of time lost during the second half of the shift due to "down" time. It was estimated that a total of 186 minutes was spent by the observed worker in actual work during the entire shift. An additional 82 minutes were spent in the area of his work site during "down" time. The remaining time was spent in a cooler area of the foundry. The company records indicate a total "down" time of 215 minutes. Though this appears to be an atypical work day, the "down" time was similar to that which occurred the last work day of the worker who succumbed to heat stroke.

2. Physiological Responses

The activity level of the job observed would be considered light. The Bioastronautics Data Book, Second Edition, NASA 1973, lists standing, doing drafting work, as producing a metabolic heat of 1.9 kcal/min for a 76 Kg man, or 114 kcal/hour (452 BTU/hr). The measured energy expenditure during work, using a portable respirometer on the observed worker averaged 1.86

kcal/min or 112 kcal/hour (444 BTU/hr). The total caloric expenditure for his 186 minutes of work would be 346 kcal. The estimated caloric expenditure for the total time, exclusive of lunch, was about 750 kcal. The hourly time-weighted average for the metabolic heat production of the entire shift would be approximately 100 kcal.

The oral temperature taken at the first-aid station before starting work was 97.8^{o}F. The post shift oral temperature was 99.6^{o}F. There was an increase in oral temperature of 1^{o}F during the first hour of work, thereafter a gradual increase occurred until the final measurement was taken.

The starting and final heart rates, taken at the first-aid station, in the sitting position, were 74 and 112 beats/minute, respectively. Heart rates taken during the first and second part of the shift averaged 112 and 119 beats/minute, respectively. The highest heart rate was obtained near the end of the shift which was 132 beats/min. Heart rates during the shift were obtained while the worker was standing and immediately after cessation of work.

The blood pressure taken at the first-aid station before and after the shift was 136/94 and 92/64 mm Hg, respectively.

The total sweat loss of the worker, exclusive of his lunch break, was 2.89 liters, determined by standard techniques. The worker's body weight pre and post shift was 77.79 and 76.20 kg, respectively. This was a loss of 1.59 kg which represents 2 percent of his initial body weight and a water deficit of 1.59 liters.

3. Discussion

Assuming a 0.8^{o}F difference between oral and body core temperature, the worker's core temperature would be 100.4^{o}F at the end of his shift. This is the upper limit of permissible body temperature according to the NIOSH criteria document. Since the metabolic work load was a low level of activity, the increase in body temperature would be primarily attributed to the environmental conditions. The average shift heart rate was undoubtedly influenced by the environmental conditions which caused a rate above that expected for this level of work. The sitting heart rate taken at the end of the shift (112 beats/min) at the first-aid station could be the result of an increase in body temperature. The highest heart rate was obtained near the end of the shift (132 beats/min). At this time, very little production work was being done. Consequently, the results of both heart rate and oral temperature may indicate that physiological strain was being manifested in this job, which, however, was within tolerable limits for healthy individuals.

From the decrease in body weight that occurred from the beginning to the end of the shift, it would seem the worker did not hydrate himself sufficiently. Water was available from a nearby fountain; however, it was tepid. Under normal operating conditions as described above, when the worker receives one break during each half of the shift, his ability to hydrate himself may be unsatisfactory because the water replacement must take place in short time intervals. Assuming a normal operation and environmental conditions as encountered the day observations were made, a worker would produce as much as four liters of sweat during the eight hour shift. It has been suggested that a dehydration in excess of 1.5 percent results in decreases in physical fitness and tolerance to heat.

The blood pressure of the observed worker before the work shift showed an increased diastolic pressure. However, the diagnosis of hypertension can not be made from one measurement under the given circumstances. It is suggested that he be examined by a physician to determine whether he indeed has hypertension, in view of the preventive medical work practices recommended in the NIOSH criteria document for heat stress.

It would appear that this particular job could result in heat syncope or fainting in some individuals. The body position for the job was primarily erect. Standing can cause fainting by the pooling of blood in the lower extremities, resulting in a reduction of the blood supply to the brain, even in comfortable environments. This condition may be further hastened by dehydration and the redistribution of blood to the peripheral vessels as a result of being in a hot environment. The final blood pressure reading of 92/64 mm Hg would suggest the worker became hypotensive.

The "down" time during the day observations were made (July 15, 1977) was similar to the "down" time the day the worker succumbed to heat stroke (July 6, 1977). It was suggested by plant management that the worker who succumbed performed other duties during his "down" time. The observed worker did not engage in other activities during his "down" time.

As mentioned above, the day observations were made may not have been a typical work schedule. It is conceivable, that, given normal operation, the worker's physiological responses would have indicated excessive strain from the environmental conditions. Though a worker becomes acclimatized to certain climatic conditions at his work site, he would not be satisfactorily acclimatized to conditions of a sudden heat wave.

That the worker observed during this evaluation did not show signs of excessive strain does not mean other workers would also tolerate these conditions without excessive strain, depending on their state of health, physical fitness, and level of acclimatization for work in heat.

E. Company Medical Program

The Ford Motor Company has a comprehensive medical program for its employees. The company does not have a particular medical program for heat stress but does provide salt tablets, drinking fountains, air-conditioned relief rooms, and additional break time during the hot weather for select jobs. Production employees may report to the first aid station if they feel that they are having difficulties because of heat stress. If the employees have cramps and a fever they are sent home. Otherwise, if the employees have just weakness, headaches, or cramps, they usually return to work after resting in the first aid room and drinking cold water. During a hot spell such as July 5-7, 1977, about 10-12 DSF employees reportedly visit the medical facility per day. Of these 10-12 DSF employees, maybe 3-4 will be sent home because of cramps and fever. On the day shift (July 15, 1977) 27 employees visited the medical facility; none of these were sent home. On the evening shift (July 15, 1977) 23 employees visited the medical facility, four of whom were sent home. It is to be noted that these numbers of employees visiting the medical facilities represent the DSF (about 1600 hourly employees) and not just the crankshaft lines (about 160 employees).

F. Circumstances Preceding the Death of the Mold Blow-off Operator[1]

On July 6, 1977, the operator worked the day shift, checking in at 6:00 a.m. and checking out at 2:32 p.m. He was given two 34 minute relief periods during the shift, working through the normal 30 minute lunch break. He ate his lunch during the first break which commenced at 8:55 a.m. During his second relief break which started at 1:10 p.m., a fellow employee observed the operator "washing up" in the G-20 washroom. The operator appeared to be his normal self and did not indicate that he was sick or feeling ill. He was observed to be perspiring. Several other employees observing the operator during the shift, likewise received no suggestion that he may have been sick or feeling ill.

The North Crankshaft Line was down a total of 213 minutes during the day shift on July 6th. Consequently, the operator was requested to work through his normal lunch hour. During down times, the operator normally performed cleanup activities at his work station or cleaned up broken shell molds about 10 feet from his work station. Reportedly, the operator did not do much cleanup work on the day of discussion. During short down times the operator generally sat on his stool waiting for the line to resume operation. A drinking fountain is located about 70 feet from the operator's work station.

[1]Abstracted in part from Ford Motor Company Safety Incident Report (unpublished).

The operator punched out at 2:32 p.m., boarded the parking lot bus (not air conditioned) and sat down across from the driver. At 2:45 p.m. the crowded bus departed for the employee's parking lot. A few minutes later the employee left the bus and presumably used a pedestrian bridge (33 steps to climb) over Miller Road to reach the hourly employees' parking lot.

The operator drove to a gas station (Raupt Road and Schaefer Road) where he attempted to communicate (both verbally and with hand written notes) with the owner. The operator did not purchase beverages or drink from the drinking fountain. The owner of the gas station did note that the operator was not perspiring. While walking back to his car, the operator staggered, grasped a sign for support, and collapsed. A gas station attendant provided an observing person a wet towel to apply to the operator's face and neck.

A Melvindale Police Officer arrived at the scene at 3:14 p.m. and notified the Rescue Squad who arrived at 3:17 p.m. There were no unusual items (beverage containers, medicine, etc.) in the operator's car. The operator was admitted to Outer Drive Hospital at 3:25 p.m. suffering from what appeared to be a heat stroke. He expired at 12:48 a.m. on the following day (July 7th).

G. Discussion Relative to the Death of the Mold Blow-Off Operator

Review of the medical record of the deceased worker's hospitalization showed that at the time of admission he was unconscious, had a body temperature severely elevated to 108.1°F, a pulse rate severely elevated to 180 beats/minute and a systolic blood pressure of 106 mm Hg with an unidentifiable diastolic pressure. He was breathing rapidly and deeply and was noted to be overweight. His skin was hot and he was perspiring. He had some diarrhea. In spite of efforts to cool and hydrate him, he died about nine hours after admission. An autopsy was performed by the Assistant Medical Examiner.

Based on the history of the day's events, the elevated temperature and pulse, the decreased blood pressure (blood pressure the previous year on physical examination was 160/98), the increased breathing, the unconsciousness and the lack of any specific findings on autopsy to suggest some other cause of death, the diagnosis of heat stroke, by the attending physician and the Assistant Medical Examiner, seems appropriate.

Several factors which may have contributed to his illness deserve comment. Constitutional factors of importance were that he was overweight which would decrease his body's ability to handle a combined exertional and environmental heat load, and that his impaired hearing and speaking ability may have caused a problem in communicating at a critical point in his illness. Environmental factors of importance are: 1) his work area was one of significant heat stress as shown by environmental studies the following week under similar ambient temperatures. By skipping his lunch break, the worker seriously reduced his cool-down breaks. 2) The shuttle bus to the parking lot was not air conditioned and was crowded. The ride would have given him but little opportunity to lose body heat. Since he sat up front he probably had greater opportunity for heat loss than most of the other passengers. 3) The 33 step climb over Miller Road in 99°F heat, coupled with his weight, would be quite stressful. The worker then walked to, and entered his very warm vehicle. It is not known whether the vehicle was air conditioned.

IV. RECOMMENDATIONS

At this time, no future actions are pending or considered (by NIOSH). At the close out conference with company, union, and OSHA officials, it was stated (by the NIOSH project officer) that at least two recommendations would probably accompany the NIOSH report. These were:

1. The company should strengthen their employee education program as regards working in hot environments at the DSF. It is reported that the company has carried out this recommendation.

2. The company should carefully study all heat-stressful work environments at the DSF. This study might include physiological monitoring of the workers to insure that they do not get into heat strain difficulties because of heat exposures. Perhaps a heat stress alert system could be developed for those unusually hot days (e.g. July 6 and 15, 1977). Heat stress alerts have worked well for the U.S. Armed Forces' training programs. A careful company study would elucidate the effectiveness of all current DSF heat stress control techniques and may suggest needed changes.

V. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Table 1

Psychrometric Data

North Crankshaft Line - Dearborn Speciality Foundry

Ford Motor Company
Detroit, Michigan

July 15, 1977

Time	Sample Location	Botsball F*	Natural Wet Bulb F	Globe Temperature F	Air Velocity fpm*	Aspirated Dry-Bulb F	Aspirated Wet-Bulb F	WBGT* Index F	Belding Hatch HSI*	A.E.T.* HSI (min)
6:55a	Vacuum Operator - Left Side	83	81.5	113	25	101	81	91	254	29
7:25a	Vacuum Operator - Right Side	80.5	80.5	107	500	101	80.5	89	50	>480
9:05a	Vacuum Operator - Right Side	85	83	116	650	112	84	93	66	>480
9:35a	Vacuum Operator - Right Side	86	83	119	400	115	84	94	82	>480
11:45a	Vacuum Operator - Right Side	86.5	82.5	122	450	120.5	84.5	94	78	>480
1:30p	Vacuum Operator - Right Side	90	87	126	350	124.5	86.5	99	98	>480
3:05p	Vacuum Operator - Left Side	90	85	131	50	123.5	85	99	233	20
8:40a	Strip Shells - No. 1 Table	92.5	92	136	50	119	85.5	105	291	16
1:30p	West Aisle - Ent. to C.S.Area	80	80	100	300	99	79	86	40	>480
1:55p	Trans. Shells to Belt	90.5	84	124.5	75	122.5	85	96	169	31
2:10p	Strip Shells - No. 3 Table	86	83.5	130	700	120	83.5	97	84	>480
2:50p	Attach Clips to Molds	-	84	124	50	122.5	84	96	198	28

*Notes:

1. F = degrees Fahrenheit.
2. fpm = linear feet per minute.
3. WBGT = wet bulb globe temperature.
4. AET = allowable exposure time (minutes).
5. HSI = Heat Stress Index.
6. A metabolic rate of 450 BTU/hr was used for the calculation of the HSI (see report text - physiological study).

Table 2

Evaluation of Values in Belding and Hatch HSI.

Index of Heat Stress (HSI)	Physiological and Hygienic Implications of 8-hr. Exposures to Various Heat Stresses
−20 −10	Mild cold strain. This condition frequently exists in areas where men recover from exposure to heat.
0	No thermal strain.
+10 20 30	Mild to moderate heat strain. Where a job involves higher intellectual functions, dexterity, or alertness, subtle to substantial decrements in performance may be expected. In performance of heavy physical work, little decrement expected unless ability of individuals to perform such work under no thermal stress is marginal.
40 50 60	Severe heat strain, involving a threat to health unless men are physically fit. Break-in period required for men not previously acclimatized. Some decrement in performance of physical work is to be expected. Medical selection of personnel desirable because these conditions are unsuitable for those with cardiovascular or respiratory impairment or with chronic dermatitis. These working conditions are also unsuitable for activities requiring sustained mental effort.
70 80 90	Very severe heat strain. Only a small percentage of the population may be expected to qualify for this work. Personnel should be selected (a) by medical examination, and (b) by trial on the job (after acclimatization). Special measures are needed to assure adequate water and salt intake. Amelioration of working conditions by any feasible means is highly desirable, and may be expected to decrease the health hazard while increasing efficiency on the job. Slight "indisposition" which in most jobs would be insufficient to affect performance may render workers unfit for this exposure.
100	The maximum strain tolerated daily by fit, acclimatized young men.

Adapted from Belding and Hatch, "Index for Evaluating Heat Stress in Terms of Resulting Physiologic Strains," Heating, Piping and Air Conditioning, 1955.

Table 3

U.S. Weather Service Psychrometric Data

Wayne County Metropolitan Airport
Detroit, Michigan

Time	July 6, 1977 Dry-Bulb F	July 6, 1977 Dew Point F	July 15, 1977 Dry-Bulb F	July 15, 1977 Dew Point F
6:00am	75	68	74	67
7:00am	80	70	77	69
8:00am	84	72	84	74
9:00am	88	72	89	74
10:00am	91	73	93	76
11:00am	94	74	95	76
Noon	96	73	98	75
1:00pm	97	73	99	73
2:00pm	98	72	100	76
3:00pm	99	73	101	75
4:00pm	100	73	102	67
5:00pm	99	72	101	68
6:00pm	98	71	97	69

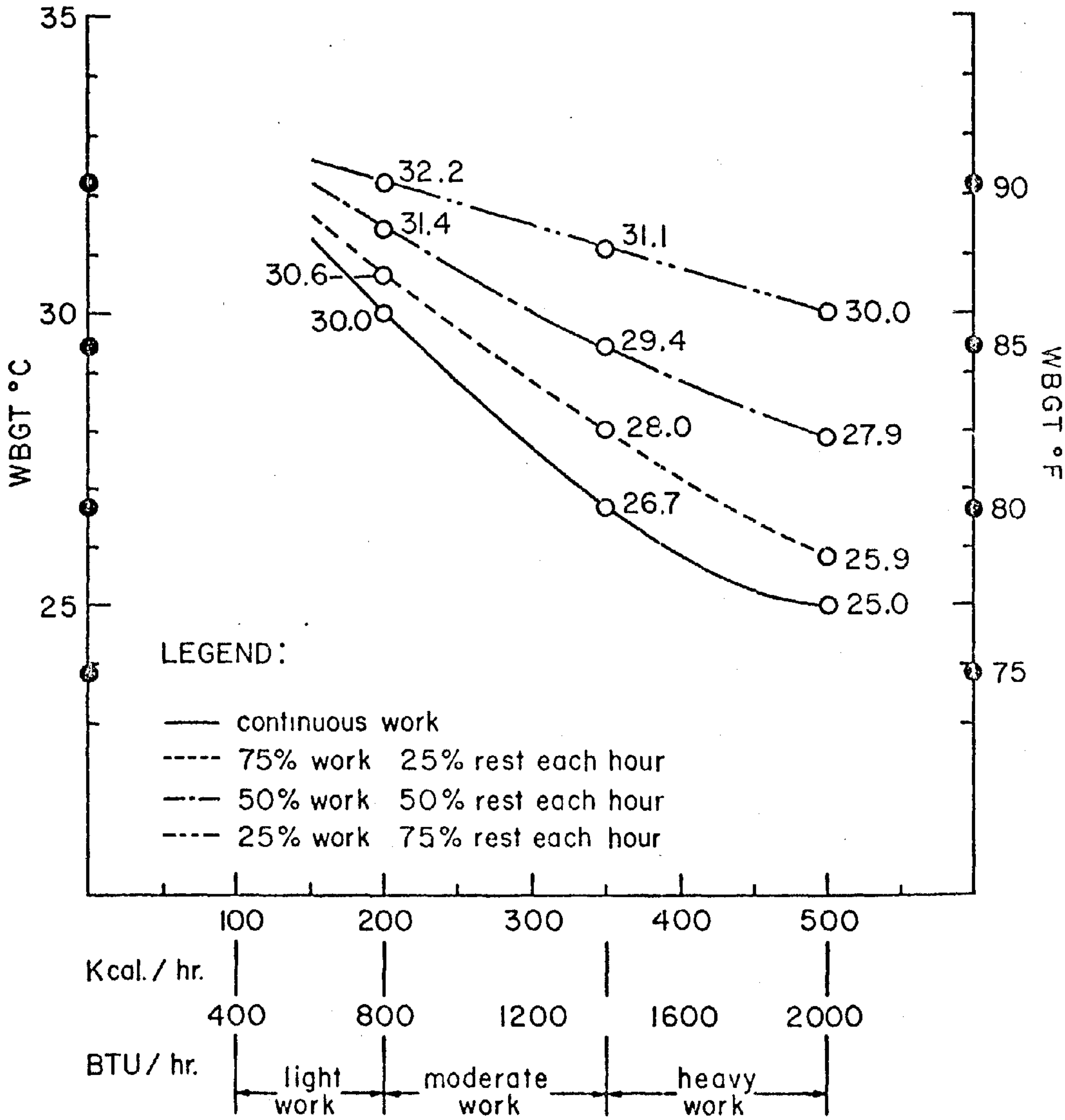
Notes:

1. F = degrees Fahrenheit.
2. Measurements actually taken about 10 minutes before the hour.

Figure 1

Permissible Heat Exposure Threshold Limit Value

American Conference of Governmental Industrial Hygienists
Cincinnati, Ohio 1976



50272-101

NIOSH-00115517

REPORT DOCUMENTATION PAGE	1. REPORT NO. TA-77-65	2. NA	3. Recipient's Accession No. PB82 157744
4. Title and Subtitle: Hazard Evaluation and Technical Assistance Report No. TA-77-65, Dearborn Specialty Foundry, Ford Motor Company, Dearborn, Michigan			5. Report Date: October, 1977
			6. NA U032055
7. Author(s): Kronovetes, K. J., T. Thoburn, and W. S. Carlson			8. Performing Organization Rept. No. NA
9. Performing Organization Name and Address: NIOSH, Hazard Evaluation and Technical Assistance Branch, Cincinnati, Ohio			10. Project/Task/Work Unit No. NA
			11. Contract(C) or Grant(G) No. (C) (G) NA
12. Sponsoring Organization Name and Address: Same as Above			13. Type of Report & Period Covered: Technical Assistance
			14. NA

15. Supplementary Notes

NA

16. Abstract (Limit: 200 words)

Exposures to heat stress were investigated at the Dearborn Specialty Foundry, Ford Motor Company (SIC-3465) in Dearborn, Michigan on July 15, 1977. The survey was requested by the Area Director, Detroit Area Office, OSHA following the death of a machine operator from heat stroke. The Wet Bulb Globe Temperature and (WBGT) and Heat Stress Index (HSI) were calculated for the work station. An operator was observed throughout the work shift and work activity, down time, lunch and relief breaks, energy expenditure, oral temperature, heart rates, blood pressure, and sweat and weight loss were recorded. The WBGT index ranged from 89 to 99 and the HSI ranged from 50 to 98 for the observed operator. A temperature rise of 1.8 degree F occurred during the work shift, and sweat loss was 2.89 liters. The worker's pulse rate increased and blood pressure decreased. The WBGT, HS Indexes, and physiological factors were all at the maximum tolerable ranges established by the American Conference of Government and Industrial Hygienists. The authors conclude that severe thermal insult occurs to some employees and that the work is extremely stressful. The authors recommend that the company strengthen its employee education program for work in hot environments and implement a physiological monitoring program and a heat stress alert program.

17. Document Analysis a. Descriptors

Region-5, Hazards-confirmed, Thermal-stress, Health-surveys, Physiological-stress, Industrial-hygiene, Foundry-workers

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Available to the Public	NA	[illegible]
	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35)