# 18.—PROBLEMS OF EVALUATING HEAT STRESS IN SITUATIONS WHERE NON-ACCLIMATIZED WORKERS ARE EXPOSED INFREQUENTLY TO PARTIALLY NON-PREDICTABLE HEAT STRESS

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The development of a heat stress TLV and its application in situations where workers regularly perform the same job in an environment which can be predicted with a reasonable degree of certainty is relatively simple compared with the situation where workers undertake jobs infrequently in an environment which is generally unpredictable not only for a particular day but even hour by hour. The problem is confounded by the possibility that mixed male and female work crews may exist in the future.

## THE WORK

The heat stress situation described here involved the hauling of telephone cable into underground tunnels connecting buildings, and the subsequent splicing of the cables. These tunnels among other services, carry high-pressure steam pipes. Not only was it found that heat stress conditions varied widely from tunnel to tunnel but also at one location considerable hourly variations were recorded.

The work proceeds in the following stages:

1.) Sidewalk grilles are removed.

2.) Cable drum is located at one grille and powered hauling equipment at the other, above ground.

3.) Necessary blocks are installed in the tunnel.

4.) The wire which is later used to pull the cable, is first pulled through the tunnel from one grille to the other.

5.) The cable is attached to the wire and hauling commences.

6.) The work crew in the tunnel ensures the smooth and uninterrupted passage of the cable. Time involved in stages 1 through 6 is about three hours.

7.) When the desired length of cable has been hauled into the tunnel the entire crew (about six men) manually haul the cable to the selected adjacent part of the tunnel. This may take 20 to 30 minutes.

8.) Two or three men remain in the tunnel to lift the cable, section by section, to wall brackets to which it is tied.

9.) The ends of the cables are spliced. This takes one or more days depending on the cable size. This work is usually done seated.

## THE WORK CREW

Ages: 18 to late 50's
Sex: All male (so far!)
Heat acclimatization: None
Physical fitness: Of typical U.S. male

## THE ENVIRONMENT

The tunnels are concrete, approximately 8 feet high and 5 feet wide, connecting the numerous buildings on a university campus. They are a few feet below ground surface. The heat source is the high pressure steam service pipes. Humidity varies widely from one tunnel to another according to the amount of ground water seepage and steam pipe leaks. Air movement also fluctuates widely depending on whether access doors are open or closed, manhole covers are grilles or solid steel plate, and natural winds.

Heat stress determinations are summarized in Table 18–1.

## DISCUSSION

1.) The cable hauling job, even in the fall, winter, and spring would definitely be affected, and rightly so, by the tentative TLV.

The jobs may be undertaken for only a few days each year, most likely in September when the heat stress situation would be greater than in the months actually measured. There is no effective means of reducing the heat stress for the cable hauling operation, but, as seen in Figure 18–1 and Table 18–2, the construction of a temporary air conditioned enclosure using tarpaulins and a 6,000 BTU home air conditioner, resulted in a heat stress reduction which would avoid any heat strain. Moreover, the speed and accuracy of the intricate cable splicing operation would be improved. The air conditioner actually used was not operating as efficiently as expected; therefore a further reduction in heat stress could be expected by using a more efficient air conditioner and carefully designed and constructed enclosure.

2.) While the WBGT's of 91 F and 108 F determined at two locations in the tunnels when work was not being undertaken was, from personal observation, obviously grossly excessive, the WBGT of 85 F calculated during actual cable hauling work was only marginally in excess of the proposed TLV (Figures 18–2 and 18–3). The physiological response (Table 18–3) of the unacclimatized and no doubt physically unfit work crew confirmed the minimal hazard.

3.) Medical review of telephone personnel assigned to work in heat stress situations is required. Safety personnel, who must always be present while tunnel work is undertaken, have been given education in thermal stress and instructed in methods of monitoring the environment and work crews. Actually, the wet globe thermometer was selected for environmental monitoring as it appeared to provide a

**TABLE 18–1—Heat Stress Values in Tunnels**

| Location | Date | Time | Temperature, F | | | | | | Air Velocity, ft/min | Relative Humidity, percent |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dry bulb | Globe | Wet bulb | Wet globe | Wet bulb globe | Outdoor dry bulb | | |
| 1 | 11/4/71 | 1:00 pm | — | — | — | — | — | — | 125 | — |
| 1 | 11/4/71 | 1:40 pm | 98 | — | — | — | — | — | 10 | 68 |
| 1 | 11/4/71 | 1:50 pm | 102 | 95 | 90 | 86 | 91 | 46 | 0.0 | 78 |
| 1 | 1/5/72 | 11:30 am-3:30 pm | 108 | 109 | 75 | 76 | 85 | 32 | 100 | 33 |
| 11 | 11/4/71 | 3:00 pm | 120 | 126 | 90 | 86 | 108 | 46 | 350 | 48 |

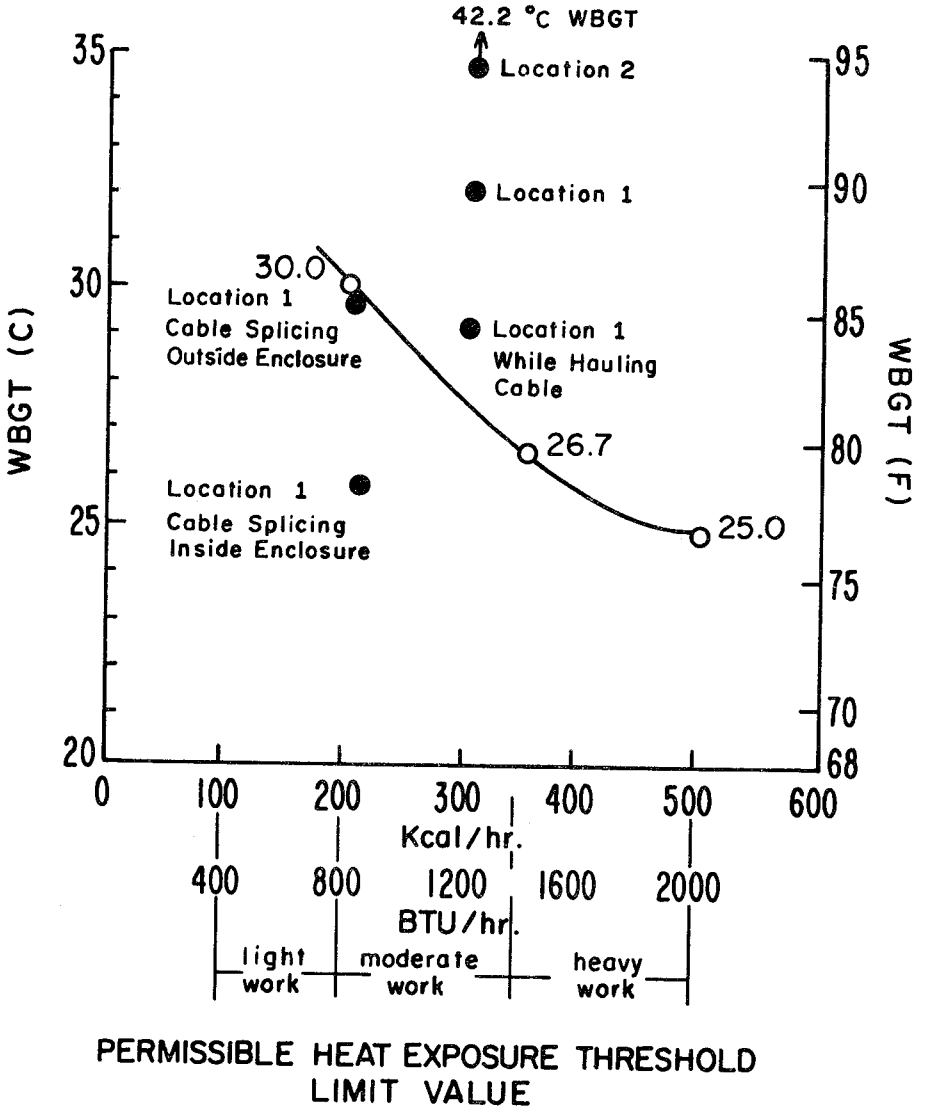


**FIGURE 18–1.—Wet bulb globe temperature levels at locations 1 and 2.**

reasonably accurate index of the heat stress, and had the added advantage of one simple direct reading. Climate control in work areas is practicable only for cable splicing. The provision of climate control rest areas in these circumstances is not practical or justified. The crews can rest outdoors in the shade, or, if they prefer, in adjacent buildings. No further mechanization of the work is possible. Personnel are educated in the health hazards of the work and the necessity for taking additional salt with their food on the few days of the year they work in the tunnels. Water is readily available. No protective clothing or equipment is practical. Work-rest schedules have been developed.

Increasing the number of the work force would allow the work to proceed more rapidly, but under the circumstances, would hardly be economical. Prior acclimatization of workers is

**TABLE 18–2.—Comparison of Heat Stress Values Inside and Outside Air-conditioned Enclosure, In Tunnel At Location 1, April 13, 1972**

| Measurement made | Temperature, F | | | | | Air velocity, ft/min | Relative humidity, percent |
|---|---|---|---|---|---|---|---|
| | Dry bulb | Globe | Wet bulb | Wet globe | Wet bulb globe | | |
| Outside Enclosure | 102 | 107 | 77 | 78 | 86 | 25 | 26 |
| Inside Enclosure | 95 | 97 | 70 | 70 | 78 | 150 | 29 |

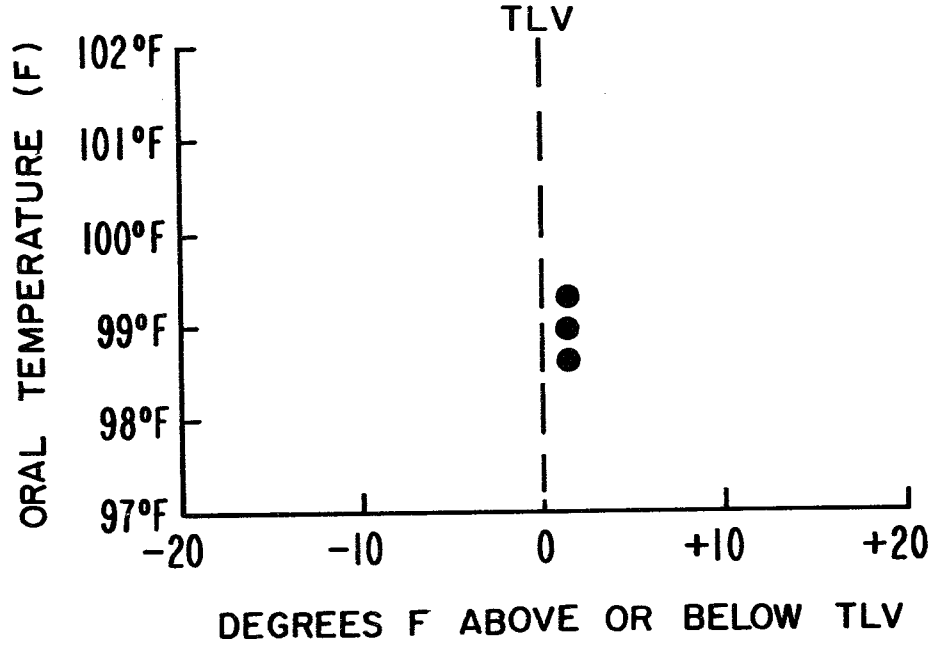


**FIGURE 18–2.—Exposure in degrees F above (+) or below (−) the TLV for the hour preceding the oral temperature measurement.**

impractical. An attempt is made to avoid tunnel work in the hottest weather, but circumstances may dictate otherwise.

4.) The job is done so infrequently that it is unlikely to affect the very low existing labor turnover.

5.) No heat illness or accidents have occurred.

6.) The outdoor weather definitely will influence the tunnel heat stress. Other factors, water seepage and steam leaks, and the replacement of grilles by steel plates (for security reasons) may be equally important.

7.) The use of the wet bulb and the globe thermometer in this type of situation does present some problems. One direct reading instrument would be preferable. Rapid changes in environmental conditions, usually unpredictable, make heat stress evaluation a most difficult task even for an experienced environmentalist. These jobs are similar in this respect to maintenance and repair work which are now recognized to present greater health hazards than most routine production operations.

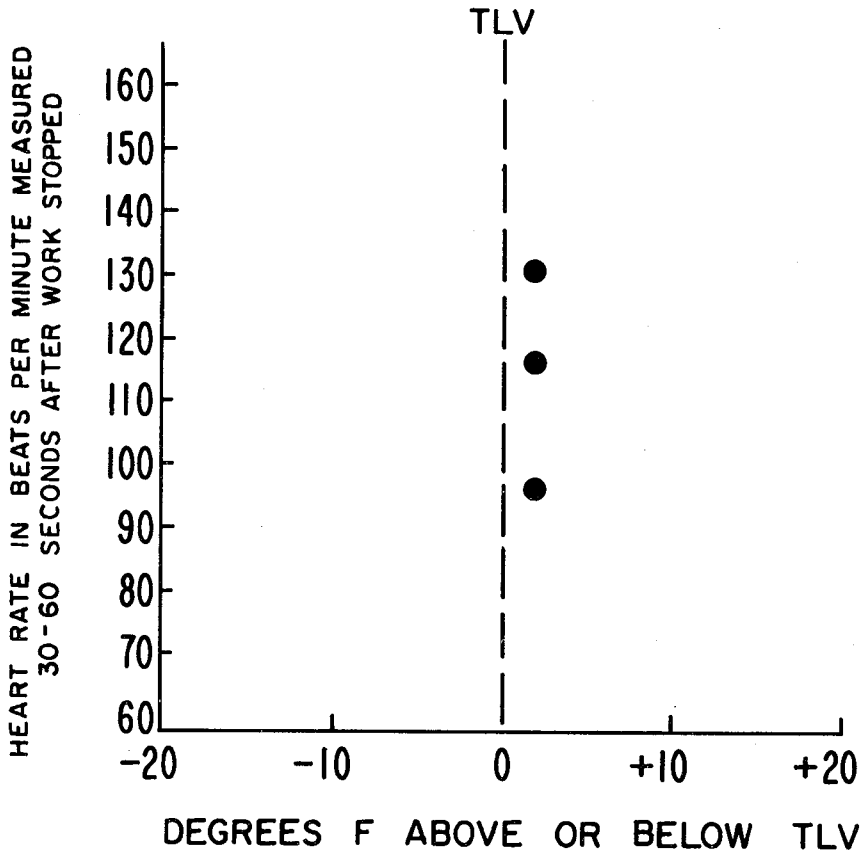


FIGURE 18–3.—Exposures in degrees F above (+) or below (−) the TLV for the hour preceding the heart rate measurement.

TABLE 18–3.—Oral Temperatures (T) and Pulse Rates (PR) Work Crews, Location 1, January 5, 1972 (WBGT = 85 F)

| Crew | Before entering tunnel | | After 1 hour moderate work | | After 3 hours moderate work, last 10 min. heavy | |
|---|---|---|---|---|---|---|
| | PR | T,F | PR | T,F | PR | T,F |
| R.T. | 88 | 97.0 | 112 | 98.8 | 116 | 98.6 |
| U.C. | 72 | 94.6 | 104 | 98.6 | 130 | 99.0 |
| D.D. | 84 | 98.4 | 88 | 99.2 | 96 | 99.6 |

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