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Recommendations to Improve Employee Thermal Comfort When Working in 40°F Refrigerated Cold Rooms

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Abstract

Cold rooms are commonly used for food storage and preparation, and are usually kept around 40°F following food safety guidelines. Some food preparation employees may spend 8 or more hours inside cold rooms. These employees may not be aware of the risks associated with mildly cold temperatures, dampness, and limited ventilation. We performed an evaluation of cold rooms at an airline catering facility because of concerns with exposure to cold temperatures. We spoke with and observed employees in two cold rooms, reviewed daily temperature logs, evaluated employee's physical activity, work/rest schedule, and protective clothing. We measured temperature, percent relative humidity, and air velocities at different work stations inside the cold rooms. We concluded that thermal comfort concerns perceived by cold room employees may have been the result of air drafts at their workstations, insufficient use of personal protective equipment due to dexterity concerns, work practices, and lack of knowledge about good health and safety practices in cold rooms. These moderately cold work conditions with low air velocities are not well covered in current occupational health and safety guidelines, and wind chill calculations do not apply. We provide practical recommendations to improve thermal comfort of cold room employees. Engineering control recommendations include the redesigning of air deflectors and installing of suspended baffles. Administrative controls include the changing out of wet clothing, providing hand warmers outside of cold rooms, and educating employees on cold stress. We also recommended providing more options on personal protective equipment. However, there is a need for guidelines and educational materials tailored to employees in moderately cold environments to improve thermal comfort and minimize health and safety problems.

Keywords

Food service; airline catering; cold rooms; thermal comfort

Introduction

There were 807,800 food preparation workers in the United States in 2012.[1] Some food preparation employees may spend 8 or more hours inside cold rooms. Cold rooms can be large climate-controlled refrigerators used for food storage and preparation. Food cold rooms are usually kept around 40°F following food safety guidelines.[2] These rooms usually recirculate the air without bringing in outdoor air and may not be designed for continuous

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human occupancy. However, employees may not be aware of the risks associated with mildly cold temperatures, dampness, and limited ventilation. Further, information and educational resources on cold stress in the occupational health and safety literature are often based on working in extreme cold temperatures (i.e., below freezing temperatures)[3,4] and working outdoors,[5,6] conditions that do not apply to employees working in 40°F refrigerated cold rooms.

The American Conference of Industrial Hygienists (ACGIH®) states that there is “little danger” with temperatures lower than 40°F when air velocities are less than 10 miles per hour; and warm-up schedules are only recommended for employees working in temperatures below −15°F.[7] This leaves employers and employees using 40°F refrigerated cold rooms with no specific health and safety guidelines related to breaks for thermal comfort. Further, because of the mild temperatures and air velocity conditions inside a 40°F refrigerated cold room, wind chill recommendations are not available from health and safety cold charts.[7] However, ACGIH has a threshold limit value (TLV®) air velocity guideline of 200 feet per minute that should not be exceeded at workstations inside refrigerated rooms, and suggests this can be achieved by a properly designed air distribution system.[7]

Even though employees inside cold rooms may not be exposed to wind chill enough to cause frostbite or other extreme cold temperature health conditions, thermal comfort may become a health, safety, and productivity concern if not adequately addressed. Employees’ perception of temperature in cold rooms has been associated with deviations from the optimum comfort range especially in the peripheral parts of the body (e.g., hands).[8] Discomfort from cold hands has been associated with a decline in manual performance capacity[8] and manual dexterity. [9] Enander et al.[8] measured hand skin temperatures in cold rooms and showed that pronounced discomfort because of cold hands usually happened when the hand temperature approached the pain threshold, i.e., around 50°F.

Cold exposure has a negative impact on human performance, particularly for those with certain pre-existing medical conditions such as certain infectious diseases, cardiovascular and metabolic disorders, or musculoskeletal problems.[9,10] A cold environment may also increase the chances of an injury or aggravate an existing injury.[11] Employees can preserve body heat, particularly in their hands, by wearing appropriate protective clothing such as thin cotton gloves underneath metal gloves when cutting meat. However, in cool workplaces, preservation of manual dexterity may pose challenges for the employees.[9]

This manuscript describes work conditions of cold room employees at an airline catering facility and provides recommendations to improve thermal comfort in 40°F refrigerated cold rooms and prevent health and safety problems.

Background

NIOSH received a request for a health hazard evaluation from a union representing airline catering employees. One of the union’s concerns was employee exposure to cold temperatures inside cold rooms. This manuscript covers the findings and recommendations on cold rooms at this facility.[12]

Facility Description

The company provided catered food for 16 international flights and between 220–260 domestic flights per day. At the time of our evaluation, the company had about 500 employees, with 130 preparing food in either of two cold rooms. Employees typically worked 8-hour shifts with a 30-minute lunch break and an additional 20-minute break. The company operated two shifts, and employees worked voluntary overtime.

Cold room employees worked from 3–8 hours each shift preparing food in trays or loading completed food trays on carts. Both cold rooms were climate conditioned to approximately 40°F using recirculating roof-mounted refrigerator units (heat pumps). The company maintained a daily temperature log, and calibrated their thermometers monthly against a primary standard. Room temperatures were displayed inside and outside each cold room.

Methods

We spoke with and observed employees in both cold rooms, reviewed the daily temperature logs, and obtained temperature records for one summer month and one winter month for each of the 2 years prior to our evaluation. We evaluated employee's physical activity, work/rest schedule, and protective clothing using guidance from the Canadian Centre for Occupational Health and Safety[13] and thermal stress metabolic rate guidelines.[7] We measured temperature and percent relative humidity (RH) in different workstations using a HOBO H08-032-IS Pro Series RH/Temperature Data Logger. We measured air velocities at chest height in different workstations using a VelociCalc® Plus thermal anemometer (model 8386A). We compared these air velocities to the ACGIH threshold for working in cold environments.[7]

Results

Characteristics of the two cold rooms are listed in Table 1. Cold room 1 is larger and hosts more employees than cold room 2. In cold room 1, employees spend longer hours inside the cold room and perform more food preparation than in cold room 2. In cold room 1 employees spent most of their workday at workstations assembling meals either individually or in teams of two or three. These workstations were set up as dictated by the work tasks. Some of the assembled meals required fine manual dexterity (e.g., decorating with small garnishes, picking shrimp with toothpicks, cutting very thin slices of fish). Employees performing these tasks stated that they chose to wear thin plastic gloves because thicker gloves limited dexterity. Because some of the food they handled was frozen, these employees mentioned that their hands got cold and numb.

Some cold room 1 employees believed that drafts made some areas inside the cold room colder than other areas and that the temperature displays inside the cold room were inaccurately high. Some employees also felt that they did not have enough time during breaks to warm up or change out of their clothing if they became wet. In response to employee concerns about drafts, the company had installed metal deflectors (Figure 1) on some of the refrigerator units several years before our evaluation. We noticed condensation from the cold air striking the metal deflector.

Tables 2 and 3 present the cold room temperatures, relative humidity, and air velocities. Air temperatures in the cold rooms were kept about 40°F, with small differences (plus or minus 5°F) between workstations. As shown in Table 3 the air velocities inside the cold rooms were more variable, with upper limit ranges above the ACGIH cold stress TLV guideline of 200 feet per minute.[6] We measured the highest air velocities in the food preparation area in cold room 2, a location where there were no deflectors on most of the refrigerator units. However, because 40°F was the lower operating limit of the air velocity instrument we used, it is possible that instrument limitations could have influenced our air velocity measurement fluctuations.

Table 4 summarizes the daily temperatures in the cold rooms for two months in 2010 and 2011. Recorded temperatures remained uniform between the months and work shifts and agreed with our measurements (Table 2).

We estimated the physical activity for most cold room employees as requiring a light to moderate metabolic rate, depending on the job tasks for the day. Light metabolic rate included sitting with light manual work with hands, or hands and arms, standing with some arm work, and occasionally walking when preparing and assembling food trays. Moderate metabolic rate included sustained moderate hand and arm work or moderate arm and truck work when moving trays, and pushing and pulling carts. The company required employees to wear a lab coat, hairnet, plastic sleeve guards, plastic or polyvinyl chloride gloves, and apron to protect the food from contamination, and provided optional personal protective equipment (PPE) for warmth that employees reported using (e.g., coat, hat, and liner gloves). There was no cold room training or written safety policy.

Discussion

Thermal comfort concerns can be influenced by differences in air velocities, PPE use, physical activity, work practices, physiological characteristics to adapt to cold, and certain medical conditions. Lack of knowledge about health and safety in cold rooms is an obstacle in taking preventive measures to protect employee health.

Some cold room employees reported cold fingers and did not wear gloves because they believed that wearing gloves reduced dexterity. ACGIH recommends that when performing fine work with bare hands for more than 10–20 minutes in an environment below 60.8°F, special provisions should be established for keeping the employee’s hands warm.[7]

Although physical activity may help improve thermal comfort by generating heat, moderate metabolic rates may result in some employees sweating during work tasks, especially for those wearing layers of clothing. If not given the opportunity to change into dry clothing employees that are sweating could have increased thermal discomfort.

Thermal comfort can also affect work performance. For example, temperature satisfaction among office employees has been highly correlated with self-assessed productivity leve.[14] Further, Huizenga et al.[14] describe that in 11 office buildings across the United States, Canada, and Finland, 42% of employees were dissatisfied with the temperature in their workspace. Huinzenga et al.[14] also state that employee reports of lack of control of

temperature in their environment were highly correlated with thermal discomfort. Employees engaged in food preparation have little if any control over the cold room temperature because of food safety requirements. Therefore, one approach for improving thermal comfort is to limit the time employees work inside a cold room. This may be challenging depending on the process, type of facility, and staffing.

Another approach to improving work conditions in cold rooms is minimizing drafts. For example, in this evaluation changing the style of air deflectors on the refrigerator units to a less-restrictive horizontal design (Figure 2) would improve the volumetric airflow and efficiency of the refrigerator unit while also redirecting airflow away from employees. Additionally, to minimize condensation that could collect inside the deflector and become a potential source for microbiological contamination,[15] non-metallic spacers could be added between the refrigeration unit and the deflector to create a thermal break.

In addition to redesigning deflectors on refrigerator units, hanging non-porous baffles from the ceiling may help decrease drafts that could reach employees without overly restricting room airflow. A trial-and-error approach could be used to decide the best baffle placement.

Another strategy for improving work conditions is to train cold room employees about the hazards and protective measures. Employees in food preparation often rely on on-the-job training,[1,17] making it important for facilities to develop health and safety related training tailored to cold room employees.

Conclusions

In this evaluation, cold room employees worked in consistently moderately cold (approximately 40°F) temperatures, and the air drafts blowing on some employees exceeded recommended guidelines. Thermal comfort concerns perceived by cold room employees may have been the result of air drafts at their workstations, insufficient use of PPE due to dexterity concerns, work practices, and lack of knowledge about good health and safety practices in cold rooms. These moderately cold work conditions with low air velocities are not well covered in current occupational health and safety guidelines, and wind chill calculations (a technique used in colder work environments) do not apply. There is a need for guidelines and educational materials tailored to employees in moderately cold environments (i.e., 40°F refrigerated cold rooms) to improve thermal comfort and minimize health and safety problems. Topics to be addressed include symptoms of cold stress, health conditions that may be aggravated by cold stress, and measures for improving thermal comfort.

Recommendations

We encouraged the airline catering facility to use a labor-management health and safety committee or working group to discuss the following recommendations and develop an action plan. Some of these recommendations may apply to other facilities with employees spending most of their work shift inside 40°F refrigerated cold rooms. Recommendations may also apply to employees working inside cold rooms in other industries such as meat and poultry processing and food manufacturing.

- Redesign deflectors with a non-metallic spacer in all refrigerator fans to reduce unnecessary employee drafts and minimize condensation.
- Install suspended baffles in cold rooms where employees spend more than a few hours a day to further decrease drafts, if needed.
- Consider having employees wear thinner, fingertip-less, or fingerless liner gloves underneath the required plastic gloves when performing fine manual dexterity work.
- Encourage employees to change out of wet clothes if working inside the cold room. Rotate employees performing work requiring fine manual dexterity between warmer and colder areas throughout the workday. Rotating every 2 hours will also allow for breaks from colder temperatures.
- Minimize work requiring fine manual dexterity in the cold rooms when feasible.
- Implement a replacement schedule for gloves and other non-disposable PPE which includes checking for degradation of the materials, excessive wear, tears, or other factors that may impede its effectiveness.
- Provide hand warmers (e.g., warm air hand drier) outside of the cold rooms so that employees can warm their hands periodically.
- Educate employees on the symptoms of cold stress, as well as how to improve thermal comfort (e.g., appropriate use of PPE, changing wet clothing immediately, taking short breaks to warm hands).
- Encourage employees to report work-related symptoms to their supervisor. Employees with work-related symptoms should promptly seek medical attention from their healthcare provider.

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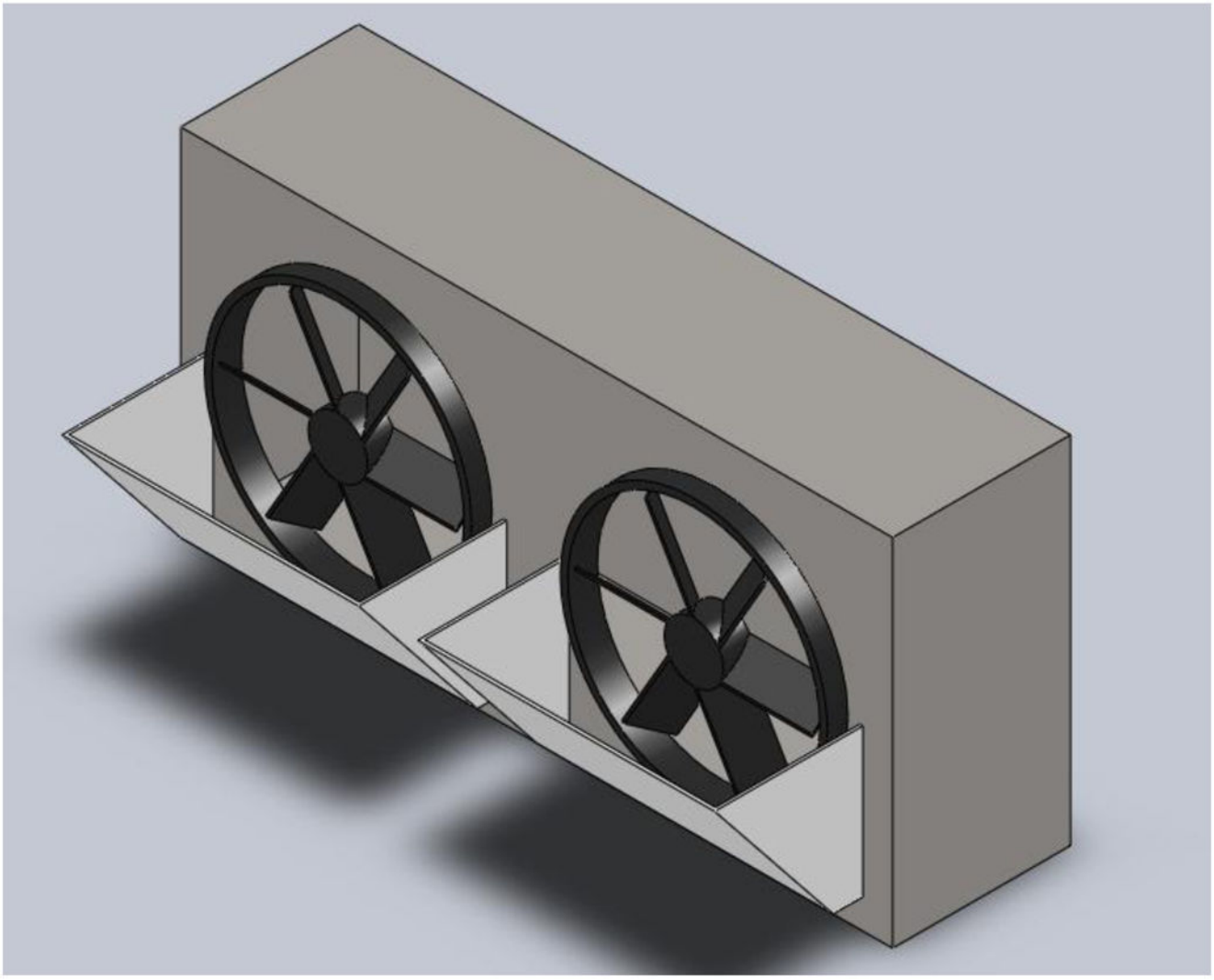

Figure 1.
A diagram of the fan refrigerator unit assembly with deflectors.

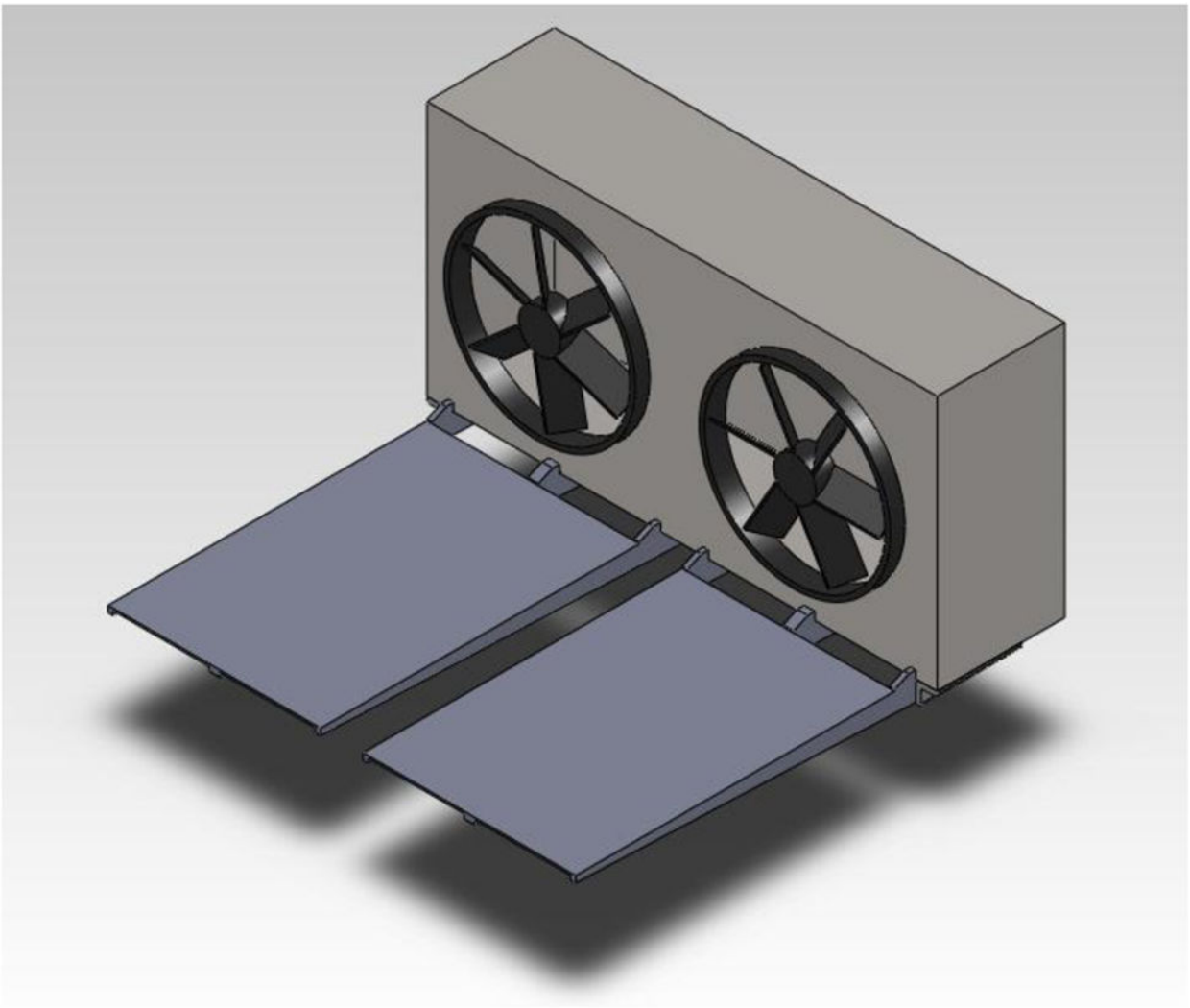

Figure 2.
Suggested fan assembly with horizontal deflector design and spacer.

Table 1

Characteristics of the cold rooms

	Cold room 1	Cold room 2*
Size (width × length × height)	50 ft × 60 ft × 9 ft	60 ft × 70 ft × 9 ft
Entrances	3 strip curtains 2 solid doors	2 strip curtains 2 solid doors
Workstations†	12–16	0–3
Approximate number of employees	7–25	0–3
Work hours per shift inside cold room	3–8	3–6
Number of refrigerator units (number of fans)	6 (12)	8 (24)
Fan deflectors	Yes	No‡
Main work areas	Food storage Food preparation Food assembly lines	Food storage Food preparation Carts storage
Main work tasks	Food preparation Meal assembly (in teams of 1 to 3 employees)	Food stocking and organizing Checking carts Food preparation Moving carts

*The cold room 2 had two sections but we only focused on the section where employees worked.

†Employees could set up and take down workstations based on the work tasks.

‡Only a few fans had deflectors.

Table 2

Temperatures and relative humidity measured inside cold rooms

Workstation	Sampling time	% RH*		Temperature, °F			
				Work station 1	Work station 2	Work station 3	Average
Cold room 1	9:06 a.m. – 5:04 p.m.	67–95	Average	42	44	44	43
			Minimum	40	43	43	
			Maximum	44	45	47	
Cold room 2	9:06 a.m. – 4:45 p.m.	59–89	Average	40	39	NS†	41
			Minimum	38	37	NS	
			Maximum	45	41	NS	

*RH = relative humidity

†NS = not sampled

Table 3

Air velocities inside cold rooms on September 21, 2011

Work area	Shift	Number of samples	Air velocity* (feet per minute average and range)
Cold room 1	Day	7	59.3 (14–116)
	Night	7	53.3 (24–105)
Cold room 2	Day	6	146.3 (30–240)
	Night	6	103.4 (25–259)

* A range of air velocities was noted instead of a single value when the instrument displayed unstable readings due to turbulent flow conditions. We used the average of the minimum and maximum from several readings within the cold room to calculate the reported average.

Table 4

Cold rooms temperature records

Date	Temperature averages, °F			
	Cold room 1*		Cold room 2†	
	Day shift	Night shift	Day shift	Night shift
February 2010	40.6	40.7	40.8	40.3
February 2011	41.7	40.9	42.2	41.8
July 2010	40.8	40.9	40.5	38.1
August 2011	42.9	42.3	43.4	37.7

*Data from company. Five percent of the temperature data were illegible and, thus, were not included in the data analysis

†Data from company. Twenty percent of the temperature data were illegible and were not included in the data analysis