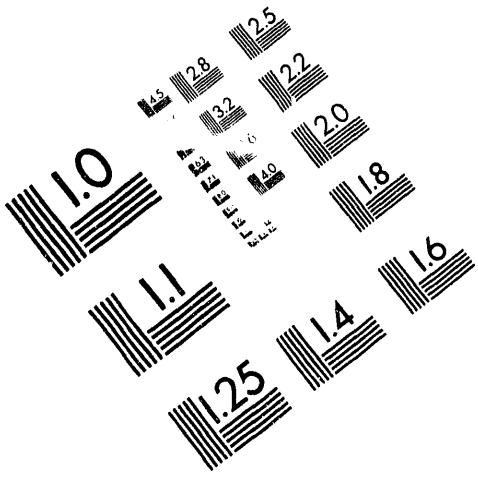

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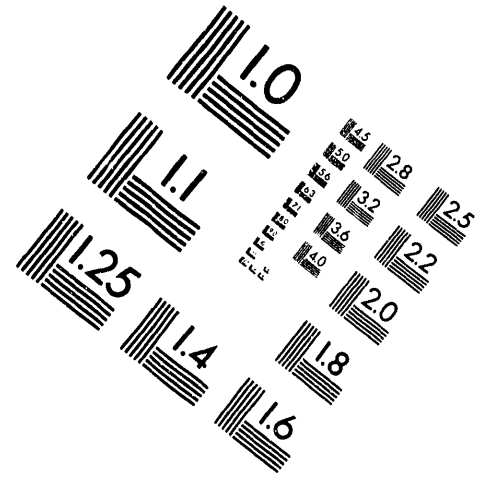

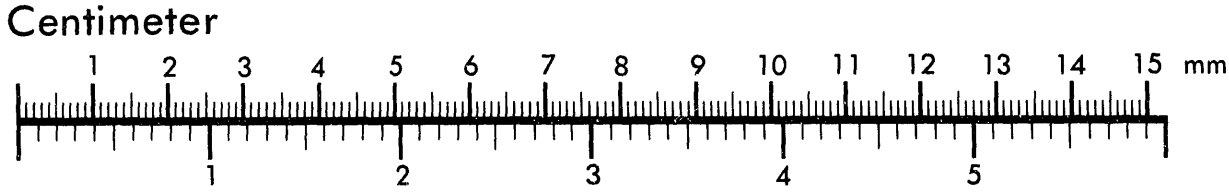

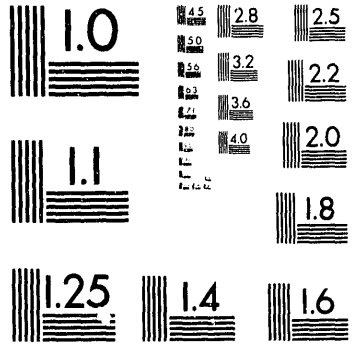

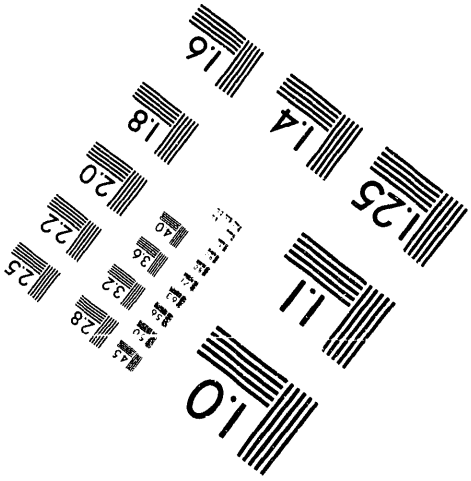

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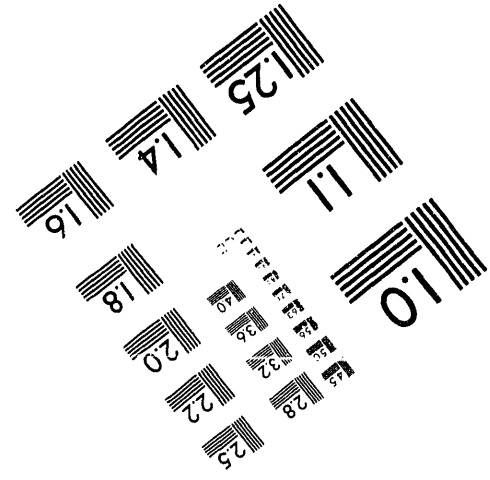

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ERGONOMIC ASSESSMENTS OF THREE IDAHO NATIONAL ENGINEERING LABORATORY CAFETERIAS

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The Idaho National Engineering Laboratory is a Department of Energy facility that performs a variety of engineering and research projects. EG&G Idaho is the prime contractor for the laboratory and, as such, performs the support functions in addition to technical, research, and development functions. As a part of the EG&G Idaho Industrial Hygiene Initiative, ergonomic assessments were conducted at three Idaho National Engineering Laboratory Cafeterias. The purposes of the assessments were to determine whether ergonomic problems existed in the work places and, if so, to make recommendations to improve the work place and task designs. The study showed there were ergonomic problems in all three cafeterias assessed. The primary ergonomic stresses observed included wrist and shoulder stress in the dish washing task, postural stress in the dish washing and food preparation tasks, and back stress in the food handling tasks.

INTRODUCTION

The Idaho National Engineering Laboratory (INEL) is a 2472 square kilometer Department of Energy site that performs a variety of engineering and basic research functions. EG&G Idaho is the prime contractor for the laboratory and, as such, performs the support functions in addition to technical, research, and development functions. These support functions include warehousing, food service, bus service, laundry service and respirator cleaning service. This report focuses on the food services provided by EG&G Idaho, Inc. As a part of the EG&G Idaho's Industrial Hygiene Initiative, an ergonomic assessment team was assembled from members of EG&G Idaho's Human Factors and Systems Analysis Unit. The team was tasked with conducting ergonomic assessments of work places identified by the various departments' industrial hygienists. Industrial hygienists working in the Administration Department identified the cafeterias as having potential ergonomic stressors. Three cafeterias were assessed. The three cafeterias were located at: Central Facilities Area (CFA), Test Reactor Area (TRA), and the Chemical Processing Plant (CPP). The number of customers the cafeterias served is shown in Table 1. The CFA cafeteria functions as the primary food preparation and storage facility for all the cafeterias on site. There are other cafeterias on site. However, only these cafeterias were identified by the department's industrial hygienists as having potential ergonomic problems.

METHODOLOGY

The methodology used to conduct the assessments involved: (1) conducting an initial tour of the facility; (2) a review of the accident statistics for the facility; and (3) conducting a detailed ergonomic assessment of the facility. After the detailed assessment was complete, recommendations to correct observed deficiencies were provided to the facility management. The recommendations were continuously reviewed for effectiveness by the Human Factors and Systems Analysis Unit, the department's industrial hygienist, and the facility management while being implemented.

TABLE 1. Number of Customers Served per Cafeteria

Cafeteria	Meal	Number of Customers
CFA	Breakfast	84
	Lunch	560
	Late*	77
	Total	721
CPP	Breakfast	162
	Lunch	402
	Late	89
	Total	653
TRA	Breakfast	80-100
	Lunch	200
	Late	30-50
	Total	310-350

*Late is defined as a meal after about 1:30 in the afternoon and runs until early evening.

Initial Tour

The purposes of the initial tour were to determine: the conditions at the work places; the tasks that were conducted in the facility; and, instrumentation, such as a light meter, sound level meter, and a weight scale, which would be required to conduct the assessment. A tentative date was then schedule for conducting the detailed assessment. Efforts were made in scheduling the assessments to ensure activities were going to be as normal as possible and not either a heavy or light work load.

Review of injury statistics

Table 2 shows the musculoskeletal injury statistics for the years 1988, 1989, 1990 and part of 1991 for the cafeteria employees.

Table 2 clearly shows that back strain is the most frequent musculoskeletal injury experienced by the cafeteria employees. This is consistent with general industry (Ayoub and Mital, 1989). It is logical that the employees working for the CFA cafeteria would have the most injuries because it employs the most employees, does the bulk of food preparation, and also serves the most customers. The total number of employees that work in all the cafeterias is 27. So, in 1990, one in nine employees working in the cafeterias experienced a musculoskeletal injury. Injury statistics from general industry show an incidence ratio of less than 2 strains per 100 employees (Ayoub and Mital, 189). Therefore, the site cafeteria was experiencing a significantly higher incidence ratio as compared to general industry statistics.

Table 2 also shows that the number of musculoskeletal injuries per year in the cafeterias increased over the time period reviewed. However, this could be misleading because the reporting of injuries by employees improved in 1990 due to awareness of reporting requirements and injury symptoms.

TABLE 2. Injury Statistics Before the Ergonomic Assessments

Cafeteria	Injury Type	Number of Cases
	1988	
CFA	Back Strain	1
	1989	
CFA	Back Strain	1
	1990	
CFA	Back Strain	1
TRA	Back Strain	1
CPP	Elbow Strain	1
	1991*	
CFA	Back Strain	1

*These were the injuries up to the time of the ergonomic assessment.

Detailed Ergonomic Assessments

The assessments included observing the employees performing their jobs and determining which tasks or elements appeared to be the most physically stressful. Once the more stressful tasks were identified, they were studied in more depth. In most cases, the physiological work load of the tasks could be classified as moderate (Astrand and Rodahl, 1986) and therefore, not physiologically stressful. However, they were physically stressful due to the number of repetitions the employees performed per hour, the postures the employees had to attain to perform the tasks, or the wrist deviations required by the tasks. The work load for some of the lifting tasks was classified as high. A checklist described in Ostrom, et al. (1992) and Ostrom, et al. (1991) was used as a screening tool to help identify ergonomic stresses in the work place and task design. The information needed for

conducting the assessments and developing the ergonomic checklist was obtained from Ayoub and Mital (1989), Calisto, et al. (1986), McCormick and Sanders (1982), NIOSH (1973), NIOSH (1981), OSHA (1990), Putz-Anderson (1988), and Rodgers (1983).

When assessing a task involving repetitive motions of the wrists the ergonomic team observed the motions the employees made and took periodic samples using work sampling techniques (Barnes, 1980) to determine the average number of motions per hour. Video taping the employees performing the tasks was impractical because of the limited amount of space available. Also, video taping in certain cafeterias is restricted.

RESULTS

The results showed there were ergonomic stresses in each of the cafeterias assessed. The tasks assessed in the cafeterias were broken down into four categories; (1) food storage and delivery, (2) food preparation, (3) food service, and (4) dish washing. Examples of the kinds of ergonomic problems found are presented in the following sections, with more emphasis placed on the dish washing task, since it was found to be the most stressful task.

Food Preparation

The problems found in the food preparation task were related to weights of the containers and their design and the heights of the work surfaces.

The assessment showed that the employees lifted a variety of large containers of food, both in original food packing containers and in cooking pots. Cartons of canned goods weighed up to approximately 20 kilograms. Cartons of meat weighed up to approximately 31 kilograms. The cooking pots were usually large, with capacities up to 76 liters. Some of the smaller cooking pots had long handles to protect the worker from the heat of the cooking surface. Larger pots had handles close to the pot and thus required the worker to carry the pot in an awkward posture to avoid being burned. The food containers and pots were lifted at relatively high frequencies during rush periods in the cafeterias. The team determined the lifting tasks in the cafeteria were physically stressful due to the frequency combined with the weight lifted and the height of the work surfaces.

The work heights of the food preparation surfaces were not adjustable and the workers ranged in stature from 150 to 188 cms. Some employees were observed in very stressful postures during times when food was being prepared. In some cases, the employees were also required to reach to the bottom of deep sinks. Step-stools were available, but the employees sometimes viewed these as nuisances, rather than aids.

Food Storage and Delivery

The CFA cafeteria also serves as the distribution point for certain types of prepared food. The food is prepared at the CFA cafeteria and distributed to the CPP and TRA cafeterias. To do so, the food is loaded into a van and driven to the other two cafeterias where it is unloaded. Several work place problems were evident in this operation. First, the loading docks at the three cafeterias did not allow the use of carts or dolleys to move the food from the cafeteria to the food van and vis versa. Therefore, the van driver and cafeteria workers would carry the containers of food from the cafeteria into the van. As previously stated, the food containers were not standardized and could be quite heavy. For instance, containers of hot soup up to 36 liters in volume were carried to the van. These containers weighed over 38 kg. Two people usually performed this task. However, the employees had to maneuver the container of soup through the door of the cafeteria and into the back of the van.

Food Service

The primary problem found in the food service task was the height of the work surfaces. In a number of cases, the height of the work surfaces was too high for a large percentage of the employees. In one instance, an employee, who was approximately 148 cm tall, would serve food from a steam table that was located approximately at her mid-torso height. She would then lift the filled dishes of food to approximately 132 cm where customers would put them on their trays. This was at approximately her shoulder height. This task was determined to be very stressful for the employee's shoulders and back.

Another problem facing cafeteria workers was the design of food serving ladles and scoops. Often the implement handles were small, had sharp edges, had a long moment arm, and required pinch grasps to operate. The small handle reduced the span of the hand as they grasped the tool, the sharp edges can compress the median nerve in the hand, and the pinch grasps increase the force in small areas of the hand which are contributing factors to CTS in the wrist (Konz, 1975).

Dish Washing Task

The problems found in the dish washing task were the number of wrist motions the dishwashers made per hour and the design of the work station in the CFA and TRA Cafeterias.

The dish washing task in the three cafeterias appeared to be the most stressful of those tasks assessed, with this task in the CFA cafeteria appearing to be the most stressful. In this operation, dish washers pulled the trays containing dirty dishes off a set of shelves where they were placed by the cafeteria's customers. Table 1 shows that 560 customers use the CFA cafeteria, so approximately that many trays were used each lunch time.

The design of the dish washing task required several very stressful motions. The first of these motions required the employee to lift the tray containing the dirty dishes from one of four shelves. The highest shelf was above shoulder height for 90% of the population. The other three shelves were at or below shoulder height for the majority of the population. The employee would grasp the tray with a pinch grip on each side and lower the tray to the wash bench. The employee then removed the dishes, rinsed them, and then placed them in a wash rack. This required up to two wrist deviations to perform. The dish washer then dumped the remaining contents from the dirty glasses and turned the glass over into a wash rack. The employee dumped the remaining contents of the glasses using one of two sets of motions. The simpler set of motions appeared to be more stressful. In this set of motions, the dishwasher grasps the glass with his/her left hand. The employee's wrist started this set of motions in a neutral or slightly flexed posture. The employee would then supinate his/her forearm until the glass was parallel with the wash bench top. He/she would then extend his/her wrist until the contents of the glass poured out. The employee then pronated the forearm and allowed the glass to rotate in his/her hand until the mouth of the glass was pointed down. Finally, the employee set the glass, mouth down, in a wash rack. The wrist at this point was again in a flexed posture. When the glass rack approached three quarters full, the employee would shift motions to the second set. This series of motions involved the employee grasping the glass with the left hand with the wrist in a neutral posture and pronating the forearm and lifting the shoulder until the contents poured out. The employee would set the glass down, mouth first, in the wash rack. At this point the wrist was slightly flexed.

The dish washing task resulted in the dishwashers performing over 2000 wrist motions per hour. However, this level of activity only lasted for up to one hour per day. Most days the dish washers rotated every 30 minutes, but if an employee was on vacation, then one employee would have to perform this task for the entire lunch hour. At the CPP cafeteria a cart was placed near the point the dirty dishes were placed on a conveyer and the customers were expected to dump their own glasses. The ergonomic team estimated that if this were done at the CFA cafeteria it would reduce the number of wrist motions among the CFA Cafeteria dishwashers by up to 1120 per hour. This is because each dirty tray contains at least one glass and it takes up to two wrist motions per glass to place them in the wash rack.

The work place design of the CPP and TRA dish washing areas also required considerable trunk twisting on the part of the dishwashers.

RECOMMENDATIONS

Recommendations were made to reduce the stress of these tasks and a plan was drawn up by the responsible managers to correct all the deficiencies found. Follow-ups are being done as the manager institutes corrective actions. For instance, a platform has been built for the food service employee discussed in the Food Service section in order to elevate her in relation to the height of the work surface. The design of the work platform was evaluated by industrial safety, industrial hygienists, and ergonomics professionals to ensure it met all applicable criteria.

DISCUSSION

From this assessment it is clear that ergonomic considerations need to be made when designing cafeterias and related food handling tasks. Classically, dish washing has been considered either an entry level position from which workers are promoted to various other food service and preparation tasks (or a temporary job for those who forget their wallets.) Therefore, the task may not be viewed as having a high priority for ergonomic assessment or redesign. This study showed that dish washing is ergonomically a very stressful task that needs more attention.

During 1992 the Administration Department instituted a program to train employees how to perform various stretching exercises and encouraged them to do so. The combined effect of the ergonomic assessments along with the stretching program have been very positive. Table 3 shows the injury statistics for the remainder of 1991 and 1992. This table shows that the cafeteria employees experienced three

more injuries during 1991, but did not experience any injuries during 1992. It could not be determined when the injuries in 1991 occurred in relation to the implementation of the recommendations, but it is very evident that the a reduction in injury rate did occur.

TABLE 3. Injury Statistics Since Ergonomic Assessments

Cafeteria	Injury Type	Number of Cases
	1991*	
CPP	Back Strain	1
TRA	Back Strain	1
CPP	Shoulder Strain	1
	1992	
	None	

*These injuries occurred since the ergonomic assessments.

ACKNOWLEDGEMENTS

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