Rob Strickland, OTR
Ergonomics Consulting

27422 SE Division Drive
Gresham, Or. 97030
503-667-3564

Ergonomic Evaluation
PECO Manufacturing Co., Inc.
Semi-automated Thermal Calibration (103)
April 2001
By Rob Strickland, OTR

A worksite visit was conducted on April 20, 2001 in the area of manual calibration of thermal control units. This was done at the request of Dave Looper, Manufacturing Consultant from OMEP as a part of an Oregon OSHA Worksite Redesign Grant project for this facility. Videotaping and digital photos of the work tasks were conducted and are available for review. Employee discomfort surveys were completed.

Purpose/Background:

The purpose of this evaluation is to provide an initial assessment of the musuculo-skeletal disorder (MSD) risk factors associated with the process of calibrating thermal control units. These job tasks have resulted in a number of injuries/disorders among employees involving hands, wrists, forearms, elbows, shoulders and upper back (19 documented cases in 5.5 years totaling $127,563.00 in direct costs- see Worksite Redesign Grant Application). PECO Mfg. intends to improve this job process in an effort to reduce the incidence of MSD injuries.

General Description: The following information is adapted from material provide by PECO Mfg. and is contained in the Worksite Redesign Grant Application: PECO Mfg. Co. employs approximately 250 employees involved in the business of making thermostat controls for various applications. Approximately 10 of these people are employed on two shifts related to the calibration of the 103 product line. They generally work 8 hours per day, 5 days per week and rotate as needed on and off of the calibration tasks. In a typical shift, approximately 300 units are calibrated.

Thermal calibration sequence: Currently employees manually perform the following sequence:

a) Place actuator bulb in a water or oil bath for 3 minutes.
b) Apply Glyptal (thread lock) to secure the calibration screw inside thermostat (squeeze bottle).
c) Secure the stat assembly in a fixture (snap-down clamp device)
d) Attach the stat assembly lead wires to the calibration fixture.
e) Place a “pointer” device onto the switch shaft.
f) Rotate the pointer by hand 270 degrees for three cycles to wear in the switch shaft and cam.
g) Rotate pointer to a specified angular setting.
h) Adjust and double check the 4-40 calibration screw until an indicator is activated or deactivated indicating the proper set point has been achieved.
i) Repeat the rotation process in step G to verify the proper setting.

Work Environment and Equipment: Relevant dimensions

Indoor, temperature controlled environment.
Workstation tables 96" long X 30.25" deep X 37.25" high
Tall, manually adjustable stools with back support
Anti-fatigue standing pads provided on floors
Calibration fixture mounted on table
    Horizontal Reach distance= 5" from front edge of workstation
    Vertical Reach height= approximately 12" above workstation
Calibration tanks 8" wide X 18" deep, 2" high lip above workstation
    Horizontal Reach distance= 6" to 24" from front edge of the workstation table

Observations: While sitting or standing at the workstation, the employee's right arm is largely unsupported while reaching forward and upward to shoulder height to manipulate the small screw driver. The left arm intermittently reaches forward and upward to rotate the pointer up and down. At other times the left hand may rest on the table for a brief interval (several seconds).

Key physical demands which contribute to risk of musculo-skeletal injury include:

1. Repetition- movements of the upper extremities are classified as moderately repetitive (reaching forward and upward to shoulder height, wrist flexion, extension, deviation, pinching and thumb/finger manipulation). Cycle time varies from 50 to 70 seconds with approximately 50% of cycle time involved in the same fundamental movement patterns. Approximately 300 units are calibrated per shift.

2. Awkward postures- moderate neck flexion with occasional lateral flexion and trunk twisting, shoulder forward flexion, elbow extension and flexion, wrist deviation, flexion and extension.

3. Static postures- while sitting or standing- maintaining moderate neck flexion and unsupported reaching with both arms for approximately 50% of the cycle time.

4. Forces and Loads- primarily related to postural control and static holding of the arms in a forward reaching & unsupported position.

Job Hazard Analysis Tools Utilized

Rapid Upper Limb Assessment (RULA)* results: Action Level 2 (rating score 4).

A RULA rating of 4 (on a scale of 1-7) results in a RULA action level of 2. This results in a recommendation of "investigate and changes may be required".

**See Applied Ergonomics 1993, 24(2), 91-99, "RULA: a survey method for the investigation of work-related upper limb disorders" RULA is a survey method developed for use in ergonomics investigations of workplaces where work-related upper limb disorders are reported. This tool*

RULA (Cont.)

requires no special equipment in providing a quick assessment of the postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicated the level of intervention required to reduce the risks of injury due to the physical loading on the operator.

The Requirements for action into which the grand scores are divided is summarized into action levels as follows: (The action level leads in most cases, to proposals for a more detailed investigation)

Action level 1- A score or 1 or 2 indicates that posture is acceptable if it is not maintained or repeated for long periods.

Action level 2- A score of 3 or 4 indicated that further investigation is needed and changes may be required.

Action level 3- A score of 5 or 6 indicated that investigation and changes are required soon.

Action level 4- A score of 7 indicates that investigation and changes are required immediately.

Strain Index Analysis results* Strain Index (SI score)= 13.5

An SI Score above 7 is the highest classification and is rated hazardous in terms of risk for distal upper extremity disorders.

**See American Industrial Hygiene Association Journal 56:443-458 (1995) "The Strain Index: A Proposed Method to Analyze Jobs for Risk of Distal Upper Extremity Disorders". The Strain Index is a semi-quantitative job analysis methodology that results in a numerical score (SI score) that is believed to correlate with the risk of developing distal upper extremity disorders. The index is based on multiplicative interactions among its task variables, consistent with physiological, biomechanical, and epidemiological principles. The SI score represents the product of (1) intensity of exertion, (2) duration of exertion, (3) exertions per minute, (4) hand/wrist posture, (5) speed of work, and (6) duration of task per day. Preliminary testing has revealed that jobs associated with distal upper extremity disorders had SI Scores greater than 5. SI Scores less than or equal to 3 are probably safe. SI Scores greater than or equal to 7 are probably hazardous.*

The scores from these job hazard tools, combined with the significant MSD claims history and discomfort survey results indicate a strong need for engineering controls to eliminate or materially reduce worker exposure to this task.

Employee Discomfort Survey Results:

Job Title- 103 Calibration Number of surveys completed= **12**

Discomfort Area	Number of employees with discomfort	Percentage of the total (12)	Average Rating (0-10 scale)
Shoulder	6	50%	4.3
Elbow/forearm	5	42%	4.0
Neck	4	33%	4.5
Hand/wrist	4	33%	4.3
Lower back	4	33%	2.8
Upper back	3	25%	3.7
Hip/thigh	2	17%	4.0
Knee	1	8%	5.0
Lower Leg	1	8%	4.0

Recommendations: Engineering controls

Re-design the Thermal Calibration 103 process according to criteria set forth in section C of the Worksite Redesign Grant application (semi-automating the calibration aspects of the process). This would eliminate many of the repetitive movements of the arms which now occur in un-supported non-neutral positions. The resulting manual tasks performed by employees would primarily relate to loading/unloading and documentation functions.

The following ergonomic improvement goals should be considered to the extent that they are feasible:

1. Maintain the ability of workers to choose sitting, or sit/stand/lean-options while operating the equipment to minimize the physical stresses of static positioning. This requires maintaining knee clearance below the equipment to allow sitting without increasing reach distances.

2. Provide foot bars, platforms or moveable foot rests where possible underneath equipment at workstations to allow an alternating, foot-up position (4"-6" high) while standing.

3. Design the employee-machine interface to accommodate the widest range of adult working population (such as 5^{th} percentile female to 95^{th} percentile male) while allowing them to work with upright trunk/neck postures, elbows close to their side and wrists/hands in a near-neutral range of postures around elbow height. This could be accomplished by making the equipment adjustable or a floor platform adjustable. *For example: if the optimal hand position for this task is determined to be at elbow height while standing, the adjustment range would be from 36.5" to 45.4" vertical height from the floor.* (Specific design parameters can be established following the development of initial concept drawings).

The new equipment should be efficient, simple to operate and not create any additional MSD risk factors.

Photos

Figure 1

Extended forward reach for thermostat while sitting

Figure 2

Right arm reaching in a static, unsupported position while manually calibrating thermostat

Figure 3

Neck flexion (looking down) while standing, reaching forward

For further assistance or questions regarding this report please contact Rob Strickland, Ergonomics Specialist. Phone (503) 667-3564.

Respectfully,

Rob Strickland, OTR
Ergonomic Specialist