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Ergonomic Evaluation
Electronics Assemblers Inc.
Heat Shrink Conveyor
April 2001

A worksite visit was conducted at Electronics Assemblers Inc, (EAI) on April 24, 2001 to evaluate the manual heat shrink tasks. This was done at the request of Mark Biederbeck, 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 manual heat shrink process. These job tasks have resulted in one carpal tunnel case and five other work injury claims. Numerous employee complaints have been reported involving hands, wrists, forearms, elbows, shoulders, neck, upper and lower back. EAI intends to improve this job process in an effort to reduce the incidence of MSD injuries.

General Description & Observations:

The following description is adapted from information provided by Electronics Assemblers Inc. and Mr Biederbeck: The current process for applying heat-shrink tubing to most cable ends is:

1. Operator picks up a pre-cut length of heat shrink tubing
2. The cable is placed by the operator through the heat shrink and manually positioned for correct placement.
3. While holding the cable with heat shrink in one hand, the operator picks up the heat gun and turns it on, applying heat for 15 to 30 seconds at a time.
4. The cable and heat gun are maneuvered around each other until the tubing is correctly shrunk around the cable end.
5. The heat gun is turned off and set back down.
6. An alternate method is to leave the heat gun on the table pointed up and hold the cable over the stream of hot air while manipulating it.

While holding the heat gun or a length of cable, the arms are held unsupported for 5 to 15 seconds at a time (average 10 seconds) often with the elbows out to the side at close to shoulder height.

Work Environment and Equipment: Relevant dimensions

Work is performed in-doors in heated (not cooled) environment. (Can become hot in summer months)
Work tables are 32.5" high
Chairs are various older style, padded office chairs without arm rests
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The primary physical demands likely to contribute to risk of musculo-skeletal injury include:

1. Awkward/static postures- significant, prolonged, static positioning- sitting at a fixed height table while holding and manipulating wire cables and the heat gun. Moderate shoulder flexion (holding arms out with elbows away from the body), wrist flexion/extension and neck flexion.

2. Forces and Loads- sustained & repetitive muscle loading of the neck, shoulders, forearms, hands and fingers while manipulating and holding wire cables and heat gun. Most often this occurs with the arms held in an unsupported position.

3. Repetition- highly repetitive movements of shoulders, forearms, wrists and hands to manipulate wire cables and heat gun.

4. Pressure points- workstation edges & surfaces against forearms or elbows and hard wire cable against soft tissues of hand and fingers.

5. Health and safety hazards- workers are also exposed to high temperatures of the heat gun (up to 1,100 deg. F.). This poses substantial potential dangers of burns to the skin and drying of the moisture in the eyes and skin.

Job Hazard Analysis Tools Utilized

Rapid Upper Limb Assessment (RULA)* results: Action level 3 (rating score 6).

A RULA rating of 6 (on a scale of 1-7) results in a RULA action level score of 3. This is the second from the highest possible classification (3 on a 1-4 classification scale) and results in a recommendation of “investigate and changes are required soon”

*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 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.

RULA (cont.)

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.

Employee Discomfort Survey Results:

Job Title- Assembler- heat shrink Number of surveys completed= 10

Discomfort Area	Number of employees with discomfort	Percentage of the total (19)	Average Rating (0-10 scale)
Shoulder	10	10%	6.6
Hand/wrist	7	70%	7.2
Neck	7	70%	6.7
Elbow/forearm	5	50%	7.0
Upper back	3	30%	7.0
Lower back	3	30%	7.7
Eyes	2	20%	7.5
Hip/thigh	1	10%	6.0

These identified ergonomic risk factors, job hazard analysis tool results, discomfort survey results and EAI claims data together indicate a need for engineering controls to eliminate or greatly reduce worker exposure to this task.

Recommendations:
Engineering controls

Design and build a semi-automated bench top heat-shrink device as per section C of the Worksite Re-design Grant Application, which will eliminate the manual handling of the heat gun. Additionally,

it should reduce some of the manual handling and fingering of the individual cables as the machine performs the processing. The device should be efficient, simple to operate and not create additional MSD risk factors.

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

1. Provide a few standing height workstations which employees can choose while operating the equipment to minimize the physical stresses of static sitting positioning for prolonged periods.

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

Engineering controls (cont.)

Note: *1 & 2 above are suggestions made for EAI to respond to if able, and as such are not considered part of the Worksite Redesign Grant changes.*

3. Design the employee-machine interface to accommodate the widest range of adult working population (such as 5th percentile female to 95th 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.

For further assistance or questions regarding this report please contact Rob Strickland, 667-3564.

Respectfully,

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