

**DRAFT**

**Post Project Ergonomic Evaluation**  
**Electronics Assemblers Inc.**  
**Heat Shrink Conveyor**  
**June 2002**

An on-site ergonomic evaluation of the task of heat shrinking material onto cables using the new Heat Shrink device was conducted at EAI Inc. on June 24, 2002. 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 company, with the goal of reducing the risk of MSD injuries. Videotaping and digital photos of the use of the device were conducted and are available for review.

**Purpose/Background:**

The purpose of this evaluation is to provide an assessment and documentation of the improvements in the Musculoskeletal Disorder (MSD) risk factors associated with the use of this new device.

**General Description:**

Rather than using a heat gun to shrink the material on cables, the new heat shrink device uses radiant energy generated from the elements in a bench top device. The worker now places the heat shrink material over a cable, positions the cable in between the paired elements and activates a foot switch to close the elements around the cable. After the material has shrunk tightly around the cable, the foot switch is then released. An alternative is to set the timer on the control unit to a pre-set time and depress the foot pedal to activate the heating cycle. At the end of the cycle the elements automatically turn off and open.

**Work Environment**

Work is performed indoors with the heat shrink device and control/power unit resting on a table surface. The worker sits in a chair, resting elbows/forearms on the table in front of the device.

**Device Description and Relevant Dimensions:**

Heat shrink device- 18" wide X 7.5" deep  
Device work platform (with elements) has adjustable angle tilt (horizontal to nearly vertical positioning)  
Functional work height of paired elements = 5" above table surface  
Tinted, adjustable eye protection shield  
Separate control/power unit  
Foot switch for element control (on/close, off/open)

Ergonomic Evaluation

**The improvements in risk of musculo-skeletal injury due to the implementation of this new tool include:**

1. Awkward postures- have been nearly eliminated with the use of the heat shrink device allowing the worker to sit with balanced neck, upright and supported trunk, using arms in an optimal position at abdomen level with near neutral hand/wrist postures.
2. Static postures- Workers continue to be exposed to mild static postures of sitting at a fixed height table while holding and manipulating wire cables but, this is much improved by supporting the arms on the workstation surface.
3. Forces and Loads- have been significantly reduced by the ability of workers to support the arms on the table surface and the elimination of grasping, holding and manipulating the heat gun. (Sustained & repetitive muscle loading of the neck, shoulders, forearms, hands and fingers while manipulating the heat gun have been eliminated). Holding and manipulating sections of cable is a very light activity.
4. Repetition- is greatly reduced by eliminating the movements of the hands and arms to manipulate the heat gun and by decreasing the manipulations of the cables and wires. Now the cables are held and moved slowly while being heated by the elements.
5. Pressure points- Workers continue to be exposed to contact pressure from workstation edges & surfaces against forearms or elbows. This can easily be ameliorated by the addition of corner and surface padding material (see recommendations)
6. Health and safety hazards- workers continue to be exposed to high temperatures (radiant heat from the paired elements rather than blowing, heated air from the heat gun), but this is partially ameliorated by the adjustable eye shield on the device.

**Employee Discomfort Survey: Pre Project**

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

Discomfort Area	Number of employees with discomfort	Percentage of total	Average Rating (0-10 scale)
Shoulder	10	100%	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

**Average rating = 7.0**

### **Employee Discomfort Survey: Post Project**

Due to business slow-down and lack of heat shrink projects prior to the time of the post-project survey, no post –project employee discomfort surveys were completed. This could be done in the future after a period of production using the device.

### **Job Hazard Analysis Tools Utilized**

**Rapid Upper Limb Assessment (RULA)\* results:** Action level = **2** (rating score **3**).

A RULA rating score of 3 (on a scale of 1-7) results in a RULA action level of 1. This is the second from the lowest action level classification on a 1-4 classification scale and represents a significant improvement over the pre-project RULA score of 6 (action level 3).

*\*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 of 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)= **1.5**

An SI Score below 3 is the lowest classification and is rated "probably safe" in terms of risk for distal upper extremity disorders. This also represents a marked improvement over the pre-project Strain Index score of 13.5.

### Strain Index (cont)

\*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.

### Worksite Redesign Project Completion Summary

The evaluation of MSD risk factors identified above along with the RULA and Strain Index results, indicate that the engineering controls and related work processes involving the use of the new heat shrink device have been very successful. Although the final design of this device differs somewhat from the original plan of a semi-automated, conveyor fed machine, all of the primary goals for this tool outlined in the initial ergonomic evaluation report have been accomplished. The MSD risk factors have been substantially reduced. Employees and management indicate satisfaction in the over-all outcome of the engineering changes.

#### **Additional suggestions/ideas:**

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.

**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. Provide extra guarding around the lateral aspect of the paired elements to prevent unintended contact of the hands to the elements (potential burn hazard).
4. Provide optional material holders on device platform to hold cables while being heated in elements.
5. Provide edge and surface padding to reduce contact pressure to elbows and forearms.
6. Provide employee training in best practices for optimal positioning, neutral postures and body mechanics using the new device.

For further assistance or questions regarding this report please contact Rob Strickland, 503-667-3564.

Respectfully,

Rob Strickland, OTR  
Ergonomic Specialist