

WRAPPING AND BUILDING ELECTRICAL WIRING HARNESSES

Potential Hazards and Possible Solutions

Preparing Wiring Harnesses

Preparing wiring harnesses for Ford Aerostar vans. A variety of wires are assembled and wrapped with something that looks like black electrical tape. At the beginning and end of each wrapped section a short piece of tape is obtained from a separate dispenser and used to secure the ends. In several areas a split plastic tube is placed over the wires and the ends of the tube are again secured with tape. The entire harness is held in place on a pegboard arrangement which appears to be positioned at about a 30 degree angle. There is no apparent adjustment in either the angle or height of the work surface. The floor appears to be wooden and has no cushioned areas for the employees to stand on.

- The employees have excessive reaches with torso flexion to obtain work materials from storage areas located at the back of the work station. Excessive reaches create stress on the muscles and joints of the shoulder and upper arm and are a recognized cause of musculoskeletal injury and pain. The torso is frequently flexed during the reaching motion and this creates a strain on the lower back which has to support the weight of the arms and the upper body. Even while handling relatively light weights in the hand the load created by the weight of the upper body and arms can be significant and is a recognized cause of stress, pain and injury to the low back area.

Reduce the distance the employee is required to reach to obtain work materials. Place material in bins under the work surface or have employees wear work aprons which hold the materials needed for the job. The present placement of the bins might be satisfactory if the depth of the work surface were reduced. By reducing the depth of the work surface the reach required to obtain materials would be reduced to an acceptable level. In general reaches should be limited to 16 to 17 inches and torso flexion should be limited to 6 to 10 degrees from

vertical.

- Employees have extended periods of standing which creates static loading on the muscles of the back and legs. This is consistent with the development of muscle fatigue and soreness.

- Where employees are required to stand for long periods of time provide anti fatigue mats.
- Where employees work in a single spot provide sit/stand stools. Where employees are required to move up and down the line and sit/stand stools are not practical provide a padded rail behind and/or in front of the employee along the entire length of the work station. This will allow the employees to lean against the rail and relieve pressure from the legs and back for short intervals.
- Provide a padded kneeler in front of the employees that would allow them to change work positions by slightly kneeling forward while performing tasks located in front of them.

- Employees have severe deviation of the wrist with finger force during the wrapping and taping of the wire bundles. Deviation of the wrist with finger force is a recognized cause of UECTDs such as carpal tunnel syndrome.

- Educate the employee on the basics of body biomechanics and the importance of maintaining the wrist in an ergonomically neutral position while performing manual tasks.
- Increase the utilization of slip on covering devices which are currently in use on some sections of the harness. These can be applied with less deviation of the wrist and with fewer repetitive motions.
- Put some of the wire coverings on at the time the electrical plug in connectors are attached to the uncovered wires. This would reduce the number of sections that need to be wrapped when the harness

is in final assembly.

- Investigate the possibility of using a wider tape that would require fewer wraps to cover the same area.
- Develop a rotational schedule to allow employees to work at different areas which do not require performance of repetitive motion tasks, e.g., two hours doing harnesses, two hours packing boxes, lunch, two hours doing harnesses, two hours resupplying work stations.
- It appears there is less deviation of the wrist when the wrapping is done in a manner which; has the tape placed on the wires in such a manner that it is pulled away from the employee and released. The employee then reaches below the wires and regrips the roll and pulls it towards them and starts over. It appears easier for the employees to maintain a neutral wrist with this wrapping technique.
- Investigate the possibility of a replacement for the wrapping portion of the job. Develop another method of protection and grouping which does not require repetitive motions for their application.
- It appears that there is less ergonomic strain to the hands during wire wrapping when the person can orient themselves so the wire to be wrapped is parallel to the forearms of the person doing the wrapping. Investigate the possibility of reorienting the work so that most of wrapping can be done with this orientation.

- Employees have excessive reaches to slip protective connectors over sections of the harness which are located at the far side of the work surface. There is also excessive torso flexion caused by reaching to do work located at the far side of work surface. Excessive reaches create stress on the muscles and joints of the shoulder and upper arm and are a recognized cause of musculoskeletal injury and pain. The torso is frequently flexed during the reaching motion and this creates a strain on the lower

back which has to support the weight of the arms and the upper body. Even while handling relatively light weights in the hand the load created by the weight of the upper body and arms can be significant and is a recognized cause of stress, pain and injury to the low back.

- Reduce the depth of the work surface so the work performed at the most distant point does not utilize excessive reaches and torso flexion. In general reaches should be limited to 16 to 17 inches and torso flexion should be limited to 6 to 10 degrees from vertical.
- Increase the angle of the work surface toward the employee which will move the task closer to the employee. This will allow the employee to stay within the recommended guidelines listed in control #1 above.
- Develop any other suitable technique that will bring the employee in closer proximity to the work performed.

- Employee uses pinch grips with a deviated wrist when placing cylindrical plastic covers over wires. The utilization of pinch grips especially with deviation of the wrist is a recognized cause of UECTDs such as carpal tunnel syndrome.

- Educate the employee on the basics of body biomechanics and the importance of maintaining the wrist in an ergonomically neutral position while performing manual tasks.
- Instruct the employee to use a power grip when pushing the wire covering on and perhaps use some kind of lubricant either on the wires or inside the cover to facilitate slipping the cover along the wires.
- Investigate the possibility of using gloves or finger cots to increase the coefficient of friction between the employees hands and the wire coverings.

- Employees perform many operations with one or both elbows abducted away from their bodies and elevated at or above shoulder level. Working with the elbow abducted and elevated creates static loading on the muscles of the shoulder, arm and neck and is a recognized cause of muscle fatigue, pain and injury.

- Design a work surface which has enough adjustability so the employee can change the work height to an ergonomically sound level. Ideally the work should be at a height where the employee can work with the elbows at about a 90 degree angle and held close to their body.
- Increase the angle of the work surface toward the employee which will move the task closer to the employee and change the angle of operations. This will allow the employee to work on a particular section without elevating the elbow.

Preparing Wiring Harnesses With Three People

This is basically the same operation seen in Task #1. There are three employees working at this station instead of two as was the case in the previous task. All of the hazards identified in the previous task are present in this sequence and the following additional problems were noted.

- The middle employee is significantly shorter than the other two people working on the line. She has to constantly work with her elbows in an abducted and elevated position. Her elbows are usually at shoulder height and at many times are above shoulder height. This is a recognized cause of static loading on the muscles of the shoulder, neck and upper arm and is consistent with the development of musculoskeletal pain and injury.

- Provide employees with adjustable work areas. The work surface should be fully adjustable by the employee without the use of tools. Time for and training about the proper adjustments should be provided to the employee prior to each work shift. Ideally the employee should be able to access the work with the elbows close to the body and bent at

approximately a 90 degree angle.

- Provide the employee with an elevated area to stand on which will lift her up in relationship to the work so the guidelines mentioned above can be met.

- The employee wraps the wires with tape with a technique that uses an inward rotation of the left arm and deviation of the wrist while exerting finger force. Rotation of the forearm with wrist deviation is consistent with the development of UECTDs such as medial epicondylitis.

- Instruct the employee to wrap in a manner that does not involve forearm rotation and wrist deviation.
- Educate the employee on the basics of body biomechanics and the importance of maintaining the wrist and forearm in an ergonomically neutral position while performing manual tasks.
- Increase the utilization of slip on covering devices which are currently in use on some sections of the harness. These can be applied with less deviation of the wrist and with fewer repetitive motions.
- Put some of the coverings on the wires at the time the electrical plug in connectors are attached to the uncovered wires. This would reduce the number of sections that need to be wrapped when the harness is in final assembly.
- It appears there is less deviation of the wrist when the wrapping is done in a manner which; has the tape placed on the wires in such a manner that it is pulled away from the employee and released on the far side of the wire. The employee then reaches below the wires and regrips the roll and pulls it towards them and starts over. There is a better possibility of the employees maintaining a neutral wrist with this wrap configuration.
- Investigate the possibility of a replacement for the wrapping portion of the job. Develop another

method of protection and grouping which does not require repetitive motions for their application.

- Employees use pinch grips with wrist deviation to push wires into electrical connectors. The use of pinch grips with wrist deviation is consistent with the development of UECTDs such as carpal tunnel syndrome.

- A device should be designed that will allow the employee to push the wires into the connectors while using a power grip.
- Investigate the possibility of using gloves or finger cots to increase the coefficient of friction between the employees hands and the wires. If the coefficient of friction is increased it should allow the employee to perform the operation with utilization of minimal finger force. Repetitive motion injury is a combination of force and repetition. If the force exerted on the tendons can be reduced the chance of injury will also be reduced.

Heater and Vacuum Assembly

Preparing wiring harnesses for heater assembly and vacuum assembly. A variety of wires are assembled, plugged into plastic connectors and wrapped with something that looks like black electrical tape. At the beginning and end of each wrapped section a short piece of tape is secured from a separate dispenser and used to secure the ends. In several areas a split plastic tube is placed over the wires and the ends are again secured with tape. The entire harness is held in place on a pegboard arrangement which appears to be held in place at about a 30 degree angle. There is no apparent adjustment in either the angle or height of the work surface. The floor appears to be wooden and there are no cushioned mats for the employees to stand on.

- Employees have extended periods of standing which creates static loading on the muscles of the back and legs. This is consistent with the development of muscle fatigue and soreness.

- Where employees are required to stand for long

periods of time provide anti fatigue mats.

- Where employees work in a single spot provide sit/stand stools. Where employees are required to move up and down the line and sit/stand stools are not practical provide a padded rail behind and/or in front of the employee along the entire length of the work station. This will allow the employees to lean against the rail and relieve pressure from the legs and back for short intervals.
- Provide a padded kneeler in front of the employees that would allow them to change work positions by slightly kneeling forward while performing tasks located in front of them.

- Employees have severe deviation of the wrist with finger force during the wrapping and taping of the wire bundles. Deviation of the wrist with finger force is a recognized cause of UECTDs such as carpal tunnel syndrome.

- Educate the employee on the basics of body biomechanics and the importance of maintaining the wrist in an ergonomically neutral position while performing manual tasks.
- Increase the utilization of slip on covering devices which are currently in use on some sections of the harness. These can be applied with less deviation of the wrist and with fewer repetitive motions.
- Put some of the wire coverings on at the time the plastic plug in connectors are attached to the uncovered wires. This would reduce the number of sections that need to be wrapped when the harness is in final assembly.
- Investigate the possibility of using a wider tape that would require fewer wraps to cover the same area.
- Develop a rotational schedule to allow employees to work at different areas which do not require performance of repetitive motion tasks, e.g., two

hours doing harnesses, two hours packing boxes, lunch, two hours doing harnesses, two hours resupplying work stations.

- It appears there is less deviation of the wrist when the wrapping is done in a manner which; has the tape placed on the wires in such a manner that it is pulled away from the employee and released. The employee then reaches below the wires and regrips the roll and pulls it towards them and starts over. There is a better possibility of the employees maintaining a neutral wrist with this wrap configuration.
- Investigate the possibility of a replacement for the wrapping portion of the job. Develop another method of protection and grouping which does not require repetitive motions for their application.
- It appears that there is less ergonomic strain to the hands during wire wrapping when the person can orient themselves so the wire to be wrapped is parallel to the forearms of the person doing the wrapping. Investigate the possibility of reorienting the work so that most of wrapping can be done with this orientation.

- Employee has excessive torso flexion caused by reaching to do work located too far away on the work surface. The torso is frequently flexed during the assembly operation and this creates a strain on the lower back which has to support the weight of the arms and the upper body. Even while handling relatively light weights in the hand the load created by the weight of the upper body and arms can be significant and is a recognized cause of cause of stress, pain and injury to the low back.

- Reduce the depth of the work surface so the work performed at the most distant point does not cause excessive reaches and torso flexion. In general reaches should be limited to 16 to 17 inches and torso flexion should be limited to 6 to 10 degrees from vertical.

- Increase the angle of the work surface which will move the task closer to the employee. This will allow the employee to stay within the recommended guidelines listed in control #1 above.
- Develop any other suitable technique that will bring the employee in closer proximity to the work performed.

- Employee uses pinch grips with a deviated wrist when placing cylindrical covers over wires and when placing wires into plastic connectors. The utilization of pinch grips especially with deviation of the wrist is a recognized cause of UECTDs such as carpal tunnel syndrome.

- Educate the employee on the basics of body biomechanics and the importance of maintaining the wrist in an ergonomically neutral position while performing manual tasks.
- Instruct the employee to use a power grip when pushing the wire covering on and perhaps use some kind of lubricant either on the wires or inside the cover to facilitate slipping the cover along the wires.
- Investigate the possibility of using gloves or finger cots to increase the coefficient of friction between the employees hands and the wire coverings.

Wire Wrapping

This is another wire wrapping task and has basically the same hazards as those addressed earlier. There are still ergonomic issues of repetitive hand motions with deviation of the wrist, excessive reaches with torso flexion, and long periods of standing with inadequate cushioned floor materials or devices to allow changing work postures. The controls listed in previous sections should be applicable to the problems seen at this station.

This station seems better suited to implementation of recommendations than the Aerostar harness work areas did. It has a less complicated mix of operations to perform and does not require

extensive movement of the employee along the work surface. Sit/stand stools, replacement of the taping operation with slide on covers, heat shrink tubing or other suitable replacement and adjustability of the work station height should be very applicable to this operation. Other specific problems that should be addressed are listed below.

- Employees have excessive reaches to plug connectors together at areas on the far side of the work surface. There is also excess torso flexion caused by reaching to do work located at the far side of work surface. Excessive reaches create stress on the muscles and joints of the shoulder and upper arm and are a recognized cause of musculoskeletal injury and pain. The torso is frequently flexed during the reaching motion and this creates a strain on the lower back which has to support the weight of the arms and the upper body. Even while handling relatively light weights in the hand the load created by the weight of the upper body and arms can be significant and is a recognized cause of cause of stress, pain and injury to the low back.

- Reduce the depth of the work surface so the work performed at the most distant point does not utilize excessive reaches and torso flexion. In general reaches should be limited to 16 to 17 inches and torso flexion should be limited to 6 to 10 degrees from vertical.
- Increase the angle of the work surface toward the employee which will move the task closer to the employee. This will allow the employee to stay within the recommended guidelines listed in control #1 above.
- Develop any other suitable technique that will bring the employee in closer proximity to the work performed.

- The tape dispensers are poorly positioned on the work surface and require considerable force to remove the tape when needed. The dispensers are positioned such that the employees have to reach across their bodies and over various objects on the work table to obtain tape. In general the dispensers are too far from the employee. The tearing motion often requires the elbow to be

raised to almost shoulder level to separate the tape due to the problem of reaching over other objects on the table. This is an awkward position for the arm to exert force and is consistent with the development of shoulder pain and injury.

- Move the tape dispensers closer to the employee so she does not have to reach to obtain the tape. Position the dispensers so the employee does not have to reach over other materials to obtain tape and can keep her elbow in tight against her body during the tearing action.
- Develop an automatic dispenser that does not require the use of force to separate a single piece of tape from the roll.
- Educate the employee on the basics of body biomechanics and the importance of maintaining the body in an ergonomically neutral position. This includes not reaching across the body to perform manual tasks. Generally reaches across the body should be limited to about 20 degrees inward from a body/arm angle of 90 degrees.