Volume I

Level I Ergonomics Methodology Guide for Maintenance and Inspection Work Areas

Contract Number F41624-95-D-9017
Order 0001

January 1997

Produced For: **AL/OEMI**
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Brooks AFB, Texas 78235

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFMC	Air Force Materiel Command
AFOSH	Air Force Occupational Safety and Health
AL/OEMO	Armstrong Laboratory/Occupational Medicine Division
BEF	Bioenvironmental Engineering Flight
CAD	Computer Aided Drafting
CTD	Cumulative Trauma Disorder
EPRA	Ergonomics Problem Area
EWG	Ergonomics Working Group
fc	Foot-Candle
JR/PD	Job Requirements/Physical Demands (Survey)
MIG	Molybdenum Inert Gas
MMH	Manual Materials Handling
PEPA	Potential Ergonomics Problem Area
PHF	Public Health Flight
RM-ANOVA	Repeated Measures Analysis of Variance
RSI	Repetitive Strain Injury
TIG	Tungsten Inert Gas
USAF	United States Air Force
VDT	Video Display Terminal
VWF	Vibration White Finger
WMD	Work-Related Musculoskeletal Disorders
WPAFB	Wright-Patterson Air Force Base

ACKNOWLEDGMENTS

This Level I Methodology Guide for Maintenance and Inspection Work Areas was developed as the result of a contract effort by the Armstrong Laboratory, Occupational and Environmental Health Directorate, Contract Number F41624-95-D-9017, Order 0001. Pacific Environmental Services, Inc. and The Joyce Institute/A Unit of Arthur D. Little, Inc. were the prime contractor and critical subcontractor, respectively. Armstrong Laboratory Consultants, HQ AFMC/SGC and Bioenvironmental Engineering personnel from Air Force Materiel Command Bases all contributed to the development effort. This commitment to provide and share technical information, based on sound research and practical application combined with knowledge of Air Force operations, resulted in this Guide. The Guide is directed at improving the health, safety, and overall performance of Air Force personnel by preventing work-related musculoskeletal disorders (WMD) and is a key step in the process used to identify, recognize, and control ergonomics risk factors in the workplace.

ABOUT THIS GUIDE

This Level 1 Ergonomics Methodology Guide (Guide) for Maintenance and Inspection Work Areas is designed to be read and implemented by Bioenvironmental Engineers and Bioenvironmental Technicians. The purpose of the Guide is to enable the BEF to identify risk factors, to prioritize problems to select realistic controls, and to facilitate modifications so the Air Force can maintain readiness by improving employee performance and well-being.

This Guide is organized for ease of use. Initially, users will need to rely on all the parts in order to complete the process as it is designed. After they are familiar with the process, they can excerpt only those sections that they need. For example, the Guide is organized so that the parts needed for data collection can be extracted for use in the field. Other parts used in problem prioritization, solution selection, etc., may be left in the BEF shop for later use.

The Guide has **three chapters and six appendices**.

Chapter 1: Introduction provides users and other readers with the background information they need to understand the process. It provides the following information:

- the objectives of the Guide;
- the role of this Guide in the overall ergonomics efforts of the Air Force. In particular, it describes the circumstances in which the Guide is to be used; and
- the criteria and processes that were used to develop the Guide.

Chapter 2 : General Background on Ergonomics provides a brief explanation of the issues that the Guide is intended to address. Although this chapter will be particularly helpful to users who may have limited knowledge of ergonomics, it can serve as a refresher to those who are already knowledgeable. The chapter also provides insight into the intended outcomes of the process and provides the framework for the more detailed ergonomics information included in the other sections.

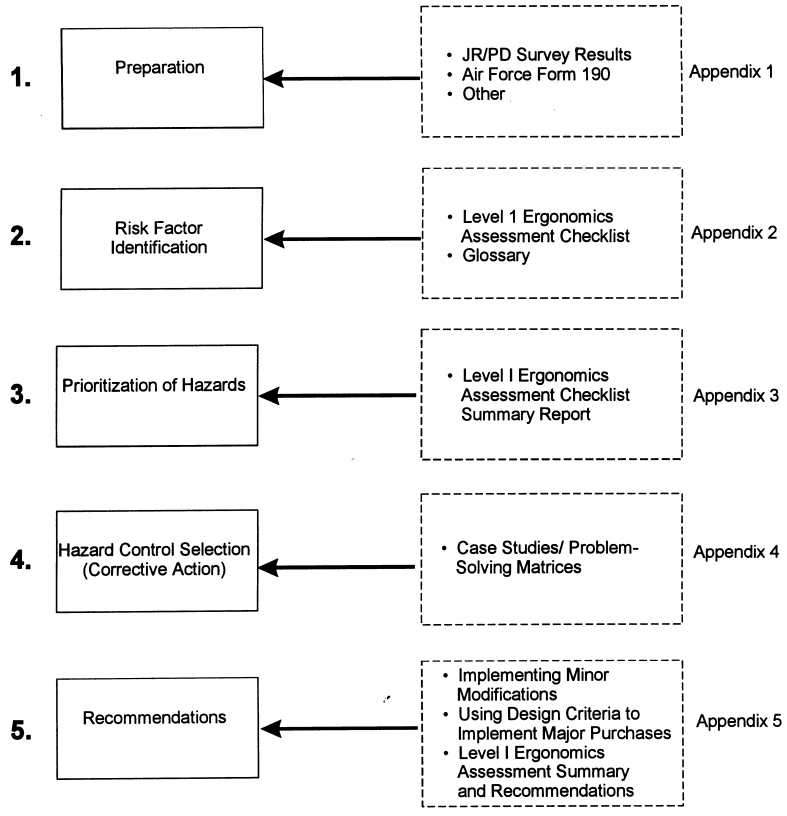
Chapter 3: User's Guide is the heart of the Guide. This section will used to implement the Level I Ergonomics Assessment and Problem-Solving Methodology. It is designed to provide step-by-step instructions to a BEF technician with two to three years of experience. The chapter details the ***Five Step Process*** and refers the user to ***Appendices 1-5,*** which provide the tools required to complete each step in the Methodology and examples of results obtained at each step. (Appendix 6 provides a master copy of each form that is used to apply the Methodology.)

The Five Steps and the tools required are:

Step 1. Preparation
Step 2. Risk Factor Identification
Step 3. Prioritization of Hazards
Step 4. Hazard Control
Step 5. Recommendations

The Level I Ergonomics Assessment and Problem-Solving Methodology for Maintenance and Inspection Work Areas is shown in Figure 1.

Figure 1
Level 1 Assessment Process



Appendices
The Appendices are an integral part of the Guide and are designed for quick reference. Each Appendix relates to a step in the process.

Appendix 1: Preparation
This appendix provides users with a sample summary from the JR/PD Survey, with an Air Force Form 190, and other information that they need to begin the process.

Appendix 2: Risk Factor Identification
This appendix provides users with a sample *Level 1 Ergonomics Assessment Checklist* to use as a guide in completing the checklist they are using on a job. Most importantly, it includes the Glossary which defines each checklist question in detail and provides guidelines on what to look for when observing the jobs.

Appendix 3: Prioritization of Hazards
This appendix provides users with a sample of a completed *Checklist Scoring Summary* so that they know how to score the jobs on which they have completed a checklist.

Appendix 4 : Hazard Control Selection
This appendix is the focal point for identifying the causes of ergonomics risk factors and for selecting corrective actions. *Case Studies* for 50 tasks in Maintenance and Inspection Work Areas (bucking/riveting, welding, etc.) are included here. Case Study problem-solving matrices are organized so that users simply look for the body region and risk factor identified in the Level I Checklist in order to pattern match the cause with corrective actions, risk factor by risk factor. Once users become familiar with the process, this is probably the only appendix that will be needed for subsequent assessments.

Appendix 5: Recommendations
This appendix provides an example of a completed *Summary/Recommendations* form so that the user has guidance when completing Step 5. It also includes the "Implementing Minor Modifications" section, which provides further detail on selected Corrective Actions referred to in the Case Studies.

A section on "Using Design Criteria to Implement Major Purchases" is included to provide users involved in the selection of furniture or accessories, with the ergonomics criteria upon which to evaluate products. The evaluation forms provided can be sent to prospective vendors to help identify which products meet the criteria.

Appendix 6: Blank Forms
This section simply provides the blank forms that users can copy in order to apply the Methodology.

Appendix 7: References/Bibliography
References noted in the Guide and the bibliography for this effort are found in this section.

This Guide enables users to identify risk factors and recommend corrective actions on most of the jobs and tasks they will observe with the assurance that in most cases, a professional ergonomist would have made the same decisions. It will also let them know when they should obtain assistance from Armstrong Laboratory (AL/OEMO) or other ergonomists in cases when the pattern-matching process may not adequately address the problem and a Level 2 Ergonomics Assessment is needed.

In any case, this Guide provides the Air Force with the Methodology it needs to identify and abate ergonomics hazards in a wide range of administrative jobs.

A Research Report describing the development and testing of this Guide is available. Please contact Armstrong Laboratory (AL/OEMO) for further information.

1.0 INTRODUCTION

1.1 PROGRAM OBJECTIVES

The U.S. Air Force has sponsored the development of standard ergonomics assessment methodology guides and management tools which will be integrated into the AFOSH Program. The methodologies and tools will be used as a means to minimize or eliminate work-related musculoskeletal disorders (WMDs) associated with routine exposure to ergonomics risk factors at Air Force installations.

The basic elements of an installation ergonomics program include: Potential Ergonomics Problem Area (PEPA) designation, Ergonomics Problem Area (EPRA) designation and control, work area analysis, medical management, and training and education. Both qualitative (PEPA) and quantitative (EPRA) screening techniques are used in sequential fashion to identify employees at risk. The flow chart in Figure 1.1 describes the ergonomics program process.

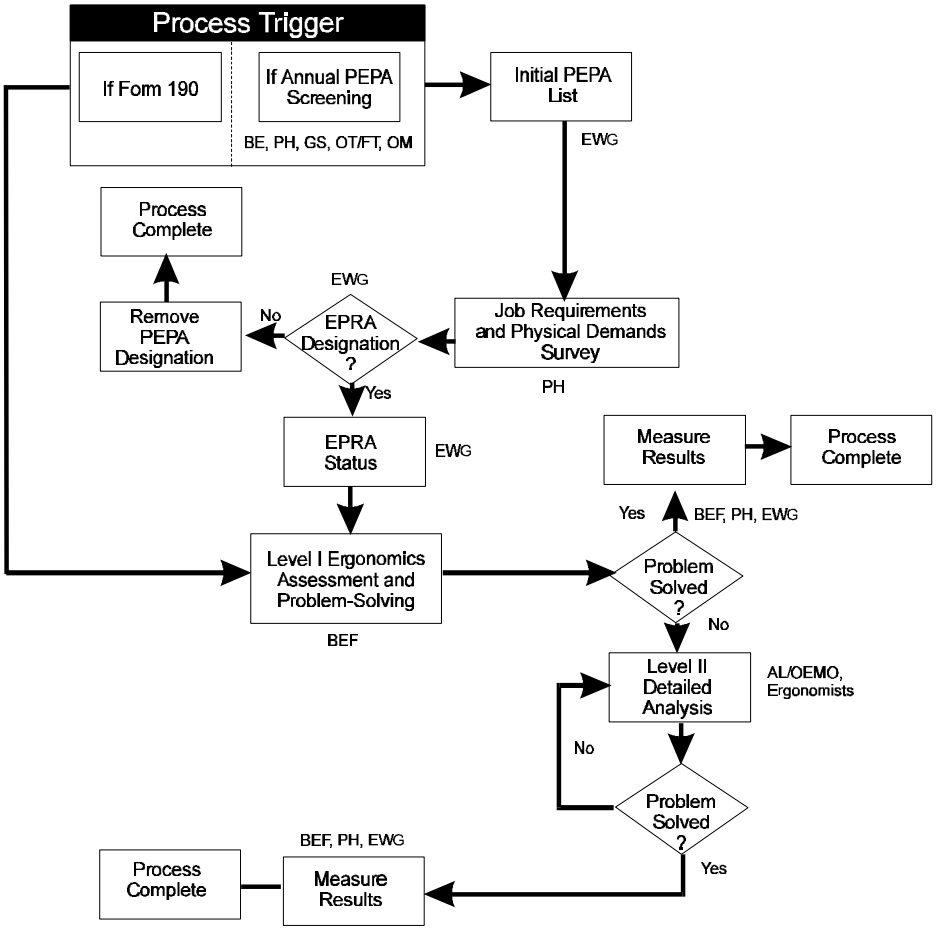


Figure 1.1
Ergonomics Problem-Solving Process

1.2 DEVELOPMENT OF CRITERIA

The Level I Ergonomics Assessment and Problem-Solving Methodology Guide for Maintenance and Inspection Work Areas (hereafter referred to as the Guide) details a process that can be applied to the full variety of Air Force maintenance and inspection jobs.

The Guide was designed to enable a Bioenvironmental Engineer or technician with 2-3 years of experience to conduct aggressive task-based problem-solving efforts in an Ergonomics Problem Area (EPRA). The Guide is designed such that the process can be completed as follow-up to the Job Requirements and Physical Demands Survey (hereafter referred to as the JR/PD Survey) completed by PHF or in response to an Air Force Form 190 investigation.

The Guide was developed in accordance with criteria established by the United States Air Force (USAF). This criteria was that the Guide must be designed to enable users, primarily through visual observations and employee/supervisor interviews, to:

- identify potentially hazardous tasks within a shop and job;
- determine if the content of the job and task(s) meet established ergonomics (risk factor exposure) criteria;
- determine which type(s) of additional (Level II) analyses may be used if further quantification of ergonomics hazards is required; and
- choose from a menu of control options (both short- and long-term) which when implemented, will minimize the risk of musculoskeletal disorders by reducing the hazards identified within the job and tasks.

The Guide must enable the user to complete data collection and analysis of a maintenance and inspection work area in 1-2 hours depending on the number of tasks evaluated. Hazard Control selection and development of a summary report (recommendations) should require 1-2 hours.

The Guide is to include case studies for typical maintenance and inspection tasks. The case studies serve as the basis for the pattern-matching process that will be used to “match” the hazards identified in the tasks with controls that will reduce employee exposure to accordance those hazards.

The Guide is to identify metrics which will be used to judge the impact of ergonomics improvements on employee health, safety, and performance (e.g., quality, productivity).

In addition, the Guide will incorporate information and lessons learned from the JR/PD Survey in order provide an integrated ergonomics analysis and problem-solving process for the Air Force.

1.3 DEVELOPMENT PROCESS

The Guide design is the result of a development and testing process that benefited from the support and cooperation of Air Force personnel at several AFMC locations:

- Armstrong Laboratory (AL/OEMO), Brooks AFB, Texas
- Wright-Patterson AFB, Ohio (WPAFB)
- Eglin AFB, Florida
- Tinker AFB, Oklahoma
- Kelly AFB, Texas
- Patrick AFB, Florida (AFSPC)

1.3.1 Initial Efforts. The development of this Guide began with a review of the scientific literature. The purpose of the review was to compile information on ergonomics analysis tools that would be relevant to the development effort. The goal was to identify methods which would require minimum expertise yet would provide maximum benefit for the USAF. The literature review indicated that there was a lack of validated ergonomics assessment/problem-solving methodologies which satisfied the criteria established by the USAF. However, several tools were identified which served as the basis for individual components of the Guide.

Development continued with site visits to selected USAF installations: Wright-Patterson AFB, Eglin AFB, and Tinker AFB. The purpose of the site visits was to collect data (e.g., videotapes, digital photographs, workstation measurements, employee interview results, etc.) on the job types that would be used for developing Case Study Problem-Solving Matrices. The job types were selected by the Air Force and are consistent with "Types of Work" listed in Section III of the JR/PD Survey which will be used by PHF. Many of the jobs observed the collection of the 50 task-based Case Study Problem-Solving Matrices, listed in Table 1.1, are based on a compilation of the most common elements found in one or more jobs at one or more of the bases.

Table 1.1
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
1	Abrading	• Vehicle Maintenance: Changing Battery	• Tinker AFB
2	Assembly/Disassembly - Internal Components	• Fuel Line Maintenance • Electrical/Light Fixture Maintenance • Plumbing-Toilet/Sink Maintenance • Radio Maintenance	• WPAFB • Tinker AFB • Tinker AFB • Tinker AFB
3	Assembly/Repair - Bench Work	• Radio Maintenance	• Tinker AFB
4	Bolting/Screwing	• Remove Panel: Flight Line	• Eglin AFB
5	Chipping	• Prepare Pavement for Repair	• Eglin AFB
6	Cleaning by Hand	• Corrosion Control • Teeth Cleaning • Scuff, Sand & Paint	• Eglin AFB • WPAFB • Tinker AFB
7	Cleaning with High Pressure Equipment	• Aquamiser	• Tinker AFB
8	Coating/Immersing	• Plating	• Eglin AFB
9	Computer Work	• Heat Treat • Radio Maintenance	• Tinker AFB • Tinker AFB
10	Crimping	• Electrical/Light Fixture Maintenance • Radio Maintenance	• Tinker AFB • Tinker AFB
11	Cutting/Shearing	• Refurbish Aircraft Exterior • Fabricate Aircraft Component	• WPAFB • Eglin AFB
12	Drilling	• Museum Construction • Structural Maintenance: Cabinet Repair	• WPAFB • Eglin AFB
13	Driving (Vehicles)	• Prepare Pavement for Repair	• Eglin AFB
14	Excavating/Shoveling	• Prepare Pavement for Repair	• Eglin AFB
15	Flame Cutting	• Process Structural Component	• Eglin AFB
16	Folding/Fitting	• Parachute Packing • Raft Packing	• WPAFB • WPAFB
17	Forming	• Forming Sheet Metal	• Tinker AFB
18	Gluing/Laminating (Dopping)	• Museum Construction	• WPAFB

Table 1.1 (cont'd)
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
19	Grinding	• Structural Component Fabrication • Refurbish Aircraft Exterior • Process Structural Component • Scuff, Sand & Paint • Case Frame Repair	• WPAFB • WPAFB • WPAFB • Tinker AFB • Tinker AFB
20	Hammering	• Museum Construction • Fabricate Aircraft Component • Vehicle Tire Operation: Breakdown	• WPAFB • Eglin AFB • Tinker AFB
21	Hose Handling	• Aircraft Refueling	• Patrick AFB (AFSPC)
22	Lifting	• Heat Treat	• Tinker AFB
23	Machining	• Fabricate Aircraft Component	• Eglin AFB
24	Masking	• Scuff, Sand & Paint • Heat Treat	• Tinker AFB • Tinker AFB
25	Masoning	• Prepare Pavement for Repair	• Eglin AFB
26	Media Blasting - Blast Cabinet	• Heat Treat	• Tinker AFB
27	Media Blasting - High Pressure Gun	• Media Blasting Booth	• Tinker AFB
28	Melting	• Crown/Bridge Work	• WPAFB
29	Monitoring (of displays)	• Heat Treat	• Tinker AFB
30	Nailing	• Museum Construction	• WPAFB
31	Opening/Closing Heavy Doors	• Remove Panel: Flight Line	• Eglin AFB
32	Ordnance Disposal	• Improvise Explosive Device	• WPAFB
33	Packing	• Parachute Packing • Raft Packing • Improvise Explosive Device	• WPAFB • WPAFB • WPAFB
34	Painting/Spraying	• Corrosion Control • Scuff, Sand & Paint • Vehicle Maintenance: Changing Battery	• Eglin AFB • Tinker AFB • Tinker AFB
35	Paving	• Prepare Pavement for Repair	• Eglin AFB
36	Prying	• Vehicle Tire Operation: Breakdown	• Tinker AFB

Table 1.1 (cont'd)
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
37	Pumping	• Crown/Bridgework	• WPAFB
38	Riveting/Bucking	• Repair Cowling • Structural Maintenance: Cabinet Repair	• Tinker AFB • Eglin AFB
39	Sanding	• Corrosion Control	• Eglin AFB
40	Sawing	• Scuff, Sand & Paint	• Tinker AFB
41	Sewing	• Assemble Draperies for Display	• WPAFB
42	Soldering	• Case Frame Repair	• Tinker AFB
43	Stripping/Depainting by Hand	• Refurbish Aircraft Exterior	• WPAFB
44	Stripping/Depainting by Mechanical Methods	• Aquamiser	• Tinker AFB
45	Turning Valves	• Plumbing-Toilet/Sink Maintenance • Liquid Fuels Maintenance	• Tinker AFB • Patrick AFB (AFSPC)
46	Tying/Twisting/Wrapping	• Jet Engine Repair • Parachute Packing • Raft Packing	• Eglin AFB • WPAFB • WPAFB
47	Visual Inspection	• Case Frame Repair	• Tinker AFB
48	Welding	• Process Structural Component • Process Structural Component • Case Frame Repair	• WPAFB Eglin AFB • Tinker AFB
49	Wiring	• Electrical/Light Fixture Maintenance	• Tinker AFB
50	Wrenching/Ratcheting	• Jet Engine Repair • Remove Panel: Flight Line • HVAC-Pipe Fitting	• Eglin AFB • Eglin AFB • Tinker AFB

Based on the results of the literature review and the site visits, the following components of the Guide were developed:

1. User's instructions;
2. A Level I Ergonomics Assessment Checklist;
3. Checklist Glossary;
4. An Ergonomic Summary Report (scoring sheet, case study selection key, and control summary list); and
5. Case Study Problem Solving Matrices (Corrective Actions).

These components were used to test and validate the design of the Guide.

1.3.2 Testing and Validation. The purpose of testing and validation was to establish strengths and limitations of the initial Guide and to identify the need for changes based on quantitative information. The testing and validation was conducted in two phases: alpha testing and beta testing.

Five ADL/TJI ergonomists not directly involved in Guide development participated in the **alpha** testing. The ergonomists commented on the usability of the Guide tools and user's instructions. A second draft of each of the Guide components was developed to reflect those comments. After alpha testing was completed, a consensus score for several measures (e.g., each Job and Environmental Factor question), from the Guide was developed to serve as a testing standard during beta testing.

Ten Air Force personnel were selected to participate in a **beta** test at Hill AFB. These personnel were to be selected to "match" the targeted end-user population: BEF technician with 2-3 years of experience. The ergonomist/facilitator provided a two-hour briefing using a sample job to demonstrate the Guide, use of the tools, and process for completing the assessment and pattern-matching activity. The actual testing process and materials provided were the same as for the alpha test (with the appropriate revisions). Information on usability was obtained during an out-briefing and additional refinements were made to the Guide to improve usability.

For each phase, the results were tested for Usability, Reliability, Sensitivity, and Validity. Usability testing was performed to ensure that the users would be able to apply the Guide as intended. Reliability testing was performed to determine how consistently that application of the Guide yielded the same results. Sensitivity testing was performed to determine if the Level I Assessment can tell the difference between actual risk levels in a job. And finally, validity testing was conducted to measure how closely the results from experienced ergonomists matched the results obtained by Air Force personnel.

Those who are interested in a detailed description of the testing and validation process and results are directed to contract Armstrong Laboratory (AL/OEMO) for further information.

1.4 FREQUENTLY ASKED QUESTIONS ABOUT THE METHODOLOGY GUIDE

Typical questions and answers about the Guide are provided in Table 1.2.

Table 1.2
Typical Questions and Answers About the Guide

Question	Answer
What is the Guide used for?	The Guide enables Bioenvironmental Engineers and technicians to conduct aggressive, task-based problem-solving in an Ergonomics Problem Area (EPRA).
What kind of experience or ergonomics knowledge is required in order to use the Guide effectively?	The Guide was designed for a BEF technician with 2-3 years of technical experience. Although some prior knowledge of ergonomics is a benefit, ergonomics "expertise" is not required for successful application of the Guide.
Is the Guide to be used on all jobs throughout the base?	No. The intent is to use the Guide only in EPRA designated shops EPRA status is designated by the installation Ergonomics Working Group (EWG) based on the results of the JR/PD Survey administered by Public Health Flight (PHF).
When, specifically, is the Guide to be used?	The Guide was designed for use in two primary situations: • as follow-up to the JR/PD Survey if a shop has been classified as an EPRA; or • in response to an AF Form 190 investigation (completed by PHF).
How will I learn how to apply the Guide effectively?	A User's Guide provides a good foundation on which to begin. The Air Force recommends that the user participate in a 2-3 hour briefing in which a trained specialist will demonstrate use of the Guide.

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
How is the Guide organized?	You are reading the Introduction now. Chapter 2 provides basic background information on ergonomics. Chapter 3 is the actual User's Guide. Chapter 3 takes you through a 5-step process for completing the Level I Ergonomics Assessment and Problem-Solving Methodology: Step 1 - Preparation Step 2 - Risk Factor Identification Step 3 - Prioritization of Hazards Step 4 - Hazard Control Selection Step 5 - Recommendations Also included in the Appendices are examples of completed forms so you can see what the results of your work should look like at each step.
What is included in Step 1 - Preparation?	In Step 1, the Guide explains in detail, when to use the Level I Assessment and Problem-Solving Process, logistics (e.g., forms), how to interpret and use data from the completed JR/PD Survey and/or an AF Form 190 for selecting which jobs to focus on during your investigation.
What is included in Step 2 - Risk Factor Identification?	In Step 2, you will be introduced to the Level I Ergonomics Assessment Checklist. It is a practical, observation-based Checklist which does not require the use of gauges or specialized ergonomics analysis equipment. You complete the Checklist by observing the job tasks and talking with the employee.
What is the significance of the Checklist?	The Checklist helps you identify ergonomics risk factors.
Who will interpret the results?	The same person who completed the Checklist will interpret the results. The Checklist results are a direct lead-in to control identification.
What is included in Step 3 - Prioritization of Hazards?	In Step 3, you will be shown how to score the Checklist. The scoring process tells you: • if there is significant concern in the overall job; • what task(s) is the primary source of exposure to ergonomics risk factors; and • what part(s) of the body should be targeted when identifying controls.
How long does it take to complete Steps 2 and 3?	In previous trials BEF technicians with minimal to no prior experience with ergonomics analysis completed the process in a mean time of 16.6 minutes (standard deviation of 10.8 minutes).

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
What is included in Step 4 - Hazard Control Selection?	In Step 4, you will learn about the 50 Case Study Problem-Solving Matrices for maintenance and inspection work. The case studies provide you with a head start on identifying controls or corrective actions which can be implemented to reduce employee exposure to the most common ergonomics risk factors found in administrative tasks. Two categories of controls are provided; modifications and adjustments, and major changes. Approximately 50 percent of the controls can be implemented for little or no cost. For selected controls, in which you need some additional detail to implement correctly, you will be directed to the sections, "Implementing Modifications and Adjustments" or "Using Design Criteria to Implement Major Changes" in Appendix 5.
Will we use all of the case studies for every job?	No. After you have identified the task(s) that exposes the employee to the most significant levels of ergonomics risk factors, the instructions in Step 4 will explain how to select the case study or studies that "match" the task(s).
How exactly is a case study used?	After the appropriate case study is identified, you read through the Case Study Problem-Solving Matrix and "match" the risk factors identified with the Checklist to controls that can be implemented to reduce or eliminate exposure to the risk factor.
What is included in Step 5 - Recommendations?	From Step 4 you will have identified a number of controls that **could** be implemented. In Step 5, the Guide describes the process for developing the final summary report and final list of recommendations which will be provided to the shop supervisor and kept on file in Bioenvironmental Engineering. The Level I Ergonomics Assessment Summary and Recommendations form will enable you to communicate the most important information to the supervisor and establish the basis for implementing controls, planning follow-up, and measuring the results of ergonomics improvements.

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
Who gets the completed Level I Ergonomics Assessment Summary and Recommendations form?	One copy of the report is to be kept in the case file for the work center. A copy should also go to the work center supervisor who will be responsible for following-up on the recommendations. Other parties may also be provided with a copy of the report at the discretion of Bioenvironmental Engineering. It is highly recommended that you discuss the report with the work center supervisor and the employee(s) in person in order to promote a fast and effective implementation.
How long does it take to complete Steps 4 and 5?	In previous tests, BEF technicians required a mean time of 12.0 minutes (standard deviation of 7.4 minutes) to complete the pattern matching process and select controls (corrective actions). Completion of the Level I Ergonomics Assessment Summary and Recommendations form is not expected to add much additional time to the process. It is expected that, even for the most complex maintenance and inspection jobs, completion of Steps 4 and 5 should take between 30 and 45 minutes.
Can the results and recommendations for ergonomic improvement be applied throughout the shop?	Even though the Methodology may have been applied to only one job type in a work area (e.g., drilling by a sheet metal mechanic), the results may indicate, for example, that all employees who perform the drilling job may benefit from the same kinds of corrective actions. Since, however, there is so much variation in the physical demands of drilling (e.g., bench work, working on an aircraft exterior, etc.), corrective actions can be applied only as appropriate to the demands of the task within the context of the larger job situation.

2.0 GENERAL BACKGROUND ON ERGONOMICS

The information in this chapter has been assembled to provide users with limited experience with ergonomics a concise introduction to the science of ergonomics and how employees may be impacted when ergonomics is not adequately incorporated into job or workplace design. Users who have more experience may wish to skip this chapter or scan the pages as a refresher.

2.1 PURPOSE OF ERGONOMICS

Ergonomics is the science that addresses workers' job performance and well-being in relation to their job tasks, tool, equipment, and environment. Good ergonomics means designing tasks and the workplace to fit the workers - instead of the other way around.

The sciences on which the practice of ergonomics is based include: biomechanics, psychology, physiology, anthropometry, engineering, and kinesiology. The first three sciences help to define worker capabilities and limitations (e.g., how much hand strength the average male or female possesses). The other three sciences provide guidelines for designing jobs and workplaces to more closely reflect those capabilities and limitations.

The purpose of applying ergonomics in the workplace is to provide a work environment which maximizes the worker's performance while minimizing the risk of illness and injury to the musculoskeletal and visual systems.

2.2 WORK-RELATED MUSCULOSKELETAL DISORDERS AND RISK FACTORS.

Many of the work-related musculoskeletal disorders (WMDs) are a class of disorders which are also referred to as cumulative trauma disorders (CTDs) or repetitive strain injuries (RSIs).

This type of disorder develops due to an accumulation of stress or damage to the body over time. The body has great recuperative powers if provided with the opportunity to repair itself. However, when job demands are high (e.g., repeated use of awkward positions combined with forceful exertions or high effort) and the recovery time is insufficient, there is an increased likelihood that accumulated damage will lead to a disorder. Figure 2.1 illustrates this relationship.

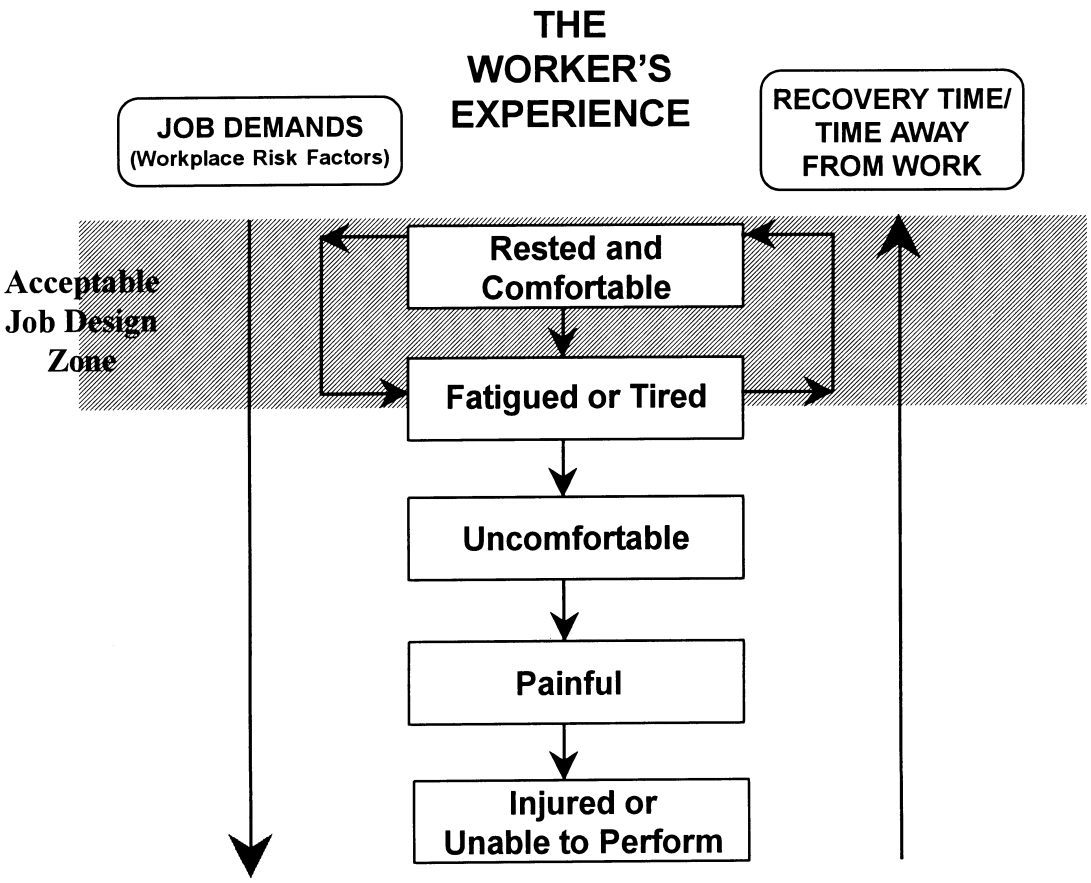


Figure 2.1
The Worker's Experience

Due to the wide variety of demands on the musculoskeletal system from maintenance and inspection work, reports of discomfort, and aches and pains can be just as varied. The following sections describe each of the major body regions, the most common WMDs, and the risk factors which impact the body region.

2.2.1 Shoulder/Neck.

2.2.1.1 Disorders. The following are the most common shoulder and neck disorders found in the industrial workplace as shown in Figure 2.2.

- **Bursitis** - an inflammation of the bursa sac (fluid-filled cushion) in the shoulder joint.
- **Tendonitis** - an inflammation of the muscle tendon, in various regions of the body including the upper arm/shoulder region.
- **Rotator Cuff Tendonitis** - an inflammation of the tendons in the shoulder.
- **Thoracic Outlet Syndrome** - characterized by a compression of the nerves and blood vessels between the neck and shoulder.

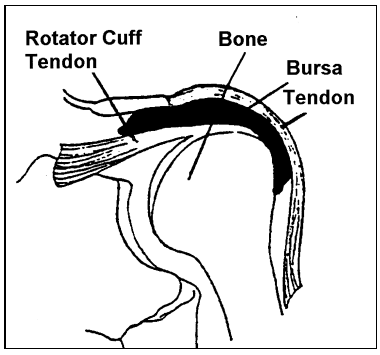


Figure 2.2
Shoulder and Neck Anatomy

2.2.1.2 Ergonomics Risk Factors. Several risk factors common in maintenance and inspection work have been shown to increase the potential for shoulder/neck/arm disorders.

- Stressful positions or movements;
- Static (fixed) work;
- Heavy or forceful work;
- Insufficient recovery or rest pauses; and
- High frequency (repetitive) or high speed movements.

Below is a more complete description of these risk factors:

- Stressful positions or movements - during an extreme reach, tendons and a structure called the bursa sac are stretched. The more extreme the reach, the more stress on the shoulder joint. The most stressful shoulder positions are reaching to the side and behind the body and working over shoulder level.

- Static (fixed position) work - static work means 'fixed position' work. In cases where the height of the work is too high and the worker must raise his/her arms to hold a position or work on a item, the muscles quickly fatigue.

- Heavy or Forceful work - forceful work on the shoulder includes push/pull forces. Examples include having to push or pull a loaded cart across the shop floor or holding a bucking bar to keep stable during a riveting task.

- Insufficient Recovery and Rest Pauses - fixed-position work often results in static muscular fatigue. Fatigue and/or discomfort in the shoulder and neck regions often develops. If no movement opportunities are built into the actual work, rest pauses can be provided which allow the muscles to recover. Specific exercises and stretches can also be performed during rest pauses to prevent the onset of static muscular fatigue.

- High frequency and/or high speed movements - the repeated use of stressful/awkward positions and/or excessive force is the primary concern. In addition, sudden 'jerky' movements cause shock to the joints.

2.2.2 Hands/Wrist/Arm.

2.2.2.1 Disorders. (See Figure 2.3) The following conditions are the most common hand/wrist/arm disorders which may result from industrial work.

1. Tendonitis - an inflammation of the tendons.

2. Tenosynovitis - an inflammation of a tendon sheath most commonly at the wrist.

3. Carpal Tunnel Syndrome - the symptoms are a result of an irritation of the median nerve as it is compressed by surrounding tissue and bony structures in the wrist.

4. De Quervain's Disease - an irritation of the tendons of the thumb.

5. Trigger Finger - an inflammation of the tendon at the joint in any finger.

6. Ganglion Cysts - inflammation of the tendon sheath. The affected sheath swells up with the synovial fluid.

7. Epicondylitis - a tendon irritation of the forearm muscles at the elbow joint.

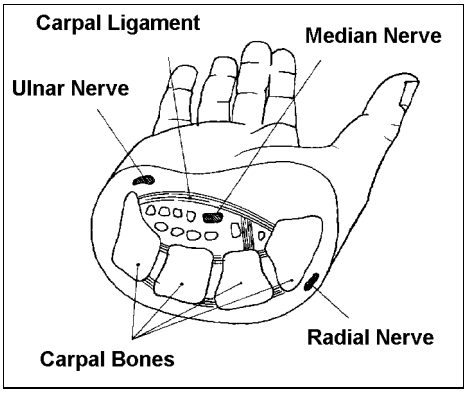


Figure 2.3
Anatomy of the Hand and Wrist

2.2.2.2 Risk Factors. The following lists the most common causes of hand/wrist/arm disorders, also referred to as "risk factors":

- Stressful positions and movements;
- Excessive forces or forceful exertions;
- High frequency or repetitions;
- Extreme duration and/or pace of the task;
- External trauma or mechanical stress;

- Prolonged exposure to vibration; and
- Temperature extremes.

Below is a more complete description of the risk factors. There are several points to remember. First, the presence of a risk factor does not necessarily mean that an injury or CTD will develop. Eliminating or even reducing the presence of any one of the risk factors will reduce musculoskeletal stress.

1. Stressful Positions and Movements - When the wrist is bent, the tendons and other soft tissues are under tension and compression. This stress can create microscopic damage that accumulates during the shift and is repaired by the body during the off-shift. On other jobs, if the stress is excessive, the body's repair system can't keep up.

2. Excessive Forces or Forceful Exertions - Squeezing a manual wire crimper with a tip grip, hammering or lifting a heavy object are examples of forceful exertions.

3. High Frequency or Repetition - Repeating the same task over and over tends to stress the same parts of the body over and over. The concern is not necessarily "repetitive jobs." Rather, the concern is repeated use of awkward postures and/or forces. If the first two risk factors can be eliminated, the 'frequency' of the task will have less impact on the worker.

4. Extreme Duration and/or Pace of the Task - Workers who perform the same stressful task (e.g. grinding, welding) for the entire shift may be more likely to experience localized fatigue than workers who perform the task for shorter periods of time. The practices of using rest pauses or job rotation or adding task variety attempt to reduce the overall impact of task-specific stress.

5. External Trauma or Mechanical Stress - The risk factor describes the effect of pressure points on the body. Examples of external trauma is using the hand or palm like a hammer, or resting the under-arm region on a blunt edge while performing a repair job on an internal component.

6. Prolonged exposure to vibration - segmental or "hand/arm" vibration should be considered as a secondary risk factor since there is no conclusive evidence that there is a direct cause/effect relationship between upper limb WMDs (CTDs) and vibration exposure. It is likely, however, that vibration exposure may increase the presence of other risk factors. For example, since workers tend to grip vibrating or "impact" tools more tightly than non-vibrating tools, the "forceful exertion" risk factor may increase. Also, since many vibrating tools (e.g., grinders, sanders, etc.) require the worker to repeatedly bend and/or twist the wrist, the stressful posture/repetition combination of risk factors may increase.

   Special Note. An accurate assessment of vibration exposure and its potential implications in the development of Raynaud's syndrome (VWF-vibration white finger)

or WMDs requires the use of sophisticated measurement equipment. If symptoms such as numbness, swelling of hand tissues, or reduced grip strength are reported, you are encouraged to contact AL/OEMO for assistance.

7. Temperature Extremes, especially cold - should also be considered as a secondary risk factor. Cold or exposure to low temperatures can affect dexterity, sensitivity, and grip strength. The fingers and hands may be exposed to cold temperatures when handling cold materials (e.g., frozen meat), working out doors in cold weather, or when exposed to exhaust air from pneumatic hand tools. Often, however, use of the proper insulating gloves may protect the worker's hands and fingers from exposure to cold.

2.2.3 Back/Torso.

2.2.3.1 Disorders. (See Figure 2.4) As the basis for understanding disorders, the following components are used to understand the various functions of the back/torso anatomy and their function.

- Backbone (spine) - the major support structure of the body.
- Vertebrae - the bones which make up the spine
  - Cervical (C1-C7) supports and controls the movement of the head.
  - Thoracic (T1-T12) supports the upper body and has limited movement.
  - Lumbar (L1-L5) has the greatest flexibility and bridges the upper to lower torso.
  - Sacrum tail bone.

- Spinal cord - conducts impulses for movement and sensation (including pain) to and from the head and body.
- Foramen - spaces between the vertebrae through which spinal nerves exit.
- Discs - sponge-like tissues which separate vertebral bones and prevent the vertebrae from grinding against one another.
- Ligaments - attach one vertebra to the next.
- Muscles - provide support and enable the body to move from one posture to another.

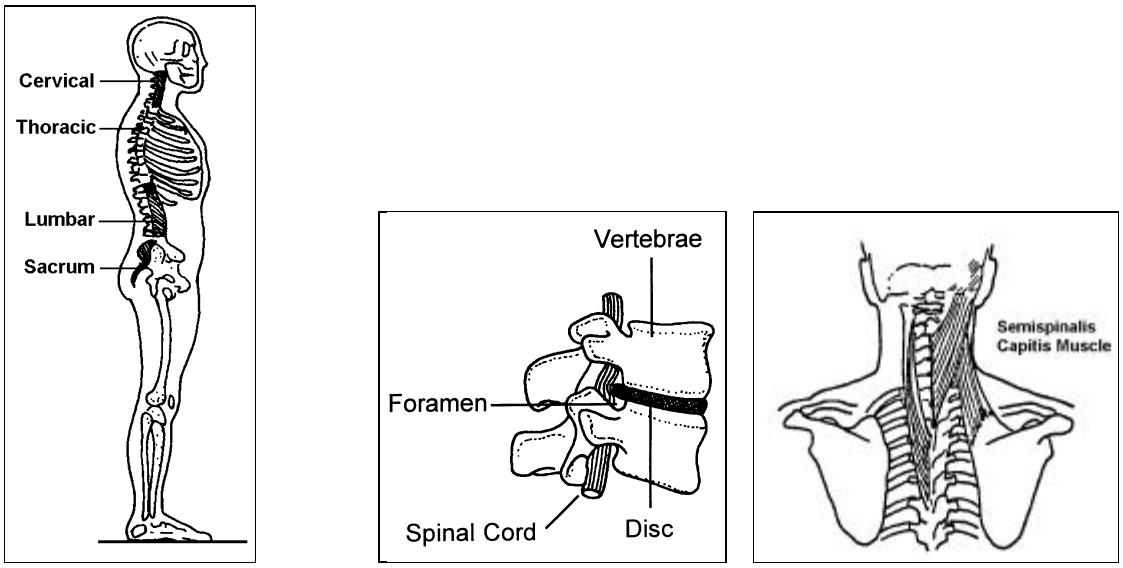


Figure 2.4
Back Anatomy

The following section discusses the common disorders associated with this area of the body:

- Disc Degeneration - with activity, intervertebral discs are stretched, torn, frayed, and worn. This can cause the disc wall to weaken, protrude, and, in some cases, press against the nerves. Weakening of the disc may also cause some narrowing of the space between the vertebra which reduces the size of the hole (foramina) through which the nerve passes as it extends into the legs (as shown in figure 2.5). If the narrowing of this space is significant, pressure may be directed against the nerve.

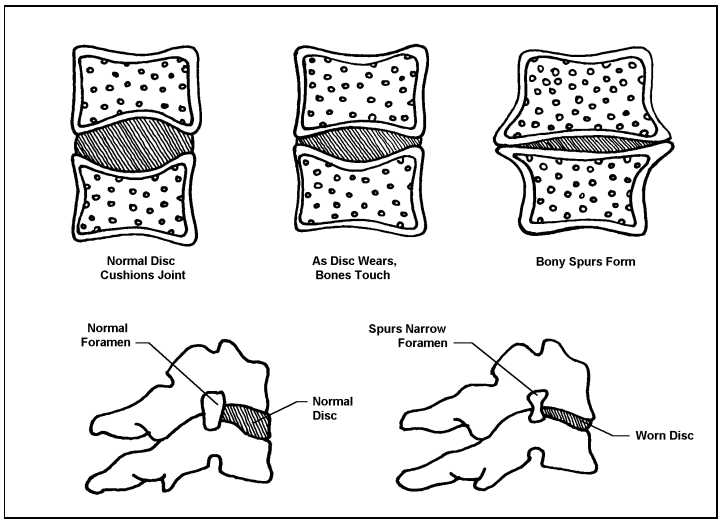


Figure 2.5
Disc Degeneration

- Strains and sprains - tearing or stretching of muscles, tendons or ligaments as shown in Figure 2.6.

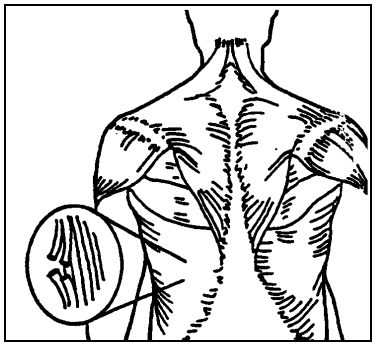


Figure 2.6
Sprains and Strains

2.2.3.2 Risk Factors. The following risk factors have been found to be associated with low back pain and back disorders:

- Awkward Postures - the degree or extent of forward bending appears to be the most significant concern. However, twisting and sideways bending also places uneven force on the spinal discs and muscles.

- High Force or Forceful Exertions - lifting heavy objects or pushing overloaded carts can create an extreme force in the low back. For lifting, the closer to the body that an object can be kept during a lift, the less force in the low back. Both object weight and body position affect the amount of force and stress created in the low back.

- Static (fixed position) Work - when someone sits or stands in a fixed position for a long time, demands are placed upon certain muscles to maintain contraction. This may cause fatigue and discomfort in the low back. On the other hand, if the job is modified to give the worker an opportunity to move in a controlled fashion, the weight of the body is shifted between numerous muscle groups. By sharing the load among different muscles over time, one muscle group is allowed time to rest while another is working. This helps reduce the tendency for fatigue.

- High Frequency Lifting - frequent lifting has been correlated with increased low back injury rates. Studies suggest that using a squat lift (lifting with bent knees and a straight back) puts less pressure on the disc than using a stoop lift (lifting with straight knees and a bent back). Repeatedly bending the spine, especially when twisting is involved, can weaken the disc and lead to injuries such as disc protrusions-a bulging of the outer wall of the disc that can press against the nerve.

- Speed of Movement - the use of smooth body movements during lifting and other materials handling tasks helps reduce the risk of developing low back injury. Jerky or sudden, unexpected movements are associated with high force levels that may create injuries and should be avoided.

- Duration of Lifting- a worker who performs a material handling task continuously over an entire shift may be more likely to experience low back discomfort than a worker who does the job for only two hours. Job rotation can be used to reduce stress to the low back by reducing the duration of exposure to the stressful work.

- Whole-Body Vibration - this is a generalized stressor that impacts virtually the entire body. Although prolonged exposure to whole-body vibration (e.g., standing on or driving large construction equipment) may be related to postural fatigue and low back discomfort, little is actually known about its direct affects. The goal is to control the transfer of energy from the vibrating equipment or surface to the employee.

2.2.4 Legs/Feet.

2.2.4.1 Disorders. The following conditions are leg and feet disorders associated with standing, kneeling or bending tasks in maintenance and inspection work areas.

- Bursitis of the knee - an inflammation of the bursa sac in the knee joints.
- Varicose veins - prolonged pooling of the blood in the vein, especially in the lower leg.

2.2.4.2 Risk Factors. The following risk factors have been found to be associated with lower limb disorders.

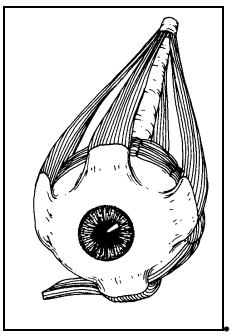
- Stressful Positions and Movements - kneeling or bending postures increase pressure inside the knee joint. Forced positions of the knees, such as those used when squatting to work in an area with limited access.
- Static Work (fixed positions) - prolonged standing or sitting while the back of the knee/thighs are compressed interferes with circulation. When standing in a fixed position, blood collects in the legs causing increased pressure on the blood vessels and joints.
- Excessive Forces - using the knees to apply pressure to a surface is one example of excessive force. The knee joint is also impacted internally when the worker assumes a kneeling posture.
- External Trauma - kneeling on a hard or uneven surface may cause immediate discomfort and long-term damage to the soft tissues of the knees.

2.2.5 Visual Issues. Eyestrain is less common in industrial tasks than in administrative work. However, maintenance and inspection jobs which require high visual demands may present the risk factors which may contribute to eyestrain or decrease the employee's ability to maintain high quality performance. In addition, since computer work may be part of many maintenance and inspection tasks, a discussion of risk factors is warranted.

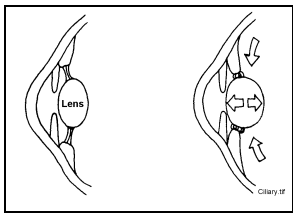
2.2.5.1 Visual Complaints. (See Figure 2.7) It is important to know the anatomy of the eyes as a foundation for understanding the sources of complaints.

- Oculomotor muscles - control movement side-to-side and up-and-down and are used whenever they are searching or reading documents or screens.
- Ciliary muscles - control focusing by changing the shape of the lens to hold images in focus. They must adjust for any change in focal length when the eyes are looking at different distances.

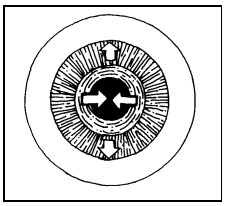
- Iris muscles - control light intake (adjust size of pupils according to light intensity) and are affected by the light from the screen, document or surrounding area.



Oculomotor muscles



Ciliary muscles



Iris muscles

Figure 2.7
Eye Anatomy

2.2.5.2 Risk Factors. Glare on a worksurface of a VDT screen makes it more difficult for the user to see clearly and easily. Though employees whose tasks have high visual demands complain of visual discomfort, there is no evidence that high visual demands (including VDT use) causes permanent eye damage. The discomfort, however, is real and needs to be addressed. Most of the discomfort results from users having to strain their visual system to compensate for the inadequate viewing conditions, which results in squinting, stretching, etc.

There are two types of **glare**: direct and reflected.

- **Direct glare** is caused by light sources within the visual field. This can cause "disabling glare" because it reduces the contrast at the retina reducing visual performance.

- **Reflected glare** is caused by the light rays bouncing off the surface.

  - It can be specular. Specular means that the operator can see the reflected image of the light source itself or the image of an object or person.
  - It can be diffused glare. Light bouncing off floor or ceiling lights may be reflected with no clear visible pattern. The background simply appears brighter.

Other visual complaints include:

- **Excessive or Inadequate Ambient Light -** Many workspaces are too bright or dark for easy viewing, causing the user to adapt by overusing his/her eye muscles.

- **Visual Disorders -** The eye does not always function properly. Some of the visual disorders people experience which affects their being able to see properly when working with or without a VDT are: far-sightedness, near-sightedness, and presbyopia.

- **Amount of Visual Demand** - If workers have intense visual tasks all day and are working with tight schedules, they are more likely to have visual problems. The amount of uninterrupted time spent on visually demanding tasks can affect eyestrain.

2.3 CONCLUSION

One of the main purposes of this Guide is to provide you with the specific ergonomics principles which you can apply to 50 of the most common maintenance and inspection tasks in order to reduce or effectively eliminate employee exposure to the risk factors. The intended result is to reduce the potential for WMDs (and visual problems) while maximizing employee performance.

3.0 USER'S GUIDE

This Guide will enable you to complete all aspects of the Level Ergonomics Assessment I and Problem-Solving Methodology. After the first few uses of the Guide, you will be able to efficiently identify job and/or task-specific ergonomics risk factors in all types of maintenance and inspection work areas. Most importantly, however, you will be able to control employee exposure to those risk factors by matching practical and effective solutions to the problems that you identify.

3.0.1 When to Use this Guide. There are two situations for which use of the Level I Methodology is intended:

- users responding to an AF Form 190 investigation
- pro-active problem-solving based on results of the JR/PD Survey

For responding to an AF Form 190 investigation, the Methodology can be used to identify a potential job or task-based source of a WMD. For pro-active problem-solving, the Methodology can be used to conduct a systematic evaluation of an EPRA-designated shop. In both situations, the purpose is to specify which specific tasks may be the source of ergonomics hazards, and to identify and prioritize Corrective Actions for those tasks.

3.0.2 Five Step Process. A five step process is provided to keep your work focused and efficient.

- Step 1: Preparation
- Step 2: Risk Factor Identification
- Step 3: Prioritization of Hazards
- Step 4: Hazard Control Selection
- Step 5: Recommendations

The remainder of this section will demonstrate how you can apply the process for both situations.

3.1 STEP 1 - PREPARATION

Item(s) Required:	AF Form 190; or JR/PD Survey Summary Report

The purpose of Step 1 is to help prepare you for the shop visit. It is recommended that you complete Steps 2, 3, and 4 while you are in the shop, and Step 5 after you have returned to the BEF office. After applying the Methodology several times, you can decide what works best for you.

3.1.1 Logistics. In order to prepare for the shop visit and Steps 2, 3, and 4, you will need:

- An appointment with the work center supervisor
- At least one copy of the Level I Ergonomics Assessment Checklist
- At least one copy of the Ergonomics Summary Report
- The relevant Case Study Problem-Solving Matrices (see Note on Case Study Pre-Selection, below)
- A pencil or pen
- A calculator
- The AF Form 190 or results of the JR/PD Survey, depending on the situation.

It will be helpful for you to have a desk or work surface near the workstation for which you are conducting the assessment. You should plan on spending up to one and one half hours in the shop. Some visits will take less time. Others may take more time depending upon the situation and how long you will need to remain in the shop to observe all aspects of the job.

Note on Case Study Pre-Selection:

There are 50 Case Studies that apply to maintenance and inspection work areas:

1 abrading
2 assembly disassembly-internal components
3 assembly repair-bench work
4 bolting/screwing
5 chipping
6 cleaning by hand
7 cleaning with high pressure equipment
8 coating/immersing
9 computer work
10 crimping
11 cutting/shearing
12 drilling
13 driving
14 excavating/shoveling
15 flame cutting
16 folding/fitting
17 forming
18 gluing/laminating (dopping)
19 grinding
20 hammering
21 hose handling
22 lifting
23 machining
24 masking
25 masoning
26 media blasting (blast cabinet)
27 media blasting (high pressure gun)
28 melting
29 monitoring (of displays)
30 nailing
31 opening/closing heavy doors
32 ordnance disposal
33 packing
34 painting/spraying
35 paving
36 prying
37 pumping
38 riveting/bucking
39 sanding
40 sawing
41 sewing
42 soldering
43 stripping/depainting by hand
44 stripping/depainting by mechanical methods
45 turning valves
46 tying/twisting/wrapping
47 visual inspection
48 welding
49 wiring
50 wrenching/ratcheting

For the first few assessments that you do, it is recommended that you take all of the Case Studies to the shop. Later, if you already know the types of tasks that are performed in the shop, you may pre-select the most relevant Case Studies (e.g., if you know that nobody in the shop performs welding work, you may wish to leave this (and others) behind in your office). The Case Studies are located in Appendix 4.

3.1.2 Review of Relevant Data and Job Selection. If you are using the Guide as part of an AF Form 190 investigation, proceed directly to Section 3.2 Step 2 - Risk Factor Identification.

If you are using the Guide to conduct pro-active problem-solving in an EPRA-designated shop, complete the following steps.

Step 1a. Obtain the JR/PD Survey Summary Report for shop from PHF. This Summary Report was used by the installation EWG to determine the work center's EPRA status.

Step 1b. Review Step 7 on page 2 of the Summary Report. Listed in this section are the types of work (e.g., welding, grinding/polishing) which were reported by over 20 percent of the employees. Your objective is to target the Level I Ergonomics Assessment and Problem-Solving Methodology on jobs or job classifications (e.g., electrician, mechanic, etc.) which *include* these types of work or tasks.

Step 1c. Review the Comments provided for Steps 8, 9, and 10 on page 3 of the Summary Report. These Comments, which summarize the comments and suggestions that participants in the survey completed, may identify very specific sources of ergonomics problems and/or improvement opportunities.

Step 1d. Identify the job classification(s) (e.g., AFSC or civilian job series) which include the types of work identified in Step 1b. When you go to the shop, your first task will be to determine how many employees from each job classification you will need to include in your investigation.

An example of an Air Force Form 190 and a completed JR/PD Survey Summary Report is provided in Appendix 1.

3.2 STEP 2 - RISK FACTOR IDENTIFICATION

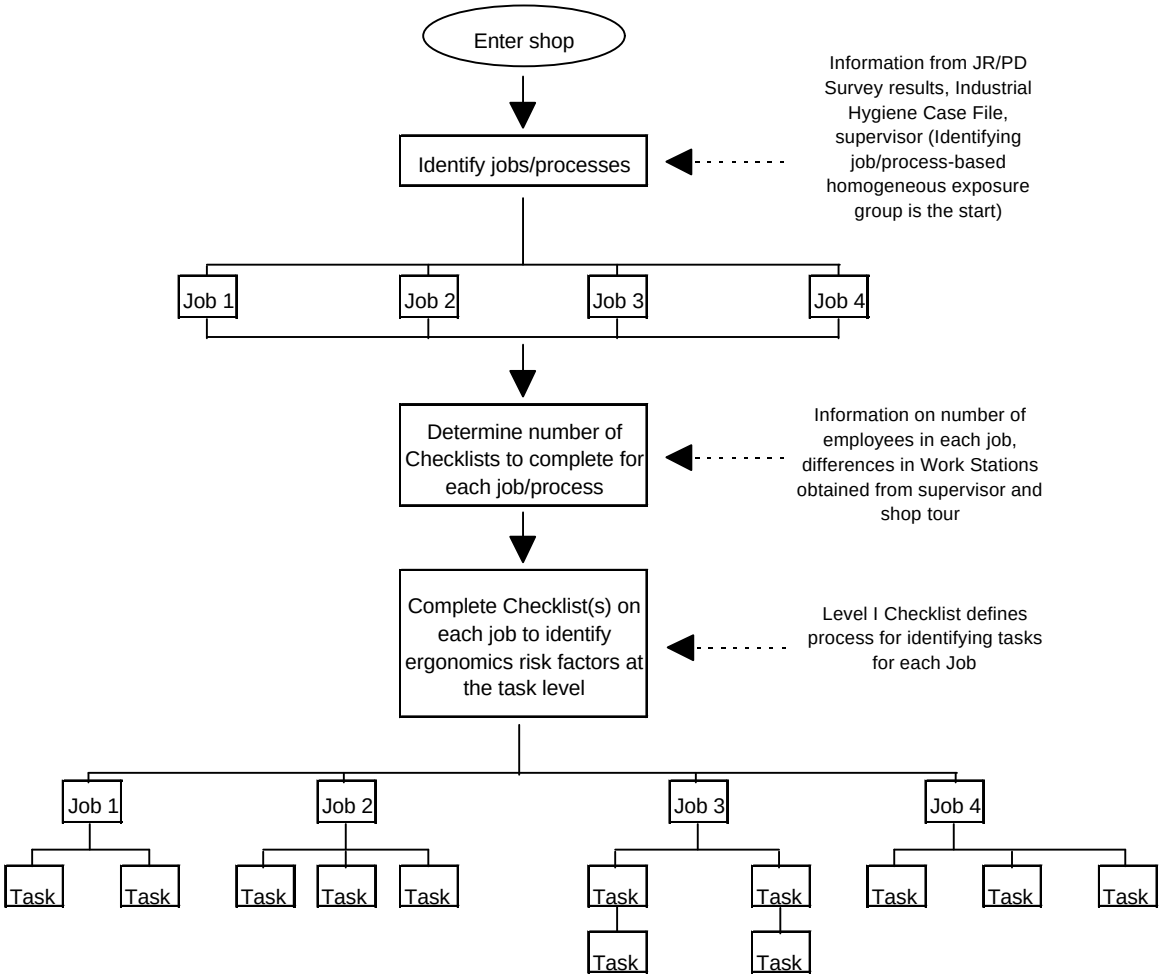
Item(s) Needed: Level I Ergonomics Assessment Checklist

The purpose of Step 2 is to identify work-related risk factors to which the employee is exposed. You will the use the Level I Ergonomics Assessment Checklist to complete Step 2.

If you are responding to an AF Form 190 investigation, proceed to Step 2d.

If you are using the Guide to conduct pro-active problem-solving in an EPRA-designated shop, complete the following steps. You may also refer to Figure 3.0 to see how process proceeds from entering the shop to performing the actual assessment.

Figure 3.0
Selecting Jobs/Processes to Performing the Assessment



Step 2a. After entering the shop and introductions with the shop supervisor, explain the purpose and process for completing the Level I Ergonomics Assessment Checklist.

Step 2b. Refer to the Industrial Hygiene Case File to identify the primary jobs/processes in the shop. Verify these jobs/processes with the supervisor and ask the supervisor how many employees perform each one of the jobs. (Note: this approach makes your starting point a job or process instead of an individual employee - unless you are responding to a AF Form 190 investigation. The job/process defines the homogeneous exposure group.)

Step 2c. Determine how many employees you need to observe/how many Checklists you will need to complete for each job/process.

There is no firm rule on how many employees is a representative sample of a job classification or homogeneous exposure group. You may want to begin by including 20 percent of the population

or 3 employees, whichever number is greater. Or, if there are 3 or fewer employees in a job category, include all of the employees.

The following factors typically determine the number of Checklists that are required:

- the number of different work situations in which the job occurs (e.g., performed on aircraft, performed on bench)
- the number of different types of tools or equipment, or aircraft devices used
- the distribution of critical tasks in the job.

Take the example of the job, "repair fuel housing" in a sheet metal shop. Say that there are two common fuel housing designs that must be repaired, Housing A and Housing B. If both housings are repaired at the same bench (or workstation), if the same equipment and tools are used during the process, and if there is the same amount of grinding, shearing, riveting, etc. for each housing - and the designs do not require the employee to use a completely different work procedure (e.g., one is done standing, one is done sitting), then the Housing A and Housing B jobs can be considered the same. The Checklist(s) competed for Repair Fuel Housing (Housing A) also applies to Repair Fuel Housing (Housing B). If the distribution of critical tasks is appreciably different (e.g., makes up 80 % of Housing A repair but only 20 % of Housing B repair), you will need to conduct the Level I Assessment separately for each repair job.

To complete the appropriate number of Checklists for each job type/process follow the steps below:

- Complete a Checklist for the first work situation noting the tools equipment, and tasks performed.
- Go to the next work situation in which the job is being done
  - If there are no significant differences in the tools, equipment, or distribution of critical tasks for the next work situation, then use the same Checklist (same pieces of paper) for that work situation. Simply observe the job/tasks to make sure that the risk factor exposure is not significantly different.
  - If there are significant differences in the tools, equipment, or distribution of critical tasks, then complete a new Checklist for that work situation.
- Repeat this process for all work situations that make up the representative sample for the job classification. This will result in a single Checklist completed for each homogeneous group in that shop. A homogeneous group is a group of employees and their jobs which have similar characteristics (similar tools, equipment, work situations and critical task distributions). Develop recommendations for each Checklist. These recommendations will apply (in general) to all work situations in the homogeneous group defined by that Checklist.

3.2.1 Format. The Level I Ergonomics Assessment Checklist is comprised of a cover page and four parts.

- Cover Page
- Part I: Work Content (Description of Tasks Performed)
- Part II: Job Factors Checklist
- Part III: Environmental Factors Checklist
- Part IV: Employee Suggestions

3.2.2 Cover Page. The purpose of the cover page is to identify the work center (shop), location of the work, the name of the Job/Process, etc. You will have one cover page for each Job/Process for which you complete a Checklist. If you complete multiple Checklists for the same Job/Process, you may use the same cover page.

Step 2d. Collect the information for the cover page from the supervisor and/or the employee. Record.

3.2.3 Part I: Work Content (Description of Tasks Performed). Part I helps you get the employee to describe, in a standardized way, the individual tasks which comprise his or her job. Fifty different task types are listed in a "Work Content Matrix." These task types are consistent with the maintenance and inspection task types listed in Part III of the JR/PD Survey. For both analysis tools, the 50 task types were selected as representative of the most common types of maintenance and inspection tasks. Additional space is provided to record other tasks that the employee described.

In order to identify appropriate jobs to assess, you must help the employee (or supervisor) try to think about the jobs and tasks that are the most fatiguing or difficult on the body. Any information from the employee (e.g., "painting the T-tail", etc.) may help you identify several initial targets for your assessment. The second question will help you get an idea from the employee about which of those jobs are done on a regular basis. Your goal is to identify the job (e.g., raft packing) that will become the focus of your Level I assessment. Then, you can proceed to the Work Content Matrix with a specific job in mind.

The Work Content Matrix is designed to allow one of three responses under the "Task Frequency" heading. The frequencies (e.g., low, moderate, high) allow you to categorize the tasks by the amount of time devoted to the task when the job is performed. A gray shaded area is superimposed in the Matrix to make a distinction between routine tasks and tasks which represent a less significant part of the job. The gray shaded area includes tasks which make up over 10% of the job. The gray shaded area also includes lifting/exertion tasks. All instances of lifting or exertion are considered critical tasks and should be included in the assessment.

Information provided in the completed Matrix is very important. First, it enables you to break a potentially complex job down into smaller component or "tasks" that can be easily analyzed. Second, it enables you to maximize the value of the subsequent assessment by focusing problem-solving efforts on the routine tasks - referred to for the remainder of the assessment as "critical tasks."

Performance measures are also recorded to help you justify the need for ergonomics improvement. For example, if the employee's performance is judged according to the quality of the surface finish on an aircraft component and the current work area arrangement makes the surface more difficult to grind, you may be able to obtain support for fabricating a height-adjustable holding fixture since it may help the employee do a better job faster as well as reduce the potential for a shoulder WMD.

Obtain the following information directly from the employee:

Step 2e. Turn to Page 1, *Part I - Work Content* **(**Description of Tasks Performed**.)**

Step 2f. Verify with the employee that the job you are targeting (you identified this job/process for investigation in Step 2b.) is performed on a regular basis (or occurs most frequently) in the shop. Note: If the employee mentions jobs that you do not have in the Industrial Hygiene Case File or that were not mentioned by the supervisor, you may wish to add these jobs to your list of target jobs for the Level I Assessment.

Step 2g. Ask each employee to explain the *purpose of the job*. The objective is to develop a complete understanding of why the job exists and the type of work done by the employee. If a task is not listed on page 2 of the Checklist, use lines 131 and 132 to write in the task names (e.g., meeting with others) and mark the appropriate time estimate.

Step 2h. *Fill out the Work Content Matrix*. Ask the employee to indicate how much time is devoted, each time the job is performed each of the tasks listed in the first column of the Work Content Matrix. Be sure to let the employee know that if a task on the list is not part of the job, they should tell you so. Mark the appropriate circle in the gray shaded *Work Frequency* columns.

Step 2i. *Ask about performance measures*. Ask the employee to describe the performance measures used to measure success in that job. Some employees may not be able to provide this type of information if their performance has not been formally measured in the past. When this is the case, simply ask the employee, "How would you know whether a person doing your job was doing a good job? - What would you look for?"
Record the responses in the *Work Performance* box on the bottom of page 1.

3.2.4 Part II: Job Factors Checklist. The format enables you to perform an ergonomics analysis for each of the critical tasks. The tasks are analyzed individually to identify the specific source of exposure to ergonomics risk factors. It is not usually the "job" (e.g., repair wing strut) that causes fatigue or discomfort. Rather, it is the individual "tasks" (e.g., grinding, welding, etc.) that are the source. You may not be able to change the fact that the employee must repair the wing strut. However, it may be possible to address the part of that job that requires prolonged grinding with a disc grinder. Figure 3.1 shows one page of the Job Factors Checklist.

Figure 3.1
Work Content Matrix from Level I Checklist

Level I - Ergonomics Assessment for Maintenance and Inspection Work Areas

Part I - Work Content (Description of Tasks Performed) (Cont.)

Maintenance and Inspection Task Key List

66. abrading
68. bolting/screwing
70. chipping
71. cleaning by hand
72. cleaning with high pressure equipment
73. coating/immersing
76. crimping
77. cutting/shearing
79. drilling
80. driving (vehicles)
81. excavating
83. flame cutting
84. folding/fitting
85. gluing/laminating (dopping)
86. grinding/buffing/polishing
87. hammering
88. lifting
90. lubricating
91. machining
92. masoning
93. melting
94. molding
95. monitoring (visual displays)
97. nailing
98. opening/closing heavy doors
99. packing/packaging
100. painting/spray painting
101. paving
102. pumping (by hand)
103. riveting/bucking
104. sanding
105. sawing
107. sewing
108. soldering/brazing
110. stripping/depainting by hand
111. stripping/depainting mechanically
113. turning valves
114. tying/twisting/wrapping
116. welding
118. wiring
119. wrenching/ratcheting
121. assembly/disassembly internal component
122. assembly & repair (bench work)
123. computer work
124. hose handling
125. forming
126. masking
127. media blasting (blast cabinet)
128. media blasting (high pressure gun)
129. ordnance disposal
130. prying
131. visual inspection

(Write in others)

131. _____
132. _____

Detailed information on question design, interpretation, and research references, has been submitted to the USAF in a separate Research Report. Further information may be obtained from AL/OEMO.

The *Job Factors* questions have been grouped into five "body zones":

- shoulder/neck (Q1-Q4)
- hands/wrists/arms (Q5-Q11)
- back/torso (Q12-Q18)
- legs/feet (Q19-Q22)
- head/eyes (Q23-Q24)

The body zones are consistent with those used in the JR/PD Survey. The questions are representative of the types of ergonomics risk factors that are most likely to be found in Air Force maintenance and inspection work areas.

The included questions were designed to ensure that each general risk factor type discussed in the scientific literature (e.g., posture, force, repetition, etc.) was reflected. The questions and illustrations were also designed to prevent the need for you to repeatedly refer to a glossary when completing the checklist (A glossary is provided in Appendix 2, to assist you the first few times you use the Checklist). No measurements are required. All of the questions may be answered based on observing the employee at work.

For each question, you can assess the employee's exposure to the Job (risk) Factor as: *Frequently, Sometimes, Occasionally or Never/NA*. First, you will indicate whether or not the task is a "moderate" or "high" frequency component within the overall job. You will then circle the appropriate Job Factor responses under that column. If the Job Factor occurs greater than 50% of the task time (e.g., the employee is exposed to repeated arm forces (question 2) "*more*" rather than "*less*" of the time) and the task is a "moderate" task, you circle the *Frequently* (F=2) response. If the Job Factor occurs between 10% to 50% of the task time and the task is a "moderate" task, your circle the *Sometimes* (S=1) response. If the job factor occurs for less than 10% of the task and the task is a "moderate" task, you circle the *Occasionally* (O=0) response. If the Job Factor does not occur or the question is not applicable to the task you circle the *Never/NA* (N=0) response.

Four response choices are provided for each of the "Moderate" and "High" categories to maximize the consistency of assessment results between users and minimize the need for interpretation and estimating actual time. It is significantly easier to decide if a Job Factor occurs "more" or "less" than 1/2 the time, than it is to make a consistent distinction between 1/3, 2/3, etc. In addition, since many maintenance and inspection jobs include Job Factors that occur, but to a much lesser extent (e.g., <10%), the *"occasional"* response choice was added. This was designed to recognize and account for risk factors that will be observed, but will not be observed anywhere near that 50% level. The numerical ratings provided for each response were determined based on the relative contribution of the Job Factor type to work-related musculoskeletal

disorders (WMDs) as well as the impact of exposure duration. Providing a numerical rating for each response allows the scoring process to be kept fast and easy.

A numerical Task Score is calculated for each task by adding the numbers in the column. The Task Score represents degree to which the task exposes the employee to ergonomics risk factors. The score is compared to evaluation criteria (*0-3/Low, 4-7/Medium, and 8+/High*) which allows you to establish priorities for problem-solving.

After obtaining a job description and a basic task frequency breakdown from the employee, you are ready to begin the *Part II - Ergonomics Checklist/Job Factors.*

Note: In some cases, the employee will not be performing all of the critical tasks at the time of your observation. When this is the case, ask the employee to demonstrate each of the critical tasks. Complete the Checklist for each task during the demonstration.

Step 2j. Turn to Page 2, Part II - Checklist, Shoulder/Neck and review the definition for Frequently (F), Sometimes (S), Occasionally (O) and Never/NA (N).

Step 2k. From Page 1 of the Checklist, note the tasks from the marked circles in the gray area and write the task(s) on the blank lines under Critical Tasks. If there are more than 3 tasks, put the additional tasks on another checklist.

Step 2l. Moderate (10%-50%) or high (51%-100%). Note that tasks which occur less than 10% of the time are excluded from the Assessment.

Step 2m. Next, answer each question for *each* task by circling (F), (S), (O), (N).

Step 2n. After you have answered *every* question for each task, compute the *Task Scores* (add each column and total at the bottom). The Comments box in the far right column is for additional notes regarding the tasks.

Step 2o. Repeat the identical process four more times. Review each critical task again for Hands, Wrist, Arm, Back/Torso, Legs/Feet, and Head/Eyes, (pages 3-6), recording the results in the same way as for Shoulder/Neck.

3.2.5 Part III: Environmental Factors. Four questions (Q25-Q28) are provided to assess potential exposure to general environmental factors (or stressors). Responses are provided on a 5-point scale. This section of the assessment is completed either by asking the employee to rate each one of the factors or by referring to environmental data already collected from previous industrial hygiene surveys (e.g., noise, indoor air quality-see Glossary in Appendix 2). Figure 3.2 shows the Environmental Factors.

Figure 3.2
Environmental Factors

Level I Ergonomics Assessment for Maintenance and Inspection Work Areas

Part III - Environmental

Environmental Factors

Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5		
25. Restricted space						
26. Extreme temperatures heat/cold						
27. Noise or distractions						
28. Air quality concerns						

Environmental Score = ____

Environmental Rating	Low	Med	High
Environmental Score	0-3	4-7	8+

This data indicates perceived employee exposure to environmental factors that may be impacting the way that the employee performs the job/tasks. For example, working in a restricted space may be one of the reasons why the employee must reach or lean forward. The environmental rating is not used to determine the overall job priority score or priority scores for individual tasks. It is, however, accounted for during problem-solving process.

Complete the following.

Step 2p. Turn to page 7, *Part III - Environmental* and answer the questions relating to Environmental Factors and circle the appropriate number.

Step 2q. Total the numbers and write the score in the Environmental Score box and circle the appropriate rating *High, Medium, or Low.*

3.2.6 Part IV: Employee Suggestions. Employee involvement is critical in the problem identification and problem solving processes. Employees who have previously completed the JR/PD Survey may have already provided feedback on improvement opportunities. Your questions for the employee in Part IV have a slightly different focus. The JR/PD Survey asked about general improvement opportunities for the shop. Part IV enables you to record any

comments or suggestions that the employee may have on how to improve the job. Employee suggestions are to be thoughtfully considered and evaluated along with the controls provided in the Case Study Problem-Solving Matrices when you develop the final list of recommendations in Step 5.

Step 2r. Ask the employee for any suggestions for Corrective Actions that he/she may have. *The employee may provide you with improvement suggestions during the initial interview*. Record employee comments.

The Level I Ergonomics Assessment Checklist is now finished.

A completed Level I Ergonomics Assessment Checklist and the Checklist Glossary is provided in Appendix 2.

3.3 STEP 3 - PRIORITIZATION OF HAZARDS

Item(s) Needed:	Completed Level I Ergonomics Assessment Checklist Checklist Scoring Summary

The purpose of this step is to "score" the Level I Checklist in order to determine the employee's exposure to ergonomics risk factors from the individual tasks and from the job overall. You will use the Checklist Scoring Summary form to determine the exposure.

3.3.1 The Checklist Scoring Summary Design. There are three parts to the Checklist Scoring Summary:

- Job Description
- Scoring Summary
- Case Study Selection

The Case Study Selection part of the Checklist Scoring Summary form will be discussed in Step 4, HAZARD CONTROL SELECTION.

A *Job Description* section is provided to enable you to briefly summarize the job requirements and the purpose of the job/position.

The *Scoring Summary* design resulted from a combination of findings from the literature review as well as the consensus judgment from experienced ergonomists at TJI/ADL. In the literature, there is a lack of validated methods for determining a "threshold" between "ergonomics problem/risk of WMD" and "no ergonomic problem/no risk of WMD." Therefore, the scoring concept and results generated by the assessment are designed to *prioritize* the need for Corrective Actions based on the highest exposure to ergonomics hazards. In other words, a *High* rating *means that exposure to risk factors which have been associated with WMDs* is high. It does not

mean that the risk for injury is high. When interpreting results, you should focus problem-solving efforts on any job, task, body region which is rated *High* or *Medium.*

Priority scores are generated for each body region, for each task, and for the overall job. Figure 3.3 shows the Scoring Summary.

3.3.1.1 Body Region Score. Body Region Scores for each task are determined by totaling the responses to the Job Factor Questions for each task. Body Region scores for the job as a whole are determined by averaging scores across tasks. The averaging process was selected to reflect the beneficial impact of task variety. Consider the following example jobs.

- Job A is comprised of just one task: grinding. This task exposes the shoulder/neck to a *High* level of ergonomics risk factors - Body Part Score = 8. Since there is only one task, the Body Region Priority Score=8, which is a *High* rating.

- Job B is comprised of two tasks: grinding and manual inspection. This grinding task, which is performed for five hours per day, exposes the shoulder/neck to a *High* level of ergonomics risk factors - Body Part Score = 8. The manual inspection task, which is performed for three hours per day, exposes the shoulder neck to a *Low* level of ergonomics risk factors - Body Part Score = 2. The average Body Region Priority Score=5, which is a *Medium* rating.

A comparison of the Body Region Priority Score for each task suggests that Job B is easier on the shoulder than Job A. The *Medium* rating on Job B suggests that, since the employee spends part of the day performing a task (manual inspection), which provides some relief to the shoulder, the overall potential for a shoulder problem is reduced. This is consistent with the ergonomics research literature which indicates that a job designed with task variety should reduce the overall potential for WMD development. Also, since the rating system still indicates that, when grinding is performed, the shoulder is at *High* risk, you are directed to identify controls which reduce exposure to ergonomics risk factors that impact the shoulder during grinding.

Figure 3.3
Scoring Summary Section of the Checklist
Scoring Summary Form

ERGONOMIC SCORING SUMMARY:

Technician _____

Date _____

1. Job Description: Please write out job description.

2. Scoring Summary: Transfer scores from individual scoring sheets.

Body Region	Task Scores					Priority Score by Body Region	Priority Rating by Body Region
	Task Name:	Task Name:	Task Name:	Task Name:		Add across row and divide by # of tasks for average	High: 8+ Med: 4-7 Low: 0-3
Shoulder/Neck					=		High Med Low
Hand/Wrist/Arm					=		High Med Low
Back/Torso					=		High Med Low
Legs/Feet					=		High Med Low
Head/Eyes					=		High Med Low

Select the highest body region score for each task then circle below for High, Med, Low	Highest Score	Highest Score	Highest Score	Highest Score
High: 8+ Med: 4-7 Low: 0-3	High Med Low	High Med Low	High Med Low	High Med Low

Environmental Rating
High Med Low

Overall	
Highest Priority Score by Body Region Score:_____ Body Region:_____	Priority Rating **High** **Med** **Low**

While averaging may not always reflect the precise daily physical experience of the employee, it provides you with a standardized method for determining the impact of overall daily exposure and how to focus problem-solving efforts in order to achieve the desired impact on employee health and safety. This concept can be referred to as high-impact, precision-strike problem-solving.

3.3.1.2 Task Score. The individual Task Score is determined by selecting the highest numerical body region score for that task. The highest numerical body region score is converted into a High, Medium or Low rating. The reason: the feeling of fatigue or pain, which are often precursors to WMD development, is not "averaged" throughout the body by the employee. For example, if exposure to a high level of risk factors causes an employee's shoulder to hurt, the employee does not think, "my shoulder hurts, but the rest of my body is OK, so I must be OK." Rather, the employee reports a shoulder problem because that part of the body hurts. Therefore, if the shoulder is exposed to a high level of ergonomics risk factors, the Task Score reflects that most significant exposure.

3.3.1.3 Overall Job Priority Score. The Overall Job Priority Score, *High*, *Medium*, or *Low*, is determined by selecting the highest Body Region Priority Score. The basis for this scoring concept is identical to that which was described for the Scoring Summary. The Overall Priority Rating is used to determine which jobs need the most immediate attention.

3.3.1.4 Use of the Scores and Ratings. While the Overall Job Priority Rating/Score is used to determine which *jobs* to address first. Task Ratings/Scores are used to determine which *task(s) within the job* need to be the focus of problem-solving efforts. And finally, the Body Region Scores for each task are used to target the identification of controls for the body parts that are exposed to the highest level of ergonomics hazards. Again, the objective is precision-strike focus, with high impact results.

There are three major steps to completing the prioritization of hazards.

Step 3a. Complete the top entries on the form (date, name, etc.).

Step 3b. Complete the *Job Description* section. It is not necessary to write a detailed job description or to transfer the information from the Work Content Matrix. Simply describe the main purpose of the job and what the employee does. (In some cases, the employee may be able to provide a written job description that you may use as the basis of the summary.)

Step 3c. Complete the Scoring Summary.

- The first step is to transfer the names of the *critical tasks* selected for the Level I Ergonomics Assessment Checklist (e.g., welding, grinding) to the *Task Scores* columns.

  Next transfer the *task scores* (column total) from each individual checklist (e.g., *Shoulder/Neck, Hand/Wrist/Arms*) to the appropriate task column. Once you have transferred *all* task scores for *each* critical task it is time to select the highest body region score (per task).

- Next, select the *highest* Body Region Score from each task and write the number in the *Highest Score* box at the bottom of each Task Name column. Then circle the appropriate box below for *High, Medium, or Low* for that task.

- Now add across the rows and calculate the *average* to obtain a *Priority Score by Body Region*. (To obtain the average, add across the row and divide by the number of tasks.) Be sure to calculate the average for all Body Regions (e.g., *Shoulder/Neck, Back/Torso* etc.) and then circle the appropriate response, High, Medium or Low for that body region in the *Priority Rating by Body Region* column.

- From page 7 of the Level I Ergonomics Assessment Checklist transfer *High, Medium or Low* Environmental Rating to the *Environmental Rating* box.

- Finally, at the bottom/right of the page complete the *Overall* box. Into this box, transfer the highest average body region score from the *Priority Score by Body Region* column above and circle *High, Medium or Low.*

A completed Checklist Scoring Summary is provided in Appendix 3.

3.4 STEP 4 - HAZARD CONTROL (Selection of Corrective Actions)

Item(s) Needed:	Completed Checklist Scoring Summary Case Study Problem-Solving Matrices (Appendix 4) Corrective Actions List (Appendix 4)

Part 4 represents the start of the pattern-matching process.

3.4.1 Case Study Selection. Figure 3.4 shows the Case Study selection list from the bottom of the Checklist Scoring Summary.

Figure 3.4
Case Study Selection List

3. <u>Case Study Selections List</u> Select the case studies that match the critical tasks that you identified for this job. Place a ✓in the appropriate boxes below and then turn to the appropriate case study in the Case Study Book.

1	Abrading	26	Media Blasting (Blast Cabinet)
2	Assembly Disassembly-Internal Compon	27	Media Blasting (High Pressure Gun)
3	Assembly Repair-Bench Work	28	Melting
4	Bolting/Screwing	29	Monitoring (Of Displays)
5	Chipping	30	Nailing
6	Cleaning By Hand	31	Opening/Closing Heavy Doors
7	Cleaning With High Pressure Equipment	32	Ordnance Disposal
8	Coating/Immersing	33	Packing
9	Computer Work	34	Painting/Spraying
10	Crimping	35	Paving
11	Cutting/Shearing	36	Prying
12	Drilling	37	Pumping
13	Driving	38	Riveting/Bucking
14	Excavating/Shoveling	39	Sanding
15	Flame Cutting	40	Sawing
16	Folding/Fitting	41	Sewing
17	Forming	42	Soldering
18	Gluing/Laminating (Dopping)	43	Stripping/Depainting by Hand
19	Grinding	44	Stripping/Depainting by Mech Methods
20	Hammering	45	Turning Valves
21	Hose Handling	46	Tying/Twisting/Wrapping
22	Lifting	47	Visual Inspection
23	Machining	48	Welding
24	Masking	49	Wiring
25	Masoning	50	Wrenching/Ratcheting

The idea is to select the Case Studies/titles that "match" the critical tasks that were identified during the scoring process in Step 3. This is the main connection between the Checklist results and the Case Study Problem-Solving Matrices. It is the foundation of pattern matching.

3.4.2 Case Study Design and Use. The Case Study Problem-Solving Matrices are the subject of Appendix 4. An overview of the Case Study Problem-Solving Matrix design, however, is provided here in the context of the pattern-matching process.

Fifty Case Study Problem-Solving Matrices were developed. The task types which were the basis for the Case Studies were selected by the Air Force and are consistent with "Types of Work" listed in Section III of the JR/PD Survey.

Each of the Case Studies presents the Job Factors commonly associated with the task type. For each Job Factor (e.g., *reaching*), the causes of the Job Factor (e.g., *the work is located too far from the employee*) and a menu of controls that reduce or eliminate the Job Factor (e.g., *remove obstructions between the work location and the employee)* are provided.

The content of the Case Studies is based, in part, on a review of representative Air Force maintenance and inspection tasks. However, the majority of Potential Causes and Corrective Actions - which were generalized such that they may be applied to *any* USAF maintenance and inspection job - were extracted from the results of years of practical applications work completed by experienced ergonomists.

The information is organized in the following sections:

- *Task Title*: In most cases the task title is simply a restatement of the Case Study name.

- *Task Description*: The task description provides details on the type of equipment that is typically used to perform the task (e.g., manual or power tools, etc.), the length of time over which the task is typically performed, and other materials that may be used. Also provided is a list of maintenance and inspection jobs in which the task is performed.

- *Job Performance Measures*: This section indicates which performance measures (e.g., productivity, quality, etc.) are typically impacted by implementing ergonomic improvements. This information, in addition to the job-specific performance measures obtained when completing the Level I Ergonomics Assessment Checklist, could be used by the technician to justify the need for change.

- *Typical Employee Comments*: The information from this section is provided to help you judge whether or not employee comments obtained with the Checklist are consistent with problems or concerns that employees typically report for the task type. In other words, if an employee whose job involves continuous welding comments about stiffness in the neck and shoulders, you can check the "Typical Employee

Comments" section of the *Welding* Case Study to see if the complaint is common for employees who weld. This information also helps you determine if you are looking at the most appropriate Case Study(ies) for the job.

- *Level II Analysis*. If you are unable to identify the causes or source of the ergonomics concerns, or if you feel that a more detailed analysis is required (e.g., complex job) each case study recommends the type of Level II analysis that may proved the information you need.

- *Job Factor, Potential Causes, Corrective Actions*. The Case Study design enables you to make a direct match between the Job Factor present in the task, and that same Job Factor in the Problem-Solving Matrix. Figure 3.5 shows part of a Case Study.

Figure 3.5
Example Problem-Solving Matrix

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1.Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface					
		• modify existing table	✓		low	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Welding tool or gas hose must be manually supported, held or steadied 	116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		med	med	med
		112. Provide support for the arms					
		• provide flexible armrests		✓	med	med	med

For example, if you observed that the job required the employee to *use repeated reaching or arms held away from the body while unsupported*, it is possible to match that Job Factor with the same Job Factor in the left hand column of the Matrix. For each Job Factor, the ergonomists have identified the most common *Potential Causes* or aspects of the workplace or work procedure that if they are not designed or adjusted properly, can cause the Job Factor to be present. If you were to decide that the arms are held away from the body while unsupported because the *Welding tool or gas hose must be manually supported, held or steadied*, you can then refer to the Corrective Actions list to see what types of controls are available to address the problem. For this example, two choices are provided: *Provide support for the arms (or nearby surface or on flexible arm supports),* and *Provide support for hose or cord (using a wire hook or a mobile tool balancer).* You must decide which of the Corrective Actions would best control or eliminate the Job Factor.

The Case Studies also include information that helps you choose the controls option which is in the best interest of the employee with consideration of the costs. For each control, the *Level of Changes* column indicates if the control is typically a *minor modification* or *major change*. The controls that are listed as minor modifications involve little or no cost. In most cases this level of control can be implemented by making adjustments to the current work area. Approximately 50 percent of the controls provided in the Case Studies are at this level. The major change category includes controls such *as provide a lighter weight tool*. The distinguishing characteristic of major changes is that the shop will need to buy something. They will need to identify a product in a catalogue (e.g., alternative tool, anti-fatigue mat, tool balancer, etc.), have the product delivered for trial, and make a purchase if they find a true benefit. Controls listed in this category may be appropriate but may need to be planned as a long-term change since they may be expensive.

Information on cost is provided only in general categories; *Low, Medium, and High*. This broad categorization was intentional and is based on an Air Force consensus. Every base may have a different idea about what represents *Low, Medium, or High* cost.

Still further, the Case Studies provide information on how implementation of the control is expected to impact quality and/or productivity. This information was compiled based on a consensus decision of experienced ergonomists at TJI/ADL who have seen similar results in their own application work. You may use this information as further justification for change.

3.4.3 Corrective Actions. The next step in the pattern-matching process is to select the Corrective Actions in a Case Study that "match" the problems. As you identify an appropriate Corrective Action in a Case Study, you will check off that selection on the Corrective Actions List. Part of the form provided in Appendix 4 has been excerpted as Figure 3.6.

Figure 3.6
Corrective Actions List

Job Factors

Corrective Actions	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
1. Provide handles with insulating material			A.5.2.2
2. Provide portable heaters			
3. Provide powered assistance for a manual activity			
4. Provide powered or mechanical assistance for door			
5. Provide protection from glare			
6. Provide protection from glare from overhead lights/task lights			
7. Provide shields or barriers from the wind			
8. Provide support for reference documents			
9. Provide support for the arms			
10. Provide support for the cable or hose			A.5.1.2

In the Corrective Actions List, all of the controls from all of the Case Study Problem-Solving Matrices have been provided.

For instance, in the previous example, if you had identified that the job required *Repeated reaching or arms held away from the body while unsupported* and that the cause was, *Welding tool or gas hose must be manually supported, held or steadied* and determined that *Provide support for the hose or cord,* was the appropriate solution, you would then make a "check" mark in the "Action Selected" box for the corrective action *Provide support for the cable or hose*,

The Corrective Action numbers on the list are the same numbers in the Case Studies. This allows you to quickly locate and mark the control when using the Case Studies. Two response columns are provided: minor (modifications and adjustments), and major (major changes). The columns have been blocked such that the check mark is placed in the column that represents the level of control indicated in the Case Studies. This distinction is made in the Corrective Actions list to minimize the amount of time required for developing the final recommendations.

There is one additional column: "Implementation Reference." In this column you have been provided with a page reference in Appendix 5. Included on the referenced pages is additional detail which you may use to "implement" the corrective action. This information will be particularly important as you develop your final recommendations in Step 5.

There are 7 major steps in completing the Hazard Control selection.

Step 4a. Preview the information in the Checklist Scoring Summary to select the Case Study Problem-Solving Matrices most appropriate for identifying controls.

- *Select the Case Study or Studies* that match each of the Critical Tasks whose Task Score is a *High* or *Medium. You may also choose to review case studies for "low" rated tasks at your discretion.*
- Place a check mark in the appropriate box (or boxes) and then turn to the corresponding Case Study Problem-Solving Matrix (or Matrices) in the Case Study Problem-Solving Manual.

Now that you have identified the appropriate Case Study Matrix or Matrices you need to identify Corrective Actions. For this you will need to have the *Level I Ergonomics Assessment,* the *relevant Case Study Problem-Solving Matrices* (Appendix 4) and the *Corrective Actions List* (Appendix 4) pages open for reference. Ideally, you should be near the workstation when identifying appropriate Corrective Actions.

Step 4b. Turn to page 1 of the Corrective Actions List, pages 1 through 3.

Step 4c. Next open Appendix 4 to the Case Study that you selected for a Task (e.g**.,** *welding*) with a *High* or *Medium* task.

Step 4d. Open the Level I Ergonomics Assessment Checklist to Page 2, *Shoulder/Neck*. Look in the task column for *Welding*. Note any of the Job Factor questions that are answered with *F, S or O*.

Step 4e. Select an appropriate Corrective Action - place a check mark in the appropriate box on the Corrective Actions List.

For example, if *Question 1, Reaching* scored *F, S, or O* then you need to suggest a *Corrective Action*. To Select a *Corrective Action* turn back to the Shoulder/Neck section of the Welding Case Study and look for Question 1-*Reaching* under the *Job Factor Column*. Review the *Potential Causes* that apply and select the appropriate *Corrective Action*. On the Corrective Actions List, record the appropriate Corrective Action. Examine the workstation to make sure the Corrective Action selected will be appropriate.

Step 4f. Repeat Steps 4d and 4e for each Job Factor Question until you have completed the Pattern-Matching (Hazard Control Selection) process for the Task.

Step 4g. Complete Steps 4a through 4f for each of the remaining *High* or *Medium* rated Tasks. You do not need to continue with problem-solving on tasks that were rated *Low.*

3.5 STEP 5 - RECOMMENDATIONS

Item(s) Needed:	Completed Checklist Scoring Summary Completed Corrective Actions List Level I Ergonomics Assessment Summary and Recommendations (Appendix 5)

The purpose of step five is to summarize all of the information from Steps 1- 4 in a way that will enable you to communicate the key problems, causes, and recommendations to the shop supervisor for reducing and/or eliminating employee exposure to ergonomic risk factors. A Level I Ergonomics Assessment Summary and Recommendations form was developed to serve as the basis for a *concise report*.

The intent of the report is for you to summarize the findings of the Level I Ergonomics Assessment Checklist and record if the findings are consistent with previous findings from the AF Form 190 or the JR/PD Survey results, which ever one applies to the situation with which you are dealing. The report also allows you indicate to the shop supervisor which tasks need to be the focus of problem-solving.

The intent is for the supervisor to use the report for planning and implementing Corrective Actions. Since this is a summary, you should transfer only the most important information from the Checklist Scoring Summary and the Corrective Actions List.

Step 5a. Fill in the information on date, workplace identifier, base, etc. on the top of the Level I Ergonomics Assessment Summary and Recommendations form.

Step 5b. In the *Critical Tasks in Priority Order* table, write in the Task Name(s) of any of the Critical Tasks that had a Task Score of *High* or *Medium*. The highest rated task goes in row 1, the next highest in row 2, etc. Note: if the Checklist Scoring Summary indicated that one or more of the Critical Tasks was rated Low, do not list the task(s) in this table.

Step 5c. For each task, circle the *Task Rating* (*High or Medium*). Then, circle the appropriate *Rating* for each *Body Region* (*High or Medium*).

Step 5d. Circle the *Overall Job Rating* (*High or Medium*). Write in the Priority Body Region (e.g., *Shoulder/Neck, Back/Torso, etc*.).

Step 5e. Indicate whether or not your results and findings are consistent with results from the JR/PD Survey (yes or no). Comment as appropriate. For example, one

comment could be: "This job may contribute to the high risk factor and discomfort ratings for the shoulder/neck region reported for the shop." If your investigation was not prompted by the JR/PD Survey, check "N/A".

Step 5f. Indicate if the results are consistent with Air Force Form 190 findings (*yes* or *no*). Comment as appropriate. An example comment could be "Each of the tasks performed by the employee exposes the employee to high to medium levels of ergonomics risk factors in the hands/wrists/arms region. This finding is consistent with employee-reported hand/wrist discomfort." If your investigation was not prompted by an Air Force Form 190, check "N/A".

Step 5g. Provide recommendations for follow-up.

This is the final list of Corrective Actions that you wish to present and discuss with the shop supervisor. The list should be based on thoughtful consideration of the appropriateness of each of the controls that you marked in the Corrective Actions List. The idea *is not* to restate all of the controls. The idea *is* to suggest Corrective Actions that you believe should be implemented and that represent the best strategy for affecting workplace changes.

Provide recommendations for *Modifications and Adjustments*. Refer to the Corrective Actions List and look for the controls marked in the "minor" column. Evaluate each of the controls for appropriateness (e.g., will implementing the control reduce employee exposure to ergonomics hazards?) and practicality (e.g., is it realistic?). To evaluate the control, refer to the "Implementation Reference" page number provided for the Corrective Actions. (Note: Not all corrective actions need further explanation than is provided in the case study. For these actions, no reference is provided). In the section "Implementing Minor Modifications," you can obtain additional detail or suggestions on how to implement the control. List the controls in priority order. Indicate whether or not you expect to see benefits to employee health/safety and/or productivity/quality.

Provide recommendations for *Major Changes and/or Purchases*. Refer to the Corrective Actions List and look for the controls marked in the *major* column. Again, evaluate each of the controls for appropriateness. Also include those controls that you think should be included in the shop's long-term planning or budgeting process for the following period. By indicating whether or not you expect to see benefits to productivity/quality, in addition to employee health/safety, a shop supervisor or manager may be open to hearing more about a potentially major purchase.

When an Implementation Reference is provided, refer to the "Using Design Criteria to Implement Major Purchases" section. In cases where you recommend the purchase of

equipment (e.g., lifting device, power tool, etc.), information in this section will help you select the appropriate choice based on ergonomics criteria.

The last step is to present the Summary and Recommendations as shown in Figure 3.7, to the shop supervisor and schedule a date for follow-up to measure the results of workplace improvements.

Figure 3.7
Level I Ergonomics Assessment
Summary and Recommendations

Date (YYMMDD)		**Workplace Identifier:**	
(*use this space for mechanical imprint)*		Base	Organization
		Workplace	
		Bldg. No./Location	Room/Area
		AFSC/Job Series	

CRITICAL TASKS IN PRIORITY ORDER

Task Name	**Task Rating**	**Body Regions and Ratings** (Circle one for each region)				
		Shoulder/ Neck	Hands/Wrists/ Arms	Back/Torso	Legs/Feet	Head/Eyes
1.	High Med	High Med	High Med	High Med	High Med	High Med
2.	High Med	High Med	High Med	High Med	High Med	High Med
3.	High Med	High Med	High Med	High Med	High Med	High Med
4.	High Med	High Med	High Med	High Med	High Med	High Med

OVERALL JOB RATING

RATING: High Medium	**PRIORITY BODY REGION:**
(Circle one)	(circle one) Shoulder/Neck Hand/Wrist/Arm Back/Torso Legs/Feet Head/Eyes

- Findings are consistent with results from Job Requirements and Physical Demands Survey (PHF): Yes No N/A
  Comment:_____
- Findings are consistent with employee reports of discomfort and/or illness: Yes No N/A
  Comment:_____

RECOMMENDATION FOR FOLLOW-UP

Modifications and adjustments		**Major changes and/or purchases**	
Expected Benefits (Check all that apply)	Health/Safety Productivity/Quality	Expected Benefits (Check all that apply)	Health/Safety Productivity/Quality