Risk Control Bulletin

Workplace Guidelines For Computer Workstations

RISK CONTROL

CNA

Introduction

In the rapidly changing information age, the distinctions between general categories of computer users is becoming less clear with each passing year. For example, many more managerial workers spend time entering or acquiring information from computers than previously have, while many data entry or clerical jobs have become more conversational. Consequently, adequate ergonomic conditions to provide comfort and productivity are important for workers using computers.

Methods for entering or extracting information from computers are also changing. Punch cards are part of the distant past. The human machine interface is no longer solely the province of keyboards, with pointing devices like the mouse or trackball just as commonplace. Voice activated interface systems are rapidly being developed and improved. Such systems may eventually become the dominant type of interface between human and machine. The voice driven interface would be the most natural of all previous types of interface.

The Goal: Neutral But Changing Postures

In general, operators are most comfortable when body postures are neutral and relaxed. Recommendations for postures and the workstation arrangements that facilitate them should be combined with reminders to change postures periodically and take frequent breaks. The human body is meant to move about as motion assists blood flow and circulation. Operators should:

- Take momentary breaks to stretch and/or perform alternative tasks
- Periodically change the adjustments on your workstation to provide a variety of positions
- Be conscientious about adjusting and readjusting your workstation for comfort

Head/Neck Posture

Your line of sight angle to the screen should be 15-20 degrees below horizontal eye level, approximately the same place where you read paper documents. The head should not be held up as in looking straight ahead since this posture stresses the neck muscles. Avoid placing your monitor in a position that forces you to look straight ahead.

If you talk on the phone while keying, use a headset rather than cradle the phone between ear and shoulder.

Seated Posture - Reclining and Non-Reclining

For operators who alternate keying with reading the screen or other tasks, a reclining posture similar to the one a person assumes while driving is recommended. Make sure your chair provides for a comfortable, reclining posture. The trunk to upper leg angle should be in the 110 to 120 degree range.

For operators who perform intensive data entry or other tasks, a more upright posture with the lower leg to thigh angle greater than 90 degrees is often most comfortable. Tilt the chair seat-pan angle forward a few degrees to encourage this posture.

Wrist/Arm/Shoulder Posture

The hand/wrist should be in alignment with the forearm during keying or using the mouse. The elbows should rest comfortably at one's side, relaxing the shoulder. If the palms are to rest on a surface, make sure the surface is cushioned and comfortable. A palm -rest, preferably the gel type, can be used if needed. Avoid resting the wrist on sharp edges or metallic surfaces.

Physical Arrangement

The arrangement of screen, keyboard, document holder, telephone and other materials in the computer work area can influence comfort and postural symptoms of operators.

Layout For Data Entry or Continuous Tasks:

For tasks which involve only retrieving or entering numbers or words into the computer from a source document, an arrangement with document holder and keyboard directly in front of operators, with the screen set to about 45 degrees to one side, is recommended.

Layout For Conversational Tasks:

For tasks, which involve frequent dialogue with customers or coworkers accompanied by intermittent data entry or data acquisition at the computer, an arrangement with both screen and keyboard directly in front of the operator with any documents to one side, is recommended.

For either continuous or conversational work, the telephone, writing surface, or other materials should be located to either side of the operator. The exact arrangement will depend on the specific attributes of the task and/or worker. For example, the most frequently used tool (e.g., telephone) might be located on the side of the dominant hand: on the left for left-handers; on the right for right-handers.

Worktables: Vertical Aspects

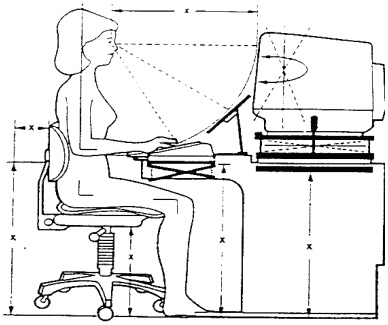
The best worktable is one whose height is easily adjustable by the user. Height adjustable tables are now becoming commonplace in both office and industry and, if considered at the design stage of facilities, add little cost. Worktables that can be adjusted with the help of maintenance personnel are more common in office environments. These at least can be set to a single level that is satisfactory for most of the tasks performed by the individual. However, if workstations are shared, this type of worktable is less appropriate and may require that workers of similar size be matched for sharing workstations. The least desirable worktable is one that has a fixed vertical height. If this height does not coincidentally suit an individual, adjustments to other components will become necessary to compensate, if these are available. A fixed worktable that is too low for a worker should be replaced with a more suitable component.

Adequate thigh clearance for individuals is vital to comfort and the ergonomic soundness of the workstation. For a nonadjustable or fixed height, the underside of the worktable should not be lower than 26 inches from the floor. This will accommodate 95% of the male workforce in terms of needed thigh clearance, and most females. However, this means that 5% of males, the largest or tallest males, will still require a higher desk surface height to sit comfortably at the workstation.

Worktables: Horizontal Aspects

The horizontal space provided by the worktable should allow the components, such as the monitor and keyboard, to be adjusted forward and backward by at least several inches. Room for a palm rest in front of the keyboard should be available. Crowding that requires a fixed horizontal location for components should be avoided. Adequate space for working documents or a vertical document holder should be available.

The available legroom (horizontally) should be at least 23.5 inches from the edge of the table to any obstruction or component wall in order to accommodate a mixed population. The minimum horizontal width for the opening under a worktable for the worker's chair and legs is 20 inches. A wider workstation may be more comfortable for some operators.



Keyboards

The keyboard location and design largely determines hand and wrist postures during use. For this reason, adjustment of the keyboard is important to minimize wrist flexion, extension and ulnar deviation (also called ulnar abduction or lateral wrist abduction—a sideward bending of the wrist toward the smallest finger).

Alternative Keyboard Designs

In addition to conventional keyboards, a variety of alternative style keyboards has become available in recent days. Alternate style keyboards include those with standard QWERTY key arrangements, but which are split into two or three separate sections or even separate keyboards—one for the left hand, one for the right, and numerical keypad. Some split the keyboard into sections fixed upon a single board. Alternate key positioning, in an attempt to better fit the hand, is also available. These include the DVORAK key arrangement. Still other designs dispense altogether with a single key for each character, and instead offer only a few keys, which must be pressed or played in chords to produce specific characters. Whether or not such radical keyboard redesigns will become widely used remains to be seen.

Keyboards: Slope

The slope of the conventional tabletop mounted keyboards shall be between 0 and 15 degrees. For contemporary or alternative keyboard and designs that attempt to minimize hand and/or wrist deviation and extension, keyboard slope may exceed this slope range.

Whereas slope adjustments up to 15 degrees have been incorporated into the conventional keyboard designs, research has shown user preferences for even greater slopes. However, it is recommended that keyboard slope be designed or adjusted (i.e., without “feet” extended) to promote wrist postures as close to straight as possible (e.g., within 5 degrees up or down). Furthermore, some contemporary or alternative keyboard designs may use height, articulation, and tilt advantageously to aid in promoting wrist postures that are as straight as possible.

Keyboards: Height From Floor

Ideally, keyboard height from the floor should be adjustable separately from the worktable. A minimum range for keyboard height adjustability is from 23 to 28 inches. However, a better range of 22 to 29 inches from the floor is recommended in order to accommodate more of the working population. The unusually large or small worker may require keyboard heights that are outside even this range. A range that is inclusive of almost any worker is from 20 to 33 inches from the floor.

The range of adjustability should allow workers to position keyboards somewhat below elbow height. Individual preference should decide the precise vertical location of the keyboard height. There is no requirement that keyboards be at exactly elbow height for all individuals.

For keyboards that are not positioned on a keyboard tray or platform, but directly on the worktable, adjustment is possible by lowering the table height as necessary and adding items under the keyboard to raise the keyboard to the most comfortable position.

Keyboards: Trays or Articulating Arms

Keyboard platforms, trays or articulating arms can allow a wide range of angle and height adjustability. These are often attached to the worktable and have several movable joints or articulations that effectively allow a large number of possible positions. For continuous or conversational VDT work, articulating arms are recommended for workstations without adjustable tabletops. Attachable keyboard trays can be used to cost effectively retrofit existing workstations, adding adjustability.

Negative angle trays may offer postural advantages over conventional keyboard trays (see Keyboards: Slope).

Monitors

Monitors can be placed upon an articulating platform or arm which allows easy adjustability in three dimensions. All three dimensions can be adjusted without an articulating platform by simply moving the monitor closer or farther away, from side to side, or by adding or removing items from underneath. However, if a monitor placed di-

rectly atop the desk is still too high for an operator, either the desk should be lowered to the extent possible, or an "in-desk" monitor arrangement can be used.

Monitor: Vertical Location

The monitor should be located so that the line of sight angle is below the horizontal plane between 0 and 60 degrees at eye level. Accordingly, the top of the monitor should never be higher than eye level. A wide range of preferences for specific monitor location has been revealed through various studies. To facilitate comfort, monitor height should be adjustable. Most monitors can be adjusted vertically by adding or removing items from under the monitor. Note that there is no functional requirement to locate monitors atop the CPUs (central processing unit) as conventional.

Monitor: Distance from Operator

The distance that the monitor is from the operator's eyes should be adjustable in a range from 20 to 40 inches. Operators preferred an average distance of 25.5 inches in a controlled study when document and screen were at different distances; some preferred a distance of up to 31 inches. Researchers have not found that visual strain was greater when the distance to screen and document differed. When operators were allowed to adjust both distance and character size, they chose distances between 20 and 40 inches (average of 30 inches) with characters 5 mm tall. These distances are greater than those, which have often been suggested to VDT operators in the past.

There is evidence that visual conditions affect not only visual symptoms, but also muscle pain in the head, neck, and upper back regions. Studies show that mental workload may have some influence on musculoskeletal symptoms. Visual strain, a form of mental strain, has been shown to affect muscle pain in the head, neck, and upper back.

In summary, operators should be able to select a preferred distance at anywhere between 20 and 40 inches from the screen, and software should allow operators to adjust character size.

Monitor Tilt

Monitor tilt is important for the reduction of reflected glare. This feature can be used to reorient the screen to change the slope of the surface with respect to nearby light sources. The recommendable tilt will depend on the lighting conditions and the preferences of the operator. Fixed monitors should be avoided.

Chairs

Adjustable chairs, which facilitate safe and comfortable work, should be provided to the computer user. Each operator should adjust his or her chair to preferred settings, recognizing that the chosen position will affect or determine many seemingly unrelated variables, like hand and wrist posture or line of sight angle. Chairs, which lack adjustability, can induce working postures, which increase the likelihood of discomfort or cumulative trauma disorders. Lack of adjustability almost guarantees some degree of static muscle loading, a major cause of fatigue, pain, and discomfort. One of the most important aspects of chairs is that they should allow frequent and easy changes in posture and in adjustments.

Chairs: Important Aspects

The features of chair design, which are most vital, are seat-pan height adjustability, lumbar support from the backrest, backrest adjustability forward and backward and seat-pan tilt. Also important for comfort is that seat-pans not be too soft or compressible as to be restrictive to frequent postural changes.

Chairs: Seat-pan Height Adjustment

A range of 15 to 22 inches or wider is recommended where possible.

Chairs: Seat Size and Type

Seat depth should be between 15 and 17 inches. If a seat depth is greater than 16 inches, the design should provide relief to the back of the knee, usually with a "waterfall" front edge. The minimum seat width should be 18.2 inches. The seat-pan should not be too soft or compressive, since such cushioning tends to restrict easy move-

ment, which produces static muscle loading and discomfort.

Chairs: Seat-pan Tilt

The seat-pan shall recline either backward and/or decline forward from the horizontal, have a user-adjustable range of at least 6 degrees, which includes a reclined position of 3 degrees.

Chairs: Backrest

Lumbar support should be provided by the backrest. The exact vertical location of the backrest may not be critical as long as the backrest makes contact with the low back area (lumbar region) and induces the lordosis curvature (natural inward curve of the spine at the low back). However, backrest height adjustability is beneficial for individual preference and comfort and accommodation of the occasional very large or very small person. If the backrest does not make contact with the low back, the operator receives no support at all.

Chair backrests should allow the worker to adjust from upright to reclining postures. Increasing the backrest angle from 90 degrees to 120 degrees (to a reclining position) reduces the load on spinal discs and also reduces muscle strain. Many or most computer operators instinctively know that reclining positions are more comfortable, and wisely ignore the admonition to “sit up straight in your chair.”

In a broader sense, computer users will be most comfortable if they assume postures, which roughly emulate those that are assumed when driving an automobile with comfortable (reclined) seating. This posture entails that feet are not flat on the floor and the trunk is somewhat reclined. One difference is that the arms should be somewhat lower at the keyboard than they would normally be positioned on a steering wheel.

Chairs: Easy Adjustability

Adjustability features are effectively useless if they are not apparent to the user. Chairs, which restrict easy adjustability, are not recommended. Adjustable features requiring use of tools, use of hidden knobs, levers or controls or forcing the user to invert the chair or consult an owner’s manual seriously restrict the user, and are not recommended. Chairs, which can only be height adjusted by rotating the chair, do not offer easy adjustability, since the adjustment feature is not visible to the user. In addition, such chairs gradually change settings during normal use. The best adjustable chair is one that is obviously and easily adjustable. Chairs should swivel so that operators do not twist the trunk or spine when turning or reaching.

Chairs: Arm Supports

Chairs may or may not offer arm supports. For many chairs, these can be added or removed as an option. Arm supports can be useful to prevent static muscle loading of the shoulders, neck and back and may be recommendable for some workers depending on other components and the type of job. Arm supports attached to chairs often interfere with the ability to pull the chair sufficiently close to the worktable to allow contact with the backrest during work. This situation should be avoided. Supports, if needed, can be attached to the worktable rather than the chair. However, a need for arm supports attached to the table should not arise if other workstation elements meet the general guidelines provided here, except for very unique or unusual circumstances.

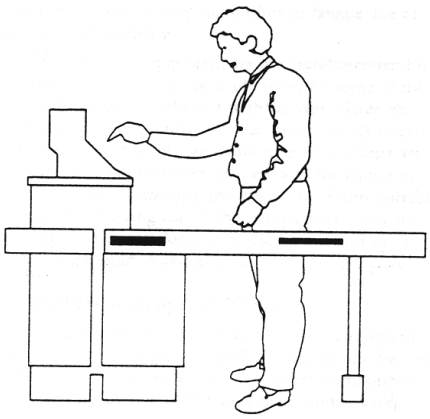
Sit/Stand Workstations

Workstations, which offer the worker a choice of sitting or standing throughout the workday, provide many benefits. Changes in posture are necessary during work in order to avoid fatigue and discomfort. No posture should be held for very long periods, no matter how good the posture. Sit/stand workstations allow changes of posture and shift loads to different sets of muscles. While sit/stand workstations are not currently conventional in office environments, they are recommendable from an ergonomic point of view. At present, only a small percentage of computer workstations are sit/stand workstations, but the number is sure to grow.

Workstation Guidelines for Standing VDT Work

For standing computer work, recommended settings are indicated in the table below. It is not recommended that both keyboard and monitor be placed on the same surface. Each surface should be adjustable individually due to the relatively larger distances between preferred settings when workers are standing versus preferred settings for seated workers.

Keyboard height adjustability range	**33 to 47 (in)**
Keyboard tilt (angle from horizontal)	**0 to 18 degrees**
Monitor height	**51 to 57 (in)**
Monitor tilt (angle from vertical)	**0 to 21 degrees**



Palm Rests

Wrist rests or supports have been shown to be beneficial for reduction of spinal disc pressure in the lumbar spine and for reducing muscle tension in the shoulders. However, only 50 to 60 percent of operators prefer palm rests. Despite their name, palm rests largely aid the low back and/or shoulders rather than the wrists. However, for some users, palm rests are thought to reduce the probability of wrist extension during typing, thereby decreasing risks of hand or wrist discomfort.

Palm rests or supports are low cost items that can be added to most workstations easily. Most are simply placed on the keyboard platform or tabletop in front of the keyboard and may be held in place by slip resistant friction strips that are attached underneath. Due to the low cost and ease of implementation, palm rests should be available to operators who prefer them.

Footrests

Footrests should be provided to any workers whose feet do not reach the floor when the chair is adjusted to a comfortable position in relation to other workstation components. If recommendations for the chair height adjustment range are met, only 5 percent of female workers will encounter this situation when chairs are set to their lowest point. For smaller workers who prefer their chair adjusted higher than its lowest setting, footrests may also be necessary.

Lighting

Lighting conditions in office environments have seldom been planned deliberately for avoidance of direct or reflected glare on monitor screens, especially among older buildings. The tilt feature on many monitors allows operators to adjust the screen to reduce the most annoying reflected glare. Positioning monitors at 90 degrees from light sources, including windows can substantially reduce reflected glare. The workstation should not be oriented so that a worker faces directly toward a light source such as a window since the resulting direct glare can cause serious discomfort or can even prevent the worker from being able to work.

Excessive illumination levels should be avoided in order to reduce the likelihood of direct and reflected glare. Illumination levels for offices with computer monitors should be lower than those for offices without computer monitor. In general, offices for which there are well-printed source documents and conversational tasks, an illumination of 300-lux (a measure of illumination) is appropriate. For poor source documents and conversational tasks, 400 to 500 lux is appropriate and for data entry tasks, 200 to 500 lux is acceptable.

Document Holders

Document holders may not be an important or even necessary component for comfortable use of a computer for all operators. However, they may be very important for some operators.

Frequent vertical head movement or a “nodding” action within the neutral range is good for providing dynamic movement and reducing static muscle loading. Remember, neutral but changing postures is the goal. Researchers have found that the greater the amount and frequency of vertical head movement, the lower the incidence of visual and postural symptoms. These findings are exactly opposite of the traditional view that fixed positions afforded by document holders are needed to reduce head movement for all workers.

However, extremes within the range of motion should be avoided, especially when such extremes are held as static positions. This is most likely to occur with continuous work. For continuous VDT work, a document holder may greatly help to bring head movements and neck postures into acceptable ranges.

Laptop or Portable Computer Users

Laptop computers were designed for short-term temporary use, such as while traveling on an airplane or staying in a hotel. Size and weight are minimized to make carrying easy. Their compactness places all components in fixed positions, which cannot be adjusted in relationship to each other, forcing users to adapt their postures to match the settings of the laptop. Some users of laptops may be required to work with the smaller computers for longer-term or non-temporary use, and may experience musculoskeletal symptoms of pain, discomfort or fatigue due to the lack of adjustability.

While laptops, in general, are not recommended for long term use, efforts can be made to regain some of the lost flexibility that is inherent with laptops. Given an adjustable tabletop, users can at least adjust overall working height. For the primary user location, extra and separate keyboards and monitors can be used with the laptop to allow the same adjustability and flexibility of non-portable computers, reserving use of the compact size only for traveling. Otherwise, long term users may find extra breaks are necessary, making work time less productive.

Workers With Special Needs

Previously injured workers or physically challenged workers may require radically different ergonomic features in their computer work areas. For these workers, components should be carefully chosen to meet their unique needs. Often an ergonomist, physical therapist, or occupational therapist can help in selecting appropriate components.

Helpful Hints: Arranging Your Workstation

Since the settings for most workstation components are interdependent; a specific sequence of adjustments is not clerical. Generally, changing one workstation setting may affect the requirements of other workstation settings, and create the need to modify those other settings. This process is repeated until a satisfactory set up is reached.

The following lists the general steps and specific arrangements, which will create a comfortable computer workstation.

1. Start with an adjustable chair. Adjust your chair seat-pan height to match your individual dimensions. Raise or lower your chair so that your feet reach the floor comfortably. Select a comfortable recline and make sure the backrest supports your lower back. If your chair has adjustable armrests, select an armrest height that allows you to fully relax your shoulders. If other workstation arrangements are satisfactory, armrests are usually not necessary. However, some operators may prefer armrests. Chairs should have separate seat and backrest tilt mechanisms, offering a wide range of combined settings.
2. Position your monitor so that the top of the monitor is at least several inches below eye level. Your line of sight to the monitor should be downward. If the monitor is too high, you could:

    - remove the CPU from under the monitor and set the monitor directly on top of the desk or table

- adjust the desk or table height to further lower the monitor

3. Position your monitor so that it is close enough to be easy for you to read, but as far away as comfortable. Often, the viewing distance will be at least 20 inches and may be as much as 40 inches, depending on the monitor size and character or font sizes produced by your software. Use your software's features to modify character sizes as needed. If direct or reflected glare is a problem, adjust your monitor's tilt to remove the glare. If glare is still a problem, you may need to modify the location of your workstation in relation to light sources or windows. Select an arrangement in which the monitor screen is at a ninety-degree angle from light sources or windows. A glare-reducing filter can also be helpful for cutting down glare (Use only as a last resort).
4. Place your keyboard in a keyboard tray and adjust the height to match your individual dimensions. Be sure that your hand/wrist can align with your forearm when typing. To accomplish this, you can raise or lower the keyboard height, and tilt your keyboard up or down (positive or negative slope). By tilting the keyboard with the back of the keyboard lower than the front you can lower your arms closer to your lap and more fully relax the shoulders. The induced hand/wrist posture is very comfortable for many people. Some users may prefer their keyboard flat, without being tilted. Some points about keyboard tray settings:

Checklist for VDT Workstations

Posture: Upper Extremity

Is the person able to work with the head facing forward?

Is extended reaching minimized?

Is the person able to work with comfortable arm positions?

- neutral shoulder positions?
- neutral wrist positions?
- comfortable elbow positions that do not force shoulder or elbow positions from neutral position?

Posture: Lower Extremity

Is the person able to rest the lower limbs comfortably?

Is the person free of uncomfortable pressure points, obstructions, or other interferences in the lower extremities?

Force & Static Body Posture

Do job requirements cause static body positions?

Workstation Design: Seat Surface

Is the height adjustable?

Is the seat surface of appropriate size for the person?

Is the seat slope adjustable?

Does the seat-pan have a "waterfall" front edge?

Be sure that there is adequate thigh clearance space underneath the keyboard tray. Some keyboard trays have adjustment levers or knobs underneath which can interfere with thigh clearance or may be bumped easily with the knee.

Modify settings on the keyboard tray until you can work without feeling pain or discomfort at the wrist. Often, small or subtle changes to your keyboard height or tilt can make a large difference in hand/ wrist comfort over time.

5. Attach a mouse pad to the right or left of your keyboard tray—depending on whether or not you are right or left handed. The mouse pad should rest at approximately the same height and location as your keyboard, not located on top of a desk which forces you to reach up and out to perform work with the mouse. Some keyboard trays provide an attachable and separate mouse pad just above the keyboard tray. These are very

comfortable for many users.

6. Readjust aspects of the workstation, which have been altered by the steps above. As you make changes to your workstation, you may need to revisit some components to readjust them as you repeat the process.
7. Obtain and use a headset if you need to talk on the telephone while typing or keying.
8. Very short operators may require a footrest. If feet do not reach the floor after all adjustments are made, an adjustable footrest can be used.
9. Use a copyholder to create additional desktop space or to improve head/neck posture for reading copy.
10. Provide adequate space for other tasks such as writing, reading copy, or dialing the telephone. Position materials within easy reach depending on the frequency of expected use. For example, if the job entails making frequent phone calls, position your telephone within easy reach of your left or right hand - depending on whether you are left or right handed.
11. Stretching and flexing can make you feel better. Do them periodically throughout your day.
12. Bifocal or trifocal lens wearers may need special glasses for computer work. Your eye doctor can advise you.

Is the seat comfortable to the person using it?

Workstation Design: Seat Backrest

Can the person easily adjust the backrest height to provide lower back support?

Can the person easily adjust the backrest angle relative to the seat-pan?

Workstation Design: Work surface

Is the work surface height adjustable?

Does the work surface provide adequate space to adjust the distance from person to monitor?

Workstation Design: Computer Monitor

Is the person able to easily adjust the height of the monitor?

Is the person able to easily adjust the tilt of the monitor?

Is the monitor positioned at least several inches below eye height?

Workstation Design: Keyboard

Is the person able to easily adjust the angle of the keyboard in either direction (tilt up or tilt back)?

Is the person able to easily adjust keyboard height?

Is the keyboard separate from the monitor?

Workstation Design: Mouse

Is the design of the mouse easy for the person to use?

Is the person able to reach and operate the mouse without extended or repetitive reaching?

Document Holders

Is a document holder needed for data entry tasks?

If used, is the person able to easily adjust the document holder position and angle?

Footrest

Is a footrest available if needed? If so, is the person able to easily adjust its location and angle?

Environment Lighting

Are lighting levels in the monitor area comfortable to the person?

Does glare from lighting or windows reduce screen visibil-

ity?

Are diffusers used on nearby light sources?

Are task or desk lights available if needed?

Do nearby windows have blinds or curtains for reducing glare?

Tasks and Activities

Is the person free to take rest pauses or breaks as needed?

Is there task variety?

Vision

Does the person need special glasses for computer work? (such as bifocal lens wearers)

Organizational

Does the person have some involvement and control over the work process?

Has the person been adequately trained?

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Date	Company Name	
Project Number/Name	Meeting Location	Person Conducting Meeting

Items Discussed:

Problem Areas or Concerns:

Attendees:

Comments: