Stationary Source Compliance Series

EPA-340/1-85-002a

Air Pollution Source Inspection Safety Procedures

Student Manual

September 1984

EPA

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OFFICE OF AIR QUALITY PLANNING AND STANDARDS
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Air Pollution Source Inspection Safety Procedures

Student Manual

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INTENDED PURPOSE

This is not an official policy and standards document. The opinions, findings, and conclusions are those of the authors and not necessarily those of the Environmental Protection Agency. Every attempt has been made to represent the present state of the art as well as subject areas still under evaluation. Any mention of products or organizations does not constitute endorsement by the United States Environmental Protection Agency.

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TABLE OF CONTENTS

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The safety precautions set forth in this manual and presented at any training or orientation session, seminar, or other presentation using this manual are general in nature. The precise safety precaution required for any given situation depends upon and must be tailored to the specific circumstances or each situation. Engineering-Science, Inc. expressly disclaims any liability for any personal injuries, death, property damage, or economic loss arising from any actions taken in reliance upon this manual or any training or orientation session, seminar, or other presentation based upon this manual.

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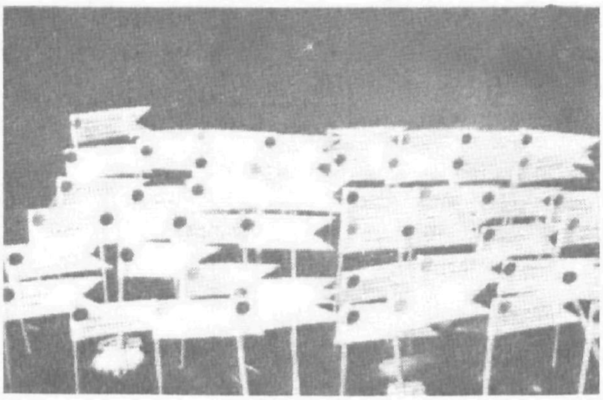
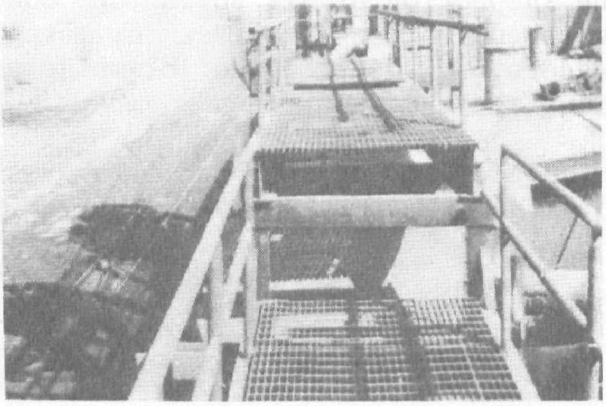
Engineering Science and Richards Engineering would like to thank the 15 companies who permitted photographs to be taken of their air pollution control systems. We sincerely appreciate the considerable support they provided in obtaining the necessary photographs. We would also like to thank Mr. Jim Orr of the Pennsylvanin Department of Environmental Resources and Mr. John Reggi of the West Virginia Air Pollution Control Commission for their help with this project.

SLIDE 1-1



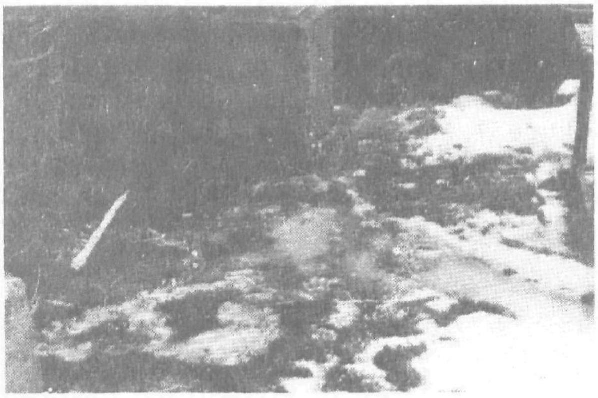
This program is designed to help air pollution control equipment inspectors recognize and avoid common health and safety hazards. The slides shown in Lecture 1 introduce the major categories ies of hazards encountered in industrial facilities.

SLIDE 1-2



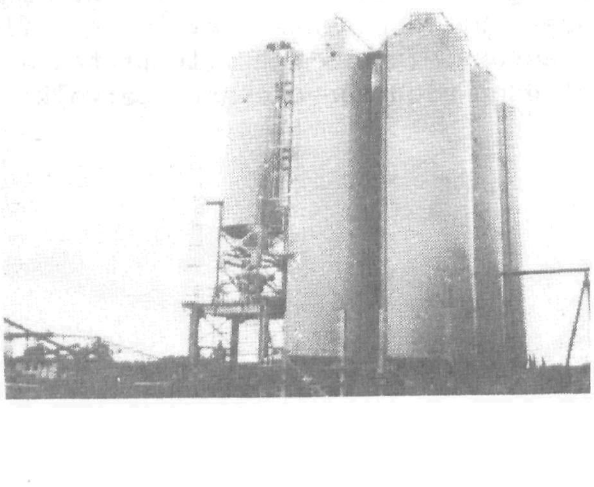
Walking hazards are one of the major causes of accidents involving field inspectors. This slide illustrates a two foot drop along an elevated catwalk.

SLIDE 1-3



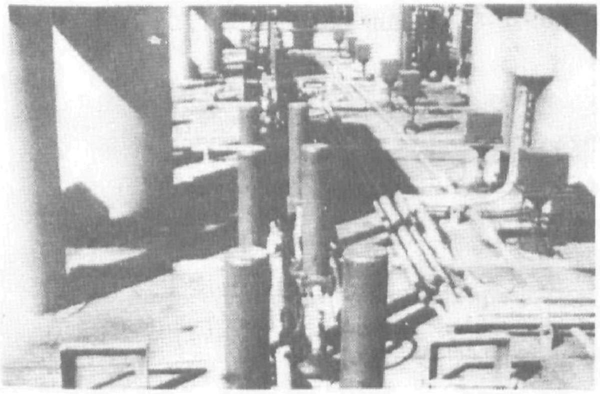
The icy surface shown in this slide is another common walking hazard. A fall in this area could easily result in a serious head injury.

SLIDE 1-4



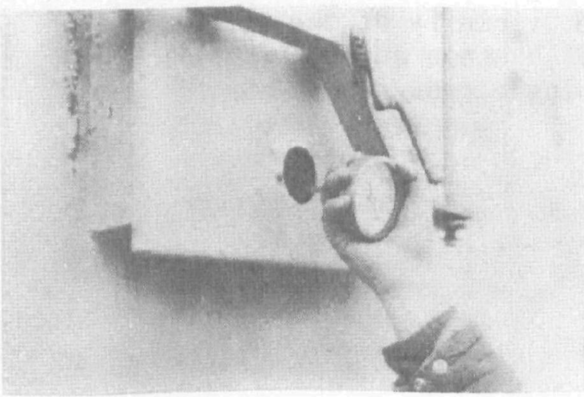
The inspection of air pollution control equipment often involves climbing of ladders. Proper ladder climbing practices are mandatory.

SLIDE 1-5



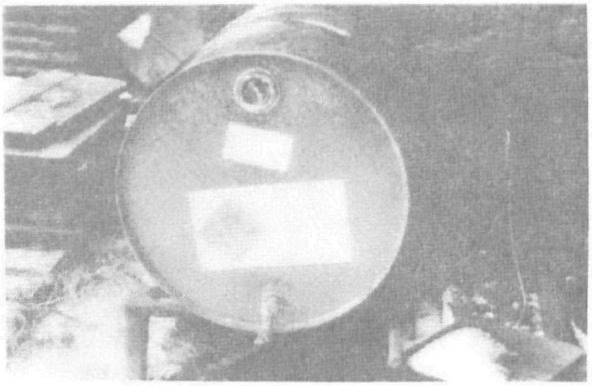
Extended exposure to high noise levels can lead to gradual hearing loss. Hearing protection is often advisable

SLIDE 1-6



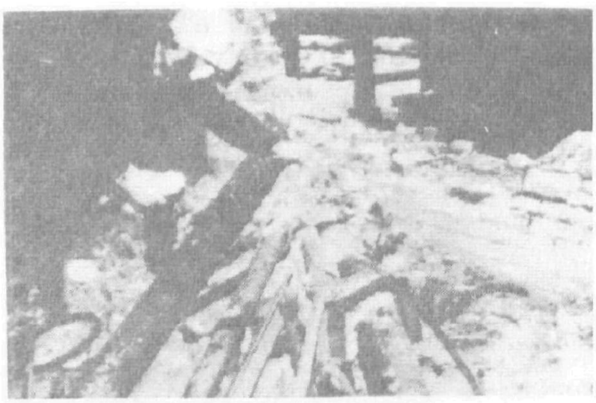
Most metallic surfaces in air pollution control equipment are very hot. Direct contact can lead to a painful burn.

SLIDE 1-7



Improper handling of flammable liquids can result in an explosion.

SLIDE 1-8



Inhalation hazards are often present in the vicinity of the air pollution control systems and other areas which must be inspected.

SLIDE 1-9

FACTORS CONTRIBUTING TO POTENTIAL INSPECTION SAFETY PROBLEMS

- Lack of personal safety equipment
- Lack of familiarity with plant hazardous locations: trip hazards, overhead obstacles, equipment movement areas, and partially confined areas
- Synergistic effects due to the accumulation of numerous pollutants
- Lack of acclimatization to heat

A number of factors increase the inspector's risk with regard to health and safety hazards. These factors are introduced in the next two slides. These are discussed in more detailed throughout the program.

SLIDE 1-10

FACTORS CONTRIBUTING TO POTENTIAL INSPECTION SAFETY PROBLEMS (continued)

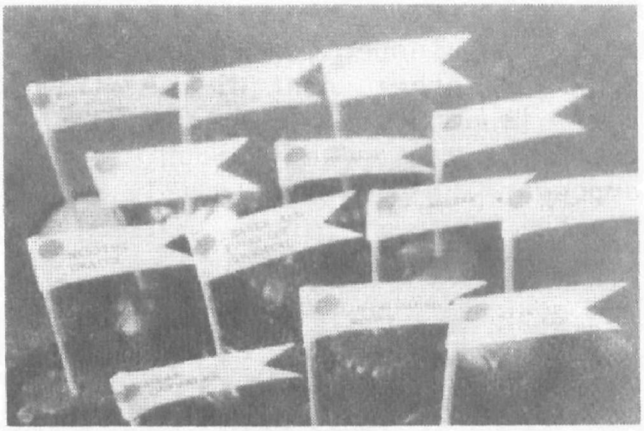
- Potential sensitivities to pollutants and materials which are encountered
- Attempts of plant personnel to hurry inspector
- Lack of safety considerations due to conversations with plant personnel
- Lack of inspector training
- Lack of medical monitoring program.

The purpose of these last two slides is to convince field inspectors that they are not immune to health and safety problems.

It is important that field personnel exercise care while performing inspections of air pollution control systems. Each inspector must be aware of and adhere to all agency and plant safety policies. Furthermore, the field work should be conducted only if the inspector is in good physical condition.

All personnel involved in the inspection of air pollution control sources should have formal training in safety policies and procedures before beginning the field work. This course is intended to supplement this formal training.

SLIDE 2-1



This lecture concerns the numerous physical hazards which can be found while walking to or working around air pollution control systems. The list presented in the adjacent slide presents some of the most common and potentially dangerous conditions.

A number of slides are presented to illustrate the importance of the safety procedures mandated by EPA Policy and described in the references listed earlier.

The risk of accidents due to these conditions can be minimized by adherence to basic safety procedures and by common sense. Unfortunately, some inspectors can get distracted while conducting the inspection. This can occur due to general unfamiliarity with the plant or due to conversations with the plant personnel. Accidents are more likely when the inspector forgets to look for the physical hazards. These problems are avoided by conducting the inspection at A CONTROLLED PACE.

SLIDE 2-2

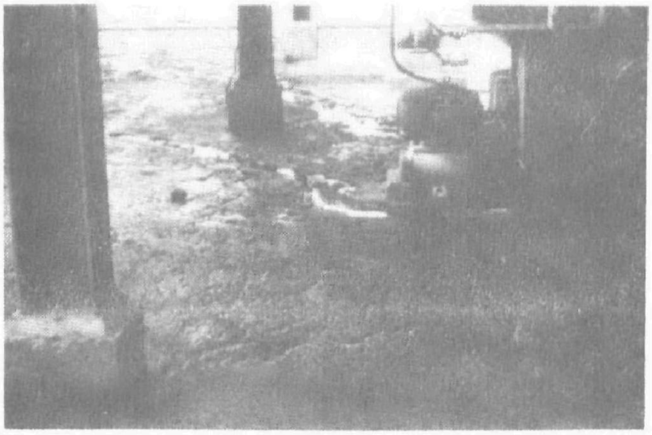
Source: National Audiovisuals Center

Slippery areas are very common near air pollution control systems. A fall can result in serious injuries to the head or other parts of the body. These areas should be avoided to the extent possible. If it is necessary to go through slippery areas, the proper type of shoe should be used.

It is not always possible to see that an area is slippery. The surfaces of some sludge and, wet fiber layers often disguise the slippery nature of the material. Even ice is hard to identify in some cases.

The inspector should be looking for slippery areas (1) around all wet scrubber systems, (2) while walking on any surface which could have oil or grease deposits, or (3) while walking on any settled deposits.

SLIDE 2-3

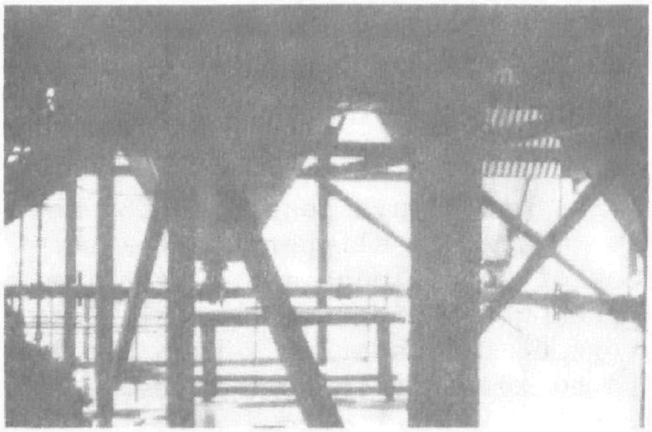


During the inspection of wet scrubbers and other control systems, there is a natural tendency to look around or up at the various system components. Falls can easily occur on the slippery areas which are often beneath these systems.

This slide shows the area around the main recirculation pump of a wet scrubber. The entire area is very slippery. A fall here could result in a head injury on one of the footings shown in the slide.

Most centrifugal pumps suffer some leakage due either to packing problems or to the packing seal water. If it is not adequately drained, the area around the pump can be very wet. This particular system also suffered an occassional recirculation tank overflow because of foaming. This deposited wet fibrous material on most of the walkways near the scrubber. Although the entire system could not be shown on this slide, it was possible to avoid this wet area without limiting the inspection.

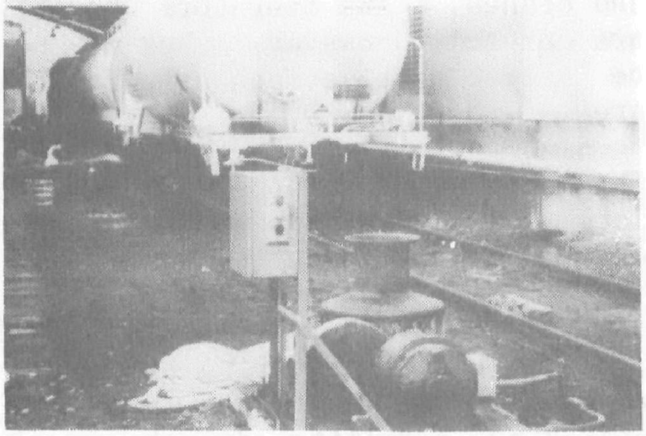
SLIDE 2-4



This is a view of the area under an electrostatic precipitator serving a pulverized coal-fired boiler. It is very common to find solids deposits in this area because of the occassional need to clean out one of the hoppers. Small puddles of water remaining after a rain can make this a treacherous walking surface. There are numerous pipes, conduits, valves, and beams throughout the area and this makes any fall particularily dangerous. It should be assumed that all areas underneath hoppers are slippery and thus they should be approached cautiously.

Later in the lecture other potential problems which can be encountered under hoppers will be discussed. These include hot, free flowing solids, high concentrations of toxic gases, and hot surfaces. Obviously, hopper areas must be approached carefully. They should not even be entered unless the inspection data gathered during the initial phase of the inspection clearly illustrates the need for information concerning the hoppers.

SLIDE 2-5

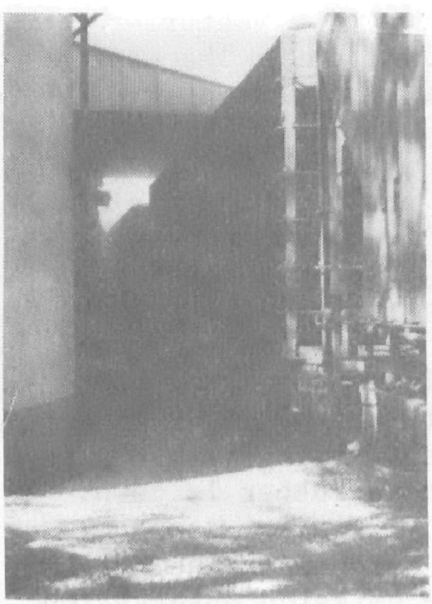


This is a railcar unloading shed which is equipped with a baghouse to control the lime unloading operation. One of the ways to get to the baghouse passes by the track and car puller shown in this slide. If the cable shown snapped while a person was walking along this track a severe injury would be possible. Inspectors should avoid the area of the car puller when the cable is under tension.

In this case, the unloading shed can be approached from the opposite direction.

Rail sidings are commonly visited by inspectors since many of them have small baghouses on the loading and unloading operations. They are also used occassionally as vantage points for making visible emission observations. It is best to avoid these sidings to the extent possible.

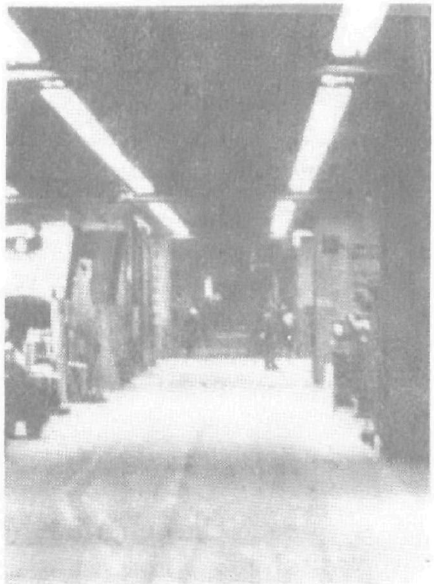
SLIDE 2-6



Another rail car unloading operation is shown in this slide. Inspectors should not walk between the cars since these trains are often remote controlled and can move without any warning. The operator may not be aware of the presence of people and may not be able to see everyone in the siding area.

As a general rule, inspectors should allow 75 foot clearance from any stopped engine or cars. Also, visible emission observations should not be made while standing on the tracks.

SLIDE 2-7



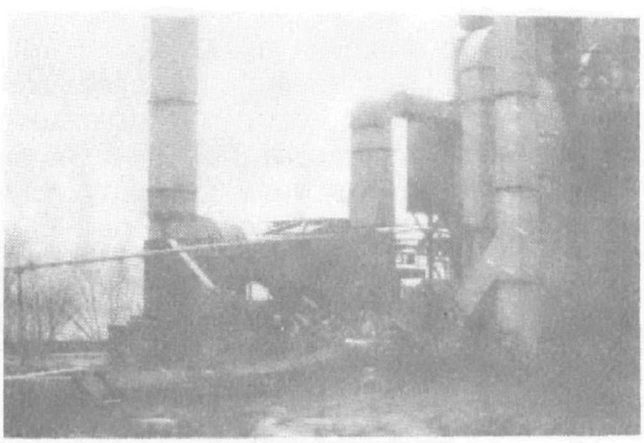
Source: National Audiovisuals Center

While walking around the plant area the inspector should be conscious of moving equipment such as forklifts and cranes. The operators usually are careful, however, they may not be aware that someone is in the area.

This problem has become more common lately as some plants reduce or turn off the plant lights to save energy. These plants may conduct operations only at night and have just a small crew in the plant during the normal working hours. Plant personnel operating forklifts do not expect anyone to be in the plant and can not see very far ahead.

In such cases, the inspector and plant representative (if any) should try to reach the air pollution control equipment by walking outside the plant buildings. If this is not possible, the inspector should be careful while walking through the plant.

SLIDE 2-8



This is the first of a series of three slides of a venturi-rod scrubber installation. The weather conditions during the inspection were less than ideal.

The vantage point of this slide is the one that would be chosen by the inspector to make a visible emission observation (if it was not snowing). There is obviously a considerable amount of sludge surrounding this area. This sludge is common at the plant except during very dry periods or when the scrubber is down.

The inspector would have to be careful to watch where he or she is walking while choosing a site to make the visible emission observation. In some cases, the inspector becomes preoccupied with checking for the proper sun angle and the wind direction and forgets about the slippery surface.

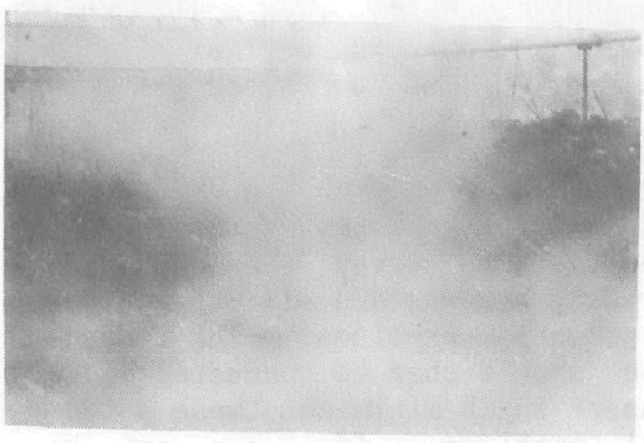
SLIDE 2-9

This is a view of part of the system from approximately the same vantage point as the last slide. There is a settling basin close to the location where a visible emission observation would be made. This has a ground level entry and a steep slope to permit front end loaders to clean out the accumulated sludge when the basin is emptied. It would be easy to slip into this pond.

This style of settling basin is very common. It is the preferred basin design in many cases because it is easy to clean out and has good settling properties.

The areas immediately around this basin or any settling pond should be avoided by the inspector. Samples of the liquor should not be obtained at this location since it is usually much safer and easier to get samples of the pond or basin liquor from sampling points downstream of the main pump.

SLIDE 2-10

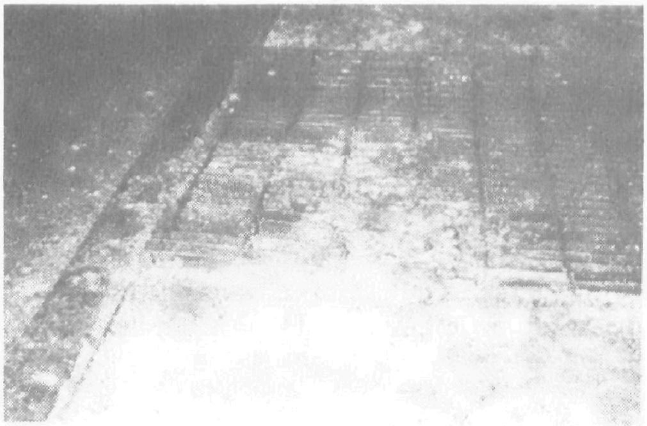


This is a view of the same area shown in the previous slide. It was taken 15 seconds after the previous slide. A large steam cloud has almost entirely obscured the location of the settling pond. An unsuspecting inspector who is moving too fast could easily get too close to the entry to the basin under these conditions.

It is common for steam clouds to intermittently "mask" the walking surfaces around air pollution control systems. The inspector should not proceed until there is adequate visibility.

Some inspectors make the assumption that they are familiar with the obscured area and can therefore proceed. This can be a very bad assumption since plant personnel may have forgotten to replace a grating, have left some rope or other obstacles, or made other changes. An inspector usually visits a plant only once or twice a year. Many changes can occur between inspections.

SLIDE 2-11



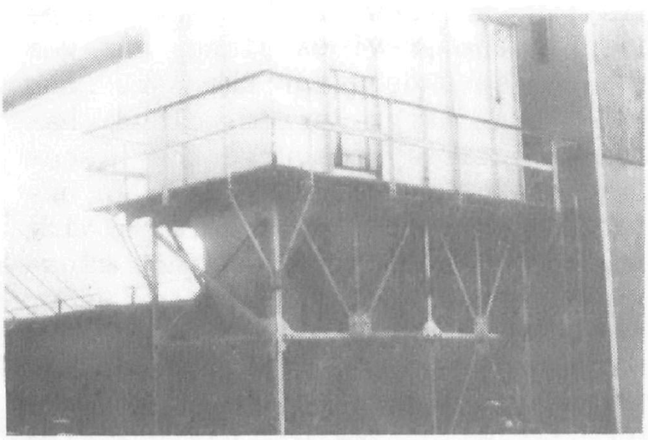
Source: National Audiovisuals Center

Up to this point every slip hazard has been wet. There are numerous other slippery areas caused by oil, grease, or solids. This slide illustrates a small quantity of very slippery "marble" type deposits. This area could be easily avoided as long as the inspector (and the plant personnel accompanying the inspector) were looking for slippery areas.

Another common cause of slippery areas is oil or grease leaking from moving machinery.

The best way to minimize the risk from these types of deposits is to avoid rushing during the inspection. In some cases, the inspector is anxious to get to a malfunctioning control device. Also, some plant personnel are anxious to get the inspector "out the door" so that they can continue with their work. It is the responsibility of the inspector to make sure that the inspection is conducted at a controlled pace so that this type of accident does not occur.

SLIDE 2-12

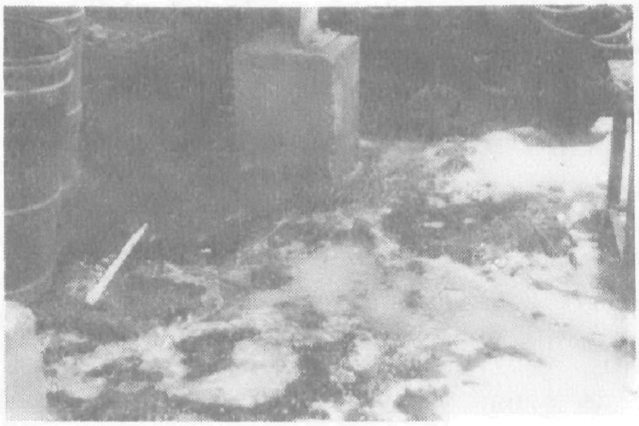


This a photograph of a small reverse air fabric filter. The ambient temperature during the inspection was approximately 20°F and it had snowed three days earlier. The weather conditions created several slip hazards.

Prior to starting the inspection of this system (or any system) it is important to survey the situation for slip hazards and all other types of potential problems. The inspection should then be conducted in a manner which minimizes these potential problems. If it can not be done safely at the present time, it should be terminated.

In this case, only part of the inspection could be safely done. It was possible to check the opacity of the filter discharge and the adequacy of the solids discharge system operation. It would have been possible to check the pressure drop safely, however, the gauge was not working. The use of portable instruments would not have been safe at this unit on this day. Furthermore, the inspector should not have gone up to the platform surrounding the collector compartments. The potential problems here are shown in the next few slides.

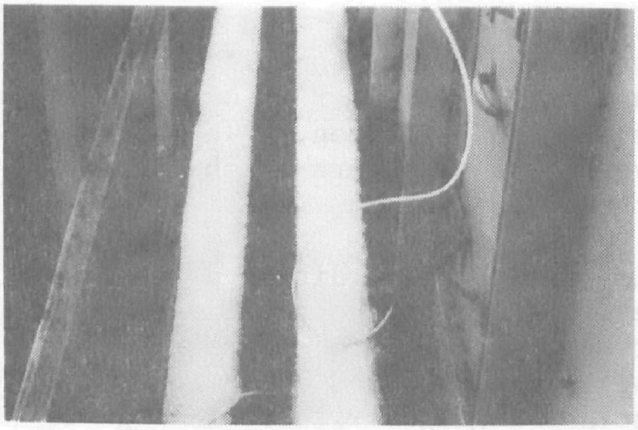
SLIDE 2-13



This is a view of the ground next to the platform access ladder. It would be easy to slip on the ice and hit one's head on one of the footings shown in the slide. There was also a lot of debris around this area which could make any fall a serious problem. This is one of the reasons that the inspector should not go up the ladder on this day.

This ice is relatively easy to spot. In some cases, it is not quite so obvious that the area is slippery.

SLIDE 2-14



This is the wooden platform around the fabric filter compartment. The mound of ice made getting traction very difficult. In addition to a simple fall on the platform, it is conceivable (but not likely) that a person could slip under the mid rail and fall to the ground due to the lack of a toe guard on the railing.

Due to the ice in this location it is unadvisable to continue the inspection. In this case, the portable instruments could not be used to check the pressure drop and the clean side deposits could not be evaluated.

It would be impossible to see this ice from the ground. Upon reaching the top of the access ladder the inspector should determine that the surface is not adequate and proceed directly back down.

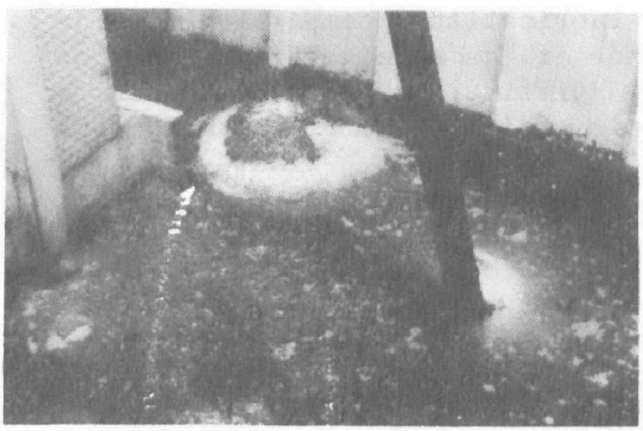
This is a common problem with fabric filters mounted on the roofs of silos and other flat surfaces. These units can be 50 to 150 feet above the ground and a fall could be very serious. It is especially difficult to remove an injured person (eg. broken leg, sprained ankle) from these high locations.

SLIDE 2-15

This is a view of a railroad siding next to a fabric filter system. It is apparent that there is some ice approximately 15 feet ahead. What may not be apparent is that the entire area is slick. The area in the foreground is "black ice". It seems slipperier than the regular ice in the background of the slide. The "black ice" is simply frozen water having a very high suspended solids content.

While looking up at the rail car loading shed baghouse it would be easy to miss this very slippery area. It must be relatively cold for this ice to form. The day this photograph was taken the temperature was 8°F.

SLIDE 2-16



This is a venturi rod scrubber mounted on a horizontal roof. A small puddle of water on one side of the unit has frozen. There were several sharp corners which might be hit during a fall.

This is the most direct path from the access ladder to the location of the differential pressure gauges. However, there was another way to reach the gauges without having to worry about the ice.

During cold weather it should be assumed that almost all elevated horizontal surfaces will have some frozen puddles or other slippery areas. Since some of these surfaces do not have guard rails, it is particularily important to avoid the slippery ones.

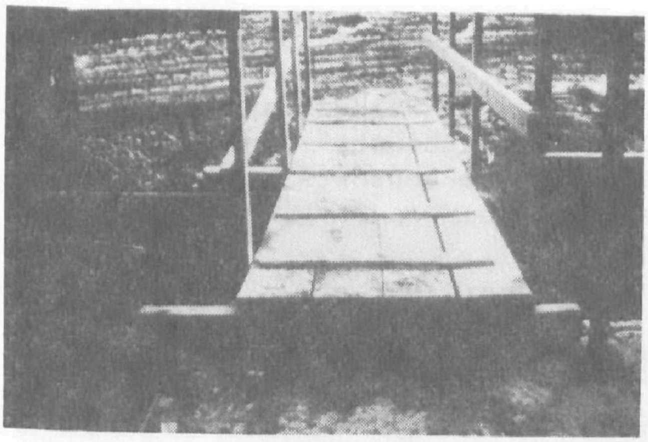
SLIDE 2-17

This is a plank leading from an access ladder over to the area of a flooded disc scrubber. The roof has some ice and there is no guard rail.

It is important to be especially careful of slip hazards on elevated surfaces. Falls from these surfaces can be fatal. Many of the elevated surfaces were not intended for walking, therefore guard rails are often missing. Some of these surfaces are also sloped.

There is no guarantee that the temporary plank or other walking surface is free from ice or water. In the case shown above, the board was moderately slippery due to water which had dripped off an adjacent roof and refrozen over night. Deposits of fugitive materials on the plank also made the walkway slippery.

SLIDE 2-18



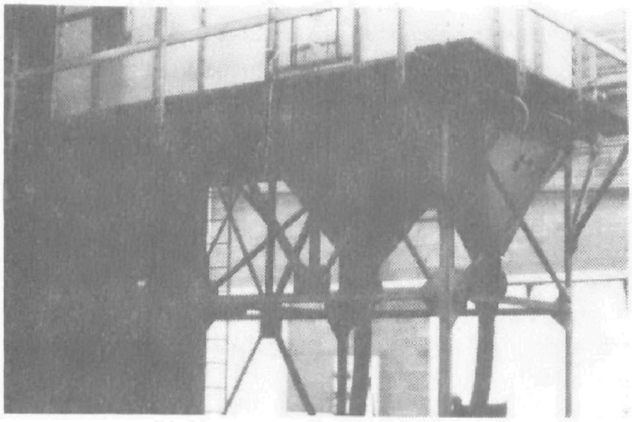
Source: National Audiovisuals Center

This is a temporary walkway over an excavated area. It is probably safe as long as (1) it is in regular use by plant personnel, (2) the wood appears to be in good condition, and (3) the ends will not slip. Nevertheless, it is a good practice to let the plant representative along on the inspection go first. Also, no more than one person at a time should cross this temporary bridge.

Occassionally, these might be found in remote areas of the plant. It is possible that the wooden planks have rotten or that the ends are no longer secured. The integrity of the walkways should be questioned and it should be avoided if possible.

Under no circumstances should an inspector cross between two platforms or buildings (or any other crevice) by means of a ladder or single plank. Ladders are not intended for this service and are sometimes not secured properly. The inspector should refuse to cross any potentially unsafe walkway (such as a ladder, a single plank, or a weakened bridge) even if the distance is short or plant personnel insist.

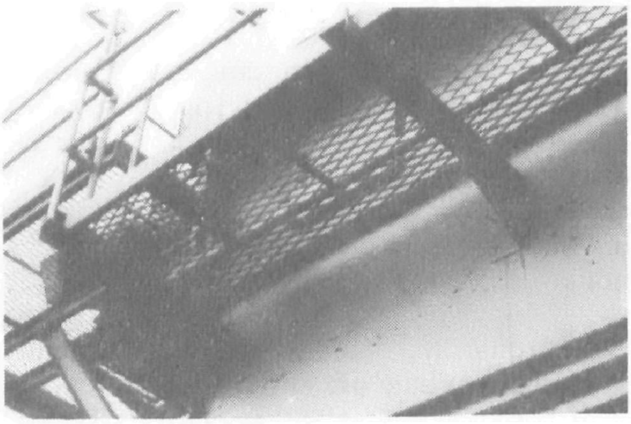
SLIDE 2-19



Before going up to any elevated platform around an the air pollution control system, the integrity of the platform should be quickly checked from the ground. This is a view of the wooden walkway on the baghouse shown earlier. The condition of the boards and the support angle irons should be checked before climbing the ladder up to the platform. Once you are on the platform, it is very difficult to confirm that it is structurally secure.

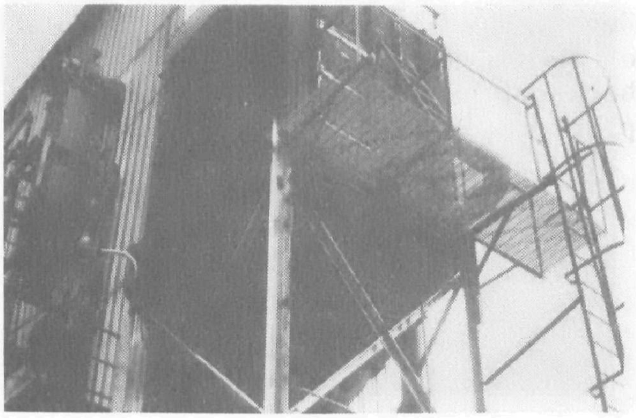
Some of the common problems include rotting of the wooden boards, corrosion of metal walkways, and failure of the supports.

SLIDE 2-20



This is the walkway around a new pulse jet baghouse. Both the walkway and the supports appear to be very secure.

SLIDE 2-21

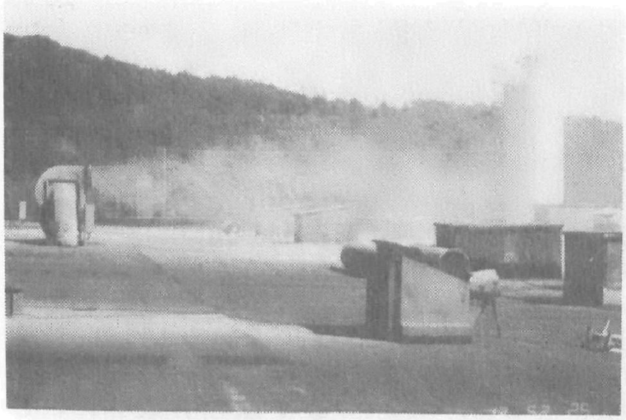


Before moving to an elevated platform the inspector should also consider whether there is a risk of being trapped on the platform while a rising cloud of toxic gas or high temperature steam passes. If so, the inspection should only be conducted when the source of the gas or steam is not on. In some cases, the inspector may be able to use a respirator and/or some protective clothing if the process equipment must be operating during the inspection.

There are some cases where an inspection can not be done safely with or without protective equipment and clothing. In such cases, the inspector must be content with simply evaluating emissions from a distance or the evaluation of instrumentation located in safe areas.

Inspectors should not underestimate the potential problems resulting from rising steam clouds and/or toxic clouds of pollutants. They can form suddenly due to a process upset and it is difficult to get off a platform when both visibility and breathing is impaired. Several inspectors have been very seriously hurt due to this problem.

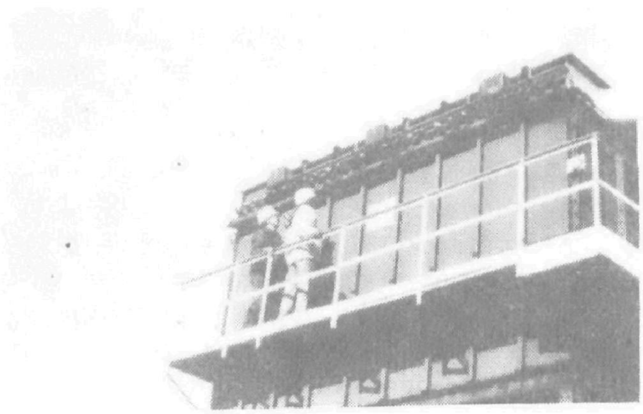
SLIDE 2-22



This is a typical roof at a manufacturing facility. It would be necessary to be on this roof to read the visible emissions coming from the various small vents. A quick shift in the wind direction would result in the fumigation of the inspector. The bluish white aerosol could contain some very toxic and irritating materials. The inspector must know ahead of time what possible pollutants are in the plume and carry with him the appropriate type of respirator for this material.

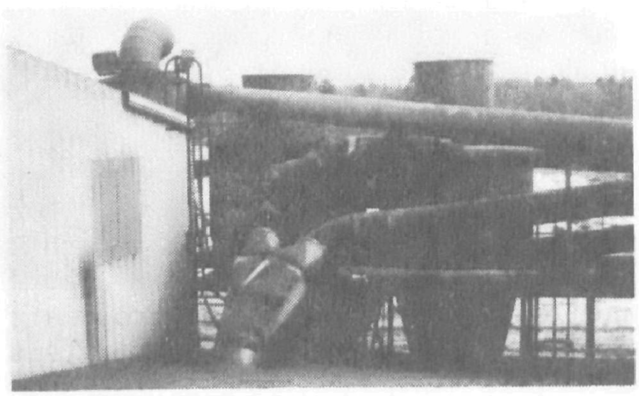
The position used for the visible emission observation should be normal to the wind direction. This places the inspector in the direct line of travel of plumes from other process vents or discharge points. Before selecting a location for the observation, the locations of all discharge points (both continuous and intermittant) should be determined.

SLIDE 2-23



Regardless of the apparent strength of an elevated platform, large numbers of people should not be on it platform at one spot.

SLIDE 2-24



There are some elevated surfaces which may not be able to withstand any additional load. An inspector who walks across a roof as shown in this slide may fall through. It is very important that inspectors only walk in areas designated as safe by the plant personnel. This is one of the reasons that it is essential that plant personnel accompany the inspector. It is prudent for the inspector to walk behind the plant personnel.

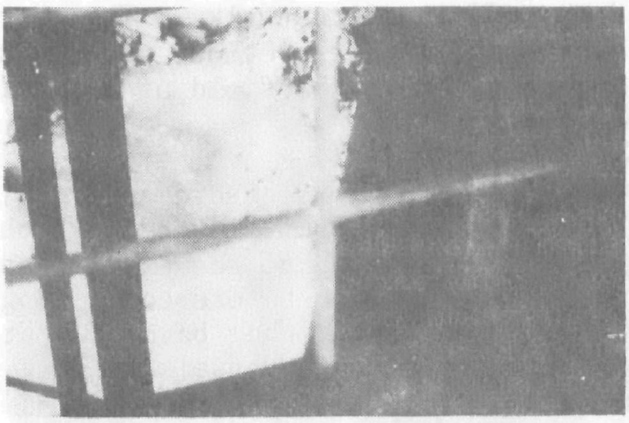
Plants may replace sections of worn corrugated metallic roofing with FRP corrugated roofing. The latter does not usually have the load bearing capability of the metallic roofing, therefore, an inspector walking across a supposedly secure roof could fall through. While the FRP material should be easy to identify, in the many cases a thin layer of fugitive material (as shown in the above slide) can easily disguise it. This is another reason that the plant representative should accompany the inspector.

SLIDE 2-25

One sign of potential roof loading problems is the presence of large deposits of solids or snow. This can render an otherwise secure roof into a major hazard, especially in the immediate vicinity of the solids deposits.

The deposits shown in this slide were due to the clean out of a plugged hopper on a baghouse which is up and to the right of the view of the slide. The area near these deposits should be avoided if at all possible.

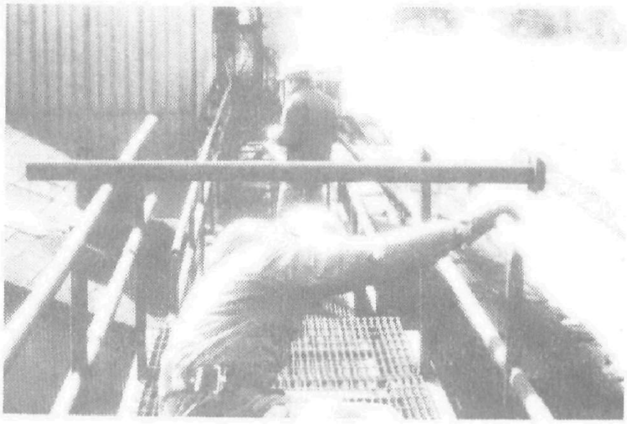
SLIDE 2-26



Not all guard rails on elevated platforms and walkways can actually withstand the 200 pound force for which they were designed. Leaning against weak railing could result in a serious accident. Inspectors should check the integrity of these railings, if possible. Under no circumstances should the inspector risk a fall, however, in order to check the adequacy of the guard rail.

This railing was next to a venturi scrubber. An inspector may have been tempted to lean against this railing in order to see the main pump and the static pressure gauges. This railing was very weak.

SLIDE 2-27

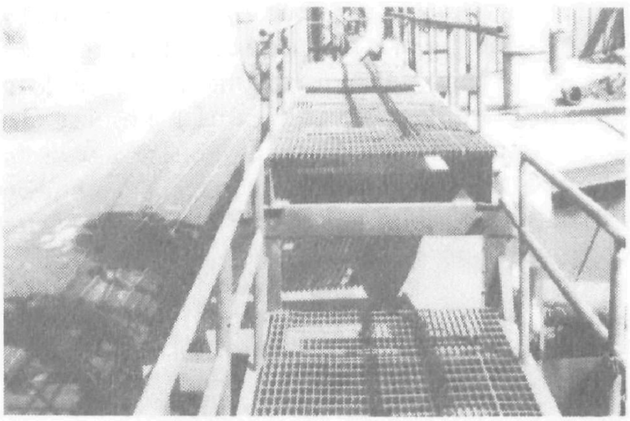


This photograph shows an inspector ducking under a pipe which has been welded to guard rails along a walkway between two baghouses. This was necessary to prevent the guard rails from falling. Despite the "fix" the inspector should place very little faith in the security of these guard rails.

The bar across the walkway provides an interesting hazard on its own. The inspector who is preoccupied in conversation with plant personnel or in looking at the baghouse exhaust could easily flip over the bar. The location of the bar is below the center of gravity of most people.

Looming directly ahead of the falling inspector is a three foot drop in the catwalk. The fall could result in (1) a fall over the catwalk, (2) serious eye injuries on the exposed ends of the grating, and (3) serious head injuries. Obviously, it is important to watch where you are going and to conduct the inspection at a controlled pace.

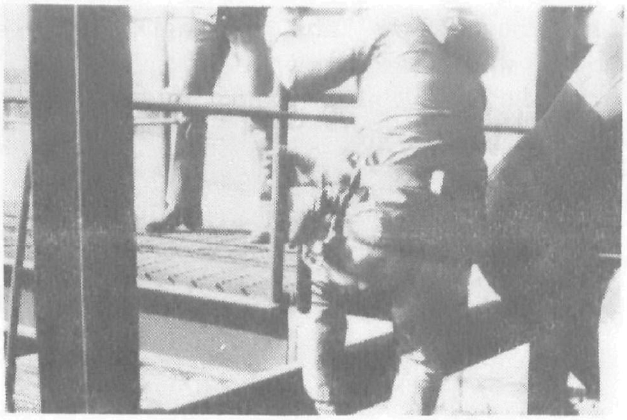
SLIDE 2-28



This is a view of the three foot drop off in the catwalk. The bar discussed in the previous slide is directly above the field of view of this slide.

This is not an adequate walkway. This is the type of situation which should be brought to the attention of your supervisor before conducting the inspection of the baghouse at the far end of this catwalk.

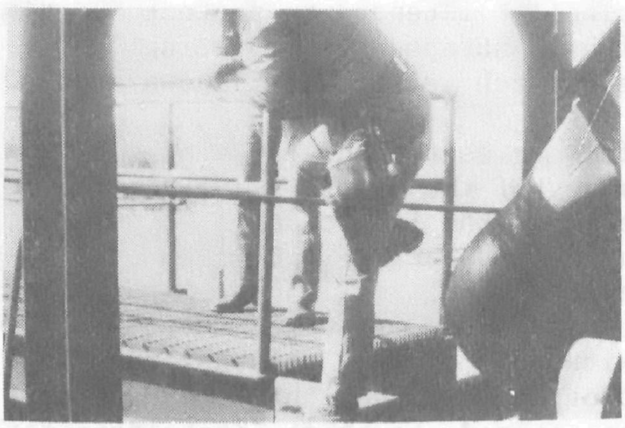
SLIDE 2-29



At the other end of the walkway shown earlier, it is necessary to step off the catwalk to a support beam, over some electrical conduits, to the next platform. This is shown in this slide and the one directly below.

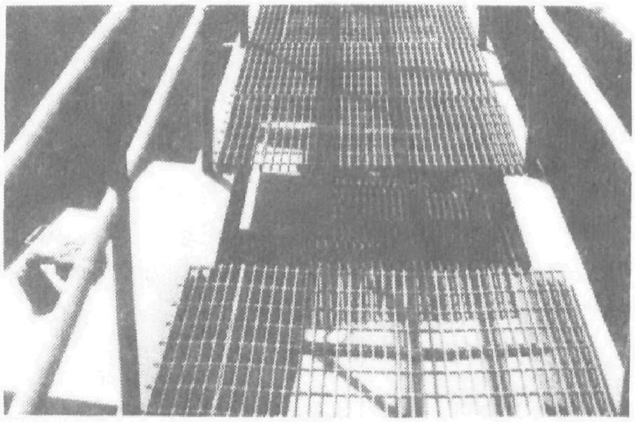
Failure to negotiate this obstacle course could result in a fall of 30 feet.

SLIDE 2-30



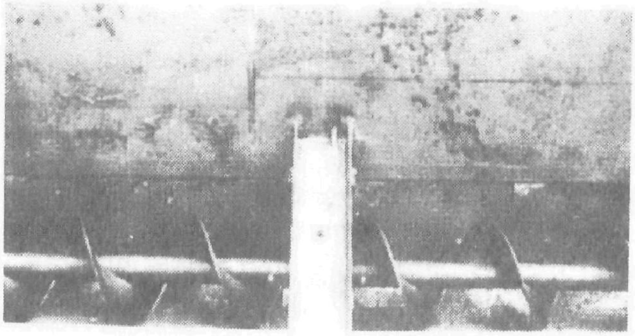
These slides were taken simply to show the types of catwalks which may be encountered, especially in some of the older facilities. Inspectors should not attempt to use these. This is not adequate and safe access to the control equipment.

SLIDE 2-31



There is a missing section of grate in this walkway. The unsuspecting inspector could fall approximately two feet to the roof of a baghouse directly below the catwalk. For those who have been keeping score, this is the fourth major hazard in the 40 foot run of this particular walkway.

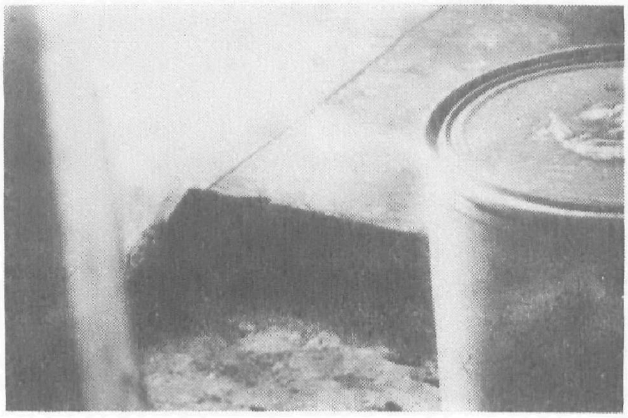
SLIDE 2-32



Missing gratings or gaps in gratings can occur anywhere in a plant. In some cases, the gratings were originally intended to protect people from entrapment in rotating equipment such as the auger shown here.

This missing sections are easy to miss if the plant is only dimly lit or if the inspector is trying to avoid obstacles which are overhead at the same time. Plant personnel often rush through these areas without giving the hazards much thought because they have become accustomed to them. The inspector should not feel obligated to "keep up" and possibly incur a serious accident.

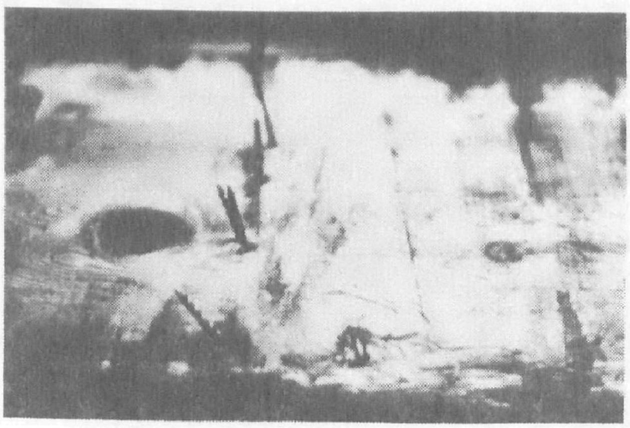
SLIDE 2-33



This a picture of the floor around a packed bed wet scrubber. The entire system is in a very dimly lit building. While walking between the barrels and other stacked material it would be easy to miss the raised section of the floor shown in this slide. The severity of the accident would depend on what was hit on the way down.

Whenever entering an internal area from the outside, it is prudent to wait for the eyes to adjust to the low light conditions.

SLIDE 2-34



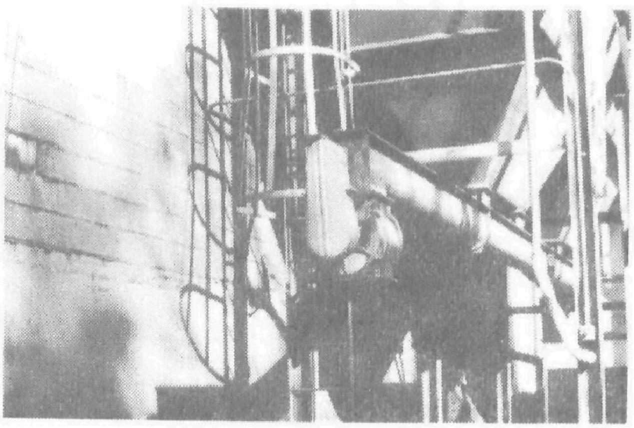
This is an example of what may be lurking in those dimly lit areas.

Source: National Audiovisuals Center

SLIDE 2-35

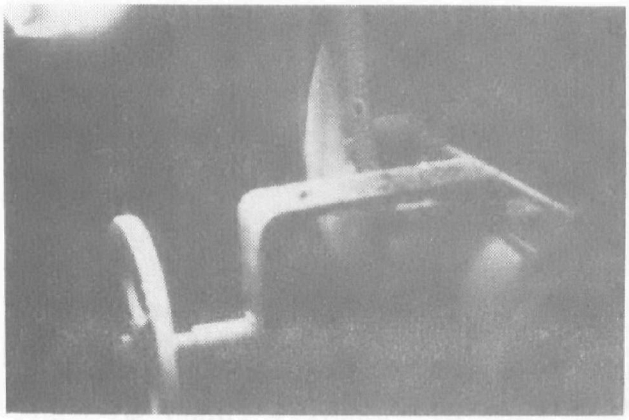
This is the pathway to a large baghouse. All of the metal is rusty and most of it is sharp.

SLIDE 2-36



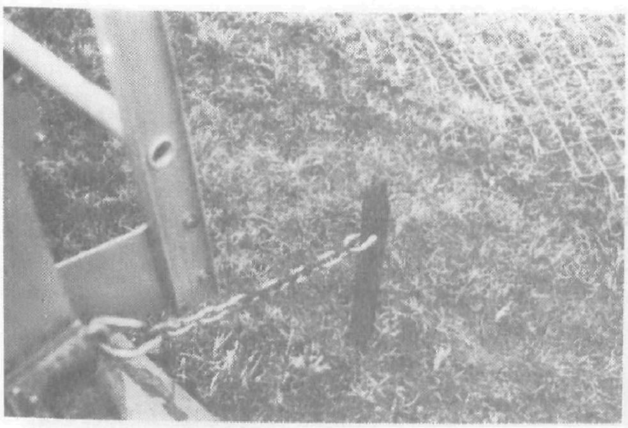
Around many small baghouses, the solids discharge valve is mounted at a low spot close to the access ladder for the unit. This is shown in the adjacent slide. The rotary valve shown here is just high enough that it may not be seen while approaching the ladder.

SLIDE 2-37



The valve stem shown in this slide sticks out onto a catwalk near the top of a venturi scrubber. It is hard to see due to the lack of light in this part of the building.

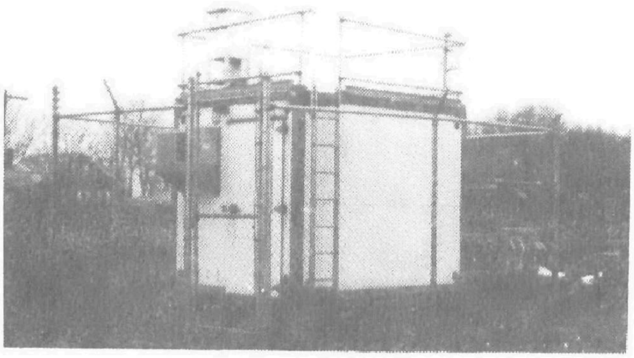
SLIDE 2-38



A tie down stack for an ambient monitoring trailer is shown next to the access ladder. It is necessary to go up the ladder to check on the Hi-Vol collector. While coming down, it is easy to forget the stake and chain.

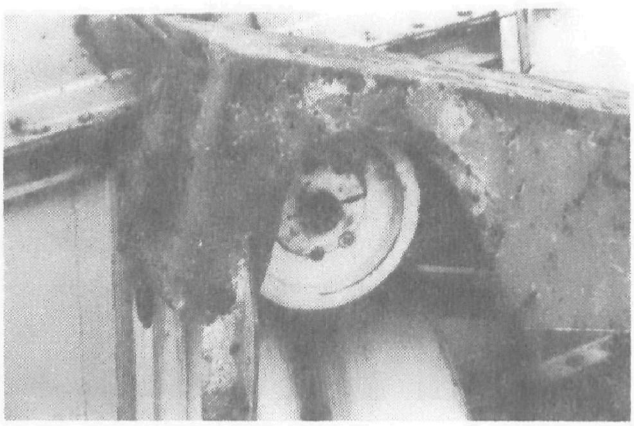
Whenever getting off any ladder at the top or the bottom, it is useful to pause momentarily to check for obstacles ahead.

SLIDE 2-39



This is the same monitoring trailer shown in the last slide. The recess shown in the slide is a favorite habitat of wasps and bees. Other common nesting areas include the sheltered areas directly below roofs of baghouses and sheltered areas below some types of outdoor control cabinets. If you are hypersensitive to wasps and bees, you should ask the plant personnel where at the plant they are usually found so that you will not inadvertently disturb the insects.

SLIDE 2-40

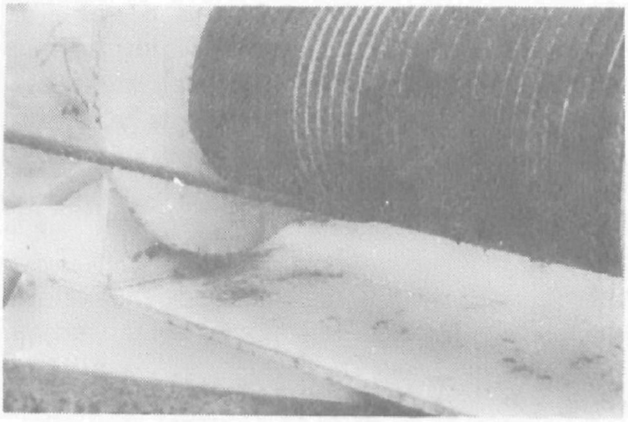


While walking around an air pollution control device, it is easy to forget about rotating equipment in the general area. This slide shows a partially covered fan sheave and drive belt. This was along a very narrow path to a venturi-rod scrubber. It is conceivable (but not easy) for loose clothing to get caught between the rapidly moving belt and sheave. Occassionally, the entire belt guard will be missing.

One way to minimize the risk of entrapment in rotating equipment is to avoid wearing loose fitting clothes. Ties should never be worn.

The area immediately around the rotating equipment should be avoided to the extent possible. If there is only one path to the control system and there is a realistic risk of entrapment even when the inspector is exercising caution, then the inspection should not be conducted.

SLIDE 2-41



This is a winch beside a narrow path to the same system discussed in the last slide. It is 4 feet above the surface and the cable cuts over the path that must be taken by the inspector. The operation of the winch is controlled by plant personnel who cannot see the scrubber from their work station. Resting one's hand on the winch or simply being too close when it starts up could result in a painful injury.

It should be assumed that equipment which is designed to move could move without any warning.

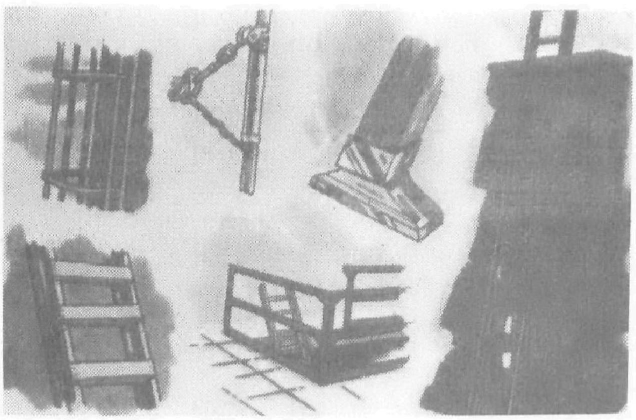
SLIDE 2-42

It is often difficult to find an acceptable location for making the visible emission observation for tall stacks such as those found at large utilities. An inspector may be tempted to climb the coal pile for this purpose. These usually have underground coal conveying equipment which makes standing on a coal pile very dangerous.

SLIDE 2-43

While walking through the plant or under control equipment, inspectors must be aware of overhead beams and other obstacles. Without a hard hat it is possible to sustain a serious head injury on these overhead obstacles. Hard hats should be worn during all plant inspections unless there is a compeling safety reason why they should not be worn at a specific plant. Inspectors should wear hard hats even at plants which do not specifically require them to be worn.

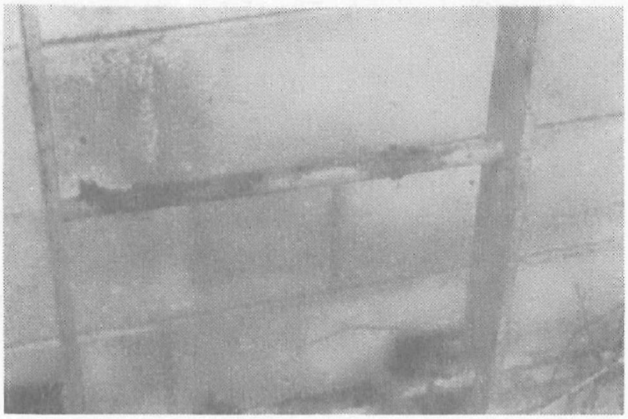
SLIDE 2-44



Many air pollution control systems can be reached only by climbing. It is also necessary to climb to almost all sampling platforms. The next portion of the lecture concerns the proper procedures for climbing ladders, recognizing safe and unsafe ladders, and potential ladder related accidents.

Source: National Audiovisuals Center

SLIDE 2-45



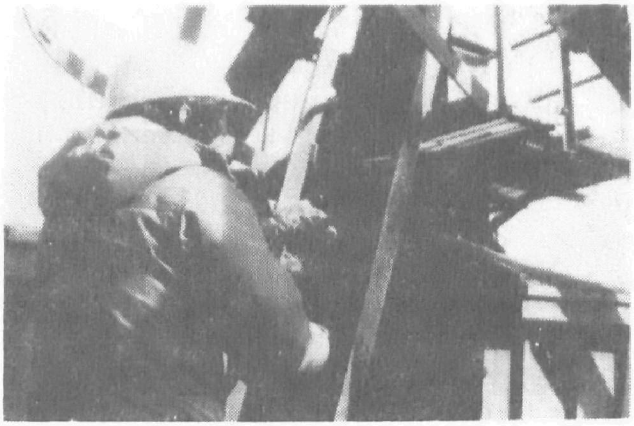
This illustrates a common problem with ladders leading to air pollution control systems. Often the first person up the ladder (normally the plant representative) deposits a layer of mud and sludge on the foot rungs. The mud and sludge comes from the general conditions shown in previous slides such as 2-3 and 2-4.

These deposits can make the ladder slippery. It is particularily important to climb the ladder carefully under such conditions. If conditions are too extreme, the ladder should not be used.

SLIDE 2-46

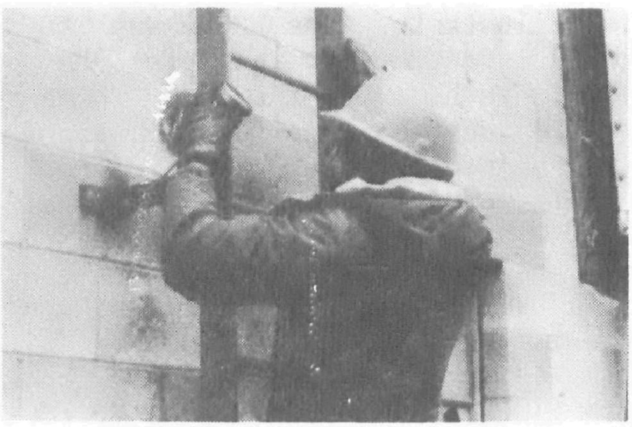
This illustrates the WRONG way to climb a ladder. The inspector has placed his hands on the side rails of the ladder to avoid the mud which is on the foot rungs. He may not be able to support himself if his foot slips on one of the slippery foot rungs. Only the foot rungs should be grabbed while climbing, never the side rails. In many cases it is necessary to have gloves for climbing the ladders.

SLIDE 2-47



This is the proper way to climb the ladder. The inspector is holding onto the the foot rungs.

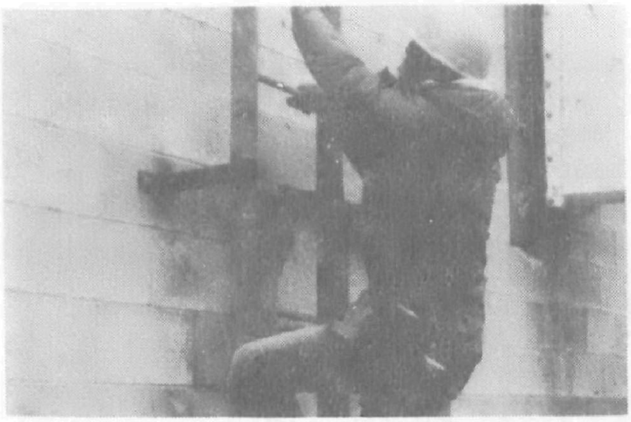
SLIDE 2-48



This illustrates another common error made in climbing ladders. The inspector shown in this slide is attempting to carry the portable instruments in one of his hands (he is also holding on to the side rails). Both hands must be free for holding on to the foot rungs.

If it is necessary to get the portable instruments to an elevated platform or control device, a rope, side pouch, or back pack can be used. It is important that the pouch and/or back pack do not interfere with climbing by getting lodged in the ladder cage or other surrounding objects.

SLIDE 2-49

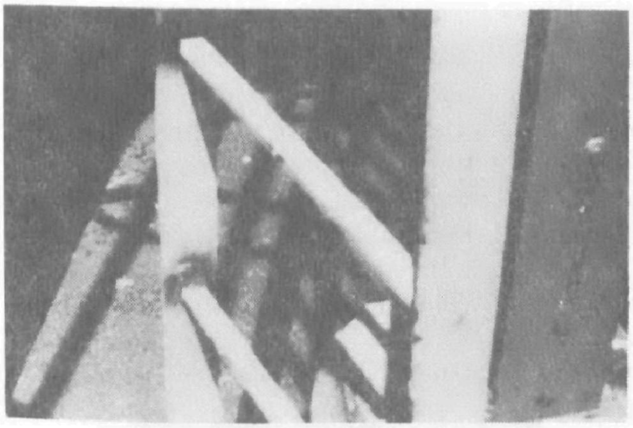


This slide illustrates climbing with the side pouch. Note that both hands are now free for climbing.

The dangling dial type thermometer near the back of the pouch could get caught of a portion of the cage (not shown). Instruments which are as long as the dial type thermometer should not be carried in the side pouch.

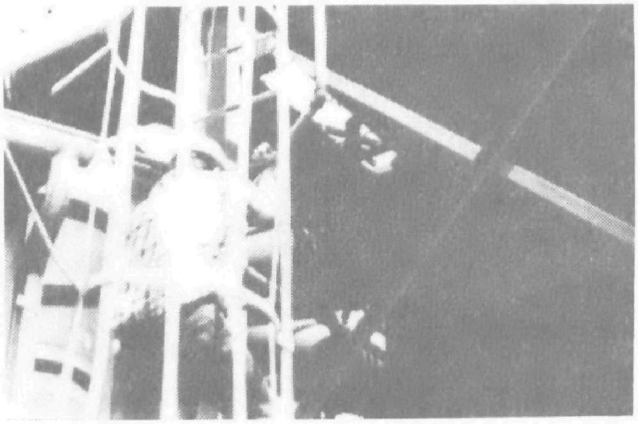
A bucket with a rope can be used to transport large instruments, cables, and any other bulky items. Obviously it is important that nothing falls from the bucket. The rope and bucket should not be used near power lines or when the wind speed is high.

SLIDE 2-50



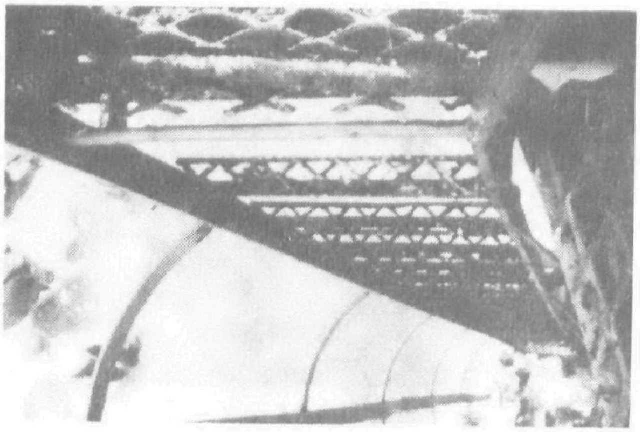
The last two slides have shown an inspector with gloves climbing the ladder. This slide shows a common type of slip resistant foot rung. It is very helpful to have gloves when climbing this type of ladder.

SLIDE 2-51



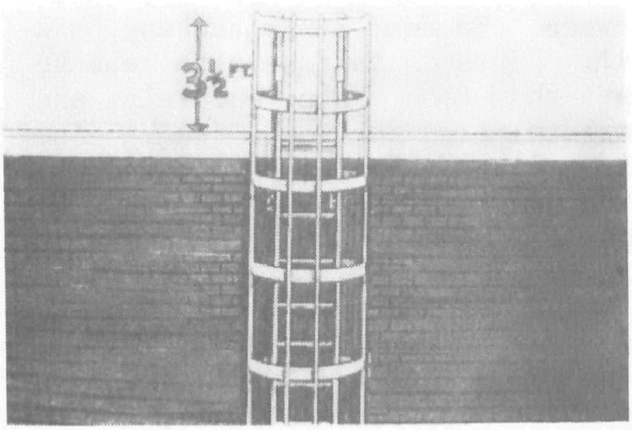
This slide shows the same ladder as the previous slide. The inspector is attempting to climb the ladder without gloves. To avoid pain, he is hooking his wrist around the back of the foot rung. He obviously has only a very poor grip of the foot rung and he could easily fall. This should never be done.

SLIDE 2-52



This is a view down a 30 foot ladder from a baghouse. It is readily apparent that the foot rungs are both rusty and have some very sharp edges. Gloves and caution are a necessity when climbing a ladder of this type. It may be advisable to find another means of access or to delay inspection of the particular unit until there is a better ladder available.

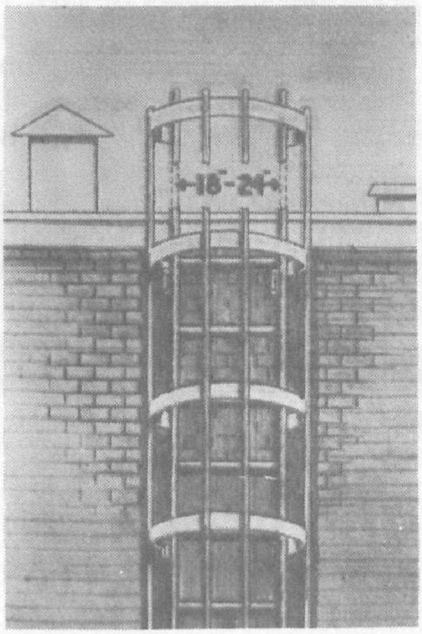
SLIDE 2-53



In evaluating whether or not a ladder is safe, there are a number of different factors which must be considered. As shown in this slide, the fixed ladder with cage must extend at least 3.5 feet above the surface of the roof or elevated catwalk.

Source: National Audiovisuals Center

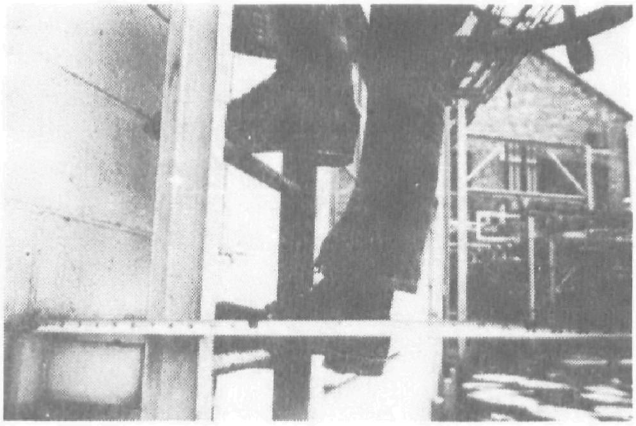
SLIDE 2-54



The ladder must be at least 18 inches wide. Generally the width of the rung meets the criteria shown here, however, the cage can be damaged. This can restrict access at the point that the cage is bent inward and can make the ladder very dangerous if the inspector is climbing with a side pouch or back pack.

Source: National Audiovisuals Center

SLIDE 2-55

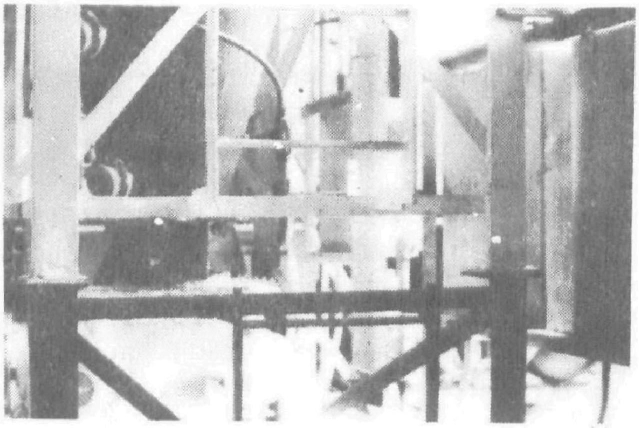


There should be 8 inches clearance between the foot rungs and any back wall. This is necessary to ensure that the foot rests securely and completely on the foot rung. The person shown in this slide should have been climbing by placing the back of the heel against the foot rung.

While the large majority of ladders on control systems initially have the necessary foot clearance, it is fairly common to have electrical conduits or obstacles at one part of the ladder. This can result in a misstep and fall.

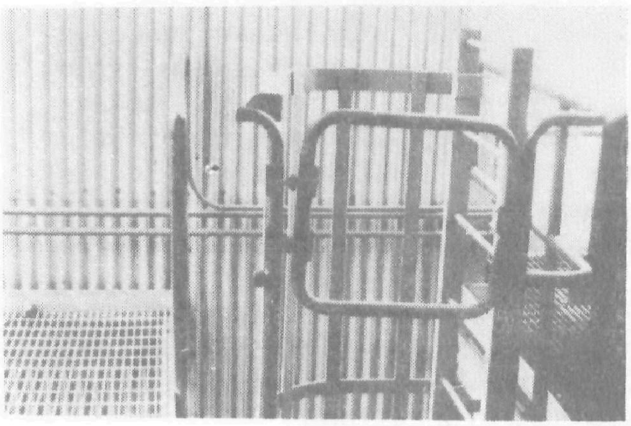
Occassionally, there may be a support beam passing across the back of the ladder closer than 8 inches. While climbing the ladder, it is useful to watch out for these beams, conduits or other potential problems.

SLIDE 2-56



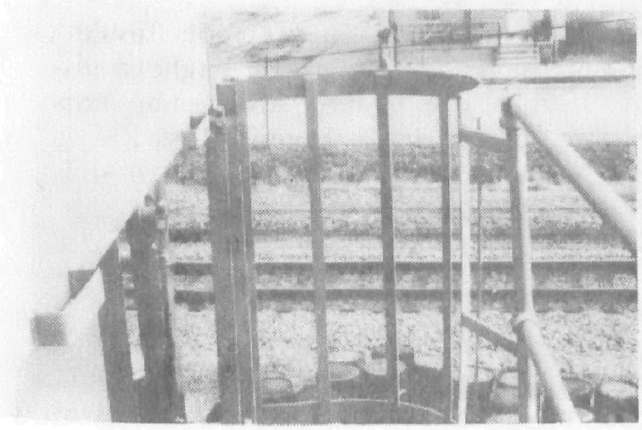
The foot rungs should be evenly spaced to prevent missteps and falls from the ladder. This slide shows the poor mating of a small extension section to the bottom of a large ladder going to a small baghouse. The gap between the two ladders is different than the distance between the foot rungs of either ladder. An accident is most likely while coming DOWN from the baghouse since it is easy to forget that the ladder has been "pieced" and you cannot see it coming.

SLIDE 2-57



Ladders are supposed have some type of secure guard to prevent someone from inadvertently walking into the open area at the top of the ladder. This slide illustrates a very good type of guard which will close automatically when leaving the ladder.

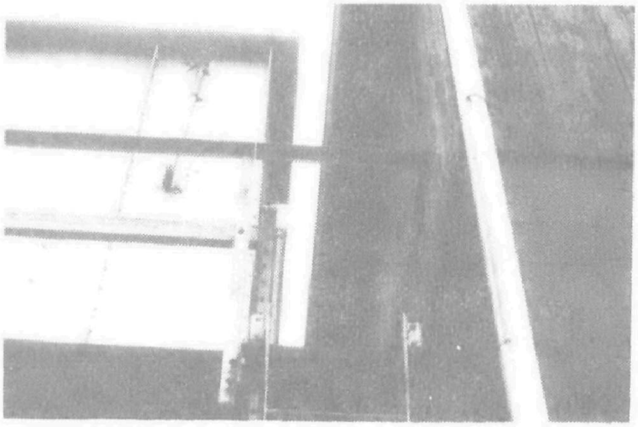
SLIDE 2-58



This slide shows the top portion of a caged ladder which does not have any restraint at the point of entry. The chain which was formerly across the entrance of the ladder has been removed.

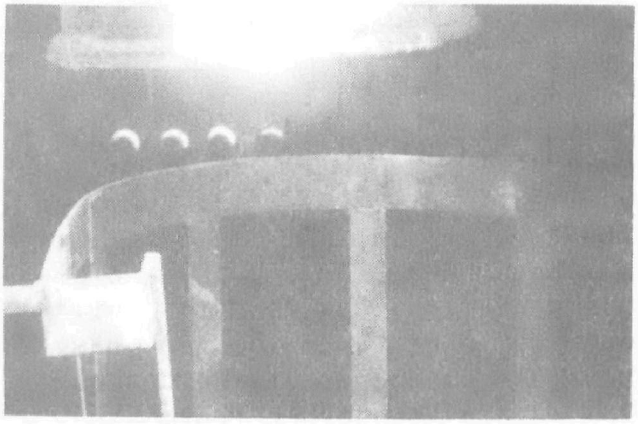
Accidents can occur at spots like this when the inspector becomes preoccupied in conversation with plant personnel or is too busy looking at components of the control system. This is another reason that the inspection must be conducted at a controlled pace.

SLIDE 2-59



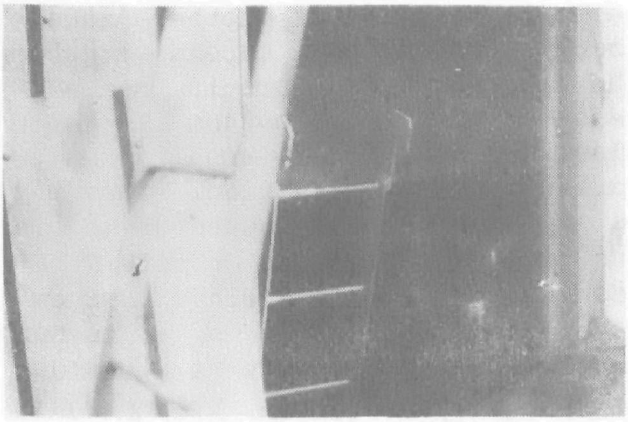
This slides illustrates an uncaged ladder with a permanent angle iron across the entry point to the ladder top. To climb down from the fabric filter shown in this slide, it is necessary to duck under the bar and then attempt to keep your feet on one of the foot rungs. This is not an adequate access ladder. The angle iron should be replaced with one of the types of restraints shown in the last two slides.

SLIDE 2-60



This is the top of a 40 foot ladder leading to a set of small baghouses. Approximately 6 inches above the top of the ladder is a large lamp. A tired or unaware inspector could hit either the lamp itself or the its sharp reflector. The result could be a head injury, a fall, or both.

SLIDE 2-61

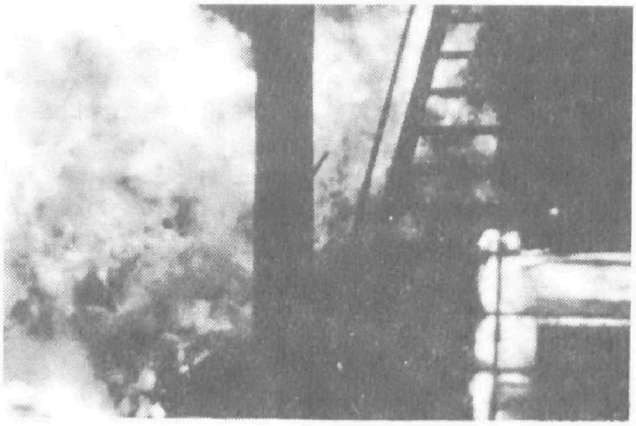


This is a ladder leading from an internal catwalk to a roof where there are several baghouses. There is very little clearance between the sloping roof and the edge of the siding directly above the ladder. To complicate matters further, the solids on the sloping roof are very slippery. While trying to concentrate on one problem, an inspector could easily forget about the other.

SLIDE 2-62

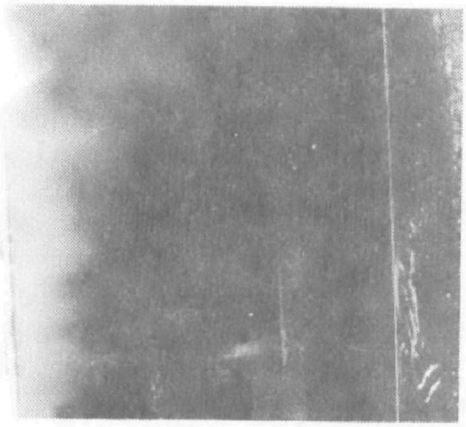
Sometimes it is not the ladder that is dangerous, but the general conditions near the ladder. This slide shows a ladder leading up to a wet scrubber on a cupola. During the short periods when slag is being skimmed, the area surrounding the ladder is enveloped with a dramatic display of sparklers.

SLIDE 2-63



This is a slide of another access ladder leading to a cupola scrubber. The plant personnel are in the process of "dropping bottom". While plant personnel are usually quite careful in this situation, they may be unaware that an inspector is in the area. The burst of fire that results from "dropping bottom" develops in a fraction of a second once the bottom support is withdrawn from the cupola. A person just coming down the ladder from the scrubber would be very seriously burned. It is necessary to be constantly aware of the operations under way at the plant during the inspection.

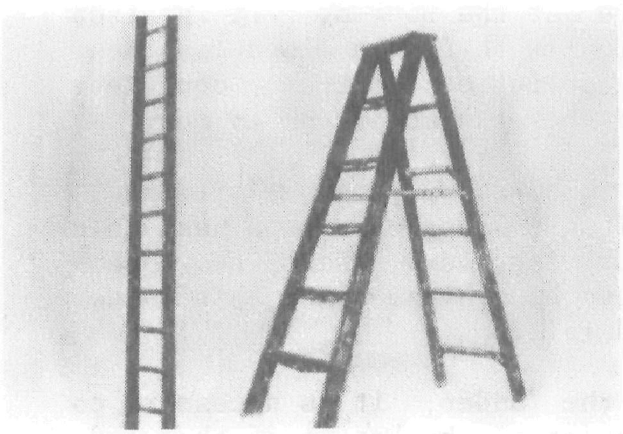
SLIDE 2-64



This is an entry way from a roof to a ladder leading down to the plant floor. Very high humidity results in a steaming effect as the cold ambient air enters the warm, humid air. A cloud of steam is apparent on the left portion of the entry way. Upon entering this area, any inspector wearing glasses will not be able to see. The steam can be so heavy at times that even those without glasses can not see more than a foot ahead. Several feet into the enclosure is an opening for the ladder. There is no restraint or other protective device to prevent the temporarily blinded inspector from taking a 30 foot plunge through the opening down to the operating floor.

Any steam filled area deserves special precautions. The inspector must slow down until it is possible to see all obstacles, openings in the floor, and other hazards. Extremely low visibility caused by steam is one of the most common conditions encountered in inspection of air pollution control equipment.

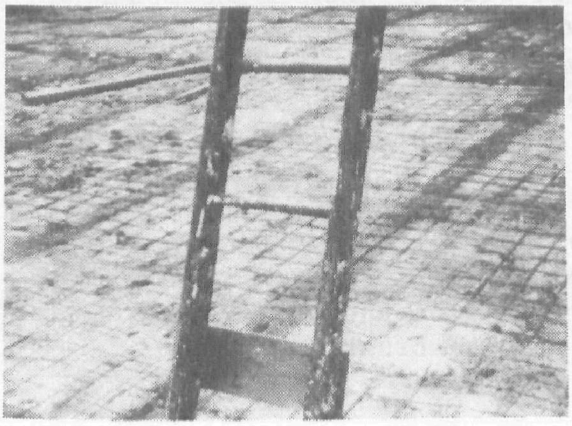
SLIDE 2-65



Source: National Audiovisuals Center

Portable ladders can present some special problems for the inspector. Before using these ladders, several basic safety checks are needed.

SLIDE 2-66



Source: National Audiovisuals Center

Makeshift ladders such as the one shown in this slide should not be used under any circumstances. If it has been necessary to "fix" one of the rungs, it is possible that some of the others have also weakened.

All of the foot rungs should be inspected before use of the ladder. If any of these appear to rotted or the rungs are separating from the side rails, the ladder should not be used.

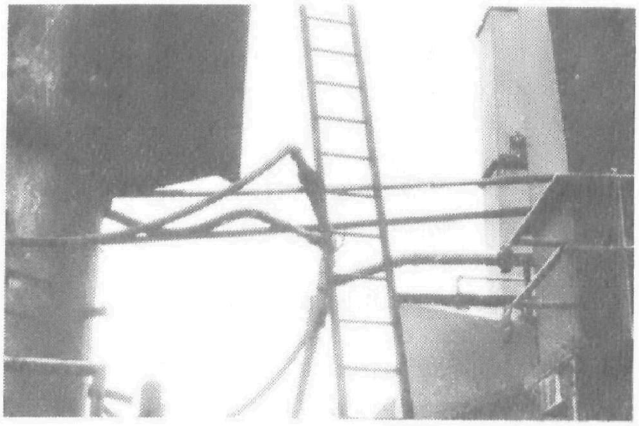
SLIDE 2-67

One of the basic requirements of a portable ladder is that it must be secure at the bottom. It is often difficult to find a location near air pollution control equipment where there is no sludge or mud.

This slide shows a ladder sitting in a slippery layer of sludge next to a venturi scrubber. There is a possibility that anyone using this ladder would fall.

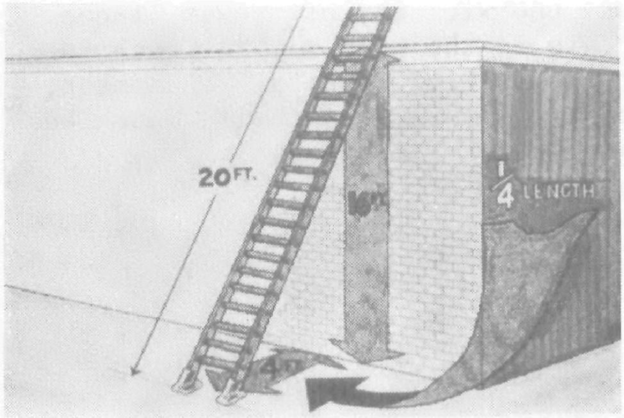
In addition to locating a dry spot for the ladder, it is necessary to have the right type of slip resistant protector on the bottom of the ladder. Two of the most common slip protectors are spurs and pads.

SLIDE 2-68



This is the same ladder shown in the previous slide. Another common problem with portable ladders involves resting them against a support which is weak. Close examination of the slide illustrates that the small angle iron which is supporting this ladder has been cut approximately 80% of the way through. The load created as the inspector climbs the ladder will be enough to cause the angle iron to break.

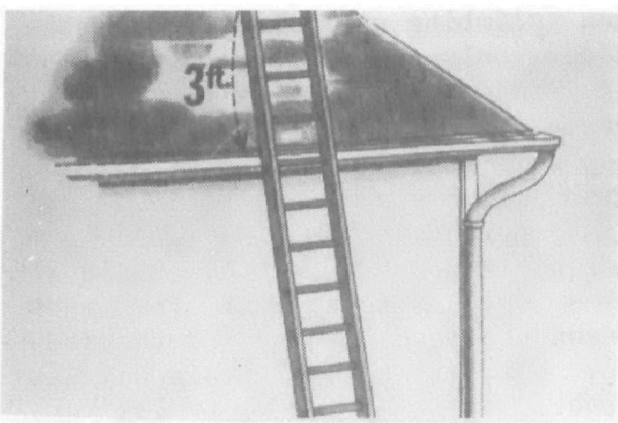
SLIDE 2-69



When using any portable ladder, it should be sloped so that the length from the wall is one fourth the ladder height. This is illustrated in this slide.

Source: National Audiovisuals Center

SLIDE 2-70



The portable ladder should extend three feet above the roof. This is illustrated in the adjacent slide.

Source: National Audiovisuals Center

SLIDE 2-71

The ladder should never go to or near the vicinity of power lines. If this is the only way to reach the air pollution control equipment, then the inspection should not be conducted at the present time.

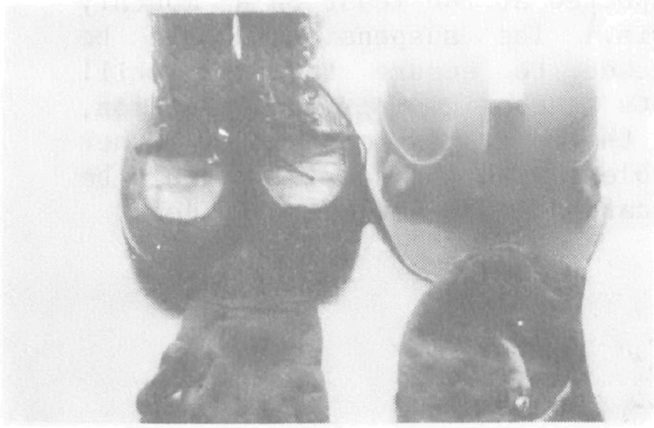
Source: National Audiovisuals Center

SLIDE 2-72

When climbing any fixed or portable ladder, only one person should be on the ladder at a time. The first person going up the ladder could drop some tools or equipment on the person climbing directly below. The first person could also fall and thereby injure the second. While it takes more time to wait for each person to reach the top of the ladder, this is the only safe way to climb.

Source: National Audiovisuals Center

SLIDE 2-73



The basic personal protective items necessary for walking and climbing are shown in this slide. These should be worn by inspectors during all inspections unless there is a compeling safety reason why these should not be used at a specific plant.

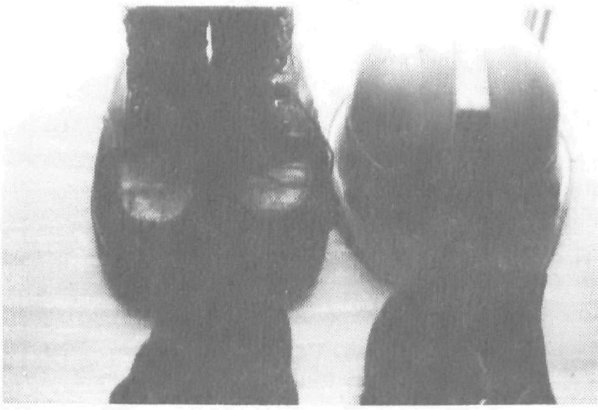
SLIDE 2-74

Safety shoes have several main functions. They protect against falling objects which could injure the toes. The types of activities where this type of accident is likely are not those performed by most field inspectors. The most important function of safety shoes, for inspectors, is the slip resistant soles. This minimizes the risk of falls on all slippery areas around the equipment and on the various types of elevated surfaces commonly encountered by inspectors.

The purpose of this slide is to illustrate that these shoes will wear out and become less useful for preventing falls. They should be replaced when they reach this stage.

The type of safety shoe must be appropriate for the type of chemicals and conditions which will be encountered. The primary considerations are (1) the extent to which chemicals could penetrate the sole of the shoe and the skin and (2) the potential consequences of static build-up. If there is the possibility for static electrical detonation of flammable vapors it may be necessary to use a shoe designed to dissipate the static.

SLIDE 2-75



Hard hats should be cleaned and inspected at the least on a monthly basis. The suspension should be checked to ensure that it still meets the originial specification. If there are any cracks or other problems with the hat, it should be discarded and a new one obtained.

SLIDE 3-1

HAZARDS TO VISION

The eye is one of the most vulnerable parts of the body to industrial hazards. This is because it does not heal as quickly or as well as other organs. The cornea, lens, and humors have very few blood vessels (so that they are clear) which results in slower healing. The nerves of the retina cannot regenerate, so damage to these is permanent.

SLIDE 3-2

EYE INJURIES

MINOR

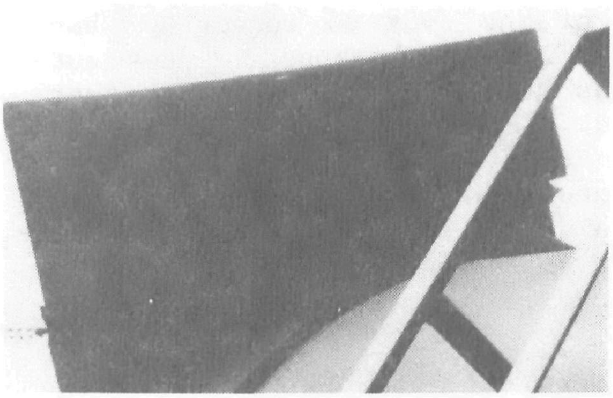
- Presence of foreign body
- Abrasion from rubbing
- Irritation from fumes
- Orbital margin bruise

MAJOR

- Perforation of eye by particles
- Thermal Burns
- Chemical burns from fumes or splashes
- Disruption by impact

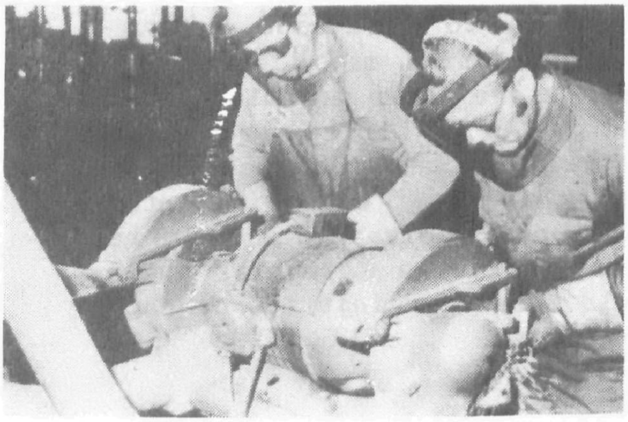
Industrial eye injuries can range from temporary to permanent. Examples of some common major and minor eye injuries are shown in this slide. The major injuries often result in partial or permanent blindness. It is probably easy for every inspector to imagine plant situations that he or she encounters on a regular basis that could result in injuries of each of these types.

SLIDE 3-3



This slide shows a fairly common plant situation; this baghouse exhaust vent is directed down at the platform around the baghouse. Under normal conditions this is not a problem, however, in the case of a bag failure, etc. particulate could be flung at the inspector at the exhaust gas velocity of 3,000 fpm.

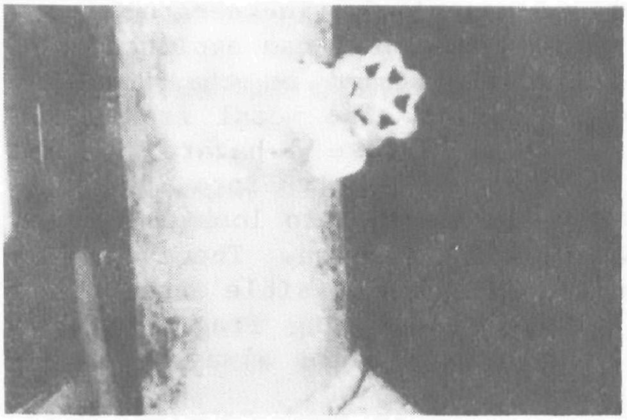
SLIDE 3-4



Grinding operations such as the one shown here or those found at foundries and in other metal fabrication industries are a common source of flying particles. Particles that get in the eye can easily scratch the eyeball, and more seriously, those traveling very fast can perforate the eyeball and cause internal damage, sometimes without even being felt.

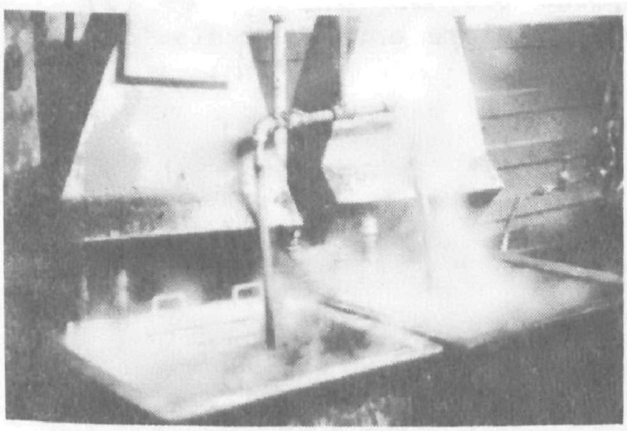
Source: National Audiovisuals Center

SLIDE 3-5



This is a photograph of a valve on the discharge line of a wet scrubber pump. The liquor is under approximately 90 psi and the pH is quite high. If care is not taken in sampling the liquor, it can easily splash into unprotected eyes. Thus, the valve must be opened gradually, the receiving container must not be prone to splashing, and the inspector should be wearing splash goggles.

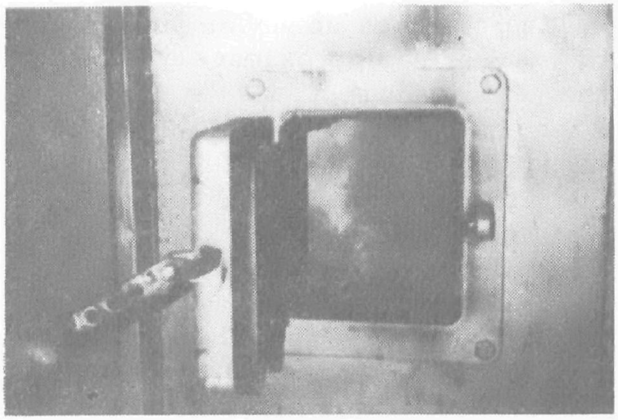
SLIDE 3-6



The fumes or vapors of some chemicals can irritate or actually burn the eyes. Chemical splash goggles (which will be shown later) should always be worn around open vats and tanks of potentially harmful chemicals such as those shown in this slide.

Source: National Audiovisuals Center

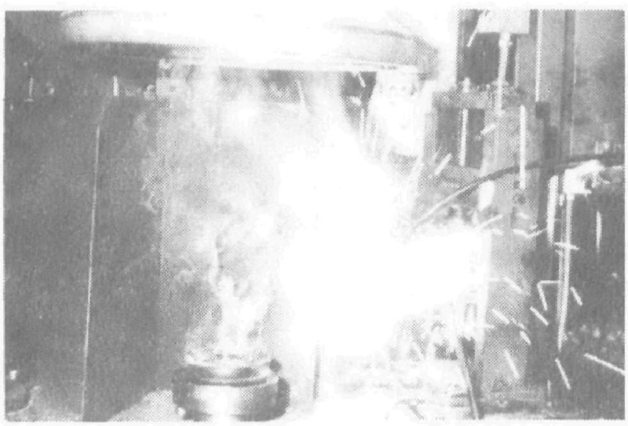
SLIDE 3-7



This is a view inside a traveling grate of a municipal incinerator. Occassionally an aerosol can explodes as the material charged to the incinerator heats up. The metal fragments from the can pose a hazard to anyone looking directly into the hatch, thus, it is wise to look into these hatches with caution. The eyes should never be in the possible direct line of flight of exiting fragments and eye protection should always be worn.

In the case where the material inside a hatch is very hot and bright, a radiation shield may also be necessary to prevent thermal or other radiation damage to the eye.

SLIDE 3-8



Although not likely in the case shown, sparking can possibly cause eye injury in either of two ways: (1) burns from sparks reaching the eye or (2) damage from glare or U.V. radiation.

Source: National Audiovisuals Center

SLIDE 3-9

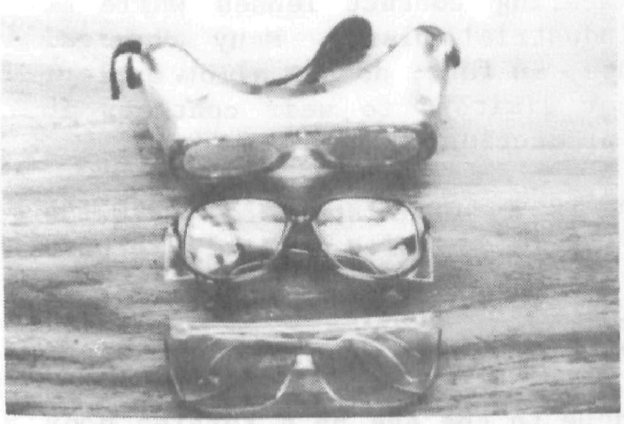
Eye hazards, including those just shown, can be grouped into four categories. Physical hazards include blows such as from walking into low hanging equipment or beams, lacerations from sharp edges moving past the eye, and the introduction of foreign bodies flying particles.

Chemical hazards include splashes from opening valves or containers under pressure or being near open process vats and tanks or irritating or burning fumes and vapors such as styrene or butanol.

Thermal eye hazards include the direct viewing of high temperature operations. Fortunately, excessive heat usually causes the eye to close, however, this results in burns to the eyelid.

Other radiation hazards include U.V. light from welding and cutting operations, intense visible light from lasers, infrared, and microwaves.

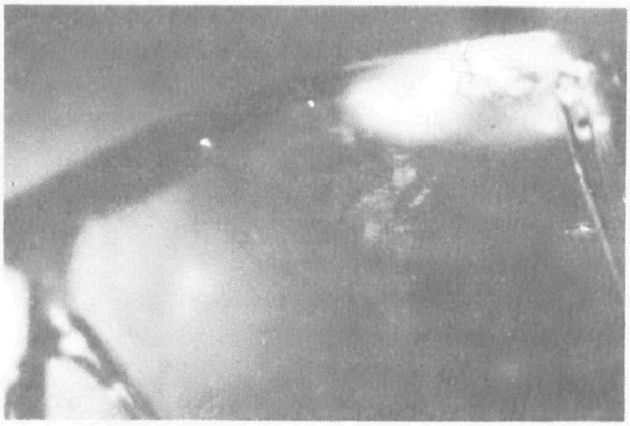
SLIDE 3-10



This slide shows three types of eye protection of general use to the air pollution control inspector. They are (from top to bottom) chemical splash goggles, safety glasses with side shields (to protect against flying objects), and visitor glasses.

Most industrial facilities require eye protection and inspectors should be sure that theirs satisfies plant requirements. It is suggested that inspectors use eye protection even if not specifically required. At the very least, it will prevent the introduction of chemicals and foreign bodies into the eye by careless rubbing.

SLIDE 3-11



Unlike this example, visitors specs or glasses should not have many scratches. If they do, a new pair should be used and the others discarded. When doing much field work, it is preferable to have prescription or nonprescription safety glasses with side shields. These are less prone to scratching and all better peripheral vision.

Splash goggles should be worn whenever there is the chance of splashing chemicals or irritating fumes. Impact goggles can as a substitute for safety glasses. Radiation shields must be used when there is danger of thermal or other radiation.

In the event that chemicals do get introduced into the eye, immediate treatment is essential. The eye should be flushed with as much water as possible using an eyewash station, if convenient, or any other source of clean water. If the individual is wearing contact lenses, they must be removed first.

SLIDE 3-12

ON INDUSTRIAL JOBS . . .
DON'T
WEAR CONTACT LENSES

This statement is from a National Safety Council slide series on eye safety. We also strongly recommend not wearing contact lenses while at an industrial plant. Many chemical plants, in fact, do not allow employees or visitors to wear contacts in the production areas.

There is an OSHA standard [1910.134 (e) (5) (ii)] which strictly forbids the wearing of contact lenses in contaminated atmospheres with a respirator.

Hard contacts can increase the damage done to the eye by a foreign body which gets trapped behind it. Soft contact lenses, particularly the gas permeable ones, may make the eye more susceptible to chemical damage. Some chemicals such as acetone may also cause soft contacts to opacify.

However, to this date the National Society for the Prevention of blindness has no contact-caused injuries on record as long as goggles appropriate for the situation are worn. They have thus just issued a position statement on the wearing of contact lenses in the industrial environment which cautions, but does not preclude the use of contact lenses. This statement is quoted in full on the following page.

"Contact lenses may be worn in many occupations. Contact lenses provide an adequate means of visual rehabilitation for employees who have had a cataract removed from one or both eyes; who are highly near-sighted, or who have irregular astigmatism from corneal scars or keratoconus. However, when the work environment entails exposure to chemical fumes, vapor, or splashes, intense heat, molten metals, or highly particulate atmosphere, contact lens use should be restricted. Certain federal or state regulations may also limit their use.*

Contact lenses, of themselves, do not provide eye protection in the industrial sense. For occupational use, contact lenses should be worn only in conjunction with appropriate industrial eye protection.**

The employer should ensure the identification of the contact lense wearer for appropriate emergency care and for protection in work areas hazardous to the eyes."

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*Wearing of contact lenses in contaminated environments with a respirator shall not be allowed. Federal Register, Volume 36, Number 105, Part II #1910, 134 (e)(5)(ii).

*To be of industrial quality, safety eyewear devices must meet or exceed all the requirements of the "American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1, 1979", or later revisions thereof, as published by the American National Standards Institute, Inc.

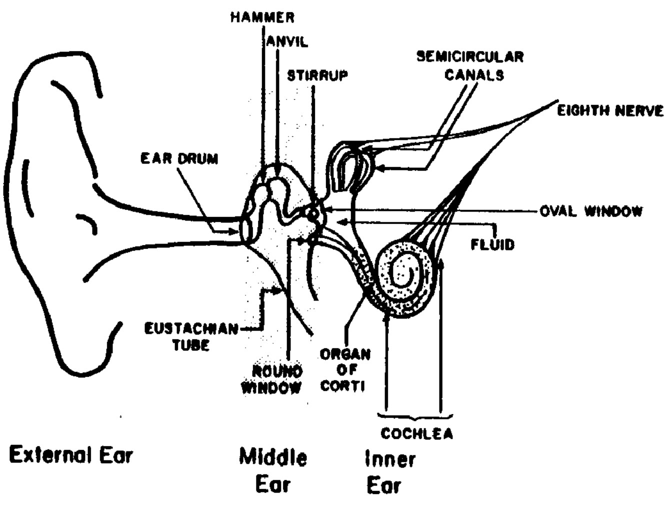
SLIDE 3-13

HAZARDS TO HEARING

There are two types of noise exposure: chronic and acute. Field inspectors are rarely subjected to the chronic exposures.

However, the short, acute exposures do add up and there is always the possibility of a temporary hearing loss even after a short term exposure. Consequently, the agency inspector must be aware of potential noise sources, the consequences of noise exposure, and the methods of hearing protection.

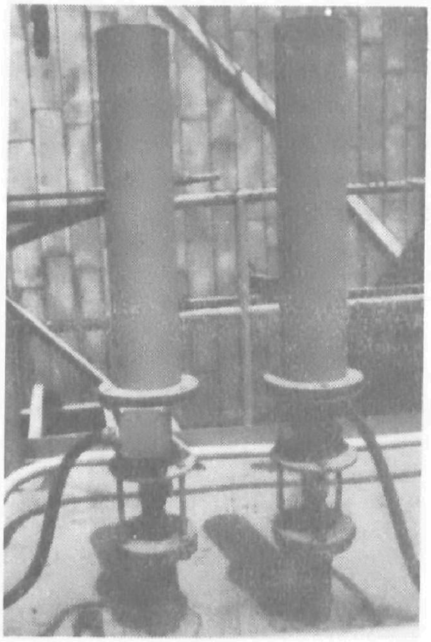
SLIDE 3-14



An intense, sudden noise (such as an explosion) can severly damage the middle and inner ear and can result in hearing loss. But the type of hearing loss associated with industry is from much lower noise levels over a prolonged period. This type of hearing loss results because the hair cells lining the cochlea are gradually destroyed by overstimulation. These hair cells transform the vibration in the liquid of the ear into nerve impulses. Once destroyed, they do not regenerate.

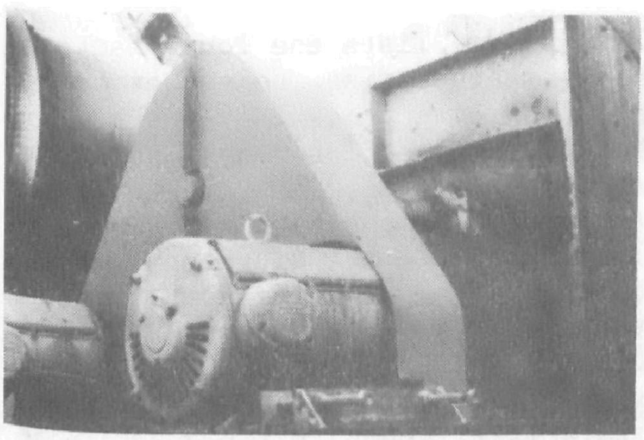
The early stages of this type of hearing loss result in an increase in the hearing threshold only at the higher audible frequencies so it is often not noticed. At first, the individual does not realize that he or she is progressively losing hearing ability. Some temporary hearing loss or ringing (TTS, Temporary Threshold Shift) does result in permanent hearing damage.

SLIDE 3-15



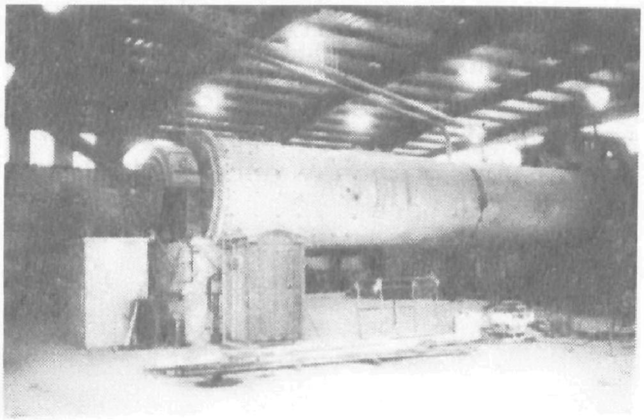
This slide shows an example of a source of impact noise, one of the types of noise that can cause ear damage. These magnetic impulse gravity impact (MIGI) rappers on the ESP roof are commonly encountered by agency inspectors.

SLIDE 3-16



This is a fan on a baghouse of a asphalt plant kiln. Areas around the large fans of control systems tend to be noisy.

SLIDE 3-17



This is a ball mill at a plant which grinds clinker. THe noise level in the area surrounding the ball mill was high enough that one had to shout to communicate; this is always a good indication that it is appropriate to wear ear protection.

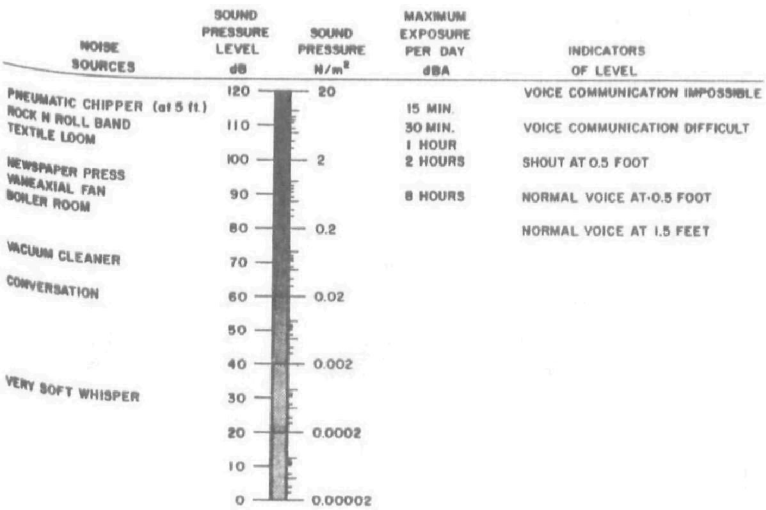
SLIDE 3-18

MAJOR FACTORS WHICH CHARACTERIZE NOISE EXPOSURE

- Overall Noise Level
- Composition of Noise
- Duration and Distribution of Exposure During the Work Day
- Total Time of Exposure During Worklife

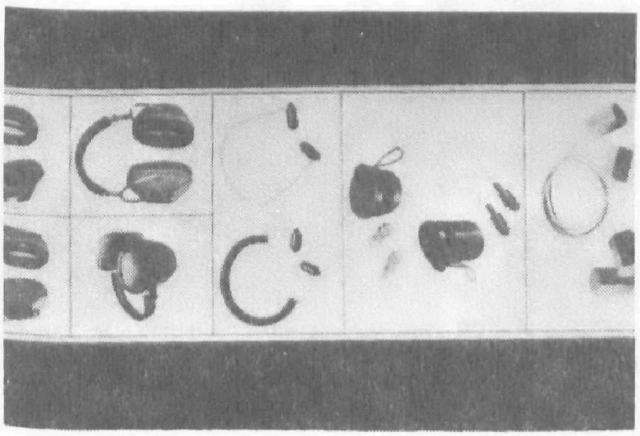
This slide lists the four factors which characterize noise exposure and which effect hearing loss. Over the same time period, the higher the noise level in dB, the greater the exposure. Composition of the noise also has an effect, single frequency noise is more damaging than broad-band noise. The exposure is cumulative so that the total time over a lifetime is important. However, it is not strictly additive and consequently duration and distribution must be considered.

SLIDE 3-19



This scale was constructed to give an idea of how the levels of some familiar noise sources related to the OSHA specified maximum exposures. At the present time, 90 dBA* is the maximum noise level to which most worker can be exposed with a reasonable expectation of no hearing damage. The information in the column on the right can be used to roughly estimated noise levels. As a rule of thumb, ear protection should always be used when normal speech can not be understood at a distance of 2 to 3 feet. (*The dBA noise level scale is weighted for frequencies in the hearing range.)

SLIDE 3-20



There are a number of options available in choosing ear protection. Pictured here are premolded ear plugs, moldable ear plugs, canal caps, and ear muffs. Not pictured are the less commonly used custom molded ear plugs. Each have advantages and disadvantages with repect to comfort, and convenience in various situations. For example, ear plugs are easy to carry but inconvenient to put in quickly.

Ear muffs and canal caps are very easy to put on and take off, but they cannot be stored in a pocket and are much less comfortable than ear plugs to wear for extended periods.

The inspector should always carry his or her own ear protection and should wear it as prescribed by the plant. Continuous wear is recommended in a moderately noisy plant; after a short period of acclimation ear protection actually aids communication. In addition, it is not good to be removing and reinserting ear plugs with soiled hands as one moves about the plant.

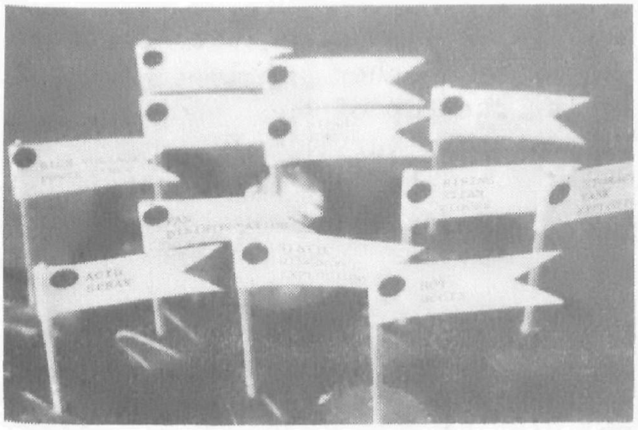
SLIDE 3-21

Ear Protector	Range of Attenuation
Cotton	5 to 20dB
Ear Plug	15 to 35dB
Ear Muff	15 to 45dB
Muff & Plug	28 to 48dB

Different types of ear protection differ in the amount of attenuation or reduction of noise level that they provide. This slide shows the reanges of attenuation for four forms of ear protection. Attenuation is given as a range because it differs at different frequencies.

The cotton is not a recommended form protection and is shown for comparison purposes. The attenuation of properly fitted ear plugs and ear muffs is nearly equivalent. A combination of the two can provide additional protection. Probably the most important factors for the inspector to consider when selecting a type of ear protection are (1) noise levels, (2) proper fit (3) reasonable comfort, and (4) convenience. If ear protection is comfortable and convenient, it will usually be used.

SLIDE 4-1

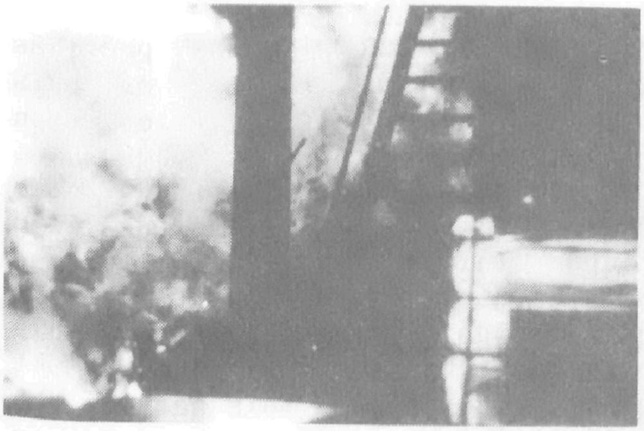


Electrical hazards, explosions and burns are discussed in this lecture. Since gas temperatures between 200 and 1800 °F are common in air pollution control equipment, there are a number of ways for a burn to occur in the vicinity of the collector. Burns can also occur due to steam from process equipment.

Explosions can occur when there are (1) deposits of solids or (2) flammable liquids being handled. Both of these situations occur during inspections.

Electrical shocks can occur due to improperly grounded equipment, improperly grounded probes, exposed wiring, high voltage tracks, and opening of electrical cabinets.

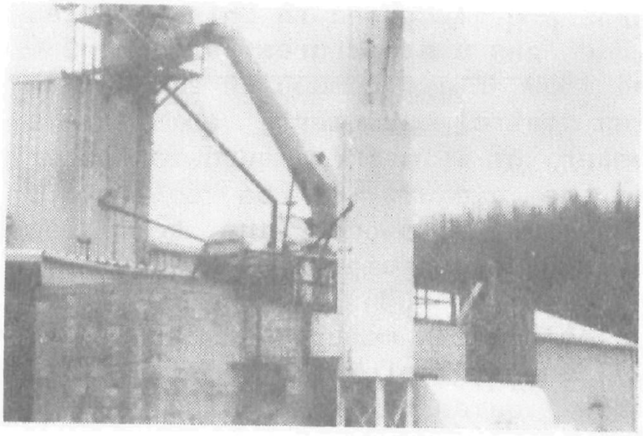
SLIDE 4-2



This slide shows flames engulfing an access ladder to a cupola wet scrubber system. This occurs when the plant is "dropping bottom". The inspector should not go near the scrubber system when this is to occur.

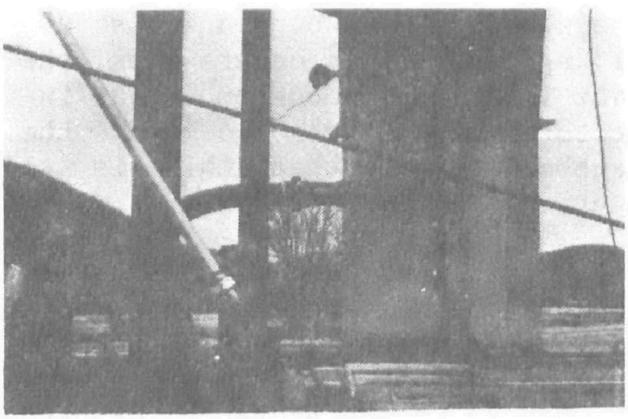
Plant personnel are usually quite careful about advising inspectors about this operation. The problem could occur when the cupola operator is unaware of the presence of the inspector. The inspector must be aware of process operations and must not assume that the operators will realize that he or she is present.

SLIDE 4-3



This is a view of a wet scrubber system on another cupola. The gas leaving the top of the cupola is at temperatures varying from 1800 to 2200 °F. There is a small quench chamber adjacent to the cupola to reduce the gas temperature to the 300 to 400 °F. The gas then travels down the inclined duct to a venturi rod scrubber. The next slide shows a close-up view of the gas duct at the inlet of the scrubber.

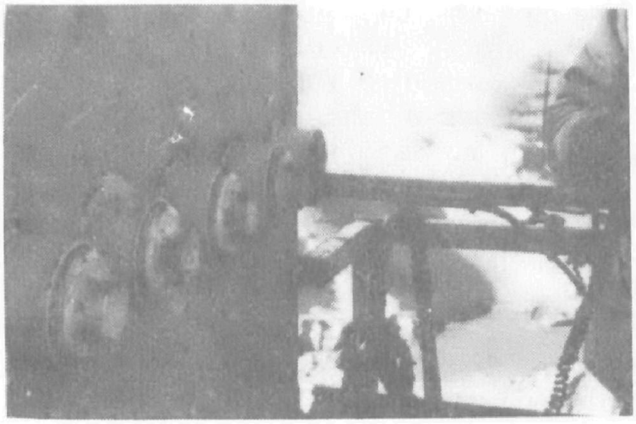
SLIDE 4-4



The gas duct shown in the previous slide is at the very top of this slide. The main liquor inlet is on the left side of the scrubber inlet (near the center of the slide). The discolored area just below the main liquor inlet shows that the gas temperature at this point can be quite high. Leaning against this portion of the scrubber could result in a painful burn. This part of the unit is within easy reach of anyone walking around the unit.

It is very common to find uninsulated ducts near air pollution control equipment that are between 200 and 800 °F . Touching the duct walls can occur as the inspector is (1) trying to move around the various obstacles around the collector or (2) attempting to use a measurement port on the duct wall. To minimize the risk of burns, it is necessary to be constantly aware of which ducts are at elevated temperature.

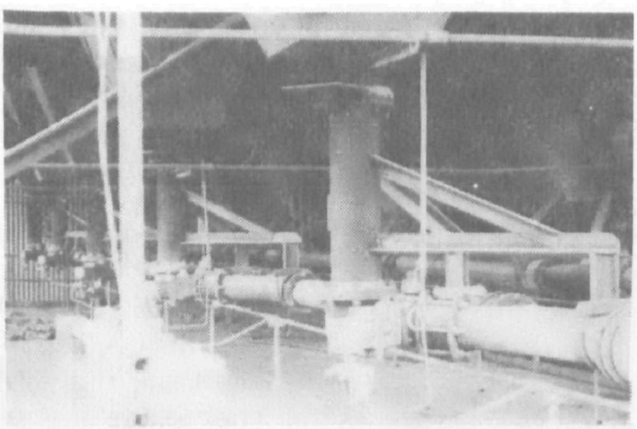
SLIDE 4-5



A row of 4 inch diameter sampling ports are shown here. Most people are careful initially and use gloves to remove the plugs. When preparing to leave, they often forget that the plugs can stay very hot for a long time. Picking up the plugs with an unprotected hand results in a burn.

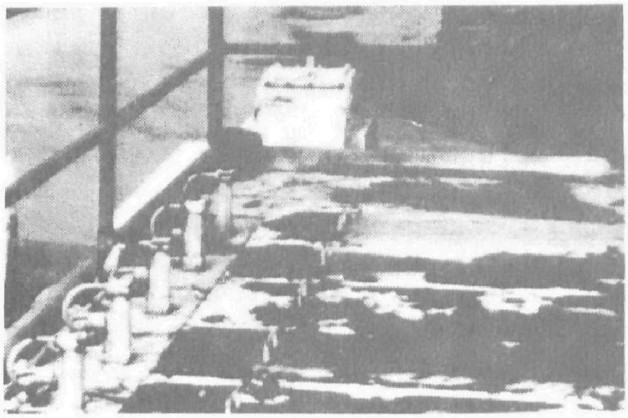
Another cause of burns is the grabbing of the probe as it leaves the stack or duct. If gloves are not used a burn will result from the 200 to 1000 °F probe. As in the case of the plugs, it takes some time for the probes to cool off. The larger the probe, the longer it takes to reach a safe temperature. Most problems occur because of hot pitot tubes.

SLIDE 4-6



This is the pneumatic solids handling system for a large hot side electrostatic precipitator. The solid material in the transport pipes can have temperatures ranging from 300 to 500 °F. Obviously, these pipes should not be touched while walking around the hopper area. Since they are mounted close to the gratings it is easy to brush up against them by accident.

SLIDE 4-7

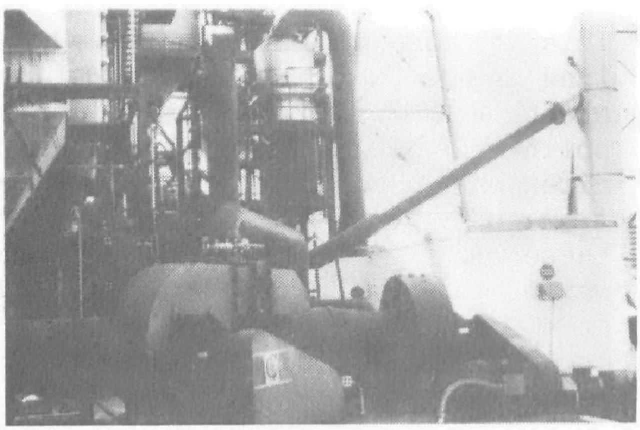


This is the uninsulated roof of a pulse jet collector on an asphaltic concrete plant. The gas temperature directly below these access hatches is normally 325 °F. One sign of the elevated gas temperatures is the loss of paint on the access hatches.

Burns can occur while standing on the roof or when reaching down to remove the access hatch to one of the compartments.

This slide shows a relatively mild case of a very common situation. It is typical for the roofs of some collectors (or process equipment in the area of the collector) to be at 400 to 600 °F. When climbing up to this area, people tend to place their hands on the flat surface as they reach the top of the ladder. In some cases, the plant personnel walk across a hot area (e.g., top of boiler near the steam drum) to reach the air pollution control system or the measurement ports. Such shortcuts are never a good idea.

SLIDE 4-8

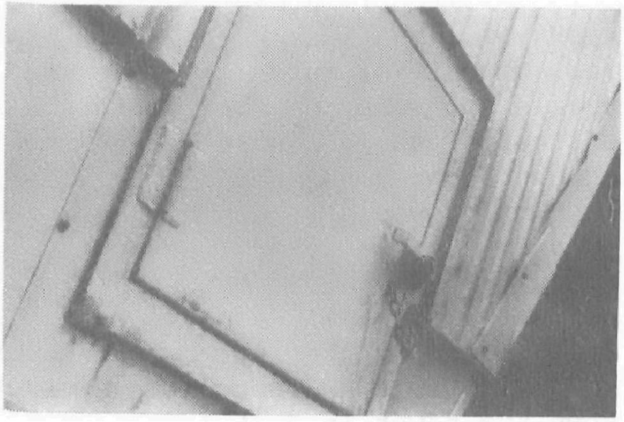


Very serious burns can occur due to steam. In some processes, very hot steam is released intermittently. If the inspector happens to be on an elevated walkway or other exposed area, a serious accident can occur.

In power stations, a high pressure steam leak can pose a significant risk. THESE LEAKS CANNOT BE SEEN OR HEARD. THERE WILL BE NO APPARENT CLOUD OF CONDENSED STEAM IN THE AREA OF THE LEAK. When the plant alarm indicates a high pressure steam leak, the inspector should not move around the boiler area. If outside when the alarm sounds, the inspector should not enter the boiler area.

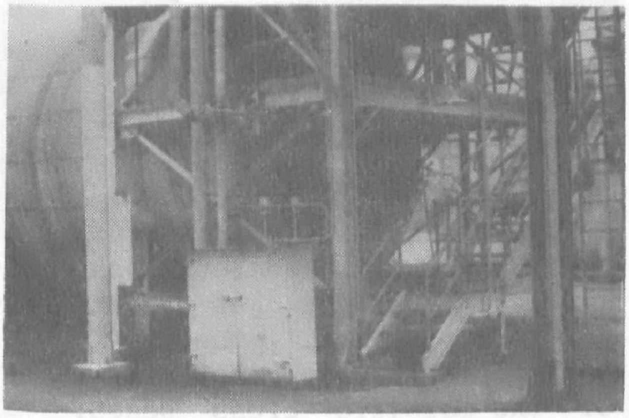
The potential for steam burns is one of the reasons that it is important for plant personnel to accompany an inspector at all times. Plant representatives are familar with the intermittent operations which result in a steam cloud and they generally know the protected locations. They also know the procedures to be followed in the event of a high pressure steam leak.

SLIDE 4-9



This is the access hatch for a hopper on a baghouse. The solids in the hopper are at 300°F and will flow like water when the hatch is opened. Serious burns can occur to anyone in the immediate vicinity of the hatch when it is opened. This problem is easily avoided since the inspector has no business being close to a hatch being opened.

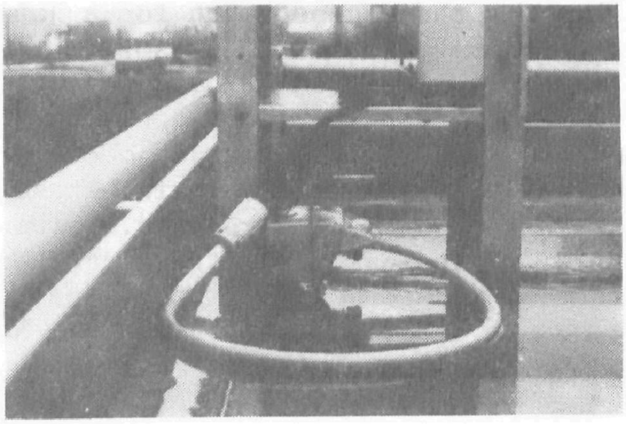
SLIDE 4-10



This is part of a chemical plant handling large quantities of acid. Chemical burns can occur from leaks or sprays of acid. If a burning sensation is felt on the head, do not look up! Leave the immediate area before attempting to locate the source of the acid.

It is an instinctive response to look up when a burning sensation is felt on the head. If it is due to a small leak above the inspector, the acid may enter the eye.

SLIDE 4-11

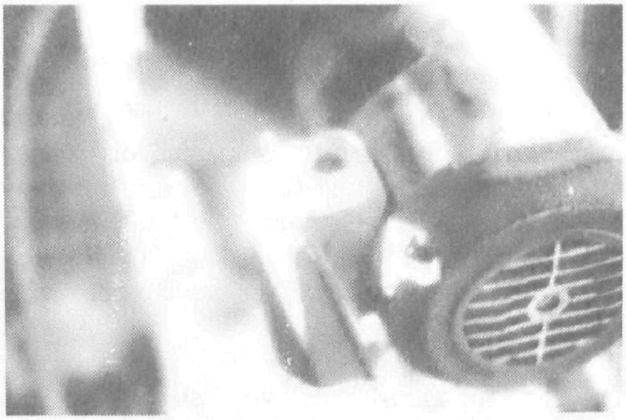


This is a view of the roof of an ambient monitoring station. The Hi-Vol is directly above the field of view of the slide. The power line for the Hi-Vol motor is lying in a puddle of water on the roof. This situation could result in a fatal shock because the person servicing the unit would be standing in the puddle with the power line in it.

All Hi-Vols should be equipped with ground fault interrupters. When a short circuit is sensed these shut down the power in just a few milliseconds, before a fatal shock can occur.

In addition to equipping the Hi-Vols with ground fault interrupters (GFIs), the power line should be removed from the puddle of water.

SLIDE 4-12

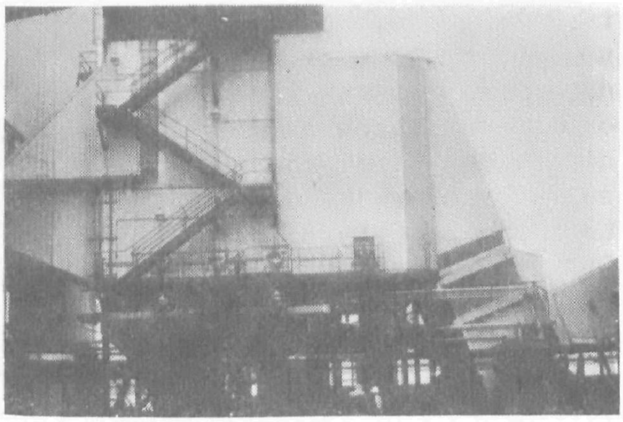


This is the electrical box for the motor operating a rotary discharge valve on a small baghouse. The box cover has been partially removed and the hot line is exposed.

Most people would not stick their hand into an electrical box, however in this case it could happen easily. The area under the hopper of the unit had a number of cross beams and other obstacles. While trying to get through this area, the box could easily be grabbed. At the time the box was grabbed, the individual would probably be hanging on to one of the metallic cross beams. It would be possible to suffer a fatal shock under these conditions.

As is so often the case, the various types of hazards occur frequently in groups. Just 3 feet from the location of this slide, there is a missing guard rail. While concentrating on ways not to fall off the guard rail, an individual may not give any thought to the electrical hazard.

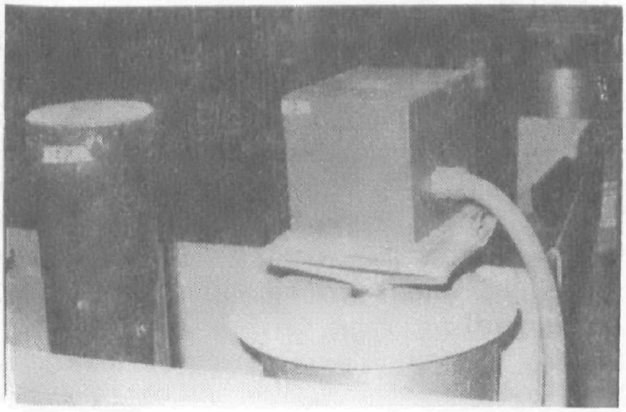
SLIDE 4-13



When making measurements downstream of electrostatic precipitators, it is very important that all probes be grounded. The highly charged particulate leaving the precipitator can impart a high static charge on the probe. When the individual touches the probe, a shock can occur. While the static shock is usually not life threatening, it may cause the person to jump backwards and fall off the sampling platform or hit his or her head on the various obstacles often found around the platform.

It is surprising how many stack samplers and field inspectors do not respect the potential safety problems related to static electricity. It is usually prudent to electrically bond all probes to the duct where the port is located.

SLIDE 4-14

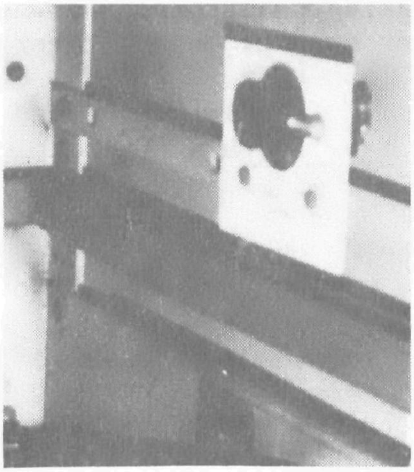


This is a electric vibrator type of rapper on the roof of an electrostatic precipitator. There is a small ground wire going from both the box and the rapper shaft to a grounding cable out of view of this slide. This protects against shorts in the vibrator which could seriously shock anyone touching a rapper.

Similiar grounding wires will be attached to all bus ducts on the precipitator roof. They are necessary to drain off the charge which builds up on the bus duct due to sparking from the high voltage line suspended in the center.

There is absolutely no need for the inspector to touch anything while on a roof of a precipitator. It is possible to check rapper intensity and sequence, to evaluate air infiltration through access hatches, and to check the operation of the purge air blowers without touching any of the components. Often contact will occur while a person is attempting to negotiate a path across the roof which is crowded with bus ducts, conduit, rappers, and transformer-rectifier sets. Although the very large majority of components are properly grounded, contact with them should be avoided.

SLIDE 4-15



This is a partial view of the inside of an electrical cabinet for one field of an electrostatic precipitator. On some older units, it is necessary to open the cabinet to determine if the field is on manual or automatic control. This can be determined from the position of the switch shown in this slide. THE CABINET SHOULD BE OPENED ONLY BY QUALIFIED PLANT PERSONNEL, NEVER BY THE INSPECTOR. Electrical components within easy reach can be at more than 400 volts.

Hazards from electrical cabinets also occur when inspectors attempt to measure the fan motor currents for scrubbers and baghouses. Opening an electrical cabinet to use an inductance ammeter should be done only by qualified plant personnel, never by the inspector. As with the cabinet shown above, they can have high voltage components around the lines being measured.

SLIDE 4-16

When walking around areas where flammable vapors are possible, inspectors should wear safety shoes designed to prevent the accumulation of static electricity. Before inspecting areas similar to that shown in this slide, discuss the type of shoes to be worn with plant personnel.

Source: National Audiovisuals Center

SLIDE 4-17

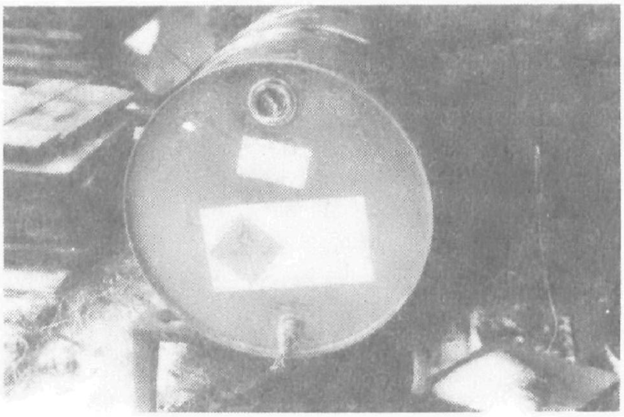
Most plants have areas where explosions could be initiated by smoking. While the plant personnel are warned repeatedly about such areas, the inspector may not recognize the hazard. DO NOT TAKE SMOKING MATERIALS ON INSPECTIONS.

SLIDE 4-18

This is a portable thermocouple for measuring gas temperature. It is one of a number of common inspection instruments powered by batteries. It should not be taken into potentially explosive areas because it can initiate an explosion.

It is necessary to obtain a hot work permit is necessary to take battery powered instruments in to areas around some air pollution control systems. Potential problems should be discussed fully before taking the instruments into such areas. The most common types of battery-powered instruments are pH meters, flashlights, and thermocouples.

SLIDE 4-19



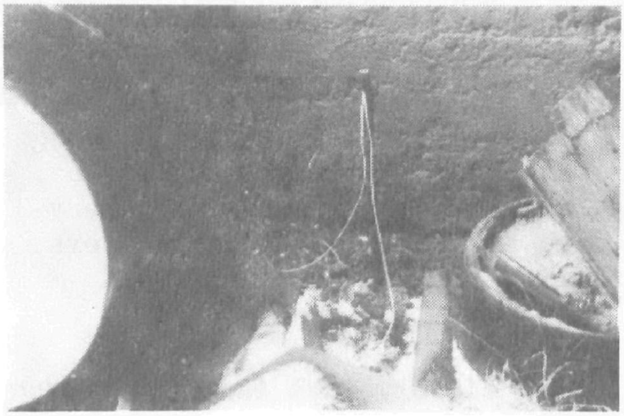
It is sometimes necessary during an inspection to get a sample of a solvent or coating to analyze for volatile content. It is also common to get a sample of fuel oil to measure the sulfur content.

When transferring flammable liquids or dusts from a storage vessel to a sample container it is possible to build up a high static voltage on the receiver. If the entire system is not grounded and bonded properly, an explosion is possible.

This slide shows a storage drum and the small clip which is meant to be attached to the receiver. This particular clip is so rusted that it is very unlikely that it could provide a proper electrical connection.

When drawing a sample, the funnel (if any) must be made of a conductive material and must be electrically bonded to the rest of the system. It is also important to prevent static electrical sparks originating from persons near the sample container. The samples should be drawn by plant personnel, not the inspector.

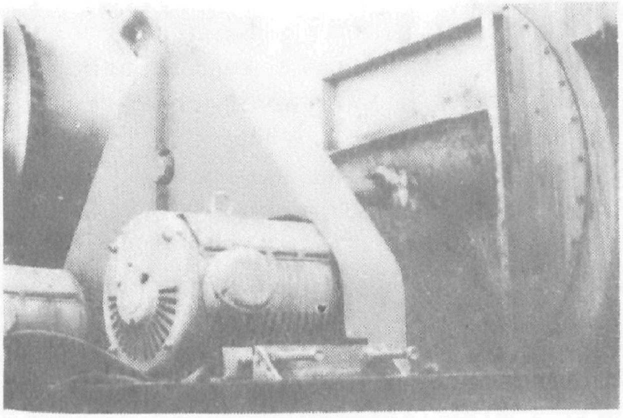
SLIDE 4-20



This is another view of the storage drum shown in the previous slide. Close examination reveals that the line leading from the grounding stake is not connected to the storage drum. Since the storage drum, funnel, and receiver may not be at the same potential, an explosion is possible.

Whenever it is noted that grounding and bonding are incomplete, the inspector should notify responsible plant personnel immediately. If the plant personnel persist in taking the sample, the inspector should leave the area immediately.

SLIDE 4-21



This is a relatively small fan on a wet scrubber system. If a fan appears to be vibrating severely, the inspector should notify responsible plant personnel immediately and leave the area. When a fan disintegrates, metal shrapnel-like fragments can be sent over a wide area, even through walls.

Excessive fan vibration can occur because of aerodynamic conditions or various physical insults. The most common physical problems include bearing failure, wheel erosion, and wheel deposits. Operating a fan at too high a speed can also cause the fan to disintegrate.

Fan disintegration often occurs during start-up of the unit. It is generally prudent to stay some distance away from fans when they are being started.

SLIDE 4-22

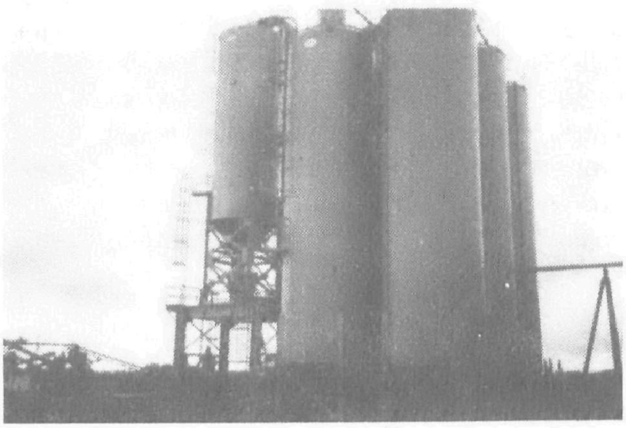
HIGH VOLTAGE LINES

High voltage tracks are common at steel mills and other plants in which it is necessary to move hot material on a routine basis.

The high voltage line can be within reach while walking through the mill. Even though there are warning signs, inspectors not familiar with the plant could conceivably touch the line. In some plants, it would be possible to accidently step on these high voltage tracks.

High voltage lines are sometimes found in the vicinity of air pollution control devices and stacks. Care is necessary whenever using long measurement probes such as pitot tubes.

SLIDE 4-23



Many air pollution control systems are located at the highest locations within the plant. Lightning can strike the structures in the area of the collector. Whenever threatening weather exists, these exposed locations should be avoided. Avoid these exposed locations when the an electrical storm is in the area.

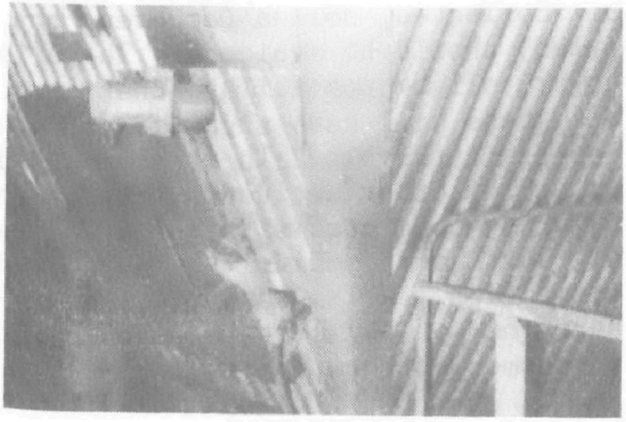
SLIDE 4-24

IONIZING RADIATION

There are several possible ways to be exposured to ionizing radiation such as gamma rays and beta particles. Gamma ray sources are used as hopper level detectors on some large electrostatic precipitator and fabric filter systems. Gamma ray instruments are used to continuously monitor process feed rates, material densities, and tank levels. Beta gauges are used for the continuous monitoring of film thickness.

It has also been reported that some dusts collected in air pollution control systems are somewhat radioactive because of the components of the ash or dust. It should be easy for an inspector to avoid any significant exposure to ionizing radiation.

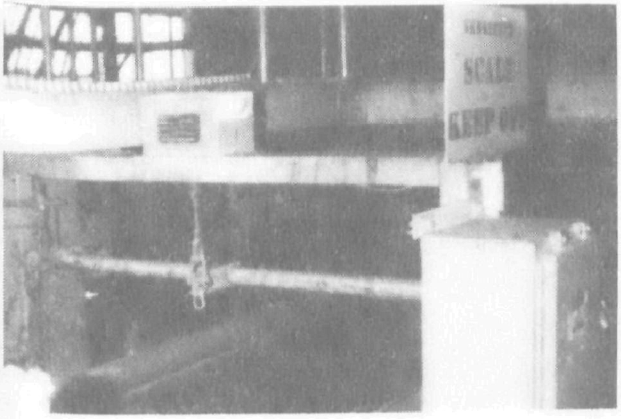
SLIDE 4-25



This is the source part of a gamma ray detector on the hopper of an electrostatic precipitator. It contains a small amount of cesium 137, a radioactive substance. Cesium 137 is constantly disintegrating by releasing gamma rays. The gamma rays are focused into a narrow beam which passes to a detector on the other side of the hopper. The presence of solids in the hopper is indicated by the absorption of some of the gamma rays.

All instruments of this type have a shutter which prevents release of the gamma rays when maintenance is being performed (the source can not be "turned off"). The entire source is shielded to reduce exposure to gamma rays in the immediate vicinity of the monitor. All instruments must satisfy a minimum radiation level within one foot of the instrument. Because of these design characteristics, the instruments are considered safe for a number of applications. Nevertheless, the regulatory agency inspector has no need to be close to the instruments and should avoid close contact. If a detector has been damaged , the entire area surrounding the monitor should be avoided because the protective shielding may no longer be effective.

SLIDE 4-26



This is a gamma ray sludge feed monitor at a sewage treatment plant. The source of gamma rays is located in the arm above the belt and the detector is located below the belt. The quantity of solids is related to the gamma ray absorption.

It is obvious that placing hands or arms between the source and the detector. would result in direct exposure to the gamma ray beam. It would also bring the individual into contact with moving equipment.

This type of instrument is shown because (1) it is the most common type of gamma ray source found during inspections of air pollution sources and (2) it has the largest open path between the source and the detector. There is no reason for an air pollution control agency inspector to be in the immediate vicinity of any of these instruments.

SLIDE 4-27

Direct contact with large quantities of collected solids (or even coal piles) should be avoided. There is a very slight possibility that some of these will have significant radioactivity levels. There are also a number of other accidents and health hazards associated with large piles of dust and solids (burns, skin irritation, falls, asphyxiation, inhalation of toxic dust, entrapment in submerged rotating equipment).

SLIDE 5-1

HEAT STRESS

Many air pollution control systems operate at elevated gas temperatures and many operate in close proximity to hot process equipment. Steam clouds are common near control devices. Furthermore, the areas which must be inspected are generally in the highest parts of the plant which means that climbing is almost inevitable. Due to these factors, heat stress is a potential threat to the inspector. This lecture concerns recognition of the symptoms of heat stress onset and ways to minimize the risk of heat-related injuries.

SLIDE 5-2

HEAT SOURCES

- Steam
- Ambient Temperature
- Radiant Energy
- Metabolic Heat

Heat stress is the additional load placed on bodily functions as the body attempts to maintain correct internal temperatures. This is not easy; there are significant sources of heat present in every industrial setting. This slide lists the four most common heat sources encountered during the inspection of air pollution control systems.

Radiant heat from hot ducts, control devices and process equipment can be a significant problem. The level of heat radiation is related to the FOURTH POWER of the temperature of the hot equipment. This means that uninsulated equipment in the range of 300 to 2000 °F can radiate very large heat levels.

Metabolic heat is the energy released during heavy work such as climbing, breathing with respirators, taking measurements, and lifting portable inspection equipment.

Steam is very common around air pollution control systems and can be a major source of heat energy . Steam makes the normal bodily cooling functions difficult because it raises the humidity in the vicinity of the control system. These varied sources of heat make it possible to suffer heat stress even when the ambient temperature is relatively low.

SLIDE 5-3

ACCLIMATIZATION TO HEAT

It is possible for the inspector to suffer the onset of heat stress while plant personnel seem to be having no difficulties at all. Inspectors are often more susceptible to heat stress because it is not possible for them to acclimate to plant conditions.

Acclimatization involves actual physiological adjustments of the body and results in enhanced tolerance to heat. It usually takes one to two weeks of exposure for total adjustment.

The majority of the changes involved in acclimatization take place during the first two days. Unfortunately, the enhanced capability to with-stand heat is also lost quickly as most body readjustments occur in just two days. Therefore, the agency field inspector does not remain acclimated even though he or she is regularly exposed (once a week) to hot conditions.

SLIDE 5-4

FACTORS WHICH INCREASE SUSCEPTIBILITY TO HEAT STRESS

- Lack of Acclimatization
- Chemical Exposure
- Noise Exposure
- Obesity
- Age
- Heart or Respiratory Disease
- Alcohol Consumption
- Fatigue
- Humidity
- Altitude

Factors which can contribute to heat stress include exposure to chemicals such as carbon monoxide and exposure to excessive noise. The physical condition of the individual is also important. Conditions such as obesity, heart disease, alcoholic consumption, and fatigue can aggravate the conditions. Susceptibility to heat stress usually increases with age.

SLIDE 5-5

HEAT-INDUCED ILLNESSES

- HEAT CRAMPS
- HEAT EXHAUSTION
- HEATSTROKE

The three major heat induced illnesses are listed in order of increasing severity. A brief synopsis of the symptoms of developing problems and emergency treatment for each problem are discussed in the following slides.

SLIDE 5-6

HEAT CRAMPS

Cause: Loss of Salts

Symptoms: Muscle Spasms

Treatment: Rest and Drink Water with 0.1% Salt

Sweating causes depletion of salts from the body vwhich in turn reduces tissue fluid levels and causes muscle spasms. The spasms are most common in the extremities, back, and abdomen.

If these symptoms are experienced, the inspection should be interrupted immediately and a cool place to rest should be found. The affected individual should drink water containing 0.1% by weight salt (1 teaspoon per 5 quarts water).

SLIDE 5-7

HEAT EXHAUSTION

Cause: Decreased Blood Circulation from Dehydration and Vasodilation

Symptoms: Fatigue, Nausea, Vomiting, Headache, Dizziness, Clammy Skin, Fainting, Rapid Pulse, Low Blood Pressure, Mental Disturbances

Treatment: Rest in Cool Area, Drink Water with 0.1% Salt, Get Medical Attention

Heat exhaustion results from the loss of body water and salt. The dilation of blood vessels results in decreased blood circulation and reduced blood supply to the cerebral cortex. This can cause an individual to collapse.

The initial symptoms include rapid pulse with low blood pressure, headache, nausea, fatique, clammy skin, and vomiting. Obviously, all inspection activities should be stopped and immediate aid obtained when these symptoms are noticed.

The individual should rest in a cool place which is not less than 75°F. It may be necessary to get further treatment from plant personnel or other qualified medical personnel.

SLIDE 5-8

HEATSTROKE

Cause: Failure of Perspiration System Resulting in Rise in Body Temperature

Symptoms: Hot, Dry Skin; High Body Temperature; Loss of Consciousness; Convulsions; Coma

Treatment: Immediate and Rapid Cooling, Get Medical Attention, Treat for Shock if Necessary

Heat stroke is an extremely serious condition. It is caused by the failure of the body cooling system and the uncontrolled rise in body core temperature. It can be fatal if not treated promptly.

The symptoms are a hot, dry skin, high body temperature, confusion, convulsions, loss of consciousness, and coma.

The treatment usually consists of immediate cooling by immersion in chilled water with massage or wrapping in wet sheets and fanning. It is often necessary to treat for shock.

It should be apparent that medical aid should be obtained as rapidly as possible when there is a possibility for heat stroke. It should be rememebered that most air pollution control equipment is located in elevated and remote portions of the plant. It may be difficult to rapidly move an unconsciousness individual to a cool air and difficult to get cool water up to a stricken individual. For this reason, it is necessary to start for protected areas and medical attention at the first sign of trouble.

SLIDE 5-9

MINIMIZING THE RISK OF HEAT STRESS

One way to minimize the risk of the various types of heat stress just discussed is to avoid hot areas as much as possible. It is often possible to schedule the inspections of hot sources during the early part of the day when the ambient temperature is low. While walking to the control systems, avoid the the hot areas of the process. Some of the most common areas which are hot are walkways near furnaces and rotating kilns, and the roofs of air pollution control devices.

Pitot traverses on hot ducts can sometimes be a cause of heat stress since the inspector could spend up to an hour at the sampling ports. If it is necessary to be close to the stack or duct during the traverse, there can be substantial exposure to heat. One way to minimize problems is to mark off the probe and perform all calculations in an area which is cooler than the sampling platform. If the radiant heat is very high, the pitot traverse should not be conducted at this location.

All inspectors should be screened for hot weather work as part of a medical monitoring program. This should identify any individuals with problems such as heart and respiratory diseases or any other condition which makes that person particularily susceptible to heat stress problems.

SLIDE 5-10

SELECTING THE APPROPRIATE CLOTHING

When working near a radiant source of heat, such as a duct or stack, protective clothing may be necessary to reduce the potential exposure.

When working near nonradiant sources of heat light clothing should be worn so that evaporative cooling is facilitated. In general, when the temperature is less than 100 °F the clothing should be light and loose fitting. When the temperature is greater than 100 °F, it should cover as much of the body as possible to decrease convective heat transfer from the surrounding air.

Synthetic materials should not be worn in areas where there is high radiant heat. It is possible for some of the synthetics to bond to the skin when the temperature is very high. The work clothes should be composed primarily of cotton.

SLIDE 5-11

GENERAL PRECAUTIONS TO MINIMIZE HEAT STRESS

Individuals working in hot areas must drink sufficient fluids to replace that lost through sweating. Nonacclimated people must take the precaution of increasing their salt intake to avoid dehydration. Heat cramps can result from drinking large quantities of unsalted water because of the muscle tissue fluids become diluted. Salt may be taken with meals, in electrolyte beverages, or in salted water. Fluids should be taken every 30 minutes and one person may consume up to 2 gallons per day.

Another precaution that can be taken to reduce the chance of heat stress is to take frequent rest breaks when working in hot areas. The work should be interrupted whenever symptoms of the onset of heat stress are observed.

SLIDE 5-12

COLD STRESS

Cold stress is the loss of body heat in situations of overexposure to cold. It can lead to skin injury, loss of extremities, and even death. For air pollution control inspectors, the principal problem is skin injuries.

SLIDE 5-13

MECHANISMS OF BODY HEAT LOSS

- Radiation
- Conduction
- Convection
- *Evaporative Cooling*
- Respiration

The five mechanisms for loss of body heat are listed in this slide. The radiation to surroundings increases substantially as the ambient temperature drops. This is again a functtion of the fourth power of the person's temperature and the surrounding temperature. Conduction occurs while standing in a layer of water or while holding on to cold objects (such as guard rails and support beams).

The convective transfer of heat from the body increases as the wind speed increases. It is important to stay in protected areas to minimize this mode of heat loss. Respiration results in heat loss since the cold air is heated to body temperature before it is released.

SLIDE 5-14

FACTORS WHICH INCREASE SUSCEPTIBILITY TO COLD STRESS

- Lack of Habituation
- Heart and Respiratory Conditions
- Fatigue
- Alcohol Consumption
- Inadequate Food
- Dehydration

Some of the factors which affect an individual's susceptibility to cold stress are listed in this slide. People do not acclimate to cold as they do to heat, however, there is some habituation, that is, increased tolerance for cold conditions.

Individuals with heat and/or respiratory problems will be more at risk from cold stress than others. Alcoholic consumption should be minimized. Fatigue, inadequate food, and dehydration also make an individual more susceptible.

SLIDE 5-15

COLD INDUCED AILMENTS

- FROSTBITE
- HYPOTHERMIA

These are the two major ailments caused by extremely cold conditions.

Frostbite is the freezing of some part of the body. Ice crystals form in the cells of the affected tissue. Usually this occurs in the extremities such as ears, hands, and parts of the face. There are three degrees of frostbite: frostnip, superficial frostbite and deep frostbite. Frostnip affects only the skin while superficial frostbite can affect tissue just below the skin. Deep frostbite affects deep tissue including even the bones.

Hypothermia is the lowering of the body's core temperature. This can result in mental and physical deterioration to the point of collaspe. It is often fatal.

SLIDE 5-16

FROSTBITE SYMPTOMS

Frostnip: Red to Pale or White Skin, Tingling, Stinging or Cold Sensation Followed by Numbness

Superficial Frostbite: White to Grey-White Skin, Waxy Skin and Lack of Sensation

Deep Frostbite: Skin and Tissue Pale, Solid Blisters and Swelling

The symptoms of frostbite are listed in this slide. Note that there is a progression in the type and severity of these conditions.

Whenever these symptoms are noted, the inspection should be stopped and a protected location found.

SLIDE 5-17

TREATMENT OF FROSTBITE

Frostnip:	Apply Body Heat
Superficial Frostbite:	Apply Body Heat
Deep Frostbite:	Remove to Warm Area, Bathe Affected Area with Warm Water or Apply Warm Packs, Get Medical Attention

The immediate treatment of frostbite is listed in this slide. To treat frostnip, apply body heat by placing the affected part in direct contact with skin of an area which is warm, such as the chest or armpit. The treatment for superficial frostbite is identical to that for frostnip.

For deep frostbite, the person should be removed to a warm area and the affected area bathed in warm water (between 104 and 106 °F). An alternative to bathing the area is to use wet packs.

SLIDE 5-18

SYMPTOMS OF HYPOTHERMIA

>95 °	Uncontrollable Shivering and Increase in Respiration
90-95 °F	Disorientation, Apathy, Dilated Pupils, Diminished Shivering and Diminished Respiration
86-90 °F	Semi-Consciousness, Muscular Rigidity and Further Pupil Dilation
<86 °F	Unconsciousness and Diminished Respiration
<80 °F	Little or No Respiration

The symptoms of hypothermia change with the body's core temperature. There is a logical progression as the core temperature drops.

As the body temperature drops to 95°F, shivering increases to uncontrollable levels and respiration increases.

Between 90 and 95 °F, disorientation and apathy occur. Diminished shivering and respiration occur. The pupils become dilated.

Between 86 and 90 °F, there is muscular rigidity and further dilation of the pupils. Semi-consciousness may occur. Below 86 °F, respiration is very diminished and the person may be unconscious.

The treatment of very mild hypothermia consists of feeding warm beverages and replacing all wet clothing with dry. In more severe cases, the person should be placed in a warm bath (approximately 105 °F) or wrapped with warm moist towels. Medical aid should be obtained immediately.

SLIDE 5-19

WINDCHILL CHART

WIND SPEED (MPH)	LOCAL TEMPERATURE (°F)										
	32	23	14	5	-4	-13	-22	-31	-40	-49	-58
5	29	20	10	1	-9	-18	-28	-37	-47	-56	-66
10	18	7	-4	-16	-28	-37	-48	-59	-70	-81	-92
15	13	-1	-13	-25	-37	-49	-61	-73	-85	-97	-109
20	7	-6	-19	-32	-44	-57	-70	-83	-96	-109	-121
25	3	-10	-24	-37	-50	-64	-77	-90	-104	-117	-130
30	1	-13	-27	-41	-54	-68	-82	-97	-109	-123	-137
35	-1	-15	-29	-43	-57	-71	-85	-99	-113	-127	-142
40	-3	-17	-31	-45	-59	-74	-87	-102	-116	-131	-145
45	-3	-18	-32	-46	-61	-75	-89	-104	-118	-132	-147
50	-4	-18	-33	-47	-62	-76	-91	-105	-120	-134	-148

For Properly Clothed Persons — Little Danger — Considerable Danger — Very Great Danger

DANGER FROM FREEZING OF EXPOSED FLESH

Routine inspections of air pollution control equipment should not be done when the wind chill factor is less than -20 °F. The chart shown on this slide allows a calculation of the wind chill factor using the temperature and the wind speed.

At wind chill factors greater than the -20 °F there is little danger, for people who are properly clothed, that exposed flesh will freeze. Below -20 °F, there is the risk of cold stress. It is also possible that observations and measurements made under very cold conditions will not be complete or accurate. Some portable instruments are not intended for service under very cold conditions.

SLIDE 5-20

SELECTION OF APPROPRIATE CLOTHING

Clothing should be layered to trap warm air and to prevent conductive heat loss. In addition, layering allows regulation of warmth. When it gets too warm, one simply takes off the appropriate layers. The outer layer should be wind proof, and in wet weather, water proof. Wet clothing causes rapid loss of body heat due to evaporative cooling. The inspector should be aware that heavy perspiration may dampen clothing enough to cause evaporative cooling. Heat regulation can be accomplished by removing layers and by opening closures at neck and wrists.

The head should always be covered since substantial heat loss occurs through the head. Insulated boots should be worn. Steel toed boots can cause rapid chilling of the feet.

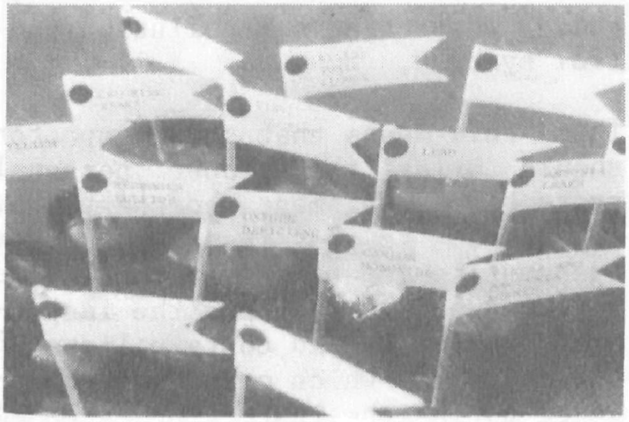
SLIDE 5-21

GENERAL PRECAUTIONS TO MINIMIZE THE RISK OF COLD STRESS

During the inspection, the work outside should be alternated with the work inside so that long periods of time are not spent in exposed areas. While inside, warm liquid should be consumed to help warm the body. The clothing should not become damp from perspiration while in the warm areas.

Regular checks for the onset of frostbite should be made. The inspector should not, under any circumstances, work alone. An accident could trap an inspector in an isolated portion of the plant and result in extended exposure to cold before he or she is found.

SLIDE 6-1



A wide variety of potential hazards may be encountered while inspecting air pollution control systems. Unlike workers who might work at the same station for 40 hours per week, inspectors are not usually subject to chronic exposure to the same chemicals. Rather, they are potentially at risk from acute exposures to a large number of chemicals. It is important for each inspector to know the warning properties of these chemical and how to choose respirators which will provide protection from various types of chemicals and different concentrations.

One of the fundamental principles of industrial hygiene is that possible exposures should be minimized or eliminated through the application of engineering controls. In the case of the field inspector for a regulatory agency this is not a realistic possibility. Most exposures occur because of fugitive leaks of the pollutant-laden gas stream out into the area immediately surrounding the air pollution control system. These conditions occur by accident and often are not identified by plant personnel. Other sources of exposure are contact with the downdraft from nearby stacks or rising clouds of toxic pollutants released from intermittent process operations. Both types of exposure result when inspectors are present on elevated platforms surrounding air pollution systems or stack sampling locations. In a sense, the inspector is at risk from the discharge points of the very engineering controls which are intended to protect plant personnel.

Since the exposures can not be easily limited by engineering controls, the inspector must substitute awareness of the potential problem areas and awareness of the warning properties of all chemicals present in the general area. The inspector must know when certain areas should be avoided and what respirators and other protective clothing to use in the areas which must be visited. The choice of respirators is complicated by the lack of monitoring data for the types of materials present. The conditions are highly variable and this makes monitoring data subject to error. Furthermore, there is rarely any monitoring data in the specific locations where the inspector may experience the most significant exposure.

The inspector who fails to use a respirator when necessary or selects the improper respirator can be at substantial risk. Synergistic action between the 300 to 600 common chemicals that may be inhaled by a single individual during a year could result in problems despite the small quantites of each that may have deposited in the respiratory tract. Also, if the inspector is hypersensitive to any chemical, he or she has a good chance of encountering this material at least once per year. The inspector does not ever get an opportunity to acclimate to the various chemicals.

SLIDE 6-2

This is one of three basic rules that field personnel should follow while inspecting air pollution control systems.

This rule means that the inspector should bring the proper personal protective equipment necessary for the areas to be inspected. The agency file for the plant should be reviewed before starting the inspection. Files should contain lists of the chemicals which could be encountered during the inspection. Based on the list and the recommendations of the plant personnel, the proper type of respirator can be selected.

Prior to entering each specific area of the plant, the inspector should consider what potential problems can exist. Partially confined areas should be avoided to the extent possible. While walking to the area of the pollution control equipment, avoid plant operations not directly related to the inspection.

SLIDE 6-3

The work should be interrupted when the inspector encounters any of the non-specific symptoms of exposure listed in this slide. While these ill feelings may not be due to any exposure which occurred at the plant, the inspector can not afford to base his actions on this assumption. The inspector should go IMMEDIATELY to a well-ventilated area and reconsider the potential inhalation hazards. Remember that the inspector may feel ill before the plant personnel because they acclimated to the conditions and are not exposed to as wide a variety of materials as the inspector.

It is important that the inspector be aware of how he or she is feeling during the inspection. Many of the pollutants have very poor and non-specific warning properties. The initial mild feelings of discomfort can quickly develop into very serious situations. At the first feeling of discomfort, the inspector should go to a well-ventilated are immediately.

SLIDE 6-4

IF THE NECESSARY PERSONAL PROTECTIVE EQUIPMENT IS NOT AVAILABLE THEN AREAS OF POTENTIAL RISK MUST BE AVOIDED

This is the third basic rule. If the necessary protective equipment is not available, or if the inspector does not have the proper training in the use of this equipment, no areas of potential risk should be entered.

One might expect that plant personnel would restrict entry to such areas. However, in a few cases they do not recognize that these are hazards since they are so familiar with the conditions. Furthermore, the inspector should not abdicate all responsibility for safety to anyone else during an inspection.

Plant personnel often provide the necessary respirators to inspectors without realizing that the individual has had no previous training in the use of the respirators and has not had a medical examination to demonstrate his capability to withstand the stress caused by the respirator. The inspector should advise plant personnel in either case and the areas of potential exposure should be avoided. This will probably mean that a large portion of the inspection can not be done as planned.

SLIDE 6-5

COMMON AREAS WITH INHALATION HAZARDS

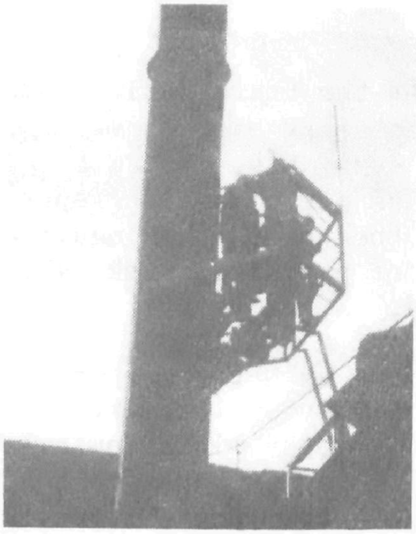
- Elevated Sampling Platforms
- Areas Adjacent to Process Vents and Discharge Points
- Partially Confined Areas
- Fugitive Process Emissions
- Fugitive Emissions from Solids Discharge Equipment

The upcoming series of slides concern the most common areas where exposure to chemicals can occur when inspecting air pollution systems. The inspector must recognize these areas so that potential exposures can be avoided entirely or minimized by using respirators.

The list presented in this slide presents some of these common areas. It is readily apparent that most sources include a number of such areas.

The term "partially confined area" has been developed for this program and will not be found in the standard industrial hygiene literature. This phrase is necessary to characterize the unique hazards which can be found near air pollution control systems. Such areas must be approached very cautiously.

SLIDE 6-6

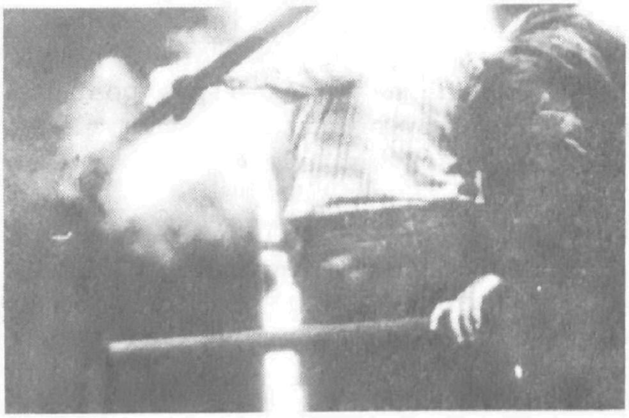


This is a photograph of a stack sampling platform on a foundry wet scrubber system. Out of view to the right of the slide are several small roof monitors which vent the process operations below. The emissions can drift across the sampling platform.

An inspector could spend more than an hour on the platform while making a pitot traverse. Stack samplers could easily spend 6 to 10 hours on the platform while performing a complete Method 5 test.

Due primarily to the length of the possible exposure, the proximity to the process vents, and the toxicity of the pollutants released from the vents during certain periods, it is advisable to use respirators. Stack samplers may need to take frequent breaks to reduce the discomfort of the respirators cause over a 6-10 hour period. Field inspectors should attempt to find a different location for making the pitot traverse. If this is not possible, then all activities associated with the traverse that do not have to be conducted directly at the sampling platform should be done in a protected location. For example, it would be easy to calculate the number of points necessary and to mark off the pitot tube at a remote location. Only the measurement of the stack diameter, and the measurement of the velocity pressures and gas temperatures need be done on the platform. Generally, about one half the time involved in a Method 2 traverse can be spent away from the platform.

SLIDE 6-7

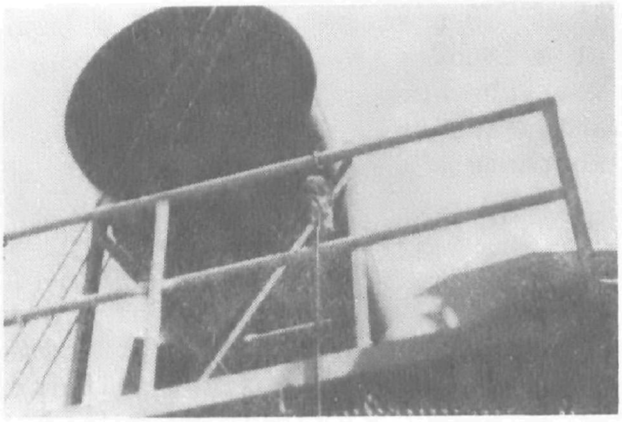


This is a photograph of several inspectors preparing to make a gas temperature measurement at a 4 inch diameter port on the duct leading from the induced draft fan. At this location, the static pressure is between one half and one inch positive pressure. Even at this low pressure, a substantial quantity of the gas can escape from the port into the breathing zone of the people. The cloud of gas is visible in the left center of the slide.

These large diameter ports should be avoided, especially when the static pressure of the gas is positive. The port should be one half to one inch in diameter to minimize the flow rate of gas through the port. Only ports with good ventilation should be used in any case. Before opening the port, the inspector should put on the appropriate respirator.

SLIDE 6-8

SLIDE 6-8

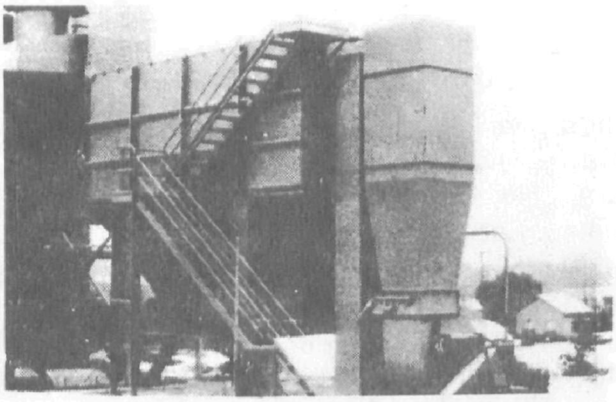


This is the discharge duct from a medium sized fabric filter. The duct is horizontal and is pointed at the platform surrounding an adjacent fabric filter. Some of the particulate matter handled by the unit shown in the slide is highly toxic. If there were a sudden bag failure, there would be undesirable levels of this material in the area where an inspector might be.

It is very common for the baghouse discharge to be very low to the ground with either a horizontal or downward orientation. In other words, many stacks do not point up! Sudden malfunctions of air pollution control devices occassionally happen.

The inspector must be aware of all the pollution control system discharge points and all process vents. It is necessary to be constantly aware of the best way to leave the area rapidly and it is advisable to have a respirator available at all times.

SLIDE 6-9

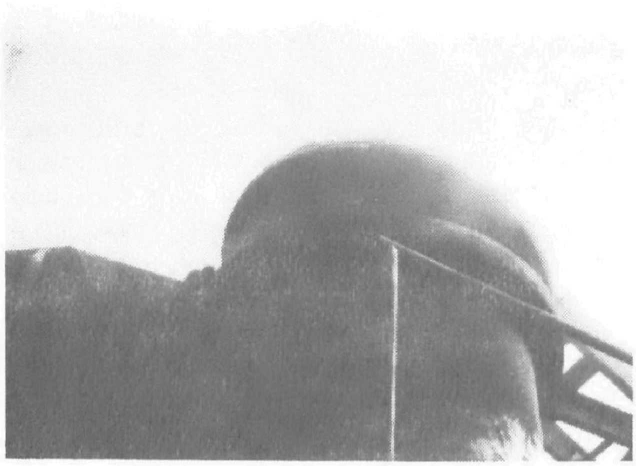


This photograph shows a modern asphalt concrete plant. The "stack" for the baghouse is the rectangular vertical duct on the right side of the baghouse. It is apparent that the inspector must walk right next to the discharge point (at the same elevation as his or her feet) while going to check the operation of the diaphragm valves and the condition of the top hatches. A cross wind would easily carry the exhaust to the breathing zone of the inspector.

Unfortunately, emissions from asphalt concrete plants do not have a high opacity even when the rate of emission is above the regulatory limit. Therefore, inspectors could underestimate the quantity of material they are being exposed to.

A baghouse does not remove any gases and vapors! Many asphalt plants (and other facilities) have moderate concentrations of sulfur dioxide and other contaminants which easily pass through the baghouse.

SLIDE 6-10

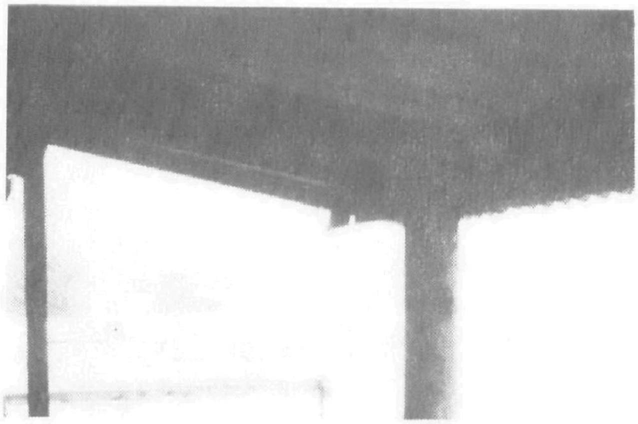


This is a view of a top of a cupola at a foundry. It is very abnormal for the top to be open and the emissions to be escaping to the atmosphere without any control at all.

The upset at this plant occurred due to failure of the induced draft fan in the air pollution control system. The emissions include particulate matter, carbon monoxide, sulfur dioxide, and partially combusted organic vapors.

It is very probable that the inspector would be on site during this time in response to the malfunction report called in by the plant personnel. The area fumigated by the plume from the upset process equipment must be avoided. Sudden changes in the wind direction can result in exposure to the highly contaminated plume.

SLIDE 6-11

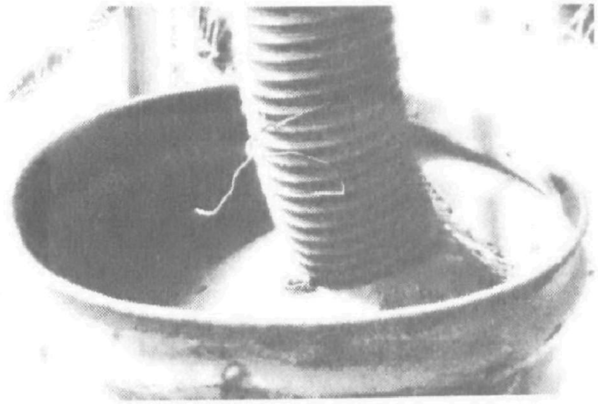


This is a photograph of the same plant shown in the above slide. It was taken approximately 30 seconds after the above picture. The plume from the cupola discharge has been caught in a downdraft and begun to fumigate the area where the plant environmental manager and the inspector were located. The picture was taken from a sheltered area out of the direct path of the plume.

Inspectors should always be aware of the location of the plume during such periods and should avoid areas where they might be trapped as the plume passes.

Inspectors should always be aware of the best means to escape an area which is suddenly in the path of the plume. It may be impossible to see due to the irritating properties of many pollutants. The inspector may experience difficulty in breathing. The potential problems related to falls from elevated surfaces (discussed in Lecture #2) become even more serious under such conditions.

SLIDE 6-12



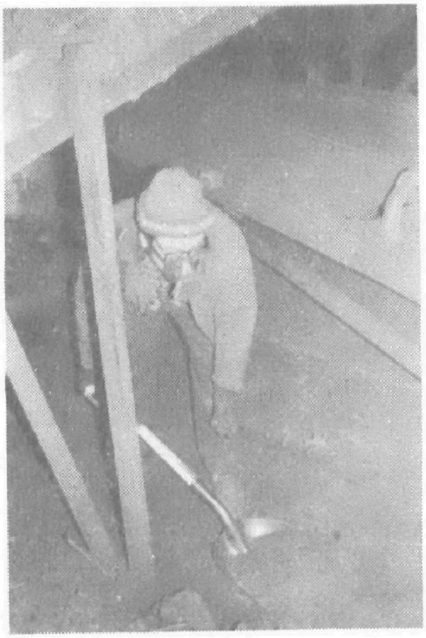
This appears to be an innocuous barrel of solids directly below the hopper of a baghouse. A gust of wind can entrain a cloud of the dust and blow it right into the face of an inspector. It is common for the composition of such dusts to be 1% to 5%, by weight, toxic metals, such as lead cadmium and/or zinc.

SLIDE 6-13

This is what a manufacturing operation will look like when the fabric filter (or other control system) has failed. Due to the poor ventilation, the concentration of contaminants can increase rapidly. It will be necessary to wear a respirator in areas which usually do not require respirators. The inspector should make every effort to minimize the time he or she spends in the affected area.

Source: National Audiovisuals Center

SLIDE 6-14



There are moderately heavy deposits on the floor in this portion of the plant. Walking through this area to reach the air pollution control device will stir up this material. The inspector should usually wear the same type of respirator as the personnel working in this area are using. This area should be avoided if there is an alternate route to the collector.

Source: National Audiovisuals Center

SLIDE 6-15

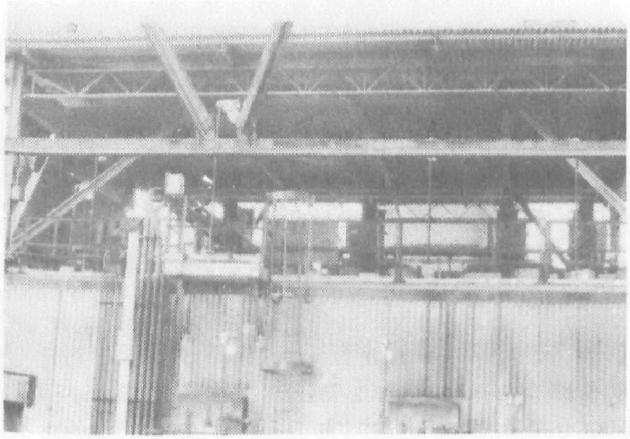
"PARTIALLY" CONFINED AREAS

High concentrations of toxic chemcials and asphyxiants can occur in any "partially confined area". This is an area outside of any equipment where there is poor air movement. Fugitive leaks of pollutant gas from the air pollution control system can result in very undesirable levels of the pollutants. These areas should be avoided if at all possible. If it is necessary to go through these areas, some kind of protective equipment is often necessary.

There are numerous partially confined areas around control devices. Not only can the trapped pollutants cause acute respiratory problems, but also the inspector is more susceptible to physical injuries because the exposure may cause symptoms such as lightheadedness which sometimes accompany the exposure.

The problems with partially confined areas are most severe when the collector is under positive pressure. Since the pressure in the unit and ductwork is above the pressure of the outside air, any leak can result in high concentrations of pollutants in the immediate vicinity of the pollution control system components.

SLIDE 6-16



This is a side view of the roof of a precipitator. There is a structure immediately above the precipitator which restricts natural ventilation on the roof. The unit is under positive pressure and there are leaks up into the roof area.

In some cases, it is necessary to spend up to several hours on the roof of precipitators like this, to check rapper sequence and intensity. Obviously a respirator would be necessary.

Areas like this are prone to pollutant build-up when the wind is calm. It is important to be especially cautious on these days. The types of gases which are common on electrostatic precipitator roofs include sulfur dioxide, nitrogen oxides, carbon monoxide, and ozone. Ozone is generated by ultraviolet photolysis of molecular oxygen by the corona on the precipitator wires. The gas streams normally have an oxygen content between 3% and 10%. For this reason, it is also possible to encounter an oxygen de-ficient atmosphere (defined as $< 19.5\%$ oxygen) in partially confined areas on the precipitator roof.

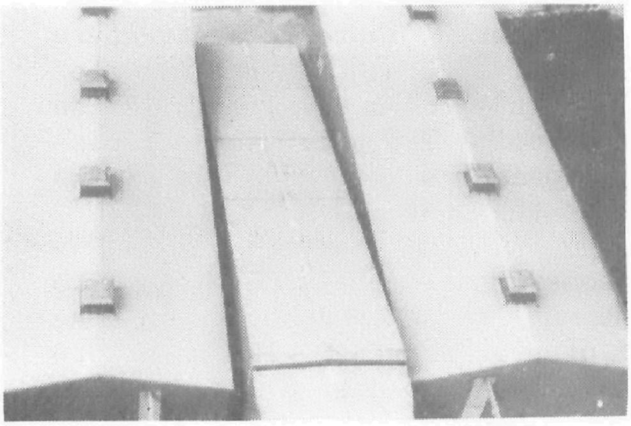
SLIDE 6-17

This slide shows the lower portion of one collection plate rapper of the unit shown previously. There is an obvious leak around the rapper seal. This is the main source of the pollutant laden gas entering the partially confined area of the roof.

It is usually not possible to see these leaks. In this case , the moisture in the leaking gas condensed rapidly, marking the location of the leaks.

It is difficult to find and eliminate all of the leaks on a large electrostatic precipitator. Some have a roof area which is close to the size of a football field. There can be several hundred plate rappers (as shown in this slide) and large numbers of discharge electrodes and gas distribution screen rappers. Access hatches on the precipitator roof are also potential leak sites. It should be assumed that leaks exist on all precipitators under positive pressure.

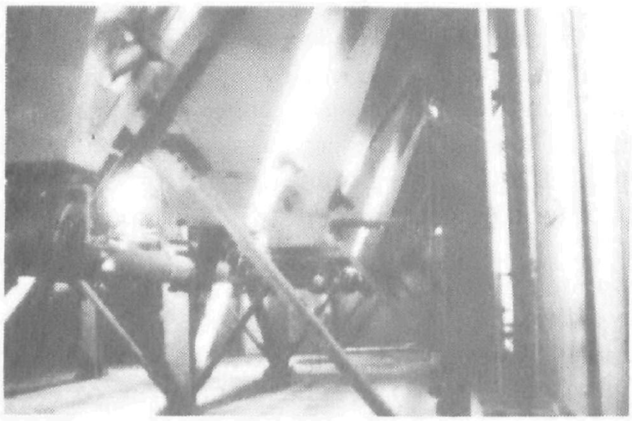
SLIDE 6-18



This is a view looking down on the roofs of two precipitators which are in an arrowhead arrangement. The stack is in the upper left of this slide. The white structures are weather enclosures over the roofs of the units. In colder climates, the weather enclosures facilitate maintenance. Even with the ventilation fan, common in such enclosures, it is possible to find high concentrations of pollutants within these structures.

The inspector should wear the same type of respirator used by plant personnel in these areas. It should be noted that these enclosures are generally desirable in that precipitator maintenance and precipitator long term performance are enhanced. They should not be discouraged solely because of some possible discomfort to the inspector. There may be a need to measure the pollutant and oxygen concentrations prior to entry. If the inspector does not have the necessary safety equipment to enter this area, then the inspection must be abbreviated.

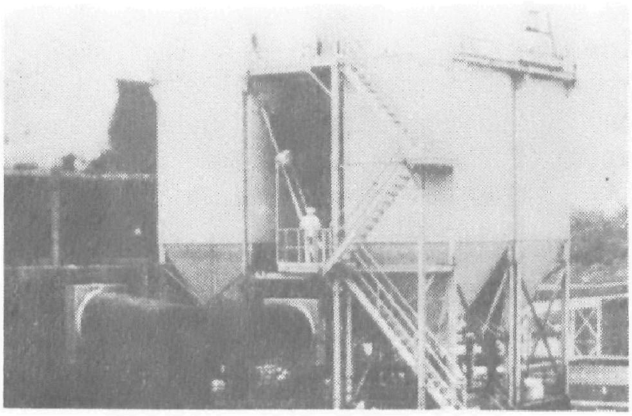
SLIDE 6-19



This is a picture inside a weather enclosure around the hoppers of an electrostatic precipitator. Pollutant laden gas may leak through the access hatches and weld gaps in the hoppers leading to high pollutant concentrations in this area. Again, it is necessary to test the oxygen level and the pollutant concentration prior to entry.

There is rarely a good reason for an inspector to enter the enclosures around hoppers of precipitators under positive pressure. Checks for air infiltration are necessary only on negative pressure units. The only other items of interest are provisions to prevent solids overflow in the hoppers. These can be seen from the access door to the enclosure; it is not necessary to enter.

SLIDE 6-20



Source: National Audiovisuals Center

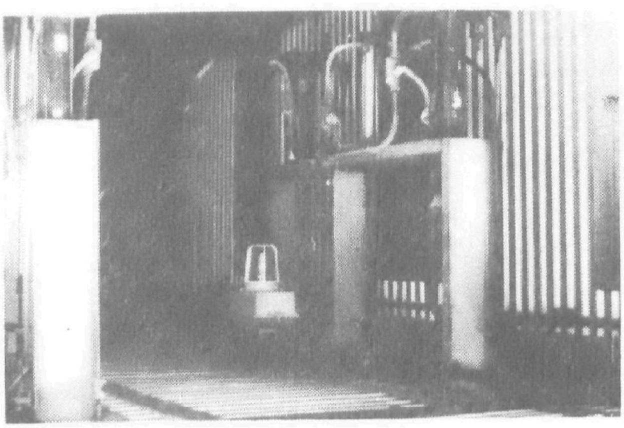
This is a multiple compartment baghouse under positive pressure. The walkway between the compartments can have very high pollutant concentrations and low oxygen levels if the access doors, shell, or ducts leak.

Some of these walkways are like tunnels or large canyons. The ventilation on a still day can be negligible. It is advisable to avoid walking through this area unless a respirator is used.

Unfortunately, this is where the differential pressure gauges for each compartment are located. Because it is necessary to observe the pressure drop for each compartment during the filtering mode and during cleaning, an inspector could spend a considerable amount of time in this area.

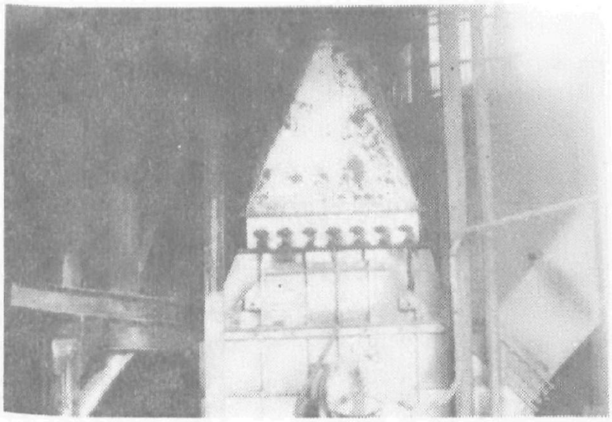
If there are any symptoms of problems, the inspector may need to look into (not go into) one of the compartments. To do this the plant personnel must isolate the compartment and then open the hatch. Since almost all dampers leak, this can result in some flow of pollutant laden gas into the walkway area. The inspector must have the appropriate respirator for the type of particulate matter and gas present. If the flow of gas out the hatch is too rapid, shut the hatch immediately.

SLIDE 6-21



This is a close-up view of a walkway between compartments of a large baghouse. This particular unit is under negative pressure. Therefore, there is less risk from accumulated pollutants and oxygen deficiency. Nevertheless, all areas with poor natural ventilation should be approached cautiously.

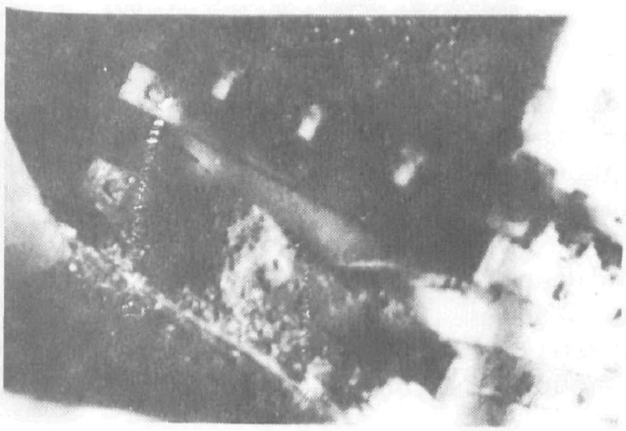
SLIDE 6-22



The fan shown in the slide serves a large venturi scrubber. It is below the scrubber and surrounded on three sides by building walls. The static pressure of the duct leading from the fan to the stack is under a low, but nevertheless significant, positive pressure. A gap in the isolation sleeve or a hole in this duct could result in high concentrations of the pollutants contained in the gas stream escaping to the inspector's breathing level.

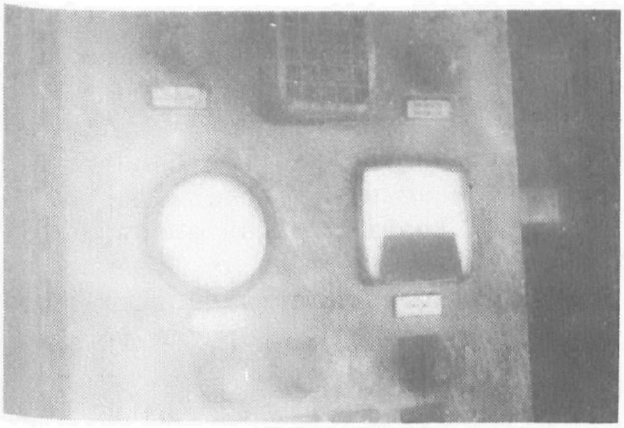
All fan houses or partially enclosed areas surrounding fans must be approached cautiously.

SLIDE 6-23



This is a close-up photograph of the isolation sleeve on the discharge side of the fan shown in the slide above. There are a number of gaps which are leaking high velocity gas into the area around the fan.

SLIDE 6-24

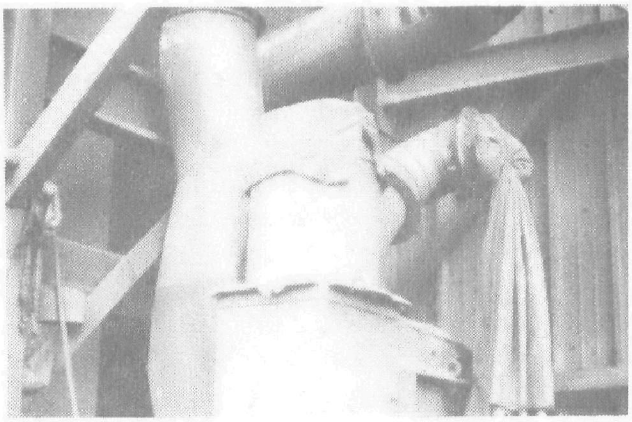


This is the scrubber control cabinet which is located less than 3 feet from the the cracked isolation sleeve (see last two slides). An inspector trying to determine the operating conditions of the scrubber could be fumigated with toxic or oxygen deficient gases.

SLIDE 6-25

This is another isolation sleeve of a fan. One half of the sleeve has been removed for reasons that are not known. A similar condition can result in extremely high levels of gases in the area around the fan. This type of condition is not as uncommon as it should be.

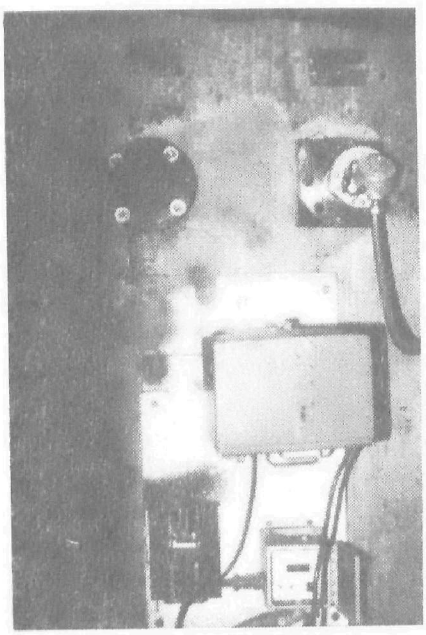
SLIDE 6-26



This is the discharge side of a fan downstream of a baghouse. A cloth has been stretched over the fan discharge presumably to reducethe amount of the solids from accumulating around the fan. The area immediately surrounding the fan had 4 to 12 inches of accumulation. It is not unusual to find high emissions from the discharge of a control system baghouse. What is unusual is the futile effort to keep the material in the fan.

This slide illustrates that high levels of pollutants can exist near fans which discharge into poorly ventilated areas.

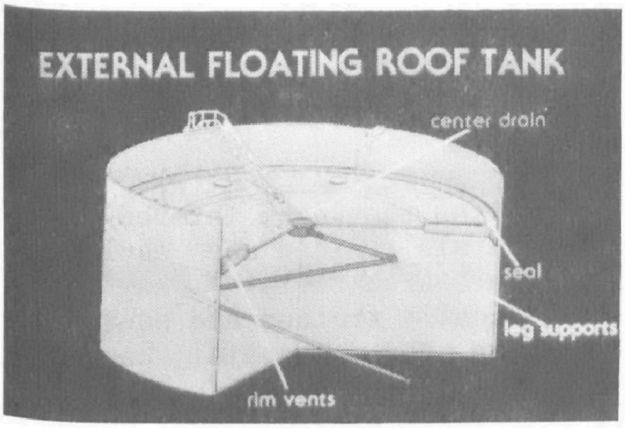
SLIDE 6-27



A continuous emission monitor mounted on a stack of a coal-fired utility boiler is shown in this slide. The unit is between the stack liner and the outer shell. The cylinders with calibration gas are stored just out of view to the left. If these cylinders leak, it is possible to have undesirable concentrations of sulfur dioxide and nitrogen oxides in the area around the transmissometer.

Transmissometers mounted on positive pressure ducts can have high pollutant levels around the unit due to fugitive leaks.

SLIDE 6-28

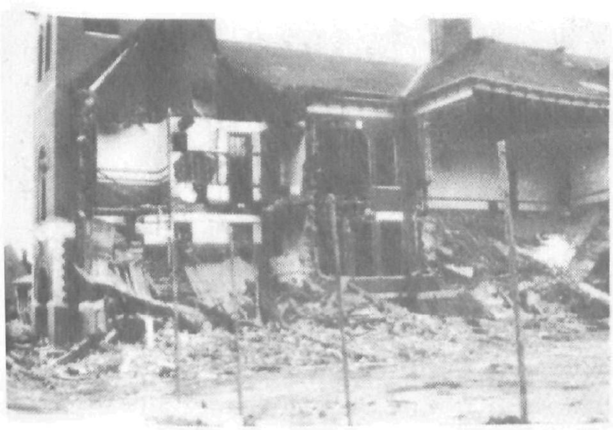


Source: EPA Air Pollution Training Institute

This is a drawing of a floating roof storage tank for hydrocarbons. High concentrations of organic vapors can exist on the top of the roof because of leaks through the seals. The vapor concentration should be measured before the inspector enters to check the seals.

The external walls of the tank block off the wind resulting in poor ventilation on the roof surface. The highest concentrations of organic vapors occur in precisely the areas that the inspectors check the seal condition.

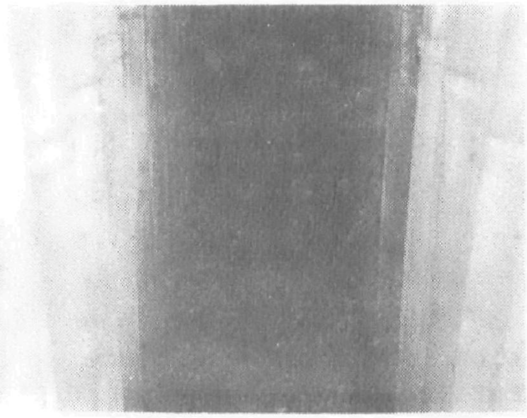
SLIDE 6-29



This is a photograph of a building demolition site. While attempting to get samples of the insulation material in the area, the inspector could enter a sheltered area where there is a high concentration of asbestos fibers.

In addition to the obvious inhalation hazards there are a number of physical hazards. These include floors which can not support the inspector's weight and falling bricks.

SLIDE 6-30



This is a view of the inside of a fabric filter. A REGULATORY AGENCY INSPECTOR SHOULD NEVER ENTER AN AIR POLLUTION CONTROL DEVICE. FATAL INJURIES ARE POSSIBLE INSIDE THESE DEVICES.

These devices should be entered only by individuals trained and equipped for confined area entry. They must be specifically trained and equipped to survive the potential hazards inside air pollution control devices. These hazards include but are not limited to:

1. Asphyxiants
2. Toxic Gases
3. Toxic Particulate
4. Hot, Free Flowing Solids
5. Oxygen Deficiency
6. High Voltage
7. Rotating Equipment

It is more difficult to rescue an individual overcome inside an air pollution control device than it is to rescue persons from sewers and other equally dangerous locations. This is because most units have very small hatches, many internal components that could snag rescue ropes, and most devices are located in high and remote parts of the plants.

A QUALIFIED AGENCY INSPECTOR CAN EFFECTIVELY ACCOMPLISH ALL OF THE INSPECTION REQUIREMENTS WITHOUT ENTERING THE CONTROL DEVICE. INSPECTORS SHOULD REFUSE TO ENTER ANY COLLECTOR EVEN WHEN ENCOURAGED TO DO SO BY PLANT PERSONNEL. PLANT PERSONNEL SHOULD ABSOLUTELY REFUSE PERMISSION FOR THE INSPECTOR TO ENTER THE CONTROL DEVICE.

When an inspector is overcome inside a collector it is probable that one or more of the plant personnel will attempt a rescue. This places these individuals at a very substantial risk.

This issue is stressed because the author has noted a wide spread lack of respect for the hazards inside these collectors despite the accident and "near miss" history. Some manuals even imply that internal inspections should be done routinely. Others place great faith in the conditions of the collectors. These individuals do not suspect that the isolation dampers on many collectors leak severely, rendering an "isolated" compartment as dangerous as a compartment which is on line. Some people also place too much faith in the lock out systems of the collectors. For all of these reasons there is a need to stress the potential hazards that exist inside air pollution control devices. REGULATORY AGENCY INSPECTORS NEED NOT AND SHOULD NOT ENTER THESE DEVICES.

SLIDE 6-31

MOST CONTAMINANTS HAVE POOR WARNING PROPERTIES

Recognizing areas that are potential sites for exposure has been the first topic presented in this lecture because avoiding hazards is the best way to minimize risk. Many of the materials inhaled during the inspection have poor warning properties. In other words, the person may have no physical sensation that there are high levels of pollutants in the air.

For example, the inhalation of dust and fume rarely causes any immediate physical discomfort or impairment. For this reason it is possible for undesirable quantities of toxic materials such as lead, arsenic and asbestos to reach the lungs where they can be slowly absorbed by the blood and attack organs such as the liver and kidney.

The chemical and physical asphyxiants are another group of chemicals with very poor warning characteristics. Chemical asphyxiants such as carbon monoxide and hydrogen sulfide can occur at life threatening levels without any odor or taste perception. The most common physical asphyxiant, carbon dioxide, also does not have any odor.

Most organic compounds and nitrogen dioxide are not very soluble and can penetrate deep into the lower lung. The initial symptoms of exposure are non-specific and may not be recognized by the inspector who is preoccupied in conversation with plant personnel or in the inspection activities. These symptoms include dizziness, drowsiness, headache, light-headedness, and nausea. Acute exposure can result in pulmonary edema hours after the exposure.

The chemicals which have the best warning properties are those which are partially soluble in body fluids. The low taste and odor thesholds of compounds such as sulfur dioxide, ammonia and chlorine are due primarily to the solubility of these materials. Most individuals (but not all) will quickly leave an area with a high concentration of such chemicals. Failure to do so, however, can lead to severe cardio-pulmonary problems.

Inspectors should review the plant files to determine which chemicals might be encountered during the inspection. The warning properties of these materials should be reviewed so that everyone is aware of the consequences of exposure to the toxic materials. One very useful document to assist the inspectors is the NIOSH/OSHA Pocket Guide to Chemical Hazards. The field manual is available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402. Each inspector should have a copy of this document and any other reference materials necessary for the types of chemicals which may be encountered.

SLIDE 6-32

BERYLLIUM

Route of Entry — Inhalation of Dust and Fume

Symptoms — Intense, Brief Exposure May Result in Nonproductive Cough, Low Grade Fever, Chest Pains, and Shortness of Breath

Consequences — Acute Exposure Can Result in Chemical Pneumonia with Pulmonary Edema Several Hours After Exposure

The next series of slides discusses several of the common chemicals which can exist in the partially confined areas and surrounding areas of air pollution control systems. This section demonstrates the importance of the use of respirators and avoidance of unnecessary exposures to the chemicals.

The warning properties and possible effects of beryllium are listed in this slide. This is one of the most toxic chemicals which may be inhaled by a field inspector. Like a number of other materials, this can cause edema several hours after exposure. The initial symptoms of exposure are not very dramatic.

Due to the poor warning properties of beryllium and the very serious consequences of exposure, field inspectors must plan to use personal protective equipment. They should not wait for the initial symptoms of exposure to this material. All areas of potential exposure should be discussed with the plant personnel before the inspection and all areas which are not relevant to the inspection should be avoided.

SLIDE 6-33

CADMIUM

Route of Entry — Inhalation of Dust and Fume

Symptoms — Acute Exposure May Occur Without Immediate Symptoms

Consequences — Pulmonary Edema

Cadmium is another toxic particulate material with little in the way of initial warning symptoms. The consequences of an acute exposure include a very serious respiratory condition.

SLIDE 6-34

HYDROGEN SULFIDE

Route of Entry — Inhalation of Gas

Symptoms — At High Concentrations There Is No Odor

Consequences — Chemical Pneumonia May Develop Several Hours After Exposure

At low concentrations, hydrogen sulfide is an eye irritant and it has a very disagreeable rotten eggs type odor. If these symptoms are noted, the inspector should leave the affected area of the plant. Exposure to higher concentrations of hydrogen sulfide can occur in areas close to the point where these symptoms were first noted. At moderate to high concentrations, hydrogen sulfide is an extremely deadly chemical: at high concentrations the gas quickly overcomes the olfactory senses.

It is possible to walk into a confined or partially confined area with toxic concentrations of hydrogen sulfide and be only briefly aware of its presence before olfactory fatigue overcomes your senses and you think the problem has gone away. Brief exposure to such conditions can lead to pulmonary edema and other serious respiratory problems in 6 to 12 hours after the exposure. The exposure can also result in immediate death.

A large number of the industrial processes frequently inspected by regulatory agencies handle high concentrations of this gas. These include sour gas wells, petroleum refineries, and petrochemical chemical plants. It can also be found in some unlikely locations such as downstream of cupolas. Pockets of the chemical can occur in partially confined areas around the sources and it can even occur in depressions along the ground.

SLIDE 6-35

NITROGEN OXIDES

Route of Entry — Inhalation of Gas

Symptoms — Initial Symptoms Include Cough, Chills, Fever, Headache, Nausea

Consequences — Acute Pulmonary Edema May Follow Five to Twelve Hours After Exposure

During the exposure to nitrogen oxides only mild bronchial irritation may be experienced. Concentrations of 100-150 ppm are dangerous for periods of 30 to 60 minutes.

Nitrogen oxides are generated in almost all combustion processes. While they do not have a distinctive odor it is sometimes possible to see the orange color of nitrogen dioxide.

Also, nitrogen oxides are often accompanied by sulfur dioxide which can be smelled and tasted at low levels. When there is the odor of sulfur dioxide it is the possible that nitrogen dioxide is present. Unfortunately nitrogen oxides can occur without the odor of sulfur dioxide.

This set of gases is one example of the nonsoluble chemicals. The site of attack is the deep lung and the consequences of acute exposure is severe. Typical effluent concentrations are 400 to 1000 ppm. Concentrations of 100 to 150 ppm are possible in partially confined areas.

SLIDE 6-36

ASBESTOS

Route of Entry	— Inhalation of Fibers
Symptoms	— No Immediate Physical Symptoms
Consequences	— Asbestos is a Confirmed Carcinogen

Asbestos is a confirmed carcinogen. Exposure to asbestos fibers can occur while inspecting building demolition sites. There are no immediate physical symptoms following the exposure to asbestos.

This is one of the best publicized of the known or suspected carcinogen compounds. Other chemicals commonly encountered include vinyl chloride, benzene, and halogenated organics.

SLIDE 6-37

CHLORINE

Route of Entry	— Inhalation
Symptoms	— Intense Irritation of Eyes, Nose, and Throat
Consequences	— Respiratory Problems

Chlorine is one of a number of chemicals which are partially soluble in mucous membranes. The initial site of attack includes the eyes, nose, and throat. It has relatively good warning properties.

Exposure can occur due to an accidental release from process equipment. Inspectors must be aware of plant warning sirens and know what to do if a cloud of chlorine is approaching their location.

The possibility of chlorine release is just one of the reasons why it is important that plant personnel accompany the inspector at all times. As soon as there is a warning siren indicating a release in the general vicinity, everyone should proceed to a safe area and check in by phone to a central location. The wind socks or pennants flying from the tops of some process equipment provide a general indication of the wind direction. Obviously, it is usually safest in the upwind direction of the suspected release area. An area engulfed by the charactristic yellow cloud should be avoided while going to a protected area. Respirators should be carried while inspecting areas where chlorine releases are a significant possibility.

SLIDE 6-38

DETECTION AND MEASUREMENT OF INHALATION HAZARDS

There are many methods and instruments currently available for the detection and measurement of inhalation hazards. For the inspector's purposes, any method or instrument used should be relatively inexpensive, lightweight and easy to transport. It should also be simple to use.

SLIDE 6-39

- Personal Protection Badges
- Detector Tubes
- Combustible Gas Indiators

Keeping the above fact in mind, this discussion will center on three ways of detecting and/or measuring air contaminants: personal protection badges, detector tubes, and combustible gas analyzers.

The personal protection badges are useful mainly to warn the inspector that he has encountered a high concentration of the applicable gas. The detector tubes can be employed for both detection and fairly accurate measurement of most types of pollutants.

The combustible gas analyzers are used to measure the explosion potential of vapors and thus are useful for detecting and measuring a number of volatile organic compounds.

SLIDE 6-40

PERSONAL PROTECTION BADGES

The commercially available personal protection badges function by two different mechanisms. One type gives a comparatively instant indication of the presence of the appropriate gas by undergoing a change in the color. The other is worn for a specified amount of time (e.g. 8-hour shift and then is sent to a lab where it is analyzed for adsorption of the pollutant). The second type is much like the radiation badges with which you may be familiar. We'll discuss only the first type at length, because this type is most useful for the inspector for instantaneous detection of inhalation hazards.

SLIDE 6-41

This type of passive dosimeter or personal protection indicator is a badge which has a piece of reagent impregnated filter paper (or button in the case of CO badges) which chemically reacts with the specified gas causing the indicator to change color. The color change provides a warning of excessive exposure to a toxic gas.

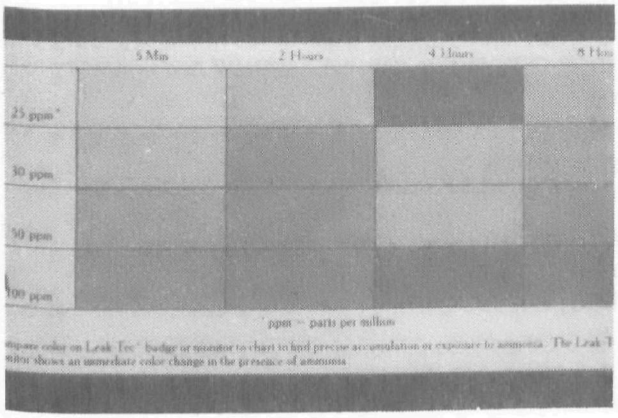
SLIDE 6-42

INSTANT READING BADGES AVAILABLE

Toxic Substance	Critical Conc.	Color Change
Ammonia	25ppm	Yellow to Blue
Carbon Monoxide	50ppm	Tan to Black
Chlorine	1ppm	White to Yellow
Hydrazine	1ppm	White to Yellow
Hydrogen Sulfide	5ppm	White to Brown
Nitrogen Dioxide	1ppm	White to Yellow
Ozone	1ppm	White to Brown

The types of badges available from one manufacturer are listed in this slide along with the critical concentration of the specific gas which affects the color change. The critical concentration is based on the time-weighted average (TWA) for 8 hours of exposure to the gas. Inspectors can clip these badges to their belts to warn them if high concentrations of these gases are present.

SLIDE 6-43



In theory, the degree of color change of these badges can be correlated with a particular concentration of the gas over time. This is shown in this slide of the manufacturer's color chart for the ammonia badge. The manufacturer, however, no longer supplies these charts, but it is useful to note that the degree of color change can be used to estimate the relative concentration of the gas. Of course, any change to blue on this badge would signal the wearer to leave the area immediately.

These badges accumulate very low concentrations of gas over time. For example: if a chlorine badge is exposed to 0.2 ppm for several days, a color change will eventually result due to the total concentration of chlorine exposure. This may result in the false conclusion that a 1 ppm of high concentration of chlorine was present in the ambient air during the day of the color change. As a result of this accumulation characteristic of the badges, it is recommended that inspection personnel use the badges only one time.

SLIDE 6-44

BADGE	BLOCKING GASES
Ammonia	High Concentration of acid gases such as: Sulfur Dioxide Nitrogen Dioxide Hydrogen Sulfide
Carbon Monoxide	High Concentrations of Nitrogen Dioxide temporarily block reaction. Temp $<0°C$
Chlorine	High Concentration of Carbon Monoxide, Hydrogen Sulfide & Hydrazine
Hydrazine	Ammonia
Hydrogen Sulfide	No known gases or vapors block the reaction
Nitrogen Dioxide	High Concentrations of Hydrogen Sulfide, Carbon Monoxide & Hydrazine
Ozone	High Concentrations of Hydrogen Sulfide, Carbon Monoxide & Hydrazine

Before making use of these badges, it is essential to understand their limitations. As this slide shows, all the types of badges except hydrogen sulfide have certain gases which "block" or prevent the color change reaction.

SLIDE 6-45

GAS	INTERFERENCES	REPEAT-ABILITY
Ammonia	Amines & other basic gases or vapors	90%
Carbon Monoxide	Hydrogen Sulfide Tobacco Smoke Ammonia Turns Indicator Blue	90%
Chlorine	Hydrogen Chloride Ozone, Nitrogen Dioxide	95%
Hydrazine	Primary Amines	90%
Hydrogen Sulfide	Gases & vapors containing reduced sulfur such as Mercaptan. Gases containing phosphorous	90%
Nitrogen Dioxide	Chlorine, Ozone Hydrogen Chloride	95%
Ozone	Hydrogen Chloride Nitrogen Dioxide Chlorine	95%

The reagents on each type of badge which affect the color change for the gas of interest are sensitive to one or more other gases. This is termed interference and a list of interfering gases for each badge is shown in this slide.

Also shown in this slide is the repeatability for each type of badge.

SLIDE 6-46

EFFECTS OF WATER

- Water is necessary for the color change reaction; badge deteriorates after 3 to 5 days exposure to the atmosphere
- Sensitivity of reaction increases with increase in humidity

Water has quite a significant effect on the indicators. Their sensitivity increases as the humidity.

Dry atmospheres also affect the badges response. The color changes that the badges undergo require the presence of water. When an indicator is exposed to the ambient atmosphere, water that is present in the paper begins to evaporate; the rate is dependent on the temperature and the humidity. As it evaporates, it removes some of the the color change reagents along with it.

Eventually a critical point is reached where the amount of water and reagent remaining is insufficient to cause a color change. This point usually occurs with 3 to 5 days of exposure to the atmosphere. Carbon monoxide badges are an exception to this because they use a different type of indicator material.

SLIDE 6-47

OTHER CONSIDERATIONS

- Temperature Range — 50° to 120°F
- Shelf Life — Six months
- Storage — Cool, dry place away from direct sunlight
- Reusable — No

Other important considerations are listed on this slide. It is clear that the badges are not as reliable under cold conditions. The shelf life should be carefully watched. Dispose of expired badges. Storage during the six months should be in a cool, dry place away from direct sunlight.

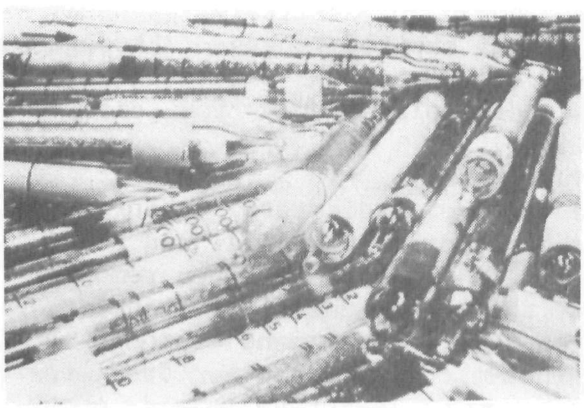
Some of the indicators (chlorine, nitrogen dioxide, ammonia, and ozone appear to "regenerate" when removed from the contaminated environment. Badges that have gone through a distinct color change due to exposure should not be reused even if it has"regenerated" to the original color. When a color change occurs a portion of the reagents are used and thus the level of sensitivity probably decreases.

SLIDE 6-48

GAS INDICATOR OR DETECTOR TUBES

Gas indicator or detector tubes offer a more sophisticated system for detection and measurement of gases and vapors than the personal protection indicators discussed in the last set of slides.

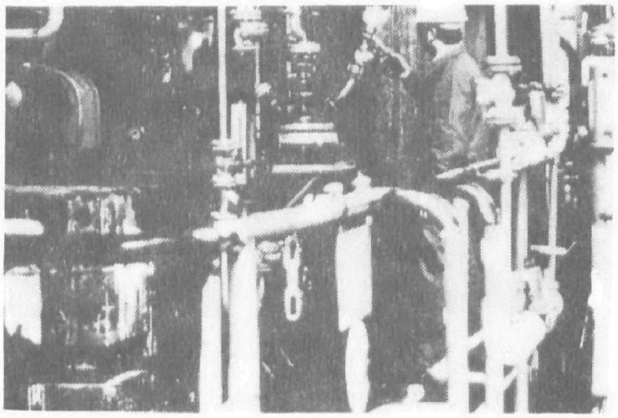
SLIDE 6-49



Source: National Draeger, Inc.

Detector tubes provide a general indication of concentration for more than 150 gases, vapors, and a few aerosols.

SLIDE 6-50



Source: National Draeger, Inc.

Although detector tubes are used in a variety of applications, the air pollution inspector is most likely to employ them for two different purposes. The first is the measurement of pollutants for monitoring purposes. This slide shows a measurement being taken to investigate a possible leak from process equipment.

SLIDE 6-51

Source: National Draeger, Inc.

The second use of detector tubes is the sampling of potentially hazardous atmospheres in confined areas, partially confined areas, and in areas around positive pressure duct systems. Sampling information can then be used to make decisions concerning entry to the area and selection of proper respiratory protection.

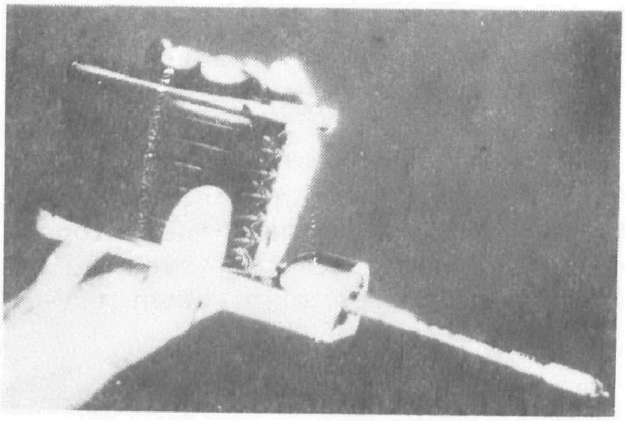
SLIDE 6-52

DETECTOR TUBE SYSTEM

- Pump
  - Bellows
  - Piston
- Indicator Tube

The detector tube system consists of two parts, the pump (usually bellows or piston) and the indicator tube (appropriate for whatever gas or vapor is being sampled).

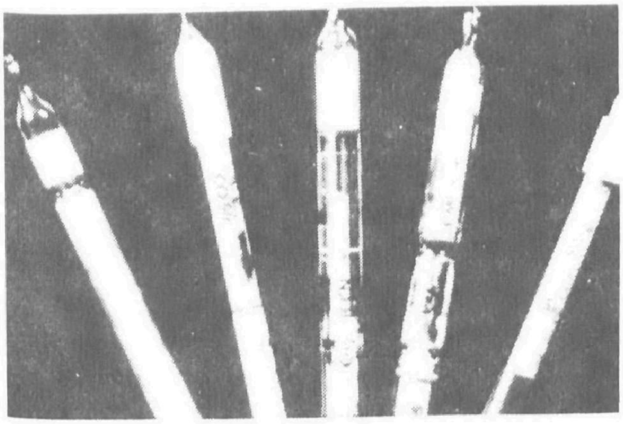
SLIDE 6-53



Source: National Draeger, Inc.

The pump is used to draw a measured volume of the air to be sampled through the indicator tube. In the case of the bellows pump shown in the slide, a fixed and constant volume of air is drawn through the tube each time the bellows are squeezed. To sample the measured volume of air appropriate for a certain indicator tube, the pump is squeezed the number of times specified in the literature for each type of tube.

SLIDE 6-54



Source: National Draeger, Inc.

The indicator tube is a hermetically sealed glass tube (the ends are broken off immediately prior to use) containing a solid granular material impregnated with an agent which reacts to a specific air contaminant as it is drawn through the tube.

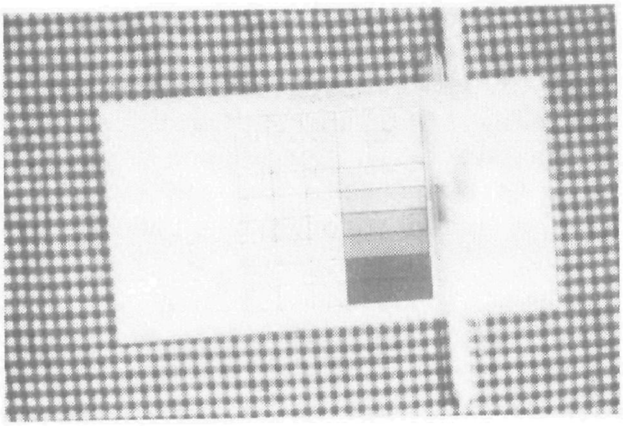
SLIDE 6-55

TYPES OF INDICATOR TUBES

1. Direct Reading Stainlength
2. Color Comparison
3. Color Matching

Based on the method used to interpret the gas concentration, there are three major types of indicator tubes. The first is the stainlength tube where the length of a colored stain indicates the concentration of the contaminant; this used either a set number of pump volumes or you count the number of pump volumes to produce a set stainlength.

SLIDE 6-56

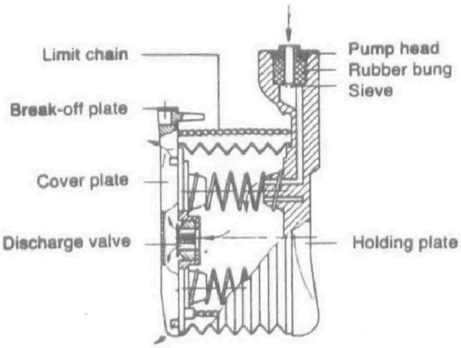


Source: National Draeger, Inc.

The second is a color comparison tube where the density of depth of the colored stain is compared to standard reference layers in the tube or a color chart provided with the tube to determine the contaminant concentration.

The third is a color matching tube where the pump strokes are counted until the color of the stain matches a standard reference layer in the tube or a reference color supplied with the tube.

SLIDE 6-57



Source: National Draeger, Inc.

To make a measurement using the system, the two sealed ends of the tube are broken off (using break-off plate), the tube is inserted into the pump head (or septum) and the specified volume of air is drawn through the tube using the pump. A specified period of time is permitted for each pump stroke to completely draw its full volume of air (see tube instructions). The concentration is read off the tube as discussed previously.

Before each use the pump should be quickly leak tested. This is accomplished by inserting an unopened detector tube into the pump head. The pump is then operated by depressing the bellows (or pulling back the piston) as far as it will go. The pump should maintain that position for the period of time specified by the manufacturer.

SLIDE 6-58

INSTRUMENT LIMITATIONS

As was true with the personal protection indicators, it is important to understand the limitations of the instruments.

A critical limitation is the quality control exercised by the manufacturer of the indicator tubes and pumps. NIOSH currently conducts a certification program designed to help insure that detector tube sampling systems. conform with established performance specifications. The manufacturer's submit test batches of tubes for certification and at the same time must submit a quality control plan for the manufacture of the same. A manufacturer's tubes are certified by specific type; the certification includes use with the pump unit.

SLIDE 6-59

ACCURACY

- Certification indicates ± 25%
- Tube calibration can be user verified
- Pump should be calibrated with respect to volume and flow rate.

The NIOSH certification on a type of indicator tube signifies that if they are used according to manufacturer's directions, they will produce readings that are within plus or minus 25% of the true concentration at 1,2, and 5 times the test standard (usually the TLV).

Their accuracy can be verified by sampling a contaminant source of known concentration prodecures for this are described in several of the references.

The pump itself can and should be user calibrated at regular intervals with respect to both volume (delivered) and flow rate. Several references also describe procedures for this.

SLIDE 6-60

OTHER CONSIDERATIONS IN THE USE OF DETECTOR TUBES

- Temperature effects on pump volume and reagent reaction kinetics
- Shelf life and storage
- Interfering gases
- Color comparison and matching accuracy
- Non-interchangeability of different manufacturers' tubes and pumps

Other limitations which must be considered are listed in this slide. Extremely high or low temperatures will affect measurement accuracy. This is due to its influence on both the volume of air sampled and the kinetics of the reaction occuring in the detector tube.

SLIDE 6-61

TEMPERATURE EFFECTS ON INDICATOR TUBE SHELF LIFE

°F	Shelf Life
75	2 years
120	1 year
175	weeks
210	1 week
255	3 days
300	1 day

Temperature also greatly influences the shelf life of detector tubes. Under normal conditions the shelf of most tubes is 2 years. But as is shown in this slide, storage at elevated temperatures can greatly decrease the shelf life. Thus, it is important that the tubes be carefully stored to insure a reasonable temperature; they should never be left in a place such as the trunk of the inspector's car. Refridgeration, in fact, can increase shelf life, but the tubes must be temperature equilibrated before use. Tubes should also not be stored in direct sunlight.

OTHER CONSIDERATIONS IN THE USE OF DETECTOR TUBES

- Temperature effects on pump volume and reagent reaction kinetics
- Shelf life and storage
- Interfering gases
- Color comparison and matching accuracy
- Non-interchangeability of different manufacturers' tubes and pumps

Similar to the personal protection badges, many of the detector tubes are not totally specific for one contaminant and there are interfering gases and vapors which must be considered. These interferences can be negative be additive and are usually noted in the manufacturer's literature.

There can also be problems with the color comparison or matching aspect of reading the tubes. Different lighting can change the look of a color chart or color standard. The color matching charts themselves can fade with time and color blindness will obviously hinder comparisons.

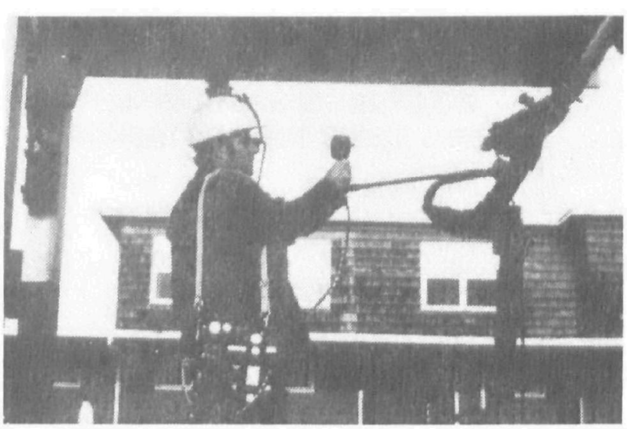
Finally, indicator tubes and pumps from different manufacturer's should never be interchanged because of differences in pump suction properties and flow rates.

SLIDE 6-63

COMBUSTIBLE GAS INDICATOR (SNIFFER)

A combustible gas indicator is used to detect and/or measure combustible gases and vapors in the atmosphere. This section covers one type of combustible gas indicator, the "sniffer", which used catalytic combustion to measure and read out in percent of the Lower Explosive Limit (LEL) for the gas being tested.

SLIDE 6-64

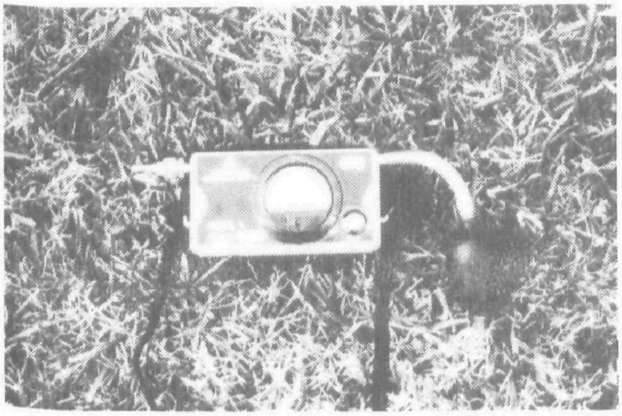


For the agency inspector, this instrument has basically the same type of uses as the detector tubes except that it detects only combustible gases and does not measure low concentrtion levels as well.

It can be used effectively for simple screening of combustible VOC leak sources. This slide shows an inspector sampling at a bulk gasoline terminal using the Century OVA a more sophisticated combustible gas analyzer than we will discuss.

The "sniffer" can be used for testing confined, partially confined, and any other suspicious area for the presence of combustible gases.

SLIDE 6-65



This is a photograph of a combustible gas indicator. It uses the catalytic combustion principle of operation. The squeeze bulb on the right draws an atmospheric sample (mixture of air and combustible gas) into the sample chamber. Here it is brought into contact with a hot platinum wire (filament) where rapid oxidation of the gas with the oxygen in the air occurs. This raises the temperature of the wire causing an increase in its electrical resistance. The change in resistance activates the readout meter.

The instrument is designed so an increase in the amount of combustible gas causes a proportional increase in the resistance of the platinum filament and thus the amount of combustible gas present is directly indicated on the meter.

The instrument also has another chamber which houses a "reference" filament. This compensates for the variable condition under which it must operate, e.g., minor voltage fluctuations and changes in temperature.

SLIDE 6-66

PREOPERATIONAL CHECK

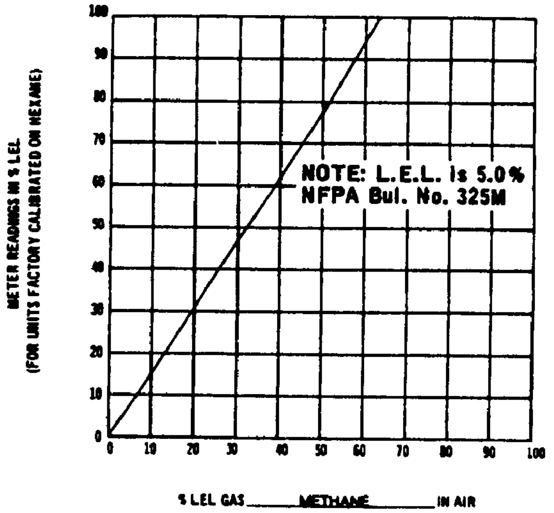
1. Zero mechanically
2. Turn on/Zero
3. Purge
4. Apply known calibration gas
5. Check for appropriate meter response based on gas calibration curve
6. Purge
7. Turn off

This slide summarizes the preoperational check (or simple one point calibration) of the instrument shown above. Other combustible gas indicators of similiar sophistication will use comparable procedures.

The meter is mechanically zeroed using the screw at the center bottom of the meter. The unit is then turned on and the meter rezeroed electrically using the on/off knob. To purge, squeeze the aspirator bulb several times.

A calibration gas of known concentration is applied to the inlet (opposite the aspirator bulb connection) and the bulb is squeezed three to four times. Calibration gases can be obtained in cylinders, made using a gas calibration kit, or made using methods described in a number of the references listed in the Appendix. The instrument response is then checked based on the appropriate gas calibration curve. Finally, the unit is purged again and then turned off until ready for use.

SLIDE 6-67



The unit readout scale in in percent of the LEL from 0% to 100%. The LEL is the leanest mixture of a gas which will burn (or explode) when ignited. This gives an instant indication of danger of explosion of an atmosphere, it does not indicate whether or not it is dangerous with regard to toxicity. Also, when a gas sample concentration exceeds the LEL, the meter pointer generally first deflects rapidly upscale and then toward or below zero.

The instrument is factory calibrated on hexane. When used to sample other gases it will read slightly higher or lower depending upon the gas. An example of this is shown in this slide which is the gas curve for methane. A methane gas concentration at 40% of the LEL (or 20% methance) will read 60% on the meter of a unit calibrated on hexane. Two percent methane-in-air is a commonly used calibration gas and should based on the proceeding discussion give the response of 60% on the meter. Other gases can be used for calibration using the appropriate gas curve (usually available with the unit).

Similarily, these curves can be used to roughly estimate the concentration in ppm of a known gas in the atmosphere, by first converting the meter reading in %LEL to %LEL of the known gas using the curve, and then converting the %LEL of the gas to a percent-in-air using this formula.

(%LEL of gas) x (LEL of gas) = % Gas-in-air

The percent gas-in-air figure is then converted to ppm by multiplying by ten thousand.

SLIDE 6-68

OPERATION

1. Purge
2. Turn on/Electrically zero
3. Sample atmosphere
4. Note response on meter
5. Purge
6. Turn off

For routine operation of the unit the steps listed in this slide are followed. It should first be purged by squeezing the aspirator bulb several times. Then it is turned on and electrically zeroed using the on/off knob.

Then it is ready to be used to sample the atmosphere in question. This is accomplished by inserting the hose or probe into the area to be tested and squeezing the bulb several times (Allow 4 squeezes for a standard 5 foot sampling hose, increase by 3 squeezes for each additional 5 feet). Note the reading on the meter when the needle stabilizes for a few moments after the last bulb squeeze. After taking the reading, purge the unit in fresh air until the needle returns to zero and then turn it off.

SLIDE 6-69

COMBUSTIBLE GAS INDICATOR LIMITATIONS

Because there are so many types of combustible gas indicators, each with slightly different limitations, the following section will only cover the general limitations of combustible gas indicators. Before using any instrument of this type, the inspector should carefully read all the manufacturer's literature and take note of the specific considerations for its use.

The slides that follow will outline items which should be considered with every instrument and should give the agency inspector a good idea of what to be aware of in using such an instrument.

SLIDE 6-70

INTRINSIC SAFETY CONSIDERATIONS

- Check instrument approval
- Repair work that breaches intrinsic safety warrants recertification

Combustible gas analyzers use heated wires, electronics, flames and other sources of ignition. When they are immersed in a test atmosphere, it is theoretically possible that they could ignite an explosion. Consequently, most combustible gas analyzers are constructed such that ignition is highly improbable in certain atmospheres. These instruments are then considered "intrinsically safe" for use in these atmospheres. Each instrument should be checked to determine for what types of atmospheres it is certified or approved.

It is also important to consult the operating and service manual before troubleshooting or servicing so that the intrinsic safety built into the detector will be maintained. If any repair work breaches the intrinsic safety of the instrument, it should be returned to the manufacturer for testing and recertification.

SLIDE 6-71

LIMITATIONS OF SUITABILITY FOR CERTAIN GASES OR ATMOSPHERES

- Halogenated hydrocarbons cause filament poisoning
- Condensible vapors cause fouling
- Oxygen enriched atmosphere may cause flash back
- Oxygen depleted atmospheres will cause a much decreased instrument response

Certain gases and/or atmospheres can cause instrument damage, explosion, or inaccurate response. Halogenated hydrocarbon gases or vapors produce thermal decomposition products which corrode the sensor and alter its sensivity and integrity. Condensible vapors foul the sensor.

In spite of the flame-arresting system, some instruments may flash back in a pure oxygen or oxygen-enriched atmposhere. Check the instruction for instrument limitations PRIOR to use.

Oxygen depleted atmospheres pose a different sort of problem. Instrument response is almost always dependent on the presence of sufficient oxygen to support combustion. Without it, meter operation ie erratic or the respons for the combustible gas is less than the actual concentration. If an oxygen depleted atmosphere is suspected, detector tubes can be used to make that determination, before using the combustible gas indicator. Other atmosphere-related limitations not listed in this slide include (1) a decreased response to sulfur compounds such as hydrogen sulfide, (2) no response to explosive dust atmospheres, and, as mentioned previously, (3) an erratic response to gas-enriched atmospheres.

SLIDE 6-72

OTHER CONSIDERATIONS

- Sensitivity to Gas
- Calibration Gas
- Zero Drift
- Temperature
- Dust and High Humidity
- Probe Length
- Position Sensitivity
- Interchangeability of Parts

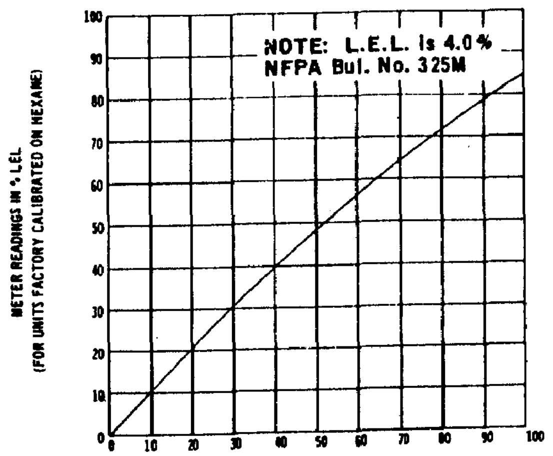
All instruments exhibit "zero drift", i.e. they drift from "true zero" as the instrument is used. Thus frequent checks of the zero, in a CLEAN atmosphere are important.

Temperature will affect instrument sensitivity and accuracy. The LEL of most gases varies with the temperature. NO instrument should be used at extremes of temperature unless the temperature's effect is knownn. Dust and humidity also have an effect; therefore, many models include a dust filter and drying agent.

When a long sampling line or probe is needed in the field, the instrument should be calibrated using the same set up. In the case of the unit shown in Slide 6-65 the user must remember to increase the bulb squeezes in proportion to the line length. This unit is also position sensitive; it must always be kept upright while sampling.

As is true with the detector tube systems, NEVER interchange parts from one type of combustible gas indicator to another.

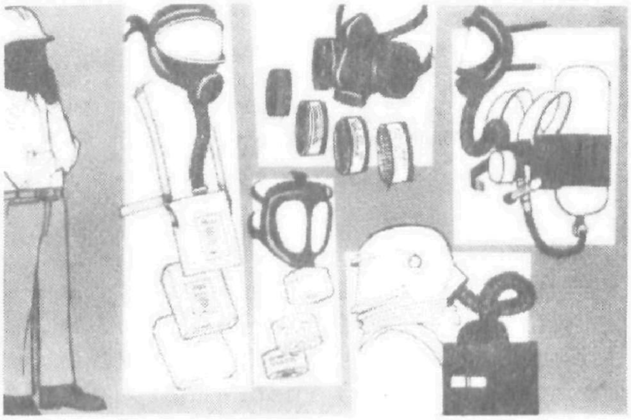
SLIDE 6-73



Finally, the user must take into account the identity of the gas he or she is measuring and the instrument's sensitivity to that gas. It must be remembered that the instrument is calibrated on only one gas at a time and it will measure only that gas accurately. This slide shows that a unit calibrated with hexane will read slightly lower when sampling hydrogen. Interfering gases and vapors can also change the readings.

The sensitivity of the particular instrument must also be considered when measuring low concentrations of toxic gases, because many instruments are not accurate at the lower end of the scale.

SLIDE 6-74



Source: National Safety Council

The next portion of the lecture concerns the selection and use of respirators. This is something that must be addressed before starting the inspection.

There is a lot more to the use of a respirator than just slapping one on when the need arises. Each person should have a medical examination to confirm that he or she can manage the additional stress caused by the respirator. Inspectors should be trained on the use and fitting of each style of respirator they will use. The training should also include instructions concerning regular cleaning and inspection of the unit. There should be written procedures covering all aspects of respirator selection and use.

This lecture will provide only a brief introduction to this topic. A complete program concerning respirator selection and use requires one half to three days, depending on the types of units to be used. All U.S. Environmental Protection Agency personnel engaged in field activites are required to have a minimum of 6 hours training on the selection and use of respirators (see EPA Order 1440.3, July 24, 1981). It is also necessary to have follow-up training of two to four hours after the initial training program.

For U.S. EPA personnel, the selection of the appropriate respirator must be based on the assessment of the hazards and the Decision Logic Table specified in EPA Order 1440.3. The inspector's preliminary assessment of the potentially hazardous conditions should be discussed with plant personnel before starting any inspection. In the selection of the respirators, it may also be beneficial to read the three references listed below, copies of which will be made available during the training program.

1. Respiratory Protection Program Guideline, U.S. Environmental Protection Agency, Draft Dated February 1983.

2. NIOSH/OSHA Pocket Guide to Chemical Hazards, U.S. Department of Health And Human Services of the U.S. Public Health Service and the U.S. Department of Labor, Dated September 1978. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

3. Respiratory Protection, A Manual and Guideline, Prepared by L.R. Birkner, Celanese Corporation and Published by the American Industrial Hygiene Association, Dated 1980

SLIDE 6-75

REQUIREMENTS CONCERNING USE OF RESPIRATORS

These are the minimum requirements for a respirator program which meets the specifications outlined in OSHA Standard 1910.134.

1. Written standard operating procedures governing the selection and use of respirators shall be established.

2. Respirators shall be selected on the basis of hazards to which the worker is exposed.

3. The user shall be instructed and trained in the proper use of respirators and their limitations.

4. Where practicable, the respirators should be assigned to individual workers for their exclusive use.

5. Respirators shall be regularly cleaned and disinfected. Those issued for the exclusinve use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

6. Respirators shall be stored in a convenient, clean, and sanitary location.

7. Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

8. Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

9. There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

10. Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. A local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

11. Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards estiablished by competent authorities. (portion of this paragraph has been omitted, the reader is referred to the OSHA Standard.)

SLIDE 6-76

SELECTION CRITERIA

- Concentration of Contaminants
- Forms of Contaminants
- Oxygen Levels
- Size and Shape of Head

The respirators must be selected based on a number of factors, some of which are listed on this slide.

One of the most important factors is the concentration of the material. The respirator must satisfactorily perform at these concentrations. It is also important to know if the concentration is Immediately Dangerous to Life and Health (IDLH) and/or if the concentration is close to the explosive range.

Unfortunately, the concentration of the contaminant or contaminants is rarely known because the exposures are due to accidential and/or intermittent conditions. Also, the inspector visits many individual sites around the control system during the performance evaluation. Rarely is there monitoring data available for all of these locations.

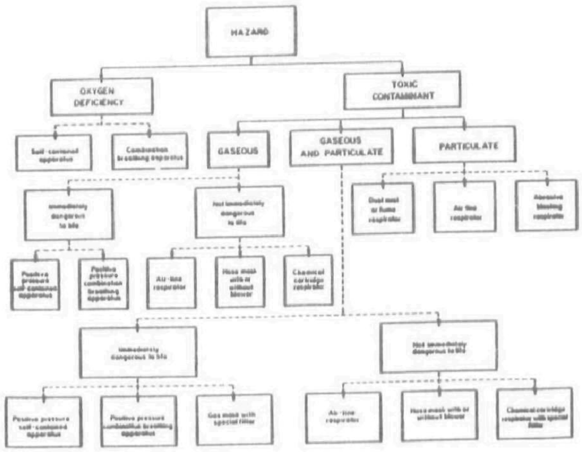
It is very important to know what the oxygen level is at the various locations to be visited. Many air pollution control systems handle gas streams with very low oxygen levels of 3 to 6%. Even some small leaks can lead to localized oxygen concentrations below 19.5%, the point at which oxygen deficiency becomes a problem.

The warning properties of the materials must also be known. This is best done by the file review before starting the inspection. If some of the chemicals are irritants, a full face piece unit may be required,regardless of the concentration. If the chemical(s) can be absorbed through the skin, protective clothing may be necessary in addition to a respirator.

The form of the material (gas, vapor, fume, dust, etc.) must be known to the extent possible. This is a verdifficult question, however, since the form of the contaminant can change after release to the ambient air surrounding the control device. In most cases, the low ambient temperature condenses vaporous material to form very small particle size aerosols. In some cases, the materials released can react very rapidly with sunlight or with available oxygen to form more toxic compounds than were in the duct originally. It is also possible for one material released around pollution control equipment to react with another to form very undesirable materials. Atmospheric ammonia can participate in some of these reactions. For all of these reasons, the determination of the form of the material is difficult. It is hard even to determine what combination of chemicals is present at a given time. Due to these problems it is advisable to avoid areas of potential exposure if at all possible. This is why so much attention was given to the recognition of potential exposure sites during the early portion of this lecture.

Another factor which must be considered in the selection of a respirator is the size and shape of the individuals head. There are usually several models of each type available, and the unit chosen must be comfortable and fit tightly.

SLIDE 6-77



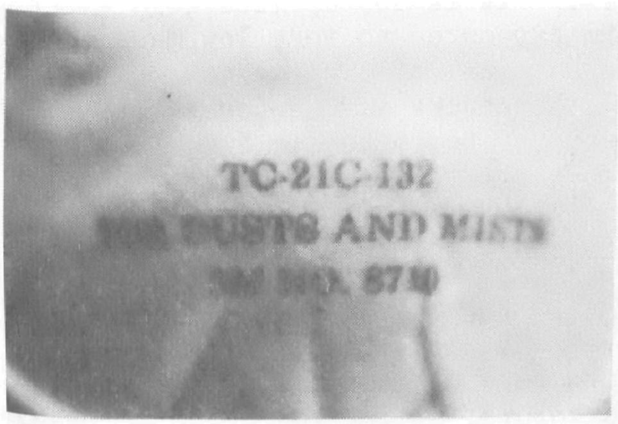
This slide shows a typical logic used to decide what type of respirator is necessary. The decision is based on the form and concentration of the contaminant(s) and the level of oxygen.

Inspectors on routine duties should not enter areas which are known to be immediately dangerous to life and health. Alternative means should be sought to determine the compliance status of a facility with such conditions. Inspectors should also not enter areas which are known to have less than 19.5% oxygen.

Regulatory agency inspectors rarely have the training necessary to wear air line respirators, hose mask type respirators, self-contained rebreathers, or the combination breathing apparatus. Areas where such equipment is necessary must be avoided.

The most common types of respirators available to field inspectors include (1) dust and mist masks, (2) dust, mist and fume masks, chemical cartridge respirators with special filters, and (3) gas masks with special filters. These will be discussed in more detail in the following slides. Information on other types of respirators is available in the publications listed earlier.

SLIDE 6-78



This is a close-up photograph of a dust and mist respirator. This is the minimum protection necessary for exposure to particulate matter. Normally, it is sufficient for materials having a permissible exposure limit (PEL) of greater than 0.05 mg/m3 or 2 mmpcf. It is limited to material concentrations which are less than 10 times the PEL. This type of respirator must never be used when the oxygen content is less than 19.5% or the concentration of the contaminant is approaching the level which is immediately dangerous to life and health (IDLH).

To be of any benefit, the mask must be fitted properly. Beards, side burns, and moustaches can prevent a good fit. This type of respirator should be discarded whenever the resistance to breathing increases, the unit is damaged, and after completing the inspection at a specific plant. They should not be used when gaseous or vapor phase pollutants are possible in the breathing area.

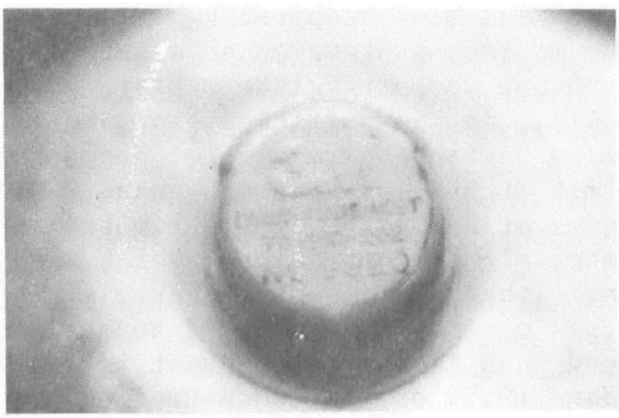
SLIDE 6-79

MAXIMUM ALLOWABLE CONCENTRATION

The maximum allowable concentrations for using the dust and mist masks are relatively low. To illustrate this, take the Permissible Exposure Limit specified in the NIOSH/OSHA Pocket Guide and multiply by a number not greater than 10. Compare the result with the concentration of the material in the duct, stack, or control device. In most cases, the the gas stream levels are one hundred to one thousand times the maximum allowable levels indicated for dust/mist mask use. Even a small gas stream leak into the partially confined areas around the equipment could lead to excessive levels.

The dust/mist mask is an acceptable respirator when only particulate is in the air and when it is possible to avoid partially confined areas or parts of the plant downstream of heavy fugitive emissions such as those shown in this slide.

SLIDE 6-80



This is a dust, mist and fume type mask. It is appropriate for short term exposures to very low mass concentrations of particulate matter. and when there is the possibility of exposure to metallic fume or any aerosol or condensed vapors.

Like any mechanical filter, this mask does not supply oxygen and should not be used if oxygen the level is less than 19.5%. These masks are not effective for gases and vapors.

All processes which operate at elevated temperature can conceivably generate fumes. The condensation of vaporous material causes small particle size material to form. Some of the materials commonly encountered by field inspectors include arsenic trioxide, mercury and lead oxide.

If the contaminant(s) are irritants it will be necessary to use a full face mask respirator rather than the unit shown.

SLIDE 6-81

CHEMICAL CARTRIDGES CANNOT BE USED FOR THESE MATERIALS

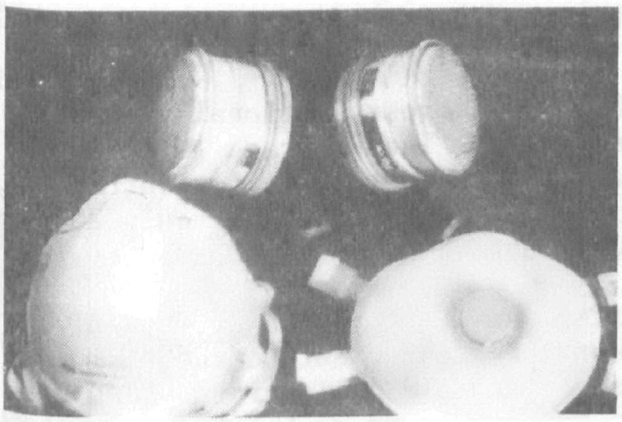
Aniline	Nickel Carbonyl
Arsine	Ozone
Carbon Monoxide	Phosgene
Hydrogen Fluoride	Vinyl Chloride
Hydrogen Sulfide	

This is a half mask type chemical cartridge respirator. It can be fitted with a number of different styles of cartridges depending on the gases, vapors and/or particulate matter in the breathing zone.

As a general rule, the half masks can be used when concentrations of hazardous pollutants are 10 times the Permissible Exposure Limit or a concentration of 1000 ppm, whichever is lower. The full face mask can usually be used when the concentration is 100 times the Permissible Exposure Limit or 1000 ppm, whichever is lower. Neither mask should ever be used when the concentrations are Immediately Dangerous to Life and Health. This figure is often less than the maximum allowable concentration calculated by multiplying the PEL by 10 or 100.

This type of respirator does not supply oxygen, therefore it can not be used in the oxygen concentration is less than 19.5% If the materials are irritants, the full mask type of respirator must be used.

SLIDE 6-82

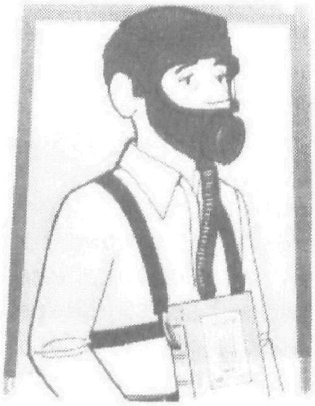


This is a partial list of the materials which cannot be well handled by chemical cartridge respirators.

Some of these materials cannot be adsorbed in the cartridge and some have such poor warning properties that it is difficult to determine when the respirator is no longer performing adequately.

Unfortunately, the list includes a number of very common chemicals.

SLIDE 6-83



Source: National Safety Council

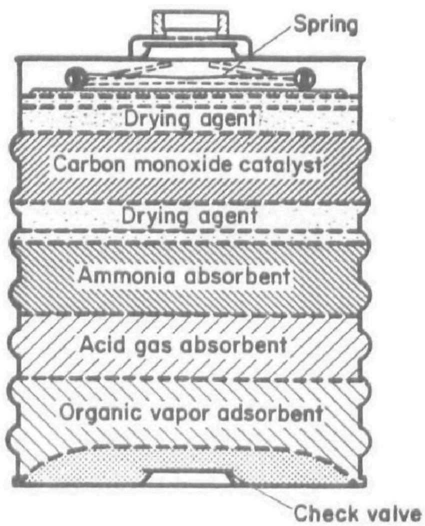
This is a photograph of a gas mask. These masks are equipped with a full face mask and a canister for removal of contaminants. They can be used at higher concentrations than the chemical cartridge units. The chin type canisters are usually acceptable for concentrations up to 5000 ppm and the industrial size canister can often be used up to 20,000 ppm. There are canisters available which remove acid gases, organic vapors, ammonia, carbon monoxide, and several other materials.

This respirator does not supply oxygen, therefore, it cannot be used when the oxygen concentration is less than 19.5%. Also, it should not be used for entry into atmospheres known to be Immediately Dangerous to Life and Health.

This type of respirator is moderately uncomfortable. The amount of time that it is worn should be minimized. This should not be a problem for field inspectors because most areas visited do not have high enough concentrations to require this type of unit. The inspector should not be in areas of high concentration.

Some of the problems associated with this unit include fogging of the face plate and difficulty in the mounting of glasses. These units should be cleaned and disinfected after each use and inspected regularly to ensure that they will work properly.

SLIDE 6-84



This is a cross sectional view of a canister. The average life of a canister at the upper concentration limit is in the range of only 20 to 30 minutes.

After use, the canister should be destroyed to prevent accidential reuse. An old canister should never be used. It is much better not to do the inspection than to go into a potentially contaminated area with an exhausted canister.

SLIDE 6-85

Source: National Safety Council

This is a self-contained breathing apparatus (SCBA). It is required when there is a suspected oxygen deficiency, when there are high concentrations of known pollutants, and when there are significant levels of unknown contaminants.

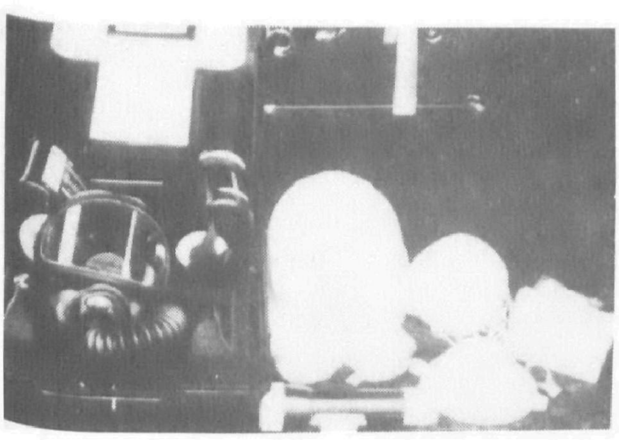
There are three basic types: (1) The demand or pressure demand open circuit systems, (2) self generating closed circuit devices, and (3) liquid or compressed oxygen, closed circuit (rebreathing) devices.

Very detailed unit-specific training is necessary be fore an individual should use a SCBA. The training should include instruction in fitting the face plate, and regular cleaning and inspection of the component parts.

Only those units which operate with a positive pressure in the face plate should be used in contaminant concentrations which are potentially Immediately Dangerous to Life and Health. All SCBAs, if they are in good condition and are used properly, can provide protection for atmospheres having less than 19.5% oxygen.

Most regulatory agencies can not afford this style of respirator. Usually only personnel assigned to especially hazardous duty (such as hazardous dump site investigation, and emergency response) have this equipment. Normally, the air pollution control inspector is not involved in such duties, therefore, he or she will not usually have SCBAs available. This means that areas where SCBAs might be necessary must be avoided.

SLIDE 6-86



All respirators used by inspectors should be checked for tightness prior to entering the contaminated area. In the case of the chemical cartridge and gas mask type units, there are several qualitative tests which can be done in the field. The tests are listed in this slide.

The negative pressure the inlet of the cartridge or canister is blocked and the wearer inhales gently. The face plate should collapse slightly and there should be not obvious in-leakage. The test itself can result in a respirator not fitting properly any longer, therefore, this provides only a very rough check of the fit.

SLIDE 6-87

QUALITATIVE FIT TESTS

- Banana Oil
- Irritant Smoke

This is a continuation of the qualitative means to check the fit of cartridge and gas mask type units.

The positive pressure test is very similar to the negative pressure test. The exhaust valve is blocked for a short period of time. If a slight positive pressure can be maintained without any obvious leakage then there is a rough indication that the respirator seals properly. This test also can disturb the fit of the respirator.

The isoamyl acetate vapor test is conducted by inserting a cartridge or canister which removes organic vapor into the respirator. The flask containing isoamyl acetate, material which has a strong scent of banana oil, is waved in the general vicinity of the individual wearing the respirator. If the individual can smell the vapor, then the respirator must be refitted. The problems with this test are individual variability in response to the odor and the olfactory fatigue which can result from several unsuccessful attempts to seal the respirator.

Another qualitative test involves the use of an irritant smoke. This should be done only in an area with good ventilation by a trained person. This test is less prone than the isoamyl acetate vapor test to the subjectivity of the individual wearing the respirator.

SLIDE 7-1

PROBLEMS OF BIOLOGICAL HAZARDS

This is an area of plant inspection safety that is not often discussed, but should be given consideration by the agency inspector. Hence, the next several slides will briefly outline the potential biological hazards in conducting plant inspections.

SLIDE 7-2

TYPES OF BIOLOGICAL HAZARDS

- Viruses
- Bacteria
- Fungi

This slide lists the major categories of biological hazards. The first two, bacteria and viruses, are hazardous because of the potential of some kinds to infect humans and cause disease.

The third, fungi, such as molds and spores, are hazardous because of the intrinsic toxins in some varieties and their potential to cause lung problems upon inhalation. The routes of entry for biological hazards tend to be inhalation, ingestion, and eye contact. Contact with the skin, except (1) in the case of a cut or other opening or (2) transfer to the mouth does not tend to be as much of a problem.

SLIDE 7-3

Here is one example of a commonly encountered potential biological hazard. This inspector is attempting to obtain a scrubber liquor sample. Since it is possible that the liquor might contain bacteria, the inspector should avoid contamination of his skin and clothing. It would be preferable to sample from a valve, but when sampling the liquor from a valve he would then have to be careful not to splash the liquor.

SLIDE 7-4

SOURCES WITH POTENTIAL BIOLOGICAL HAZARDS

- Municipal Incinerators
- Pathological Incinerators
- Foodstuff Processors

This is a partial listing of industries and source types that may have potential biological hazards. In the case of municipal incinerators, the inspector should simply avoid contact with the refuse and refuse handling equipment.

Pathological incinerators are used to dispose of refuse from hospitals, infectious disease laboratories, and other research facilities. This refuse can contain potentially infectious material. Once again, the inspector should avoid coming in contact with any of the material and in this case, he might consider respiratory protection if he must spend any time near the refuse.

Agricultural operations may potentially have biological hazards because foodstuffs are an excellent medium for fungal and bacterial growth. One example of this is molds growing on the grain in grain elevators. One mold in particular, aspergillus, that grows on grain contains the very harmful toxin, aflatoxin.

Some inspectors have expressed concern over inspecting genetic engineering firms. The organisms used by these firms to clone genes and make the product are always of a variety which does not survive in anything but controlled laboratory conditions. Thus, there is probably no risk to the inspector from these organisms.

Regarding personal protection against biological hazards, the first recommendation is to avoid the hazards (e.g. sampling scrubbber liquor without allowing skin or eye contact). As a precaution against inhalation of airborne fungi and bacteria, a disposable dust mask can be worn. Eye protection should be worn in situations where splashing of contaminated water is possible; and, of course, one should take care to avoid rubbing the eyes at ANY time. A practical recommendation for followup to all inspections is removal and washing of clothes and washing of the body.

SLIDE 7-5

PROBLEMS OF CHEMICALS WHICH ABSORB THROUGH THE SKIN

Although probably not one of the most significant air inspection safety problems, the inspector should at least be aware of the potential for chemical hazards to the skin.

SLIDE 7-6

ROUTES OF CHEMICAL EXPOSURE

- Inhalation
- Ingestion
- Skin Absorption
- Skin or Eye Contact

Toxic chemicals can enter the body by various routes. The most important route of exposure is inhalation which was discussed at length previously.

Ingestion is another route of chemical exposure. It is not usually the cause of industrial exposures. It can usually be effectively controlled by never eating or smoking with contaminated hands or in contaminated areas.

After inhalation, skin or eye contact and skin absorption are the next most common industrial exposure routes. Skin contact with many chemicals, even with no absorbtion, can cause primary irritation (such as that from many acids, alkalis, and organic solvents) and resulting skin damage or dermatitis.

In the case of skin absorption, the agent may penetrate and cause sensitization to repeated exposures (like the catechols in poison ivy) or penetrate in sufficient amounts to cause systemic poisoning (such as with significant skin exposure to phenols). Chemical contamination of the eye can result in varying degrees of eye irritation or in absorption and systemic poisoning.

SLIDE 7-7

SKIN ABSORBABLE SUBSTANCES

Phenol	Cresol
Nitrobenzol	Hydrocyanic Acid
Aniline Oil (and derivatives)	
Carbon Tetrachloride	Benzene
	Cyanides
Turpentine	Naphthalene
Nitroglycerine	Xylene

Regarding skin exposure to chemicals, the agency inspector has one advantage over most plant personnel in that he is less likely to undergo chronic (repeated or prolonged) skin exposure to one chemical. Thus, occupational dermatitis is not as much of a problem. He must, however, still deal with acute exposures to both the primary irritants and the chemicals which absorb through the skin.

General categories of chemicals that should be suspected as primary irritants and avoided include: inorganic and organic acids, inorganic alkalis, amines, metallic salts, and organic solvents. A number of these irritants produce their effect moments after contact and obviously should be immediately washed off using appropriate procedures.

Others may not show any effects for several hours or days. Thus, it is important to avoid contact in the first place. The Pocket Guide to Chemical Hazards (see Bibliography) indicates chemicals which are primary irritants with the notation "Con" (meaning skin and/or eye contact) in the "Route" (of entry) column. It also provides the appropriate first aid measures for chemical skin contact and it describes appropriate personal sanitation procedures (washing and changing of contaminated clothes) for over 380 chemicals.

This slide lists some of the more common chemicals which actually penetrate through the skin into the system and cause internal problems including damage to the central nervous system and organs such as the liver. For example, phenol is absorbed through the skin quite readily and exposure of a large part of the body (as the result of a spill, etc.) can result in death. The Pocket Guide also lists skin absorption hazards using "Abs" in the Route column. It is recommended that the inspector, prior to visiting any facility using large quantities of certain chemicals, check the entry in the handbook for each chemical to assess its potential effect on the skin including route of entry, first aid, and personal sanitation procedures.

SLIDE 7-8

FACTORS INFLUENCING SKIN ABSORPTION

- Sustained, profuse sweating
- Fat-dissolving agents
- Friction
- Amount of oils
- Length of contact
- Breaks in skin
- Hyperemia
- Age of skin

This last slide lists a number of the factors which influence skin absorption. Profuse sweating can deprive the skin of oils or increase friction in some areas of the body, both of which will facilitate absorption.

Agents which solubilize lipids (fats in the skin) can penetrate the skin themselves or create an opportunity for other substances (that normally would not have) to penetrate.

The amount of oil in the skin has an affect on absorption; the more oils the less absorption.

Length of contact with the substance is very significant. Hence the importance of washing after possible contact and removing clothes that are, or may be, contaminated.

Breaks in the skin obviously allow some chemicals to enter the body that otherwise would not have and allows others to get in faster. Hyperemia, or increased blood flow to the skin, also promotes absorption. And finally, the younger the skin the greater the absorption of chemicals.

SLIDE 8-1

SAFETY CONSIDERATIONS IN THE USE OF PORTABLE INSTRUMENTS

It is important to recognize when portable instruments are necessary and when it is safe to use the instruments. This lecture concerns some of the basic safety procedures for portable instruments such as static pressure gauges, pH meters, thermocouples, and pitot tubes.

Prior to using any instruments in a plant, the procedures to be followed should be discussed with plant representatives

SLIDE 8-2

BATTERY POWERED EQUIPMENT

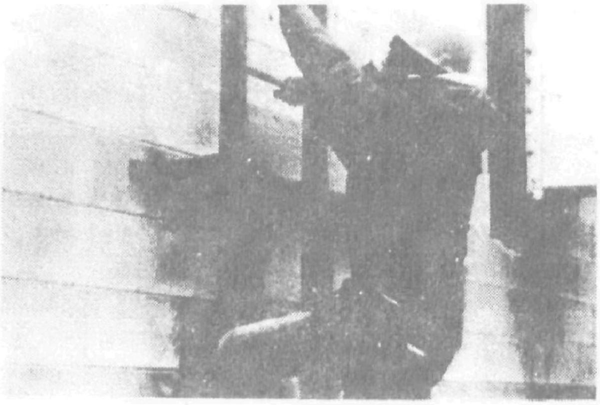
- ph Meters
- Thermocouples
- Flashlights

Some of the portable instruments are battery powered. The most common instruments with internal batteries are digital thermocouples and pH meters. These instruments should not be taken through areas with potentially explosive dusts or vapors. It is possible for them to provide a source of ignition for the explosive materials. Before taking such instruments into a plant it is necessary to get a hot work permit from plant representatives. Only instruments which are specified as intriniscally safe for hazardous locations can normally be used where there are potentially explosive dusts and/or vapors.

In the case of the pH meter, it is almost always possible to leave the meter in a protected area and bring the liquor sample to it. Often, the plant chemical laboratory is a convenient location to leave the pH meter. A dial-type thermometer can be substituted for the digitial thermocouple if there is any question concerning the safety of the thermocouple.

The problems with battery powered instruments also apply to flashlights. Inspectors should use only explosion proof flashlights. The plant representatives should confirm that the flashlights comply with plant restrictions.

SLIDE 8-3



Only the instruments necessary for the inspection should be carried. In trying to carry too much, it is possible to have an accident while walking through areas with obstacles and while climbing.

Bulky items should not be carried in pants pockets. This restricts the natural climbing actions and makes an accident more likely.

One convenient way to carry the portable instruments is shown in this slide. The side pouch allows free movement of the legs and frees the hands for climbing and support.

As discussed during lecture #2, this slide also shows one of the limits of side pouches. Long items such as the dangling dial type thermometer should not be carried. When it is necessary to get bulky items like 6 foot pitot tubes to elevated platforms, it is generally necessary to use a rope.

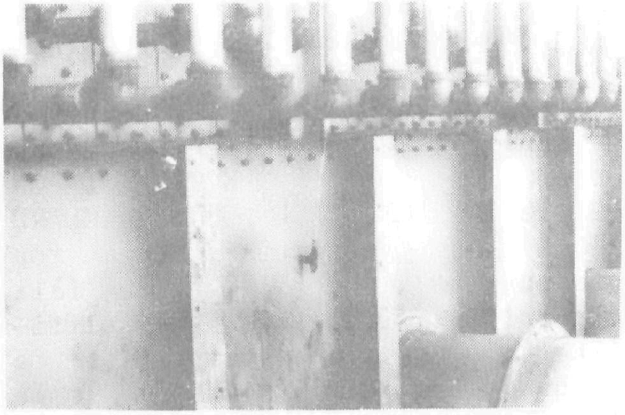
SLIDE 8-4

HEROIC PORTS

Only measurement ports with safe access should be used. NEVER MAKE HEROIC EFFORTS TO USE A PORT WHICH HAS BEEN IMPROPERLY LOCATED. Unfortunately, a large number of such measurement ports exist. The next set of slides shows some of these undesirable ports.

If there are no safe ports, the preferred locations should be discussed so that plant personnel can put in measurement ports prior to the next inspection.

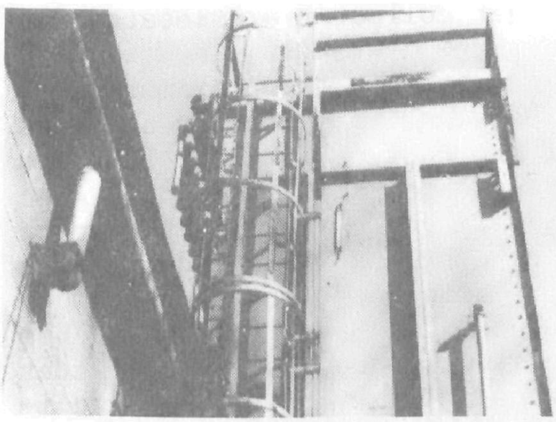
SLIDE 8-5



A close-up view of a pulse jet baghouse is shown in this slide. The port on the inlet ("dirty") side of the baghouse is shown in the center of this slide. To reach the port it would be necessary to reach over a 42 inch diameter inlet duct carrying hot gas. It should also be noted that inlet ductwork is on the edge of the building roof, therefore, it is impossible to stand in the area between the ductwork and the fabric filter.

The inlet port easily could have been placed at one or more locations along the inlet ductwork. The value of the static pressure measured would have been very similar to that measured at the port shown. The ports in the inlet ductwork would have been both convenient and safe.

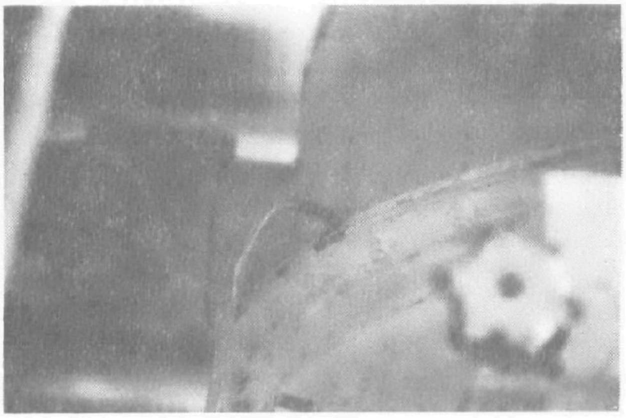
SLIDE 8-6



This is the same baghouse shown in the previous slide. A slack tube manometer is shown just to the right of the caged access ladder. If one of the two ports of this instrument had plugged, it would be necessary to disconnect the leads and rod out the ports. Then the portable gauge could be attached and the actual static pressures measured. In this case, however, it would be necessary to lean out through the cage to reach the ports. These ports should not be used.

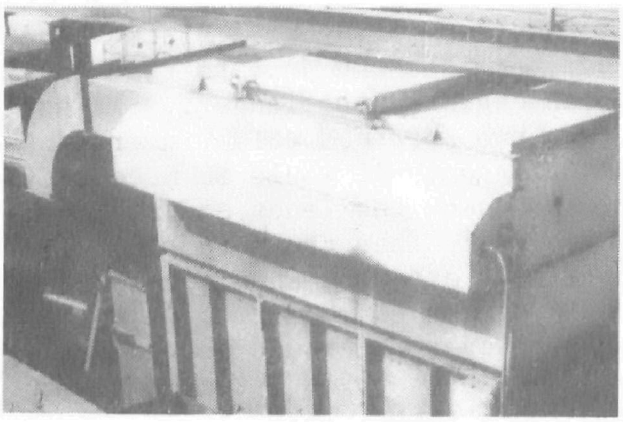
It is very common to find the situation depicted in this slide. In some cases it would be necessary to climb up the outside of the cage to reach the ports. THESE PORTS SHOULD NEVER BE USED! Ladders are for climbing only and are not intended to be used as temporary sampling platforms or gymnastic equipment.

SLIDE 8-7



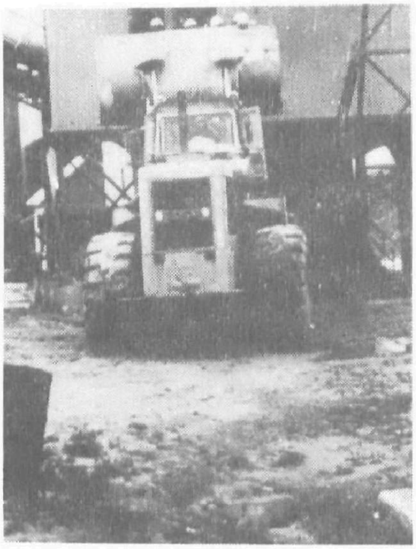
In the dimly lit upper portions of this tray type scrubber there are two apparent measurement ports across one of the trays. The only way to reach these ports is to stand on the top of the hand rails around the access platform. DO NOT STAND ON THE TOP OR MID RAILS OF ANY GUARD RAIL. They are not intended for this purpose and a very serious fall is possible. Sometimes it is difficult to resist the temptation to climb on the guard rail since some plant personnel will occassionally do this. Always resist this approach.

SLIDE 8-8



The measurement ports on this small pulse jet collector are located on side (right center of the slide). There is a gap of approximately 3 feet between the collector and the end of the roof. It is 40 feet to the ground from this location. The plant personnel may wish to reach the ports by leaning a ladder from the building roof (left portion of slide) to the collector. This should not be done. If the ladder were to slip, a very serious accident could occur. Complicating this particular situation was the fact that the roof was slightly sloped and was covered with moderately slippery solids. In any case, a portable ladder should not be used to cross a chasm between the walking surface and the collector.

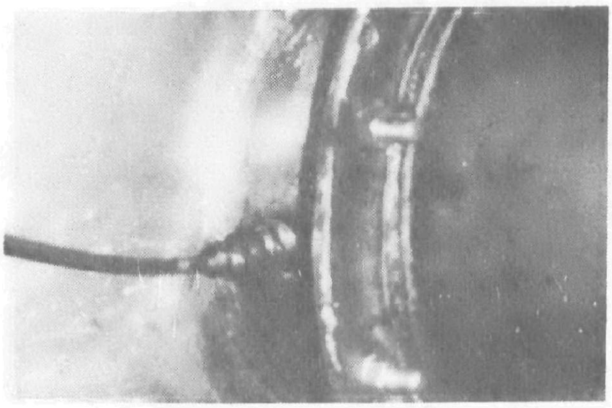
SLIDE 8-9



In many cases, the only ports which are available are the 4 inch diameter stack sampling ports. In some of the smaller plants there may not be a sampling platform around the ports. As shown in this slide, it is possible to reach the ports by riding in the bucket of a front end loader. THIS SHOULD NOT BE DONE. The bucket is not intended to serve as a temporary sampling platform and the bottom is far from level when the bucket is in the position shown. A fall against the side of the bucket could result in a serious head injury.

The buckets generally contain at least a small quantity of solids which can be quite slippery. Furthermore, the operator of the front end loader could make a mistake and dump the inspector. A front end loader should not be used as a sampling platform under any circumstances.

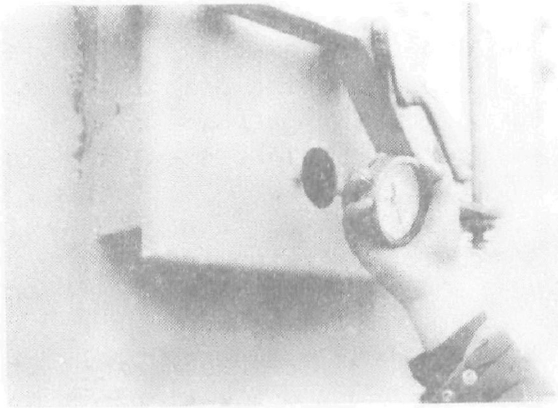
SLIDE 8-10



This is the inlet duct to a small baghouse which operates at a high gas temperature. The skin temperatures of both the collector side wall and the flange to the right of the measurement port are 320 °F. While attempting to open the port, a burn is likely. The port could have easily been placed several feet upstream of the flange or on the side wall of the collector and provided the same data. This was the only location where there was an unavoidable burn hazard.

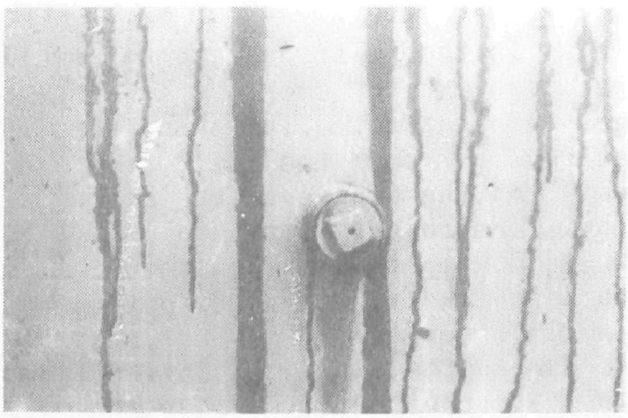
Whenever working with hot ducts (most are hot), the inspector must be very conscious of the access to the port and the general clearances around the entire platform. It is easy to inadvertently leaning against a hot duct wall while trying to stand up or while trying to move around a cluttered platform area.

SLIDE 8-11



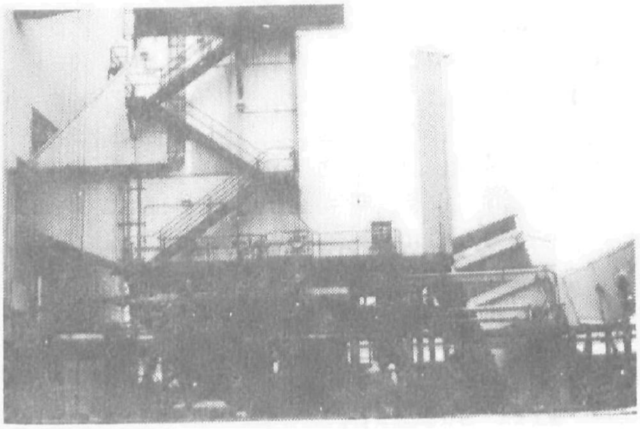
The inspector shown in this slide is about to suffer a burn on the hot wall of this scrubber. This is on the inlet portion of the unit, at a location before the gas stream has had an opportunity to cool. Gloves should be worn and the dial type thermometer should be held in the manner shown.

SLIDE 8-12



When selecting measurement ports, choose the smallest one which allows use of the various probes. The one half inch port shown in the slide is often an ideal size. The very large 4 inch diameter ports can allow substantial flow of pollutant laden gas into the breathing zone.

SLIDE 8-13

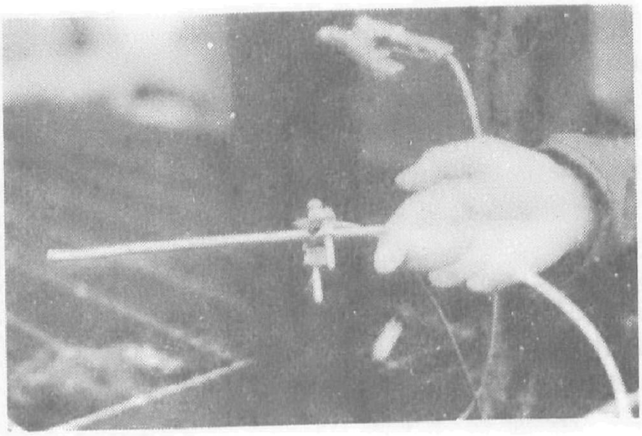


Whenever instruments are used after electrostatic precipitators it is important to use a grounding/bonding cable. It should be attached prior to insertion of the probe or pitot tube into the duct. The gas stream passing the port contains has particles with a high static charge. The static charge can accumulate to very high static voltages on the probe or pitot tube.

The shock suffered by the inspector may not have a high enough current to be fatal, but, it can surprise the individual and result in a fall off the platform. Also, the shock can be quite painful.

It is also necessary to ground all probes when making measurements within fiberglass ducts. The duct walls can accumulate a very high static charge. As the probe is approaching the measurement port, a spark will jump from the duct to the probe. This can be as painful and surprising as the shocks suffered downstream of precipitators.

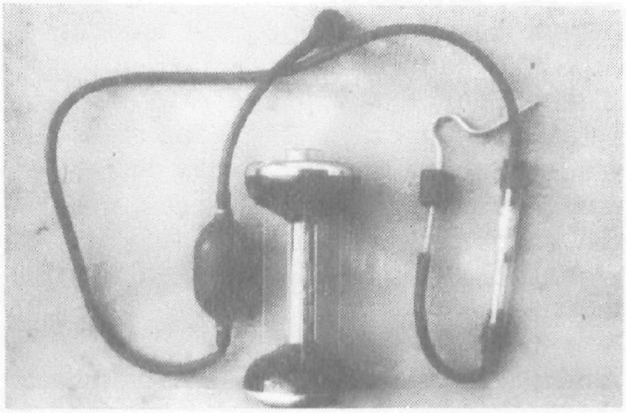
SLIDE 8-14



Static grounding/bonding cables should be used whenever there is the possibility that static will accumulate on the probe while it is in the gas stream. This can happen whenever the particulate mass concentration is relatively high and the relative humidity is low. Under such conditions the static charge probably can reach levels sufficient to cause a spark over to the duct wall (near the measurement port). If the dust is explosive and there is sufficient oxygen, then an explosion will result.

It should be noted that this problem has not been reported and the potential for an explosion is only speculation at this time. However, a large majority of the gas streams at elevated temperature have too low a relative humidity to allow dissipation of the static charge. Also, most gas streams at the inlets of the air pollution control systems have a high enough mass concentration to be in the explosive range. Some ducts also contain deposits of solids which could be explosive. In some cases, there is enough oxygen for an explosion. For all these reasons, there is the potential for a major explosion due to the static charge. It should be continuously drained off by using the grounding/bonding cables shown in this slide.

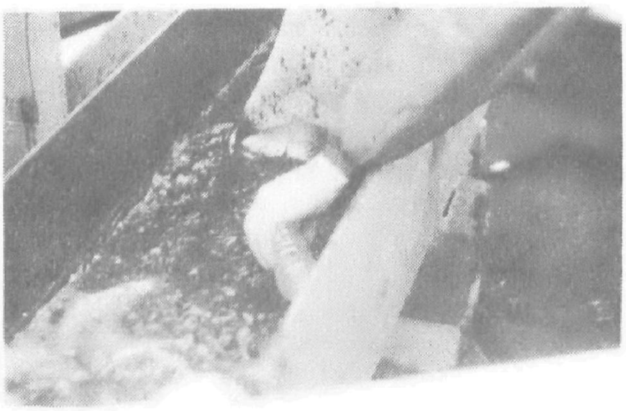
SLIDE 8-15



When using an oxygen and carbon dioxide analyzer of the type shown in this slide, care is necessary to prevent contact with the corrosive absorbing solutions. There is a top valve used for admitting the gas sample. When absorbing the components of the gas sample, the entire instrument is inverted several times to mix the gas with the absorbing solution. This top valve must not be depressed while inverting the instrument because the corrosive liquid will spill out.

If for any reason there is contact with the liquid, wash it off immediately. The oxygen solution contains hydrochloric acid and the carbon dioxide solution contains potassium hydroxide.

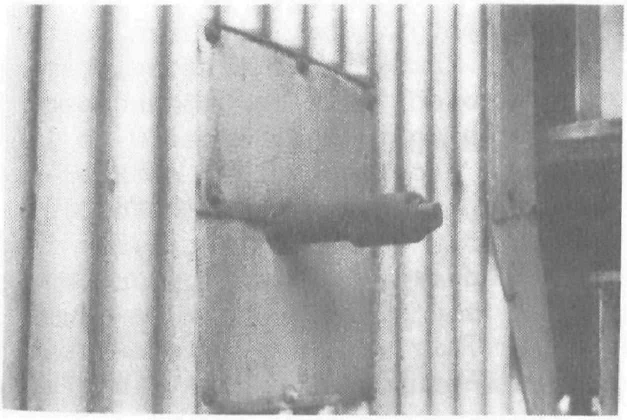
SLIDE 8-16



When obtaining a liquor sample for pH measurement or other analysis, contact with the liquor should be avoided. The slide illustrates the wrong way of acquiring a sample.

In some cases, the liquor contains bacteria and viruses. Chemicals which can be rapidly absorbed by the skin may also be present.

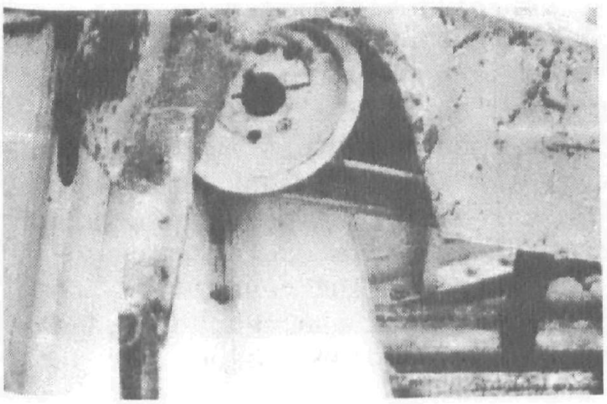
SLIDE 8-17



This is a port for a reverse air baghouse operating at approximately 400 °F on a continuous basis. The plug for this port will remain hot as long as several hours after being removed. Some people forget about this problem and pick up the plug with bare hands.

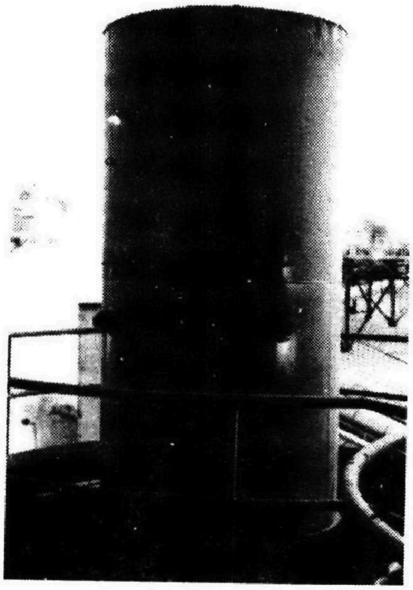
When withdrawing a probe or pitot tube from a hot gas stream, gloves should be used to hold the probe. These probes can be at temperatures ranging from 200 to 1200 °F.

SLIDE 8-18



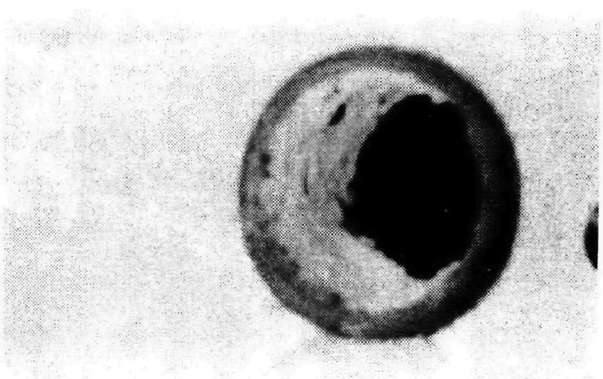
While making fan rotational speed measurements, care must be taken to prevent entrapment between the belts and the sheaves. A partially exposed belt as shown in this slide must be avoided. Only belt guards with a small access port and good protection around the entire sheave and belts should be used.

SLIDE 8-19



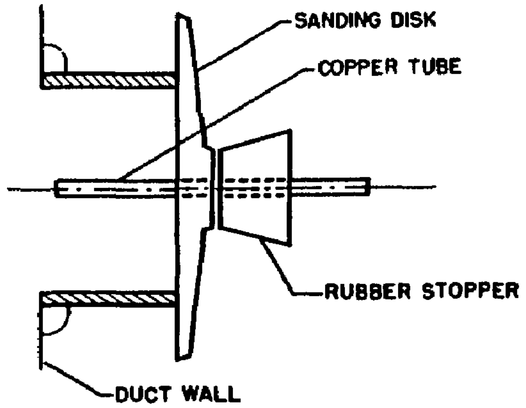
When using a long probe such as a 6 to 8 foot pitot tube, all high voltage lines and tracks must be completely avoided. It is not uncommon to have a high voltage line 10 to 15 feet above a collector or to have a high voltage track within 10 feet of a collector. As the pitot tube is being withdrawn, it may approach one of this and allow a spark to jump the gap. This can result in a fatal shock. Measurement ports in the general vicinity of high voltage lines must be avoided.

SLIDE 8-20



Many control devices operate at very high negative static pressures. If the measurement port is as large as that shown on this slide, it is possible to lose the probe into the gas stream. At the very best this would be embarrassing. Under the worst circumstances, this could damage the fan downstream and result in the disintegration of the fan. Ports of this size should be avoided if at all possible.

SLIDE 8-21



This slide illustrates one means to prevent loss of the probe into the high negative static pressure ducts. This consists of a rubber stopper (drilled to be slightly small) followed by a commercially available sanding disk having a quarter inch hole. The sanding disk must be at least one inch larger in diameter than the port being used. The rubber stopper holds onto the quarter inche O.D. probe and the sanding disk holds onto the rubber stopper. This assembly has been used up to a static pressure of -120 inches of water without any problems. The main limit of this approach is that The sanding disk can not be used for very hot ducts.

SLIDE 8-22

SUMMARY

Since there are some additional risks inherent in the use of any portable instrument, they should only be used when there is a definite need for the data. Use of the instruments should be discussed with plant representatives before the inspection.

Only measurement ports with safe access and adequate clearance for high voltage lines should be used. The potential for burns and/or exposure to toxic gases should be kept to a minimum.

The battery powered and line voltage instruments should not be taken into areas where there are potentially explosive dusts and/or vapors. All Probes used in ducts where there is the potential for static accumulation should be bonded to a grounded duct. Suction of the probe into the gas stream absolutely must be prevented.

SLIDE 9-1

AGENCY SAFETY PROGRAM

Any agency (or other organization) whose personnel are involved in air pollution control equipment inspection and/or maintenance should have an organized safety program designed to minimize the risk involved in these operations. The U.S. Environmental Protection Agency (EPA) has taken a lead in this area in response to the Occupational Safety and Health Act of 1970 and other government mandates and has itself set up a very structured program.

This lecture outlines the elements and goals which are basic to any safety program of this type. It is to every inspector's advantage to find out about his employer's program (if any) and to assist in instituting one if there is none.

SLIDE 9-2

ELEMENTS

1. Written Safety Procedures (Guideline Manual)
2. Regular Safety Training
3. Basic Protective Equipment
4. Medical Monitoring

This slide lists four basic elements of a safety program. All field personnel should have access to a written safety procedures guideline manual, regular training in appropriate safety procedures, basic personal protection equipment for their duties, and regular medical monitoring examinations.

SLIDE 9-3

SAFETY GUIDELINES MANUAL

- Recognition of Hazards
- Symptoms of Exposure
- Safety Procedures for Hazards
- Emergency Procedures
- Use of Personal Protection Equipment
- Reporting of Illnesses or Accidents

A written safety procedures manual should be prepared by every regulatory agency and private organization involved in the inspection (or maintenance) of air pollution control equipment. This manual should outline the agency's or organization's policy concerning safety and at a minimum address recognition of pertinent hazards, recognition of symptoms of exposure, safety procedures to be followed for each type of hazard, emergency procedures, use of personal protection equipment, and the reporting of illnesses or accidents.

It is recommended that this manual be dated and revised whenever necessary. All personnel covered by these guidelines should be responsible for reading them carefully and for effecting needed modifications.

SLIDE 9-4

SAFETY TRAINING

- Safety Procedures
- Use of Personal Protection Equipment
- CPR and First Aid

All field personnel should also participate in a mandatory program of safety training. This training program would include instruction in recognition of potential hazards, appropriate safety procedures, and proper use of personal protection equipment. A judicious program would also include instruction in Cardio Pulmonary Resuscitation (CPR) and basic First Aid.

This training should be regularly scheduled; at least once a year is suggested. New employees assigned field duties should receive this training PRIOR to beginning field work. Training programs should be carefully tailored to the duties of the individuals instructed; for example, an air inspector assigned the additional responsibility of responding to hazardous chemical spills should receive considerably more safety training than one assigned only to investigate odor complaints.

SLIDE 9-5

BASIC PROTECTIVE EQUIPMENT

- Hardhat
- Safety Shoes (steel-toed)
- Safety Glasses and Goggles
- Ear Protection
- Dust, Mist, and Fume Masks
- Cartridge-type Respirators

Agencies and organizations should also provide their field employees with personal protection equipment suited to their duties. This slide lists the basic protective equipment recommended for inspectors of air pollution control equipment.

SLIDE 9-6

MEDICAL MONITORING PROGRAM

BASELINE EXAMINATION

1. Medical and Occupational History
2. Physical Examination
3. Chest X-ray
4. Selected Blood and Urine Tests
5. Hearing
6. Lung Function
7. Other Special Tests

ANNUAL MONITORING EXAMINATION

This slide outlines the components of a suggested medical monitoring program. A medical monitoring program should be designed to assess the health status of individuals prior to work, monitor for evidence of post-work adverse effects, and evaluate and treat work-related injuries and illnesses.

Individuals should undergo the baseline examination prior to doing any field work to evaluate their suitability for hazardous assignments and capability for proper use of the necessary personal protective equipment and to establish baseline or reference data for comparison with findings of future examinations.

The baseline examination usually consists of a detailed medical and occupational history, a thorough physical examination, and a number of specific tests including a chest x-ray, blood and urine tests, an electrocardiogram, a hearing test, lung function tests, and any other tests indicated by knowledge of the work to be performed.

The annual monitoring examination then provides a way to detect work-related adverse health effects and a reassessment of an individual's continued fitness for assigned duties. It can also provide occupational health guidance and data for occupational health studies. The annual examination usually includes a history update; selected blood, urine, and pulmonary function tests; and a screening physical exam.

APPENDIX A

BIBLIOGRAPHY

Accident Prevention Manual for Industrial Operations, National Safety Council, 6th Edition, 1971.

A. M. Best Company. Best's Safety Directory. Volumes I and II. Oldwick, NJ. 1984. (Published annually)

American Industrial Hygiene Association. Direct Reading Colorimetric Indicator Tubes Manual, First Edition. Akron, Ohio. 1976.

American Industrial Hygiene Association. Manual of Recommended Practice for Combustible Gas Indicators and Portable, Direct Reading Hydrocarbon Detectors, First Edition. Akron, Ohio. 1980.

Birkner, L. R. Respiratory Protection: A Manual and Guideline, First Edition. B. J. Held and B. E. Held (ed.). American Industrial Hygiene Association, Akron, Ohio. 1980.

Brief, R. S. Basic Industrial Hygiene: A Training Manual. Prepared for the Exxon Corporation. American Industrial Hygiene Association, Akron, Ohio. 1975.

Burgess, W. A. Recognition of Health Hazards in Industry. John Wiley and Sons, New York. 1981.

Bonney, T. B., et al. Industrial Noise Manual. American Industrial Hygiene Association, Akron, Ohio. 1975.

Drager Corporation. Drager Gas Detector Tube Handbook, Fifth Edition. Pittsburgh, Pa. February 1983.

General Industry Standards Part 1910. OSHA Publication 2206. U.S. Department of Labor, Occupational Safety and Health Administration. U.S. Government Printing Office, Washington, D.C. 20402. March 8, 1983.

Hirschfelder, D. Contact Lenses in the Workplace. Sightsaving, Vol 52, (1): 14-18. 1983.

The Industrial Environment - Its Evaluation and Control, U.S. Department of Health, Education and Welfare, 1973.

Mackinson, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (editors) NIOSH/OSHA: Pocket Guide to Chemical Hazards. U.S. Dept. of Labor, Occupational Safety and Health Administration; U.S. Department of Health and Human Services: Public Health Services, Centers for Disease Control, National Institute for Occupational Safety and Health. U.S. Government Printing Office, Washington, DC. 20402. September 1978.

Occupational Diseases, A Guide to Their Recognition, Revised Edition. U.S. Department of Health, Education and Welfare. June 1977.

Patty's Industrial Hygiene and Toxicology, Third Revised Edition, Volume 1. G. Clayton and F. Clayton, Editors. Wiley-Interscience Publication Page 340.

A Primer on Confined Area Entry. Rexnord, Safety Products. Malvern, PA.

Safety Manual for Hazardous Waste Site Investigation, U.S. Environmental Protection Agency. Available from the Office of Occupational Health and Safety, Waterside Mall, 401 M Street S.W., Washington, D.C. Draft Manual dated September 1979.

Sax, N. I. Dangerous Properties of Industrial Materials, Van Nostrand Reinhold Company, New York, N.Y.

Schwope, A. D., P. O. Costas, J. O. Jackson and D. J. Weitzman. Guidelines for the Selection of Chemical Protective Clothing, A. D. Little, Inc. for U.S. EPA. American Conference of Governmental Hygiensts, Inc. Cincinnati, Ohio. 1983.

Stack Sampling Safety Manual, Prepared by Norman V. Steere & Associates for the U.S. Environmental Protection Agency. September 1978.

United Technologies/Bacharach Instruments. Operation and Maintenance: Model "L" Sniffer. Pittsburgh, Pa. 1981.

U.S. Environmental Protection Agency Field Health and Safety Program. Prepared by Norman V. Steere and Associates, Inc., November 1982 for U.S. EPA.

APPENDIX B

REVIEW QUESTIONS

1. Cartridge type respirators are usually rated at ________________.

   a. concentrations twice on TLV
   b. concentrations five times the TLV
   c. concentrations ten times the TLV
   d. concentrations fifty times the TLV

2. The use of hearing protection in high noise areas hinders normal communication.

   a. true
   b. false

3. Common "partially" confined areas include ________________________.

   a. walkways between large control systems
   b. weather enclosures around hoppers
   c. weather enclosures around precipitator roofs
   d. pump houses
   e. fan houses
   f. mountings for continuous emission monitors
   g. all of the above

4. "Partially" confined areas are particularily dangerous when ________ ______________________________.

   a. the ducts or control equipment operate at positive pressure
   b. the gas streams contain asphyxiants and toxic agents
   c. the gas streams contain dusts and fumes
   d. all of the above

5. Before inserting a probe into a gas stream it is important to check ______________________________.

   a. that the grounding cable is in good physical condition
   b. that the ground clamp does not interfere with the probe
   c. that the clamp has penetrated any paint or corrosion layer on the ground
   d. all of the above

6. Ionizing radiation may be a problem around ______________________.

   a. electrostatic precipitator rappers
   b. continuous emission monitors
   c. damaged hopper level monitors
   d. electrostatic precipitator electrical cabinets

7. Falls may be caused by ______________________________.

   a. slippery surface around wet scrubbers
   b. climbing ice covered ladders
   c. crossing roofs with heavy accumulations of snow or solids
   d. protruding equipment in dimly lit areas
   e. a and c
   f. a and d
   g. all of the above

8. Prior to using a respirator, an inspector should ______________.

   a. be trained in the selection and use of respirators
   b. be trained in the maintenance of respirators
   c. have a physical examination
   d. all of the above

9. When selecting what personal safety equipment is necessary during an inspection, an inspector should be guided by ______________.

   a. what the plant representative and other plant personnel are using
   b. plant policies
   c. agency policies
   d. common sense

10. Exposure to particulate and gaseous contaminants often may result from ______________________.

   a. downwash of effluent from short stacks
   b. fugitive leaks from ducts and hatches into partially confined areas
   c. fugitive leaks through open static pressure taps
   d. fugitive leaks around process equipment
   e. all of the above

11. Safety shoes should be worn ______________________________.

   a. only when required by plant policies
   b. only when required by agency policies
   c. for all plant inspections
   d. when specifically required for plant entry

12. An inspector should not work alone during an inspection, unless ______________________.

   a. plant personnel are too busy to accompany the inspector
   b. the inspector is very familiar with the plant
   c. no entry into partially confined or confined areas is anticipated
   d. the inspector has all the necessary personal protection equipment
   e. none of the above

13. Burns may be caused by ______________________________.

a. contact with hot gas ducts
b. contact with measurement probes, such as pitot tubes
c. radiation from process equipment
d. high pressure steam leaks

14. High noise levels are frequently found near ________________.

a. fans
b. screw conveyors
c. electrostatic precipitator rappers
d. process equipment such as compressors and grinding mills
e. rotary discharge valves
f. steam vents

15. The suspension of the hard hat needs to be checked at least________.

a. once a day
b. once a week
c. once a month
d. once a year
e. never

16. Most gaseous contaminants have good "warning properties" therefore the inspector is usually aware that they are present ______________.

a. true
b. false

17. The routes of entry of toxic compounds include ________________ ______________.

a. the eyes
b. the respiratory system
c. the skin
d. ingestion
e. all of the above

18. Hazards of opening access hatches include:

a. asphyxiation due to free flowing solids found in hoppers
b. positive pressure systems creating force on the interior of hatch
c. control device fires
d. burns from hot solids
e. hand injuries from "breaking the seal" of hatch in negative pressure system

19. Contact lenses should not be worn during inspections ____________.

a. true
b. false

20. Respirator or gas mask cartridges and canister air purifying capabilities are identified by both worded labels and a color code.________.

    a. true
    b. false

21. The use of a respirator exposes a worker to additional stress________.

    a. true
    b. false

22. The following symptoms may indicate exposure to air contaminants ________________________.

    a. headache
    b. drowsiness
    c. shortness of breath
    d. neausea
    e. loss of coordination
    f. eye irritation
    g. all of the above
    h. none of the above

23. Static electricity is especially likely following ______________.

    a. a wet scrubber
    b. a fabric filter collecting dry dust
    c. electrostatic precipitation
    d. mechanical collection
    e. all of the above

24. Hearing protection is necessary whenever normal conversation cannot be heard at a distance of __________________ feet.

    a. 1
    b. 2
    c. 5
    d. 10

25. Most types of hearing protection reduce noise intensity inn the 1000 Hz to 4000 Hz range by ______________________.

    a. 5 to 10 dB
    b. 10 to 25 dB
    c. 25 to 50 dB
    d. 50 to 75 dB

26. Fan disintegration can be caused by ______________________________.

    a. operating at excessive tip speeds
    b. build-up of material ou the fan wheel
    c. operating at high gas temperatures
    d. erosion of the fan wheel

27. At high concentrations hydrogen sulfide has ________________ odor.

a. a rotten eggs
b. a sewer
c. a fragrant
d. no

28. Ozone may be generated in ________________________________.

a. fabric filter
b. an electrostatic precipitator
c. a wet scrubber
d. none of the above

29. Entry into the confined areas of a fabric filter or electrostatic precipitator by an agency inspector should be done when ______________ ____________________________.

a. the equipment has been properly locked out
b. all components have been properly grounded
c. the sytem has been purged out and cooled
d. the interior environment ha been tested for oxygen and gaseous contaminants
e. a properly trained individual is stationed outside to provide assistance if necessary
f. none of the above

30. A self-contained rebreather is necessary whenever work is required around areas which ____.

a. have less than 19.5% oxygen
b. have gaseous concentrations that exceed the safe limit of the cartridge and canister type respirators
c. have less than 16% oxygen
d. have less than 12% oxygen
e. have high carbon monixide levels

31. Access hatches should be opened ____________________________.

a. when the system is down and locked out
b. when the static pressure differential across the hatch is approximately zero
c. by plant personnel only

32. The baseline inspection technique involves entry into the control systems for internal inspection.

a. true
b. false

33. If an inspector experiences the nonspecific symptoms of exposure to gases and vapors, he or she should ______________________________.

   a. continue with the inspection until more definite symptoms develop
   b. discuss the potential exposure with plant personnel
   c. leave the area immediately and reevaluate the conditions
   d. all of the above

34. When climbing ladders, inspectors should keep their hands on the ________________________.

   a. side rails
   b. foot rails
   c. either

35. Which of the following symptoms may indicate exposure to air contaminants

   a. drowsiness
   b. shortness of breath
   c. loss of coordination
   d. eye irritation
   e. light headedness
   f. all of the above

36. During the inspection, the operator of a fabric filter compartment serving a cupola states that the previous bag failure problem has been corrected by using a new bag hanger design and by modifying the tube sheet thimble. He suggests that you follow him into the fabric filter compartment to confirm that this has been done properly. What should the inspector do?

   a. check all six compartments to ensure that the same modifications were made in each
   b. just check one or two compartments
   c. limit the inspection to what can be seen from the access hatch without going inside the compartments
   d. review the drawings and do not waste time on the equipment inspection

37. An internal inspection of an electrostatic precipitator should be conducted by an agency inspector when ______________________________.

   a. there are indications on misaligned plates and wires based on the secondary voltges and currents
   b. there are indications of poor gas distribution and the source is making major modifications to the precipitator inlet
   c. there are symptoms of rapping reentrainment
   d. the operator has reported severe corrosion problems
   e. when hell freezes over

38. A victim of heatstroke, the most severe heat-induced illness, will have which of the following symptoms?

   a. hot, dry skin
   b. clammy skin
   c. confusion
   d. convulsions
   e. all of the above
   f. a, c and d

39. When should light clothing cover as much of the body as possible to prevent heat stress?

   a. when the temperature is greater than 100°F
   b. when the temperature is less than 100°F

40. The single most effective way to prevent heat stress is:

   a. wear appropriate clothing
   b. avoid sources of heat
   c. increase fluid intake
   d. stay in good physical condition

41. If the plant personnel seem to be feeling fit, the inspector should not worry about heat stress difficulties.

   a. True
   b. False

42. Environmental conditions which increase the likelihood that heat stress will occur are:

   a. steam clouds from control and process equipment
   b. radiant heat from process equipment
   c. excessive noise
   d. all of the above
   e. a and b

43. Passive dosimeters have certain characteristics which limit their effectiveness. Some of these are:

   a. They accumulate very low concentrations of gas over time and may show a high concentration of gas when there is no danger.
   b. They lose their effectiveness when exposed to the ambient air for more than 3-5 days because the water in the indicator paper evaporates.
   c. The incidence of interference gases is higher the longer the badge is worn.

44. Passive dosimeters can be reused because they "regenerate" after being removed from the contaminated environment.

   a. True
   b. False

45. Inspectors should cancel inspections if the wind chill factor is:

   a. less than -40°F
   b. less than -30°F
   c. less than -20°F

46. Hypothermia and frostbite injuries can be prevented by:

   a. layering clothing
   b. staying dry
   c. taking frequent breaks in warm areas
   d. consuming warm food and/or beverages

47. The proper way to acclimate to cold stress is to observe the following routine: Begin with an exposure period of 2 hours, Increase exposure 10 minutes per day for 5 consecutive days.

   a. True
   b. False

48. Frostbite should be treated by briskly rubbing the affected area with snow.

   a. True
   b. False

49. Hypothermia victims may exhibit the following symptoms:

   a. apathy and disorientation
   b. uncontrollable shivering
   c. decreased respiration
   d. increased respiration
   e. all of the above
   f. a, b, and c
   g. a, b, and d.

Review Question Answers

1. c
2. b
3. g
4. d
5. c
6. c
7. g
8. d
9. a,b,c,d
10. e
11. c
12. e
13. a,b,c,d
14. a,b,c,d,f
15. c
16. b
17. e
18. a,b,c,d,e
19. a
20. a
21. a
22. g
23. b,c
24. b
25. c
26. a,b,d
27. a
28. b
29. f
30. a,b,c,d,e
31. a,b,c
32. b
33. c
34. b
35. f
36. c
37. e
38. f
39. a
40. b
41. b
42. d
43. a,b
44. b
45. c
46. a,b,c,d
47. b
48. b
49. e

APPENDIX C

EXAMPLE OF ONE PLANT'S
SUBSTANCE EXPOSURE SYMPTOM CHART

SUBSTANCE	OVEREXPOSURE SYMPTOMS
ACETIC ACID	MARKED IRRITATION EYE, NOSE, THROAT, SKIN
ACETONE	MILD IRRITATION EYE, NOSE, THROAT/NARCOSIS
AMMONIA	MARKED IRRITATION EYE, NOSE, THROAT, BRONCHI, LUNGS
ASBESTOS	FIBROSIS/SHORTNESS OF BREATH/ DRY COUGH/LUNG CANCER/MESOTHELIOMA
BARIUM (SOLUBLE COMPOUNDS)	CUMULATIVE HEART, LUNG, AND BRAIN DAMAGE
BENZENE	SUSPECT LEUKEMOGEN/CUMULATIVE BONE MARROW DAMAGE
BROMINE	MARKED IRRITATION EYE, NOSE, THROAT, BRONCHI, LUNGS
2-BUTANONE (MEK)	MODERATE IRRITATION, EYE, NOSE, THROAT/NARCOSIS
CALCIUM OXIDE	MARKED IRRITATION EYE, NOSE, THROAT/SKIN
CARBON BLACK	SUSPECT CARCINOGEN/CUMULATIVE HEART DAMAGE
CARBON DIOXIDE	SIMPLE ASPHYXIATION
CARBON DISULFIDE	CUMULATIVE CENTRAL NERVOUS SYSTEM DAMAGE/REPRODUCTIVE IMPAIRMENT
CARBON MONOXIDE	CHEMICAL ANOXIA, ASPHYXIATION
CARBON TETRACHLORIDE	CUMULATIVE LIVER DAMAGE/SUSPECT CARCINOGEN/TERATOGEN
CHLORINE	LUNG INJURY/MARKED IRRITATION EYE, NOSE, THROAT BRONCHI
CHLOROBENZENE (MCB)	CUMULATIVE SYSTEMIC TOXICITY/ NARCOSIS
CHLORODIPHENYL (42% CHLORINE)	SUSPECT CARCINOGEN/CHLORACNE/ CUMULATIVE LIVER DAMAGE
CHLORODIPHENYL (54% CHLORINE)	SUSPECT CARCINOGEN/CHLORACNE/ CUMULATIVE LIVER DAMAGE

(CONT'D)

SUBSTANCE	OVEREXPOSURE SYMPTOMS
CHLOROFORM (TRICHLOROMETHANE)	SUSPECT CARCINOGEN/CUMULATIVE LIVER AND KIDNEY DAMAGE/NARCOSIS
CHROMIC ACID AND CHROMATES	SUSPECT CARCINOGEN/CUMULATIVE LUNG DAMAGE/NASAL PERFORATION, ULCERATION
CHROMIUM, SOL. CHROMIC, CHROMOUS SALTS AS CR	CUMULATIVE LUNG DAMAGE/DERMATITIS
COAL DUST (RESPIRABLE FRACTION LESS THAN 5% SIO_2)	PNEUMOCONIOSIS
COAL TAR PITCH VOLATILES (BENZENE SOLUBLE FRACTION)	SUSPECT CARCINOGEN/CUMULATIVE LUNG CHANGES
COPPER FUME	MODERATE IRRITATION EYE, NOSE, THROAT, LUNG
COPPER DUSTS AND MISTS	MILD IRRITATION EYE, NOSE, THROAT, SKIN
CYANIDE	MARKED IRRITATION SKIN, EYE, NOSE AND THROAT
DICHLORODIFLUOROMETHANE (FREON-12)	DIZZINESS; TREMORS, UNCONSCIOUS; CARDIAC ARRHYTHMIAS, CARDIAC ARREST
DIPHENYL	MODERATE IRRITATION EYE, NOSE, THROAT, BRONCHI, LUNGS
ETHYL ALCOHOL	MILD IRRITATION EYE, NOSE, THROAT/NARCOSIS
ETHYL ETHER	NARCOSIS/MILD IRRITATION EYE, NOSE, THROAT
FLUOROTRICHLOROMETHANE (FREON-11)	ACUTE CENTRAL NERVOUS SYSTEM EFFECTS
GRAPHITE (NATURAL)	CUMULATIVE LUNG DAMAGE (PNEUMOCONIOSIS)
HEPTANE	MODERATE IRRITATION EYE, NOSE, LUNGS/CENTRAL NERVOUS SYSTEM EFFECTS/NARCOSIS
HEXACHLOROETHANE	CUMULATIVE ORGAN DAMAGE/CENTRAL NERVOUS SYSTEM EFFECTS

(CONT'D)

SUBSTANCE	OVEREXPOSURE SYMPTOMS
HYDROGEN CHLORIDE	MARKED IRRITATION EYE, NOSE, THROAT/LUNG EDEMA
HYDROGEN SULFIDE	ACUTE SYSTEMIC TOXICITY/MODERATE IRRITATION EYE, (CONJUNCTIVITIS) LUNGS/CENTRAL NERVOUS SYSTEM EFFECTS
IODINE	MARKED IRRITATION EYES, NOSE, THROAT/LUNG EDEMA
IRON OXIDE FUME	LUNG CHANGES (SIDEROSIS)
ISOPROPYL ALCOHOL	MILD IRRITATION EYE, NOSE, THROAT/NARCOSIS
LEAD FUMES AND DUST	INSOMNIA/LASSITUDE (WEARINESS)/ PALLOR SKIN/ANOREXIA (LOSS OF APPETITE)/LOSS OF WEIGHT/MAL-NUTRITION/CONSTIPATION/ABDOMINAL PAIN/COLIC/HYPOTENSE/ANEMIA/ GINGIVAL LEAD LINE/TREMORS/PARA-LYSIS WRIST
L.P.G. (LIQUEFIED PETROLEUM GAS)	EXPLOSIVE/ASPHYXIANT/NARCOSIS
MERCURY (INORGANIC)	ACUTE AND CUMULATIVE CENTRAL NERVOUS SYSTEM DAMAGE/GASTRO-INTESTINAL EFFECTS/GINGIVITIS
METHYL ALCOHOL (METHANOL)	NARCOSIS/CUMULATIVE CENTRAL NERVOUS SYSTEM EFFECTS/MILD IRRITATION EYE, NOSE, THROAT
METHYL CHLOROFORM	MILD IRRITATION EYE, NOSE, THROAT/NARCOSIS
METHYLENE CHLORIDE	CHEMICAL ANOXIA (METABOLIC CONVERSION TO CO)/CHRONIC LIVER DAMAGE/CENTRAL NERVOUS SYSTEM EFFECTS/NARCOSIS
METHYL MERCAPTAN	ODOR/MODERATE IRRITATION EYE, NOSE, THROAT
MINERAL SEAL OIL (MENTOR 28)	ACCUMULATION IN LUNGS (PNEUMONITIS) SKIN IRRITATION, DERMATITIS AND SUSPECT CARCINOGEN
MOLYBDENUM, INSOLUBLE	CUMULATIVE LIVER AND KIDNEY DAMAGE/ BLOOD DISORDERS/MILD IRRITATION EYE, NOSE, THROAT, LUNG

(CONT'D)

SUBSTANCE	OVEREXPOSURE SYMPTOMS
MONOCHLORODIFLUOROETHANE (FREON-22)	CUMULATIVE LIVER DAMAGE
NAPHTHA (COAL TAR)	MODERATE IRRITATION EYE, THROAT/NARCOSIS
NICKEL, METAL AND SOLUBLE COMPOUNDS, AS NI	SUSPECT CARCINOGEN/CUMULATIVE LUNG DAMAGE/DERMATITIS
NITRIC OXIDE	METHEMOGLOBINEMIA/CENTRAL NERVOUS SYSTEM EFFECTS
NITROGEN DIOXIDE	CUMULATIVE LUNG DAMAGE (BRONCHITIS, EMPHYSEMA)/LUNG EDEMA
NUISANCE DUST	NO SIGNIFICANT ADVERSE HEALTH EFFECTS
OIL MIST, MINERAL	ACCUMULATION IN LUNGS (PNEUMONITIS)
ORTHO-DICHLOROBENZENE	MARKED IRRITATION EYE, NOSE, THROAT/LIVER DAMAGE
OZONE	MARKED IRRITATION RESPIRATORY TRACT/LUNG EDEMA
PARA-DICHLOROBENZENE	CUMULATIVE SYSTEMIC TOXICITY/ CATARACTS
PETROLEUM DISTILLATES (NAPHTHA)	MODERATE IRRITATION NARCOSIS
PORTLAND CEMENT	NUISANCE PARTICULATE/MILD IRRITATION EYE AND NOSE
PYRIDINE	CUMULATIVE LIVER, KIDNEY, AND BONE MARROW DAMAGE/CNS EFFECTS
SILICA-CRYSTALLINE	PNEUMOCONIOSIS (SILICOSIS)
SOAPSTONE	PNEUMOCONIOSIS
SODIUM HYDROXIDE	MARKED IRRITATION EYE, NOSE, THROAT, LUNGS, SKIN
SULFUR MONOCHLORIDE	MARKED IRRITATION EYE, NOSE, THROAT, LUNG
SULFURIC ACID	MARKED IRRITATION EYE, NOSE, THROAT, SKIN, BRONCHI/DENTAL EROSION

(CONT'D)

SUBSTANCE	OVEREXPOSURE SYMPTOMS
TALC (NON-ASBESTOS FORM)	PNEUMOCONIOSIS (TALCOSIS)
1,1,2,2-TETRACHLOROETHANE	CUMULATIVE LIVER AND OTHER ORGAN DAMAGE
TETRACHLOROETHYLENE	CUMULATIVE LIVER AND CENTRAL NERVOUS SYSTEM DAMAGE/NARCOSIS/ SUSPECT CARCINOGEN
TIN (INORGANIC COMPOUNDS, EXCEPT OXIDES)	ACUTE AND CHRONIC SYSTEMIC TOXICITY
O-TOLUIDINE	METHEMOGLOBINEMIA/ACUTE SYSTEMIC EFFECTS/SUSPECT CARCINOGEN
TRICHLOROETHYLENE	NARCOSIS/CUMULATIVE SYSTEMIC TOXIC EFFECTS/SUSPECT CARCINOGEN
TRIETHYLAMINE	MARKED IRRITATION EYES, NOSE, THROAT, LUNGS/LUNG EDEMA/CORNEAL DAMAGE
TURPENTINE	MODERATE IRRITATION EYE, NOSE, THROAT, BRONCHI, LUNGS, SKIN/ CUMULATIVE KIDNEY DAMAGE
XYLENE (XYLOL)	MODERATE IRRITATION EYE, NOSE, THROAT/NARCOSIS
ZINC CHLORIDE FUME	MARKED IRRITATION EYE, NOSE, THROAT LUNGS/ACUTE LUNG DAMAGE/SUSPECT CARCINOGEN
ZINC OXIDE FUME	ACUTE SYSTEMIC TOXICITY (METAL FUME FEVER)

APPENDIX D

EXAMPLE HAZARD REPORTING FORM

ʼhite Copy: Dept File
ʼreen Copy: Dept. Sends To Safety

Pink Copy: Deposit in Hazard Report Box
Yellow Copy: Originator

HAZARD REPORTING FORM

ECTION A: To be filled out by employee

No 3569

REPORTED TO:	REPORTED BY:	DATE:

DESCRIPTION & LOCATION OF HAZARD:
CAUSE:
RECOMMENDATION TO CORRECT OR ELIMINATE SITUATION:

SECTION B: To be filled out by Supervisor

DATE RECEIVED:	DATE OF RESPONSE TO EMPLOYEE:	DATE ACTION COMPLETE:

ACTION TAKEN:

SUPERVISOR	DATE:	DEPT. SUPT.	DATE:

APPENDIX E

EPA RESPIRATORY PROTECTION PROGRAM GUIDELINE

☆ U.S. Government Printing Office: 1986—625-003/41510