Accident Investigation

(Shortened and summarized for general use from the hard work of others by Don Brown)

Build a Policy = Before the accident occurs, lay the groundwork
When an accident occurs in the workplace, people will be dealing with the emergency and will not have time to put together an investigation plan. Before the accident occurs, develop a written accident analysis plan that will:

- Determine who should be notified of accident.
- Establish who is authorized to notify outside agencies and individuals (fire, police, OSHA, family, etc.)
- Determine who is assigned to conduct investigations.
- Conduct required training for accident investigators.
- Determine who receives and acts on investigation reports.
- Establish timetables for conducting the investigation and follow-up actions.

Step 1: Secure the Scene

Secure the accident scene as soon as possible so collection of data can begin. The investigation may begin while the victim is being assisted by emergency responders. Do not interfere with emergency responders in any way. The first responsibility is to make sure the victim is cared for. Observations are being made for later analysis.

The investigation will normally begin after emergency response is completed. Material evidence will not likely be in its original location. Effective interviews will help construct the scene. The cause of the accident is not yet the objective, the gathering of information for later analysis is the goal.

The accuracy of evidence will decline over time. Start the investigation as soon as possible, not to establish blame, to determine **what harmful energy caused the injury**, and then what **surface** and **system causes** were for the accident.

Things may change after an accident occurs:

- **Material evidence.** Tools, equipment, and people move or disappear from the scene. People want to clean up the scene so they can get back to work. Protect material evidence so that it does not disappear or get moved.
- **Memory.** Accidents are traumatic events. There is psychological trauma. There may be physical trauma to the victim and others. Over time, conversations with others and individual emotions distort what people believe they saw and heard. Memories of the accident will be altered. This will have negative effects on an investigation.

Information must be gathered as soon as possible. Secure the accident scene quickly. Use tape, rope, cones, or even personnel to secure the scene. Securing the scene will help prevent the loss of material evidence.

Report the accident of a very serious injury or fatality accident to OSHA within their specified time frame. Your state may have additional requirements for reporting fatalities, catastrophes, or multiple serious injuries. Once the employer has knowledge that any State or Federal OSHA reporting conditions have been met, the clock starts ticking for the reporting requirements.

Step 2: Gathering data

Once the accident scene has been secured, gather evidence from as many sources as possible. The investigator must determine **what** is relevant to **what** happened, **how** it happened, and **why** it happened.

Even if the relevancy is in question, document as much as possible. Discard information later if it proves not useful. All items at the scene should be considered potentially relevant. A team approach is the most efficient strategy when conducting an accident investigation where very serious injuries or fatalities are involved.

Sample Accident Investigator's Kit

It is important to have an accident investigation kit prepared.

- Camera
- Voice recorder
- Ground loop Impedance Tester
- Sound level meter
- Abney Level or clinometer
- Tape measure, 25 and 50 ft length
- Clipboard, paper, pencils, etc.
- Rain gear
- Rubber and caulked boots
- Plastic bags with ties
- Square, French curve template
- Personal Protective Equipment
    - Eye protection
    - Hand protection
    - Clothing
    - Respirators
    - Hearing protection
- String
- Stakes
- Warning tape

Methods to document the accident scene

Make personal observations. Take notes on personal observations. Involve all the senses.

- What equipment, tools, materials, machines, structures appear to be broken, damaged, struck or otherwise involved in the event? Look for gouges, scratches, dents, smears. If vehicles are involved, check for tracks and skid marks. Look for irregularities on surfaces. Are there any fluid spills, stains, contaminated materials or debris?
- What about the environment? Were there any distractions, adverse conditions caused by weather? Record the time of day, location, lighting conditions, etc. Note the terrain (flat, rough, etc.)
- What is the activity occurring around the accident scene?
- Who is there: Who is not? This is needed to take initial statements and interviews.
- Measure distances and positions of everything you believe to be of any value to the investigation.

Obtain initial statements. If there are one or more eye-witnesses to the accident, ask them for an initial statement giving a description of the accident. Also try to obtain other information from the witness including:

- Names of other possible witnesses for subsequent interviews.
- Names of company rescuers or emergency response service.
- Materials, equipment, articles that were moved or disturbed during the rescue.

Take photos of the accident scene. Start with distance shots, and move in closer as more photos are taken.

- Take photos at different angles (from above, 360 deg. of scene, left, right, rear) to show the relationship of objects and details such as ends of broken rope, defective tools, drugs, wet areas, containers.
- Take panoramic photos to present the entire scene, top to bottom - side to side.
- Take notes about each photo. These will be included in the appendix of the report along with the photos. Identify the type of photo, date, time, location, subject, weather conditions, measurements, etc.
- Place an item of known dimensions in the photo if hard-to-measure subjects are being photographed.
- Identification of person taking photo.
- Indicate the locations photos were taken on sketches.

Record video of the scene. The earlier video recording can begin the better. Once company or other emergency responders are attending to the victim, begin recording video. The video recorder will pick up details and conversations that can add much valuable information to the investigation. Do not get in the way.

Important points to remember when recording video include:

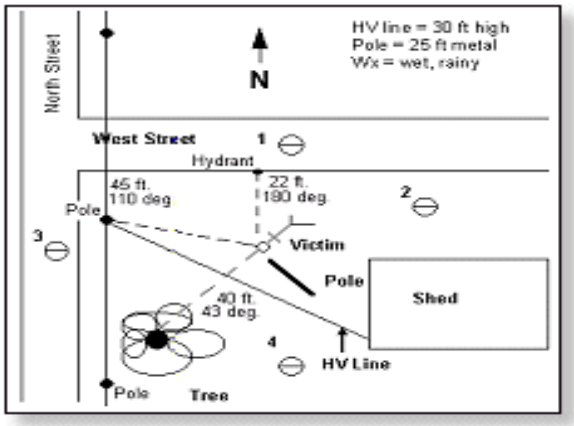
- Have witness(es) accompany and describe what happened.
- If possible, reenact the event.
- Use a tripod when recording video if possible.
- Stand back from a distance and zoom in to the scene.
- Scan slowly 360 degrees left and right to establish location.
- Narrate what is being recorded; describe objects, size, direction, location, etc.
- If a vehicle was involved, record direction of travel, going and coming.
- Make sure your video device is operating properly; the battery is charged, etc.

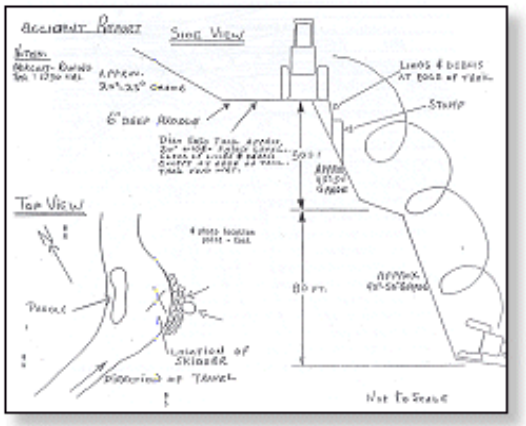
Sketch the accident scene. Sketches are important because they compliment the information in photos, and are good at indicating distances among the elements of the accident scene. This establishes position evidence. Be as precise as possible when making sketches. The basic components of the sketch are:

- Documentation. Date, time, location, identity of objects, victims, etc.
- Spatial relationships. Measurements.
- Location of photographs.

Some sketching pointers:

- Make sketches large; preferably 8" x 10".
- Makes sketches clear. Include information pertinent to the investigation.
- Include measurements. Establish precise fixed identifiable reference points.
- Print legibly. All printing should be on the same plane.
- Indicate directions, i.e., North, East, South, and West.
- Always tie measurements to a permanent point, e.g., telephone pole, building, and fixed equipment.
- Mark where people were standing.
- Use sketches when interviewing people.
- Show where photos were taken.
- Upgrade the quality of the sketch. Turn it into a precise diagram.





The sketch shown (left) illustrates the Triangulation Method it makes it possible to pinpoint the location of an object. In this accident, the victim contacted a high voltage line with a metal tree trimming pole. The position of the victim's head is measured from three points. Notice the small circles with horizontal lines through them. These circles indicate where photos were taken. North is indicated and all major objects are identified. Another sketch (right) helps to illustrate one of the major advantages of sketching, it shows motion through time. In this sketch you can see how the bulldozer rolled down the side of a hill.

Interview documents: Ask questions about the records instead of just reviewing them. Some records to review are:

- Maintenance records - to determine the maintenance history of the tools, equipment or machinery.
- Training records - to determine the training received by the victim and others.
- Standard operating procedures - to determine the established steps in the procedures.
- Safety policies, plans, rules - to determine their presence and adequacy.
- Work schedules - to determine if the victim might have been fatigued or otherwise overworked.
- Disciplinary records - to determine if disciplinary actions have occurred previously.
- Medical records - if permission granted, to determine potential physical/mental contributing factors.
- EMT reports - to determine quality of response procedures.
- OSHA Form 300 Log - to determine if similar accidents have occurred previously.
- Form 301 or similar state forms - to collect additional information on accident events and background.
- Safety Committee Minutes - to determine the history of hazardous conditions, unsafe behaviors or program elements.
- Coroner's report - to determine direct cause of injury causing fatality.
- Police report - to determine facts when criminal negligence is in question. Note: When criminal negligence is suspected stop the investigation and coordinate all activities with legal advisors.

Gathering data through interviews

After the accident scene has been documented, it is important to get details through interviews. The accident investigation interview is done to obtain a comprehensive picture of what happened by obtaining facts, interpretations, and opinions. The interviewer is to construct a composite story using the accounts of the accident and other evidence.

Questions need to be designed around the interviewee. Each interview will be a unique experience. Interviews should occur as soon as possible, but usually do not begin until things have settled down. Some people to consider for an interview include:

- **The victim.** To determine specific events leading up to and including the accident.
- **Co-workers.** To establish what actual vs. appropriate procedures have been used. Preferably people that perform the same task.
- **Direct supervisor.** To get background information on the victim. They can provide procedural information about the task that was being performed.
- **Manager.** Can be the main source for information on related systems.
- **Training department.** To get information on training the victim and others have received.
- **Personnel department.** To get information on the victim's and others' work history.
- **Maintenance personnel.** To determine background on equipment maintenance.
- **Emergency responders.** To learn what they saw when they arrived and during the response.
- **Medical personnel.** To get medical information (as allowed by law.)
- **Coroner.** Can be a valuable source to determine type/extent of fatal injuries.
- **Police.** If they filed a report.
- **Other interested persons.** Anyone interested in the accident may be a source of information.
- **The victim's spouse and family.** May have insight into the victim’s state of mind or other issues.

Cooperation is key to a successful interview. Gathering information is the focus of this process.

Effective Interviewing Techniques

- Keep the purpose of the investigation in mind: To determine the cause of the accident so that similar accidents will not recur. Make sure the interviewee understands this.
- Approach the investigation with an open mind. It will be obvious if the interviewer has preconceptions about the individual(s) or the facts.
- Go to the scene. Because people are familiar with the location or the victim’s job, do not assume that things are always the same. If a private interview cannot be conducted at the location, find an office or meeting room that the interviewee would consider a neutral location. Do not promise confidentiality.
- Interview the people involved (victim, witnesses, people involved with the process)

- Put the interviewee at ease. Explain the purpose and interviewer role. Sincerely express concern regarding the accident and desire to prevent a similar occurrence.
- Express to the individual that the information given is important. Be friendly, understanding, and open minded. Be calm and unhurried.
- Direct an eye witness to "explain what happened." Do not ask them to explain, because they may respond with a simple "no," and then the interview is over.
- Let the individual talk. Ask background information, name, job, etc. first. Ask the witness to tell what happened; do not ask leading questions; do not interrupt; and do not make expressions (facial, verbal approval or disapproval).
- Ask open ended questions to clarify particular areas or get specifics. Avoid yes and no answer questions. Avoid asking "why" as these types of questions tend to make people respond defensively. Example: Do not ask: "Why did you drive the forklift with under-inflated tires? Instead, ask: What are forklift inspection procedures? What are forklift safety hazard reporting procedures?
- Repeat the facts and sequence of events back to the person to avoid any misunderstandings.
- Notes should be taken very carefully, and as casually as possible. Ask the interviewee to review the notes for technical accuracy. Reading the notes may help them remember other details. Give the interviewee a copy of the notes to help reduce any thought that information might be concealed.
- Do not use a voice recorder unless given permission. Tell the interviewee that the purpose of the recorder is to insure accuracy. Offer to give the interviewee a copy of the recording.
- Ask for their suggestions as to how the accident could have been avoided.
- Thank them for their contribution. Ask them to contact you if they think of anything else.

Sorting it all out...
A structured analysis is being conducted to determine the events that occurred prior to and including the injury event, and what kind of impact each event had on the accident.

Separate the accident process into its component events to determine how they relate to the whole. The accident is the main event, its parts may be thought of as the individual events leading up to and including the accident.

STEP 3: Developing the Sequence of Events

Determine the sequence of events in the accident process so that it can be effectively analyzed. Once the steps in the process are developed, study each event to determine related:

- **Hazardous conditions.** Things and states that directly caused the accident.
- **Unsafe behaviors.** Actions taken/not taken that contributed to the accident.
- **System weaknesses.** Underlying inadequate or missing programs, plans, policies, processes, and procedures that contributed to the accident. .

The accident is the final event in an unplanned process. What was the initial event was. When the initial event occurs, it effects the actions of others, setting in motion a process ending in an injury or illness. Take the information and arrange it to determine what initial condition and/or action transformed the planned work process into an unplanned accident process.

For instance, if a supervisor ignores an unsafe behavior because doing so is not thought to be his or her responsibility, the failure to enforce behavior represents an event in the production process that may increase the probability of an accident.

Each event in the unplanned accident process describes a unique:

- **Actor.** An individual or object that influenced the sequence of events. An actor may participate in the process or observe the process. An actor initiates a change by performing or failing to perform an action.
- **Action.** Something that is done by an actor. Actions may or may not be observable. An action may describe something that is done or not done. Failure to act should be thought of as an act in itself.

Identify the actor then tell what the actor does. The actor is the "doer," not the person or object being acted upon. Take a look at the statement below:

"Bob unhooked the lifeline from the harness."

In this example, *"Bob"* is the actor and *"unhooking"* is the action. First describe the actor; Bob. Then describe the action; unhooking. The lifeline and harness, although "objects" are not actors because they are not performing an action, something is being done to them.

Paint a word picture

The sequence of events should describe what occurred so that someone can visualize it as they read. Increase the detail by:

1. Determine if anything else was said or done before or after the event currently being assessed.
2. Separate actors. Remember, an actor is person or a thing accomplishing a given action. If an event includes actions by more than one actor, break the event down into two events.

The example below that was prepared for an actual fatality investigation.

Sequence of Events

1. Employee #1 returned to work at 12:30 PM after lunch to continue laying irrigation pipes.
2. At approximately 12:45 PM employee #1 began dumping accumulated sand from an irrigation mainline pipe.
3. Employee #1 oriented the pipe vertically and it contacted a high voltage power line directly over the work area.
4. Employee #2 heard a 'zap' and turned to see the mainline pipe falling and employee #1 falling into an irrigation ditch.
5. Employee #2 ran to employee #1 and pulled him from the irrigation ditch, laid him on his back and ran about 600 ft to his truck and placed a call for help on his mobile phone.
6. Employee #2 than ran back to find employee #1 had fallen back into the ditch.
7. Employee #2 jumped back into the ditch and held employee #1 out of the water until help arrived.
8. Two other ranch employees arrived and assisted employee #2 in getting employee #1 out of the ditch.
9. Approximately one minute later, paramedics arrived and began to administer CPR on employee #1. They also used a heart defibrillation machine in an attempt to stabilize employee #1's heart beat.
10. At approximately 1:10 PM an ambulance arrived and transported employee #1 to the hospital where he was pronounced dead at 1:30 PM.

This example gives sufficient descriptive detail to paint a mental picture of the actors and acts that occurred immediately prior to and including the accident.

Most accidents in the workplace result from a combination of unsafe work behaviors and hazardous conditions. According to the research, they represent the cause for about 98% of all workplace accidents. "Acts of God" account for the remaining 2%. These statistics imply that safety management **system weaknesses** account for 98% of all workplace accidents.

Step 4: Determining Causes

The systems approach takes into account the dynamics of systems that interact within the overall safety program. It concludes that accidents are considered defects in the system. People are only one part of a system composed of many processes. Accidents are the result of multiple causes or defects in the system. It is the investigator's job to uncover the root causes (defects) in the system.

Why accidents happen

Theorists gradually realized that it was not sufficient to explain away workplace accidents as simple cause-effect events.

- **Multiple Cause Theory** - Accidents are not assumed to be simple events. They are the result of a series of random, related or unrelated, events that somehow interact to cause the accident. Removing the sharp edge of a work surface does not guarantee a similar injury will be prevented at the same or other workstation. Many other factors may contribute to an injury. An accident investigation will not only recommend corrective actions to remove the sharp surface, it will also address the underlying system weaknesses that caused it.

Time to analyze for cause
Information has been gathered and used to develop an accurate sequence of events. Now it is time to conduct an analysis of each event to determine causes.

- **Injury analysis**
- **Event analysis**
- **Systems analysis**
- **Direct cause of injury**
- **Surface cause of the accident**
- **Root cause of the accident**

Three levels of cause analysis
Accidents are processes that culminate in an injury or illness. An accident may be the result of many factors (simultaneous, interconnected, cross-linked events) that have interacted in some dynamic way. In an effective accident investigation, the investigator will conduct three levels of cause analysis:

Injury analysis	**Event Analysis**	**Systems analysis**
At this level of analysis, there is **no attempt to determine what caused the accident**, but rather a focus on trying to determine how harmful energy transfer caused the injury. The outcome of the accident process is an injury.	This determines the **surface cause(s)** for the accident: Those hazardous conditions and unsafe behaviors described throughout all events that interact to produce the injury. All hazardous conditions and unsafe behaviors point to possible system weaknesses.	Trace surface causes to inadequate safety policies, programs, plans, processes, or procedures. **System causes** always pre-exist surface causes and may function through poor component design to allow, promote, encourage, or even require systems that result in hazardous conditions and unsafe behaviors. This level of investigation may point to a system component that may contribute to common conditions and behaviors throughout the company.

The direct cause of injury
Whenever an injury occurs, a harmful level of energy is somehow transferred to our body. Describe the nature of that energy transfer and refer to it as the **direct cause** of the injury. Here are the various forms of energy that can be harmful:

1. ACOUSTIC ENERGY - Excessive noise and vibration.
2. CHEMICAL ENERGY - Corrosive, toxic, flammable, or reactive substances. Involves a release of energy ranging from "not violent" to "explosive" and "capable of detonation".
3. ELECTRICAL ENERGY - Low voltage (below 440 volts) and high voltage (above 440 volts).
4. KINETIC (IMPACT) ENERGY - Energy from "things in motion" and "impact," and are associated with the collision of objects in relative motion to each other. Includes impact between moving objects, moving object against a stationary object, falling objects, flying objects, and flying particles. Also involves movement resulting from hazards of high pressure pneumatic, hydraulic systems.
5. MECHANICAL ENERGY - Cut, crush, bend, shear, pinch, wrap, pull, and puncture. Such hazards are associated with components that move in circular, transverse (single direction), or reciprocating motion.
6. POTENTIAL (STORED) ENERGY - Involves "stored energy." Includes objects that are under pressure, tension, or compression; or objects that attract or repulse one another. Susceptible to sudden unexpected movement. Includes gravity - potential falling objects, potential falls of persons. Includes forces transferred biomechanically to the human body during lifting.
7. RADIANT ENERGY HAZARDS - Relatively short wavelength energy forms within the electromagnetic spectrum. Includes infra-red, visible, microwave, ultra-violet, x-ray, and ionizing radiation.
8. THERMAL ENERGY - Heat, cold, sources of flame ignition, flame propagation, and heat related explosions.

Examples describing the direct cause of injury:

- If a harsh acid splashes on our face, we may suffer a chemical burn because our skin has been exposed to a chemical form of energy that destroys tissue. In this instance, the **direct cause** of the injury is harmful, a chemical reaction. The related **surface cause** might be the acid (condition) or working without proper face protection (unsafe behavior).
- If workload is too strenuous, force requirements on the body may cause a muscle strain. Here, the **direct cause** of injury is a harmful level of kinetic energy (energy resulting from motion), causing injury muscle tissue. A related **surface cause** of the accident might be fatigue (hazardous condition) or improper lifting techniques (unsafe behavior).

The point to remember is that the **direct cause** of injury is not the same as the **surface cause** of the accident. To summarize:

- The **direct cause of injury** is the harmful transfer of energy. The direct result is injury.
- The **surface cause of the accident** describes a condition or behavior. The result of the condition and/or behavior is the direct cause of injury, a harmful transfer of energy.

The surface causes of accidents

Surface causes are those specific **hazardous conditions** and **unsafe or inappropriate behaviors** that directly cause or contribute in some way to an accident.

Hazardous conditions:

- are things or objects that cause injury or illness
- may also be thought to be defects in a process
- may exist at any level of the organization

Hazardous conditions may exist in any of the following categories:

- Materials
- Machinery
- Equipment
- Tools
- Chemicals
- Environment
- Workstations
- Facilities
- People
- Workload

Most hazardous conditions in the workplace are the result of specific unsafe behaviors that produced them.

Unsafe behaviors:

- Are actions we take or do not take that increase risk of injury or illness?
- may also be thought to be errors in a process
- May occur at any level of the organization.

Some example of unsafe employee/manager behaviors include:

- Failing to comply with rules
- Using unsafe methods
- Taking shortcuts
- Horseplay
- Failing to report injuries
- Failing to report hazards
- Allowing unsafe behaviors
- Failing to train
- Failing to supervise
- Failing to correct
- Scheduling too much work
- Ignoring worker stress

System Analysis to determine the root causes of accidents

Once an organization identifies inadequate policies, programs, plans, processes, and procedures, they are getting to the root causes. The root causes for accidents are the underlying safety system weaknesses that have contributed to the existence of hazardous conditions and unsafe behaviors that represent surfaces causes of accidents. These weaknesses can take two forms:

- **Design root causes.** Inadequate planning and design of the system. The development of formal (written) safety management system policies, plans, processes, procedures is very important to make sure appropriate conditions, activities, behaviors, and practices occur.
- **Implementation root causes.** Inadequate implementation of the system. Failure to effectively carry out the safety management system is critical to the success of the system. A system can be designed, yet if it is not implemented and demonstrated in actions, it will not work.

Root causes always pre-exist surface causes. Inadequately designed and implemented system components have the potential to result in hazardous conditions and unsafe behaviors. If root causes are left unchecked, surface causes will continue to exist.

Examples of safety management system functions

Safety systems:

Systems are developed to:

- Promote Commitment/leadership
- Increase employee involvement
- Establish accountability
- Identify and control hazards
- Investigate incidents/accidents
- Educate and train
- Evaluate the safety program

System components:

- Policies
- Programs
- Plans
- Processes
- Procedures
- Budgets
- Reports
- Rules

STEP 5: Recommend Improvements

An accident investigation is generally thought to be a reactive safety process because it is initiated only after an accident has occurred. However, proposed recommendations that include effective control strategies and system improvements can transform the investigation into a valuable proactive process that ensures similar accidents do not recur.

What is an effective recommendation?

Effective control strategies that will eliminate or reduce the surface causes of the accident are needed. System improvements are required to add missing or inadequate safety system components that contributed to the accident.

The Hierarchy of Controls

Hazard control strategies may be quite effective in eliminating hazards or reducing exposure. Effective corrective actions will include one or more of the following hazard control strategies:

1. Engineering controls. Sometimes the cause of an accident is corrected most effectively by removing or reducing the hazard. This may be done in a number of ways, including:

- **Redesign** the hazard out. Example – Fabricate a guard to reduce exposure.
- **Replace** the unsafe item with a safe item. Example - Replace a poor quality grinder stone.
- **Enclose** the hazard. Example - Place a hood over a source of noisy printer.
- **Substitute** an unsafe item. Example - Substitute a toxic chemical with a non-toxic chemical.

Engineering out the hazard is the top priority

Engineering controls have the potential to remove the hazard completely.

Engineer the hazard out if feasible. For instance, if a machine is producing an excessive noise level, OSHA expects the employer to first attempt to reduce the noise level to acceptable levels using an engineering control such as enclosure.

2. Management controls. Managers employ these control strategies to eliminate or reduce the frequency and duration of exposure to hazards. This is accomplished through:

- **Manage work practices**. Effective design and implementation of safe work procedures and practices.
- **Manage work schedules**. These strategies include job rotation, breaks, shift work, etc.

Control strategies are less effective in the long term than engineering controls because they do not remove the hazards. These controls reduce exposure to hazards by controlling human behavior. As long as employees behave or comply with the changed procedures or schedules, management controls work. Sometimes safe work procedures are not perceived as most efficient, so we may not use them. Managers must diligently oversee and maintain management control strategies or those controls will become ineffective.

3. Personal protective equipment (PPE). Some jobs require PPE by law. This control strategy is used in conjunction with the other control strategies. It should not be used to replace them. When engineering or administrative controls do not adequately eliminate or reduce the hazard(s) of a task, PPE may be needed in addition to those strategies. PPE places a barrier between workers and the hazard. PPE does not eliminate or reduce the hazard. To be successful, PPE is dependent on safe behaviors.

The Hierarchy of Controls, when used separately or in combination, may be effective in eliminating or reducing the probability of a similar accident recurring. To make sure long term risk reduction is achieved throughout the entire company, system improvements must be made.

Recommend system improvements

Missing or inadequate safety system components represent root causes for workplace accidents. Surface causes result from system weaknesses. Effort should be made to improve system components to ensure long term workplace safety.

Making system improvements might include some of the following:

- Including "safety" in a mission statement.
- Improving safety policy so that it clearly establishes responsibility and accountability.
- Changing a work process so that checklists are used that include safety checks.
- Revising purchasing policy to include safety considerations as well as cost.
- Changing the safety inspection process to include all supervisors and employees.

Proactive recommendations

To gain approval of recommendations, anticipate the concerns and questions that supervisors have when deciding what actions to take. The more pertinent the information included in the recommendation, the greater the likelihood for approval.

Answer the following questions to help develop and justify recommendations.

1. **Pinpoint the problem** - What exactly is the problem?
   What are the specific hazardous conditions and unsafe work practices that caused the problem? What are system components - the inadequate or missing policies, processes, rules that allowed the conditions and practices to exist?
2. **What is the history of the problem?**
   Have similar accidents occurred previously? If so, probability for similar accidents is highly likely to certain. What are previous costs for similar accidents? How have similar accidents affected production and morale?
3. **Pinpoint the specific solution** - What are the solutions that would correct the problem?
   What are the specific engineering, administrative and PPE controls that, when applied, will eliminate or at least reduce exposure to the hazardous conditions? What are the specific system improvements needed to ensure a long term fix?
4. **Who is the decision maker?**
   Who is the person that can approve, authorize, and act on the corrective measures? What are the possible objections that they might have? What are the arguments that will be most effective in overcoming objections?

5. **What is the decision maker's perception about safety?** It's important to know what is motivating the decision-maker. Is the manager's safety perception to:
    - **Fulfill the legal obligation**? You may need to emphasize possible penalties if corrections are not made.
    - **Fulfill the fiscal obligation**? You may want to emphasize the costs/benefits.
    - **Fulfill the moral obligation**? You may want to emphasize improved morale, public relations.
6. **What will be the cost/benefits if the recommendation is approved and the predictable cost/benefits if not?**

What are the estimated costs and benefits of taking corrective action, as contrasted with the possible costs and harm that might occur if the hazardous conditions and unsafe work practices remain? What are the employer obligations under administrative law? What is the message sent to the workforce as a result of action or inaction?

The maintenance or engineering supervisor may be able to help you determine these estimates. Also, detail the costs associated with any training that might be required.

A simple cost-benefit analysis

A cost-benefit analysis assumes that there is an expectation that a disabling injury is likely in the foreseeable future (five years) when employees are exposed (place themselves within a danger zone) to a workplace hazard. The object is to contrast the relatively **high cost/low benefit** if the hazard is not eliminated, with the **low cost/high benefit** if the hazard is eliminated.

The analysis answers the following questions:

- What are the potential costs to the company if the hazard is not eliminated?
- What are the potential costs to the company if the hazard is eliminated?
- How soon will the corrective action pay for itself?
- What is our return on investment (ROI) if corrective actions are taken?

Example: If, during a safety inspection, you notice that an elevated platform area in a warehouse does not have a proper guardrail. You note that several workers work on the platform each day, and a well-used walkway passes directly under the platform. To construct a cost-benefit analysis for this situation you would answer the above questions as follows:

Average direct dollar costs for different types of accidents

Recommendations should be supported by a bottom-line cost/benefit analysis that contrasts the relative high costs of accidents against the much lower costs associated with corrective actions. Doing a cost benefit analysis is even more important when recommending corrective actions before an accident occurs.

According to the National Safety Council, which considers all industries nationally, the estimated 2008 average costs of a lost time injury is about $48,000, and a fatality averages $1,310,000.

What are the estimated costs to the company if the hazard is eliminated?
Costs: $1,500 needed to purchase and repair guardrail.

How soon will the corrective action pay for itself?
If a disabling injury occurs within the next 5 years, using National Safety Council figures we can estimate a cost to the company of approximately $48,000. Given the cost to purchase and repair the guard rail of $1,500, the corrective action will pay for itself in just 1.9 months ($1,500/ ($48,000/60 months)).

Provide alternatives to make it more likely that corrective actions will be taken. The options might follow the logic below:

- **First option** -- If we had all the money we needed, what could we do? Eliminate the hazard with primarily engineering controls. Additional administrative controls if required.

- **Second option** -- If we have limited funds, what would we do? Eliminate the hazard with using work practice and/or administrative controls. Engineering controls if required.
- **Third option** -- If we don't have any money, what can we do? Reduce exposure to the hazard with work practice/administrative controls and/or PPE.

It is important to remember that the employer should first try to engineer out the hazard, if feasible, before using administrative controls or PPE

For an accident investigator the **objective is to uncover the causal factors that contributed to the accident, not to place blame**. Be as objective and accurate as possible.

How the findings are presented will shape perceptions and subsequent corrective actions. If the report arrives at conclusions such as; "Bob should have used common sense," or "Bobbie forgot to use PPE," it won't be effective at all. If the report concludes with statements such as this, it will be impossible to take corrective actions that permanently eliminate the causes. It is likely that similar accidents will repeatedly occur. If the accident investigation does not fix the **system**, it is most likely been a waste of time and effort.

The Accident Report Form
The following format is designed to give emphasis to root causes.

Section I. Background
This section contains background information that answers questions about the victim, and the time, date, location of the accident, as well as other necessary details.

Section II. Description of the accident
This section presents a descriptive narrative of the events leading up to, including, and immediately after the accident. The narrative must paint a "word picture" so that someone can clearly see what happened. Here is a possible format:

Event -3	Employee #1 returned to work at 12:30 PM after lunch to continue laying irrigation pipes.
Event -2	At approximately 12:45 PM employee #1 began dumping accumulated sand from an irrigation mainline pipe.
Event -1	Employee #1 oriented the pipe vertically and it contacted a high voltage power line directly over the work area.
Event 0	Employee #2 heard a 'zap' and turned to see the mainline pipe falling and employee #1 falling into an irrigation ditch.
Event +1	Employee #2 ran to employee #1 and pulled him from the irrigation ditch, laid him on his back and ran about 600 ft to his truck and placed a call for help on his mobile phone.
Event +2	Employee #2 than ran back to find employee #1 had fallen back into the ditch.
Event +3	Employee #2 jumped back into the ditch and held employee #1 out of the water until help arrived.
Event +4	Two other ranch employees arrived and assisted employee #2 in getting employee #1 out of the ditch.
Event +5	Approximately one minute later, paramedics arrived and began to administer CPR on employee #1. They also used a heart defibrillation machine in an attempt to stabilize employee #1's heart beat.
Event +6	At approximately 1:10 PM an ambulance arrived and transported employee #1 to the hospital where he was pronounced dead at 1:30 PM.

Section III. Findings

The findings section describes the **hazardous conditions**, **unsafe behaviors** and **system weaknesses** the investigation has uncovered. Each description of surface and root cause will include justification for the finding. The justification will explain how the conclusions were made.

Some report forms force the investigator to list only surface causes for accidents. The investigator believes the job is done without ferreting out the root causes. Make sure forms offer space to write findings. The form does not report the root causes uncovered associated with each surface cause. **It is not the object of this section to find fault or place blame. Just state the facts:** The hazardous conditions, unsafe procedures, inadequate or missing policies, training, accountability, etc. Be sure to write complete descriptive sentences.

Sample primary surface cause finding statements

The findings describe the hazardous conditions and unsafe behaviors that directly caused injury. They exist or occur immediately prior to the injury event.

- **Hazardous condition:** The bolts for the machine guard on the chipper were missing and the grating cut open.
- **Unsafe behaviors:** The injured employee fed limbs into the unguarded chipper, exposing himself to the hazardous condition.

Sample secondary surface cause finding statements

These findings describe those conditions and behaviors produced by individuals at some point prior to the injury event. These conditions, activities, practices and behaviors can exist at any time, in any place, and be produced by any person in the organization.

- **Hazardous condition:** Tools to repair the machine guard were broken and unusable.
- **Unsafe behaviors:** An employee failed to replace bolts on the guard. An employee defeated the guard by cutting through the guard grating producing a large hole. The injured employee had not been trained in chipper operation or machine guarding principles.

Sample safety program implementation root cause finding statements

These findings describe management failures to implement programs, processes, plans, procedures within the safety management system. These failures result in secondary surface causes; those conditions and behaviors common to work groups or the entire organization.

- **Inadequate process:** Employees are not being properly trained in safe work procedures around high voltage lines. None of the employees exposed to high voltage have been trained. Supervisors are unfamiliar with rules and have not received training in this subject.
- **Inappropriate behaviors:** Supervisors are generally allowing unsafe work practices associated with high voltage lines.

Sample safety program design root cause finding statements

These findings describe one or more inadequate safety management system policies, programs, and processes in any of the seven element areas: commitment, accountability, involvement, identification/control, incident/accident analysis, education/training, and evaluation. These "deep root causes" result in inadequate implementation of the safety management system.

- **Conditions:** Safety training policy statement does not exist. Safety training plan does not include policies and practices for employees working around high voltage line systems. The safety training plan does not include supervisor or manager level training on this subject.

Section IV. Recommendations

If root causes are not addressed properly in Section III of the report, it is doubtful recommendations will include improving system inadequacies. Effective recommendations will describe ways to eliminate or reduce both surface and root causes. They will also detail estimated investments involved with implementing corrective actions and system improvements.

Sample recommendations that correct primary surface causes

These recommendations describe how to correct those unique hazardous condition(s) and unsafe behaviors that directly resulted in injury. These recommendations will impact only the unique condition or behavior.

- To correct a condition. Repair and/or replace the machine guard. Benefit: This hazardous condition is eliminated.
- To correct a behavior. Educate and train the injured employee on hazard reporting procedures. Benefit: The injured employee will understand and gain the skills necessary to prevent a similar accident.

Recommendations that correct secondary surface causes
These recommendations describe how to correct those common hazardous conditions and unsafe or inappropriate behaviors that produced the conditions and behaviors of the injury event. Correcting secondary surface causes is accomplished by improving the implementation of the safety management system. These recommendations will have a general positive impact throughout the work group or organization.

- Implement an effective education and training process covering machine guarding principles for all maintenance and affected employees Benefit: Affected employees will understand and be skilled in identifying and correcting machine guard hazards.
- Implement improved employee orientation that includes education and training on hazard reporting procedures. Benefit: New employees will understand and gain skills in appropriate hazard reporting procedures.
- Conduct supervisor/manager training on new policies. Management will better understand and gain skills in their responsibilities in response to hazard reports.

Recommendations that correct implementation and design root causes
Solving implementation weaknesses is accomplished by improving system design. These recommendations address improvements to written safety management system and specific program policies and plans that correct inadequate implementation of processes and procedures. Recommendations may include improvements in more than one of the seven safety management system element areas. In most instances, safety committees and/or safety coordinators will be involved in this process. Draft policies, plans, procedures are developed and forwarded to upper management for approval.

- Review and improve the safety training plan to ensure it includes machine guarding, lockout/tagout, and hazard reporting procedures. Benefit: Ensures the safety training plan addresses affected employee responsibilities regarding machine guarding, and other related safety programs.
- Develop company safety policy and safe work plan addressing work near high voltage lines. Benefit: Ensures safe work policies and procedures regarding work around high voltage lines are detailed and properly implemented.
- Include supervisor/manager education and training in accountability principles and application. Benefit: Ensures management is effectively educated and trained in their accountabilities to the employer and employees, and how to administer corrective actions.
- Include supervisor/manager education and training in recognition principles and application. Benefit: Ensures management is effectively educated and trained in methods to motivate hazard reporting and discretionary behaviors such as suggesting and involvement.

Section V. Summary
This section contains a brief review of the causes of the accident and recommendations for corrective actions. It is important to include language that contrasts the costs of the accident with the benefits derived from investing in corrective actions. Including bottom-line information will ensure that the recommendations will be understood and appreciated by management.

Section VI. Review and Follow-Up Actions
This section describes the actions taken to repair equipment/machinery, conduct training, revise policies, etc. It also describes the persons responsible for carrying out corrective actions and system improvements.

Section VII. Attachment
This section describes contains all of the photos, sketches, interview notes, etc. material to the investigation. The more comprehensive the investigation, the more supporting documentation will be included here.