



Food and Agriculture
Organization of the
United Nations

Accident analysis in forestry

A practical field guide



Required citation:

FAO. 2019. *Accident analysis in forestry: A practical field guide*. Rome. Licence: CC BY-NC-SA 3.0 IGO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

© FAO, 2019



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode>).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons licence. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition."

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization <http://www.wipo.int/amc/en/mediation/rules> and any arbitration will be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org.

Cover: Loading logs in this way, without protective gear, can result in injury if logs get out of control.

© FAO/Jonas Cedergren

Log landings are dangerous places. Defining a safe area, where workers can be "in the clear", greatly improves work safety.
© Andrew McEwan



About this booklet

The present field guide is intended for those tasked with reporting and analysis of forestry accidents in practice – specifically accidents involving trees, forestry tools and forest machinery. It is a practical complement to *Accident reporting and analysis in forestry - Guidance on increasing the safety of forest work* (FAO, 2018), a working paper addressed to decision-makers, producer organizations, trade unions and forest companies, which discusses forestry accidents and illnesses, successful safety and health improvements arising from accident reporting and analysis, and various legal and regulatory approaches for improving worker safety and health.

This field guide is based for the most part on experiences from professional and industrial forestry in developed countries, primarily because occupational safety and health has been the subject of much attention in some developed countries with large forest sectors. However, the guidance will also be applicable to developing countries and other forms of forestry, including small-scale forestry and agroforestry.

Conditions differ dramatically, even within countries. The general guidelines presented here will be useful in developing more context-specific guidance tools that take local conditions into account. It is important, however, that there be a body (or bodies) responsible for accident analysis, e.g. a producer organization, and that an appropriate approach be developed, adapted to the best technical equipment and tools available for documentation and analysis of events.

The guidelines are part of FAO's work on Forest Technology and Decent Rural Employment, informing FAO's contribution to the Sustainable Development Goals (SDGs), especially SDGs 1 (No poverty), 8 (Decent work and economic growth) and 15 (Life on land).

About accident analysis in forestry

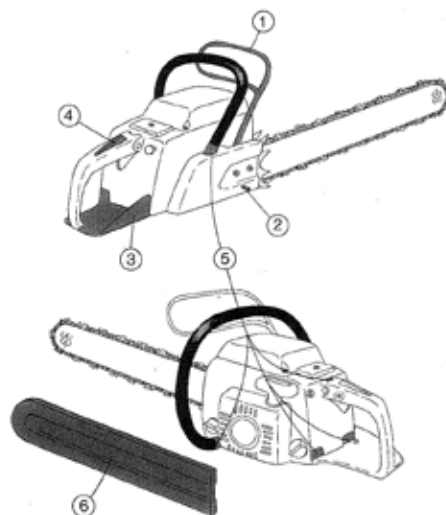
Forest activities often take place in remote areas, on steep terrain, in areas covered with vegetation and obstacles, where even walking can be hazardous. Forestry work is seen as difficult, dangerous and dirty – and sometimes deadly, especially in the case of harvesting. Many workers receive little or no formal training, and they commonly work without protective equipment.

Quantifying the number of fatalities and accidents in forestry is complex. To be complete, estimates would need to include, for example, incidents in urban forestry, family forestry and illegal logging. However, attempts to make such estimates suggest that forestry and forestry-related work is one of the most hazardous (if not the the most hazardous) of all non-military sectors of work (see FAO, 2018).

Explain, don't blame

A major impediment to accident reporting and analysis is the concern that it will lead to the apportioning of blame to individuals or organizations. For accurate reporting, it is in no one's best interest to allocate blame for forestry accidents and illnesses. For a properly functioning accident reporting and analysis system, efforts should be directed towards describing accidents and finding their causes, not establishing fault.

Safety features on chainsaws that have resulted from accident analysis: Front handle guard with chain brake that stops the loop chain during kickbacks (1), chain catcher (2), rear handle guard (3), throttle control lock out (4), anti vibration devices (5) and guide bar cover (6)



Source: FAO and ILO, 1980

Accidents should be seen as preventable, not inevitable. Accident reporting and analysis is necessary to improve the lives of workers and to avoid occupational accidents and illnesses. The purpose of accident analysis is to investigate, in an unbiased manner, what occurred and why it occurred, and to find ways of preventing future accidents. The Table illustrates improvements that can be achieved when accidents and near misses are properly analysed on a large scale. Although these examples are mainly from developed countries with large forest sectors, the example from Chile illustrates how accident analysis can turn the tide in developing countries as well. The challenge for the future will be to reach small and medium-sized companies and rural households.

This booklet provides practical advice to enable unbiased and accurate reporting of accidents in professional forestry. The guidance and recommended practices can also be used in other situations involving the use of forestry equipment, such as family forestry, salvage logging and the cutting of trees outside forests. Advice is offered on how to collect and document evidence, conduct interviews, identify causes and prepare accident reports.

Examples of forest-sector changes in response to accident reporting and analysis

Emergence of attention to the issue	Location	Reporting stimulus	Intervention and changes
1960	Canada; Sweden; United States of America	Deaths and injuries among timber fellers	Improved training and work arrangements; development of tree-felling machines
1970	Worldwide	High levels of chainsaw injuries, including those caused by kickback and vibration-induced damage	Saws and chains improved by introduction of chain brakes, reduced vibration levels and heating of saw handles; provision of training
1980	West coast, United States	Truck drivers struck by logs falling from trucks	Development of binder racks to protect drivers; assignment of responsibility to unloading facility
1985	Chile	Overall high forest industry accident rates and poor working conditions	Improved reporting, training, management commitment, working and living conditions
1990	British Columbia, Canada	Deaths and injuries to tree fellers	Adoption of British Columbia feller standards, training and certification
1990	Nordic countries	Machine operator overload and stress	Introduction of machines with reduced vibration; changes in control and work organization
2000	West coast, United States	Arm and shoulder injuries incurred by log truckers	Replacement of heavy chains used to secure logs on trucks with synthetic rope
2015	Oregon, Washington, United States; New Zealand	Injuries to workers on steep slopes	Replacement of hand felling and cable logging with tethered machines

Source: FAO 2018



Who should investigate forestry accidents?

Forestry accidents should be investigated by individuals knowledgeable about both forestry activities and accident analysis. Organizations or companies involved in or concerned with forest operations should designate and train individuals for involvement in forestry accident investigation. A combination of experience and knowledge is fundamental to understanding what has happened.

Policies and regulations may specify who should be involved in accident analysis. For example, the Occupational Safety and Health Administration of the state of Oregon in the United States of America, in its rules concerning forest activity, specifies that the employer or its authorized representative must investigate fatal, recordable and near-miss accidents; inform employees of findings; take preventive measures; and keep records.

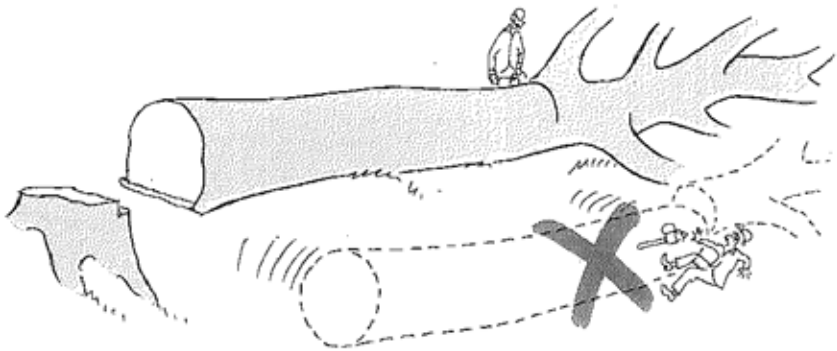
Protective equipment is worn, as it should be in this type of work. However, wearing protective gear in a hot climate can generate heat exhaustion. Workers will need water, rest and shade.
© Andrew McEwan

An accident investigation may involve multiple interested parties. For example, employers, union employee representatives, safety agencies with jurisdiction in the area, insurers and industry associations may want to be involved. Some may have requirements to carry out their own investigation with their own personnel.

Small and medium-sized companies or rural households may not have the competencies required for accident analysis, and the responsibility for it may fall to producer organizations, trade unions or farmer unions.

Some accident investigators may have vested interests and purposes. For example, they may seek to absolve clients of blame or responsibility. They may focus only on whether laws or regulations have been violated. They may seek to protect themselves, victims or co-workers. They may have financial interests in the outcome of the investigation. They may attempt to obstruct the investigation. Such motivations need to be recognized and minimized to meet the overall purpose of finding out, in an unbiased fashion, what occurred, the causes, and ways to prevent future accidents.

Workers should stand on the safe side when cross-cutting. Too many accident analyses show that the victim did not.



Source: FAO and ILO, 1980





Accident analysis in practice

The investigation team should respond to the accident as soon as possible. It is preferable to deploy a team rather than a single analyst, to facilitate the collection of information. In this way interviews can begin simultaneously with the collection of physical evidence.

Certain tools and supplies are necessary for the effective investigation of forestry accidents. The team should have an accident analysis toolkit available for immediate use at all times, containing the items listed in Box 1, and it should be inspected periodically.

BOX 1. Accident analysis toolkit

- ▶ A large first-aid kit – always required, but especially when the investigation team might arrive before emergency services (e.g. in remote areas)
- ▶ Camera (still and video) with fully charged battery (and spare batteries) (depending on the camera)
- ▶ Tape-measure, at least 15 m long, but ideally 25–50 m
- ▶ Folding carpenter's rule
- ▶ Clipboard, waterproof paper or notebook, graph paper
- ▶ Straight edge/ruler/scale
- ▶ Pencils/pens/permanent markers
- ▶ Accident analysis forms/protocol/checklist
- ▶ Flashlight, fresh batteries
- ▶ Small hatchet for cutting/pounding
- ▶ Aluminium (or other non-melting) reference tags
- ▶ Engineer's ribbon or danger ribbon
- ▶ Abney level or clinometer
- ▶ Hand compass
- ▶ Other useful items (e.g. thermometer)

A six-step approach to accident analysis

1 Secure the accident scene

- ▶ Make relevant notifications (e.g. inform adjacent logging and trucking operations so they can keep roads clear and assist in rescue operations).
- ▶ Assist with emergency aid and the rescue and tending of those injured.
- ▶ Assess the overall scene and control immediate hazards (e.g. from machinery, “hung” trees, spilled chemicals or traffic) to protect the safety and health of the people at the site.
- ▶ Preserve the scene and evidence: Prevent the removal of evidence and maintain the position of equipment and other items relevant to the investigation.
- ▶ Consider what evidence should be preserved for the future: Landowners may agree to preserve trees, stumps or vegetation, for example. You may ask to retain personal property relevant to the accident, but you cannot insist.

2 Collect facts/information on what happened

- ▶ Document the material evidence. Measure and photograph items that might move.
- ▶ Interview those who were at the scene. Prioritize interviews with those people who are unlikely to return after they leave the scene.
- ▶ Document environmental conditions.
- ▶ Make specific site measurements, using horizontal distances from a baseline. Set or locate “monuments”, keeping in mind that years may pass before the site is revisited. Prepare sketches or drawings.

3 Develop a sequence of events

- ▶ *Who* was injured, who was involved at the scene, and who was there immediately afterwards?
- ▶ *When* did it happen?
- ▶ *Where* did it happen? Identify the location, from the general to the specific, based on the measurements taken.
- ▶ *What* was involved? Document the accident, injury, damage, equipment, site, timber, terrain, personal protective equipment, tools.
- ▶ *How* did it happen? Document impact, actions, forces, sequences, timing and space involved.
- ▶ *Why* did it happen? Seek motivations, but do not make assumptions.

4 Determine potential causes

- ▶ Take all information in account, including the impacts and forces involved and the sequence of events.
- ▶ Consider hazardous conditions (e.g. terrain, machinery and equipment) and unsafe behaviour (e.g. using unsafe methods, failing to comply with rules, allowing unsafe behaviour).
- ▶ Stay objective and identify all potential causes, even if one appears to stand above all others. Try to determine the most likely root cause.
- ▶ For each event in the sequence of events, ask what happened and why.

5 Formulate recommendations

- ▶ At an early stage in the accident analysis, make preliminary recommendations for immediate corrective actions to prevent further damage or accidents (e.g. reduction of the maximum allowable speed to prevent recurrence of transportation accidents).
- ▶ The continued use of unsafe practices or equipment might lead to a recommendation to cease operations.

6 Prepare a report and secure evidence

- ▶ Present facts and findings, but no speculation.
- ▶ Include photos, drawings, notes and interview statements.
- ▶ Protect the site from further disturbance if necessary and possible.
- ▶ Store original evidence safely and keep copies of all documentation for the team's files.

An accident waiting to happen? A forest worker doing directional felling with no protective equipment, not even eye protection.
© Lars-Gunnar Marklund



A worker in a small sawmill in southern Africa maneuvers a board with no protective equipment.
© FAO/Jonas Cedergren



Documenting the accident scene

Tools, equipment, machinery and sometimes people can vanish from accident scenes. Understandably, employers are anxious to “clean up” accident scenes so people can get back to work. Effective procedures can protect material evidence, so it does not get moved or disappear before it has been documented.

It is crucial to take measurements at the time of an accident, because conditions will change. As soon as the accident scene is secure, it is important to document the relative positions of equipment, machinery and other objects that may have contributed to the accident (points of interest). This can be done using triangulation (Box 2).

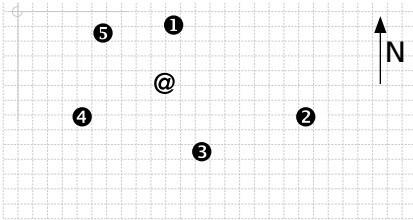
For accidents in cable logging or skidding in steep terrain, a terrain profile is necessary for payload analysis.

Geographic information systems (GIS) are excellent for documenting the general location of accident scenes and distant points of interest, but may not be sufficiently precise for measurements within the accident scene itself. Tree canopies can reduce the accuracy of GIS.

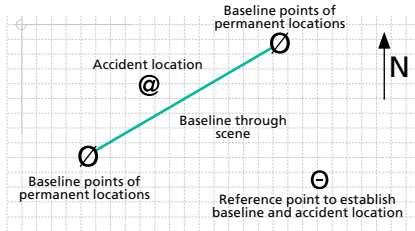
Visual information is valuable for accident analysis. Take photos or videos to show, for example, equipment, victim(s), relationships among objects and minute or transient details such as defects in equipment or tools. Photos and videos should be used to complement measurements; when properly made, they can provide valuable relational and scale information. If hard-to-measure subjects are being photographed, especially in close-up, place an item of known dimensions in camera shot. Take photos at different angles (e.g. from above, left, right and rear) or a 360-degree set of photos. Take panoramic photos to help present the entire scene with top-to-bottom and side-to-side photos. Indicate the locations where photos were taken on sketches of the accident scene.

BOX 2. Measurement through triangulation

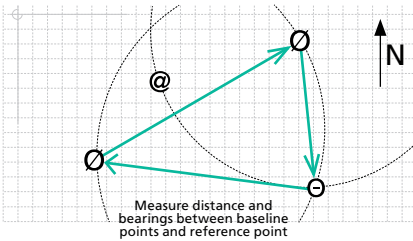
1 The accident scene with points of interest identified



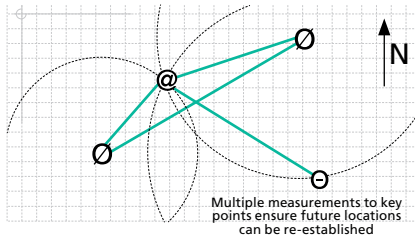
2 Establish baseline and reference point



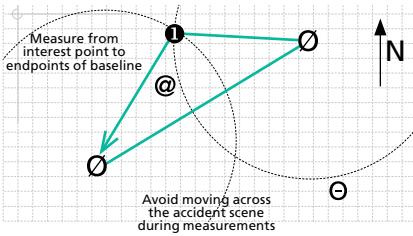
3 Establish triangulation for permanent ends of baseline and a reference point



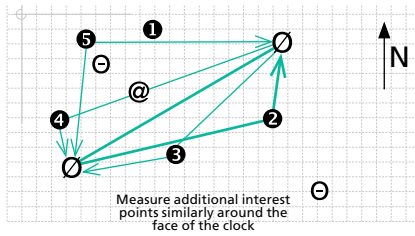
4 Measure from baseline and reference points to accident location



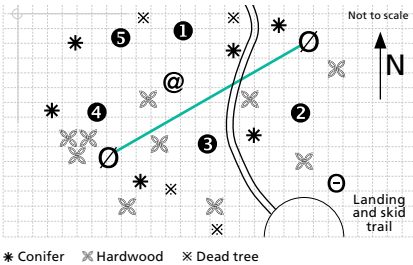
5 Localize the interest points



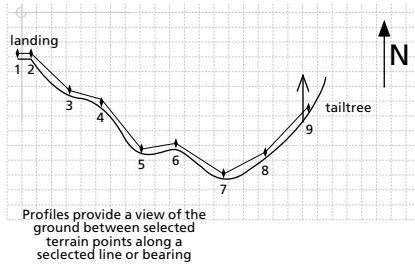
6 Localize the interest points



7 Sketch details in relation



8 Profiles



@ Accident location 1 Point of interest Ø Baseline point ⊙ Reference point

Conducting interviews

The purpose of accident analysis interviews is to obtain an accurate, comprehensive picture of the accident by obtaining all pertinent facts, interpretations and opinions. Interviews should cover what happened as well as information on hazardous conditions, unsafe work practices and system weaknesses.

Any impression of an attempt to establish blame should be avoided. Interviewers must avoid disclosing their own views or suggestions, which might compromise the effort to establish the facts. They should avoid asking leading questions (that is, questions that prompt or encourage a desired answer) and should remember that there are no right or wrong answers. “Why” questions should generally be avoided unless they are necessary, for example to establish why a victim did a certain thing that might have contributed to the accident.

The first step is to identify who is or was present before, during and after the accident, to establish a list of interviewees. Generally, this list should include the victim(s), co-workers involved in the incident, co-workers who may be witnesses, other witnesses (e.g. subcontractors, truckers and fellers), supervisors, managers, owners and any others who may have relevant knowledge. Victims should not be interviewed before they are medically stable and coherent (e.g. not under the influence of medication).

Interview work should start as soon as the victims are removed and the scene has calmed and before witnesses depart, with priority given to those who may never return to the site (e.g. truck drivers) or who may be difficult to locate later (e.g. first responders). Promptness is important; as time passes, conversations with others and individual emotions distort what people believe they saw and heard. The memory of everyone affected by an accident is likely to change over time, leading to distortion which will have a negative impact on the accident analysis.

Interviewers should keep in mind that accidents are traumatic events. The extent of psychological trauma depends on the severity of the accident and how close an individual was to the accident or the victim. The victim, and others, may suffer physical and psychological trauma. Everyone at the workplace is affected in some way.

If possible, interviews should be conducted at the scene in a quiet, neutral place without others present. Interviewers should be able to see the faces and postures of interviewees; they should be able to take good notes and to provide an accurate record of interviews.

Interviews should start with efforts to put interviewees at ease. Ask them if they are okay. They may have been injured or shaken by the accident. Give interviewees “permission” to be emotional, let them talk without interruption about how they feel, and listen carefully to what they say. Interviewers should express their concern about the accident and their desire to prevent similar accidents from happening in the future. At the outset, interviewers should explain that they will write down what interviewees say and that interviewees will be able to read the notes and make corrections at the end of the interview.

The content of interviews will depend on what an interviewee knows about the accident. Start with straightforward questions such as name, address, job and length of service. Establish the interviewee's relationship to the accident by asking the "where", "when", "what", "who" and "how" of it.

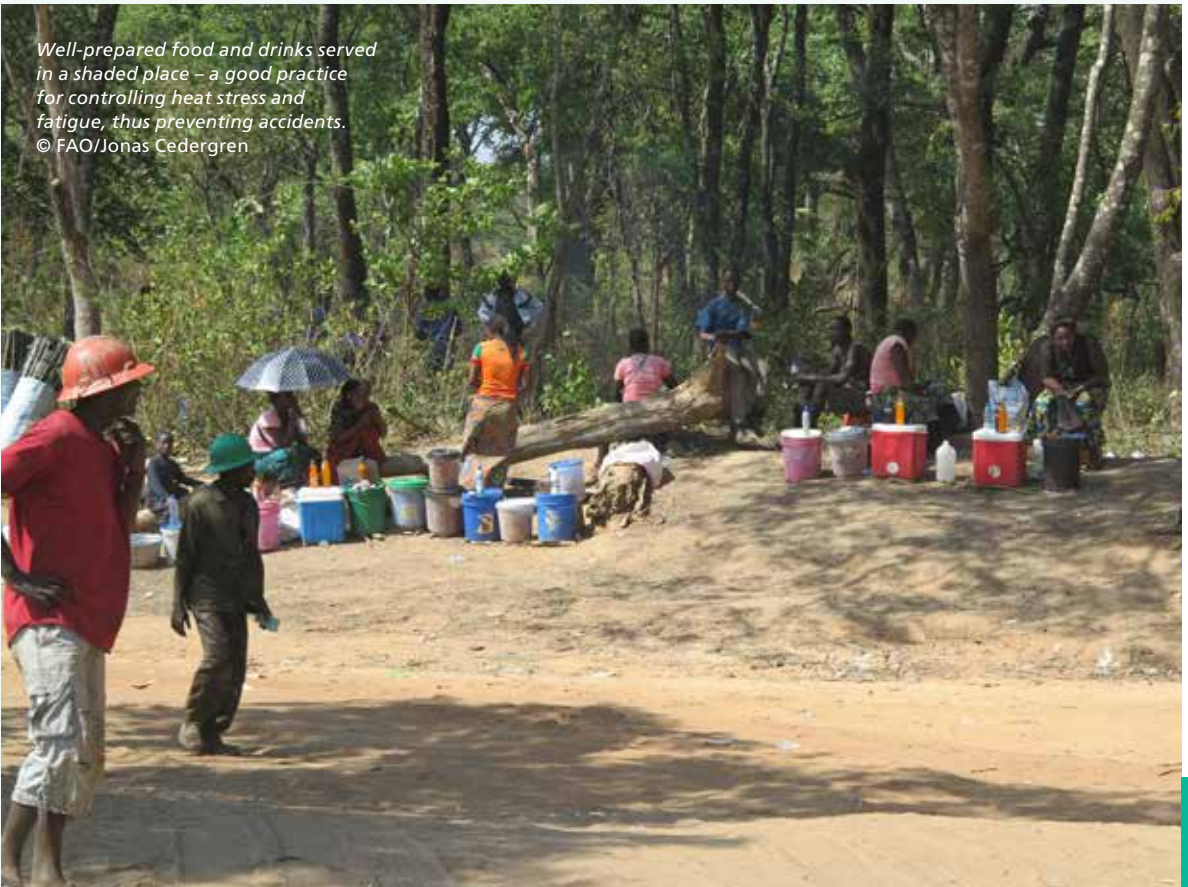
Thereafter, interviewees might be asked to describe what happened, and to provide information about:

- ▶ the sequence of events (i.e. the order in which they occurred);
- ▶ the day before, the night before, and the day of the accident, leading up to the event;
- ▶ normal or usual practices;
- ▶ the safety practices employed in relation to the accident;
- ▶ how they think the accident might have been prevented;
- ▶ who else might be able to provide information about the accident (including names, addresses and telephone numbers).

Finally, they should be asked if they have anything to say that has not already been covered.

At the completion of an interview, both parties should sign and date the notes. Interviewers should thank interviewees for their cooperation and ask that they contact the interviewer if they think of anything else of importance.

Well-prepared food and drinks served in a shaded place – a good practice for controlling heat stress and fatigue, thus preventing accidents.
© FAO/Jonas Cedergren



Identifying potential causes

The example in Box 3 illustrates how all the available information can be interpreted to identify the potential causes of the accident. The information is used to reconstruct the sequence of events. Explanations should then be sought – what happened and why – for each step in the sequence, in an iterative fashion until all the potential causes are listed and the most likely ones identified. Hazardous conditions (e.g. terrain, machinery and equipment) and unsafe behaviour (e.g. the use of unsafe methods, failure to comply with rules and tolerance of unsafe behaviour) should all be considered.

BOX 3. Identifying potential causes of an accident – an example

An accident has occurred in a cable logging operation. Rex, the rigging slinger, responsible for connecting logs to the hauling cable, has been hit by a log because hauling started before he was done and in the clear.

1 Use interview statements to form a sequence

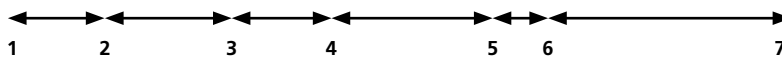
I was running the yarder, but we were having engine problems and the yarder would quit at times. I had to restart it from outside the cab. On one hard turn, the yarder quit so I jumped out of the cab to start it. I got back into the cab, revved up the engine and pulled hard. The turn came in but, on outhaul, there was no whistle to stop the carriage as usual. I tried to raise Rex on the radio but there was no answer. We found him unconscious.

Bob, yarder

I was setting chokers by myself and hooked a big turn, got in the clear and blew the go ahead. The turn hung up on a tree, with the choker needing a kicker. I blew the stop whistle and went to put the choker between the end of the log and the tree. I heard the yarder start up and that's all I remember ... the log must have swung and got me.

Rex, rigging slinger

2 Make a timeline (abbreviated example)

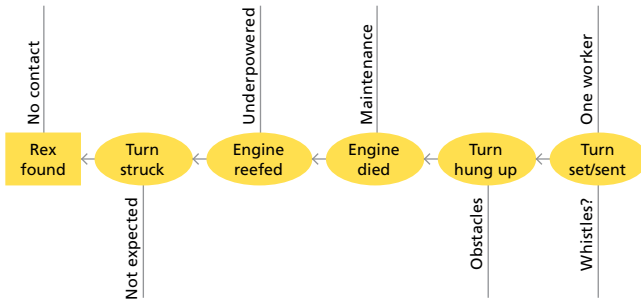


- 1 Rex found unconscious 10:29 am
- 2 Bob responds to lack of contact with Rex 10:19 am
- 3 Bob starts yarder (doesn't whistle), reefs turn in 10:11 am
- 4 Rex blows stop, moves in to put kicker on hung turn 10:09 am
- 5 Turn hangs up and engine dies 10:08 am
- 6 Rex whistles for go ahead to pull turn in 10:07:45 am
- 7 Rex sets chokers on a large turn and moves to position in the clear 9:57 am

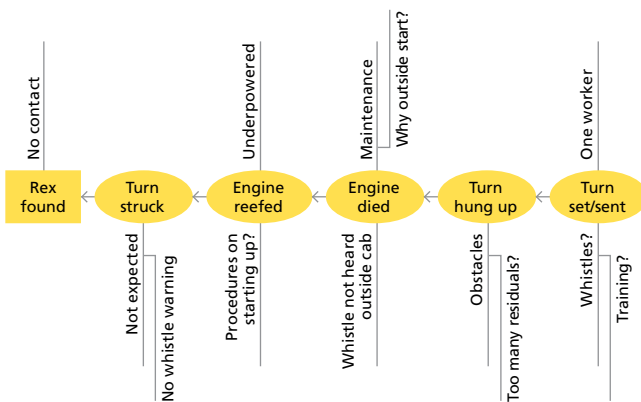
BOX 3. (continued)

3 Diagram possible causes

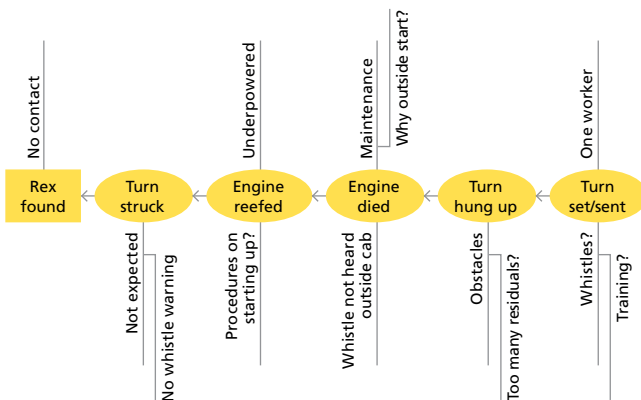
Take sequence of events and ask what happened and why
Draw some connecting lines and potential causes



4 Keep asking why and adding causes



6 Continue until all likely causes are identified




5 Make list of potential causes

- ▶ Why did the engine die? *Maintenance*
- ▶ Why did the engine rev? *Underpowered*
- ▶ Why was the engine started from outside? *Maintenance or design*
- ▶ Why was there a hang-up? *Training or residuals*
- ▶ Why did Rex go to the hang-up without a certain signal?
- ▶ Why didn't Bob hear the whistle outside the cab?
- ▶ Why didn't Bob use the start-up procedure and wait for the signal to move lines?
- ▶ Why did Bob go ahead on the turn without signalling? *Training*
- ▶ Why didn't Rex blow stop when the lines moved? *Training*

7 Summarize list of potential causes

- ▶ Whistles did not function or could not be heard
- ▶ The yarder operator started the yarder and pulled the turn without a signal on his own initiative; this is not standard operating procedure
- ▶ The rigging slinger should not enter the hazard area next to a turn without the positive stoppage of lines
- ▶ When the lines moved, the rigging slinger should have signalled stop immediately
- ▶ Two workers should have been setting chokers, making two whistle signals available. Training questions remain
- ▶ Maintenance questions remain
- ▶ Questions of design remain because the yarder operator had to leave the cab





*Dangerous practice:
a worker delimits a tree
with no eye protection,
or protection of any kind*
© FAO/Jonas Cedergren

The accident report

An accident report is the documentation of a single accident event. It is also the basis for further analysis of a given accident, and it must present the results in a detailed, accurate and unbiased way so that accident analysis experts can use it without hesitation. Such experts may address a given accident long after it has occurred, when it may not be possible to conduct new analyses at the accident site or even to find the site. The accident report, therefore, will often be the sole source of information.

The accident report should include clear descriptions of the operation, the accident and the site, with sufficient detail to allow those involved in the event and those using the report to understand what took place. All signed interviews and other documentation should be included.

References and resources

- FAO. 2018. *Accident reporting and analysis in forestry - Guidance on increasing the safety of forest work*, by J.J. Garland. FAO Forestry Working Paper 2. Rome.
- FAO & ILO. 1980. *Chainsaws in tropical forests*. FAO Training Series 2. Rome.
- ILO. 2015. *Investigation of occupational accidents and diseases: a practical guide for labour inspectors*. Geneva, Switzerland, International Labour Organization (ILO).
- Monteau, M. 2011. Analysis and reporting: accident investigation [online]. ILO Encyclopaedia of Occupational Health and Safety, Part VIII: Accidents and safety management. [Cited 22 December 2017]. www.iloencyclopaedia.org/part-viii-12633/audits-inspections-and-investigations/57/analysis-and-reporting-accident-investigation
- Oregon Occupational Safety and Health (OSHA). undated. Accident investigation online course [online]. <https://osha.oregon.gov/edu/courses/Pages/accident-investigation-online-course.aspx>

This publication is based on the work of John J. Garland, a professional with more than 45 years of experience in occupational safety and health in forestry in Africa, Europe and North and South America, who has served as an expert at more than 70 forestry accidents across the United States of America.

For more information, please contact:

Forestry Department
E-mail: fo-library@fao.org
Web address: www.fao.org/forestry/en
Food and Agriculture Organization of
the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy

CA5238EN/1/06/19