# Hazard evaluation

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Hazard evaluation (HE) can be defined as the systematic identification and analysis of hazards associated with a given product, machine, or process. It involves identifying the hazards and the failure modes that allow these hazards to cause injury, in addition to determining the exposure of the hazards and the severity of the hazard consequences. The deliverables resulting from HE are a definition of the system, a list of hazards, and a list of failure modes with the associated hazard, exposure, and consequences.

### Five steps of hazard evaluation

1. Establish boundaries
2. Identify hazards
3. Identify failure modes
4. Evaluate exposure
5. Identify consequences

## Step 1 - Establish boundaries

The first step in hazard evaluation is to set the boundaries of the study. It is important to make sure that the boundaries are clearly set and stated for future reference. Once the boundaries are set, everything within them (the "system") should be studied. Subdividing a large process or machine into pieces can make HE easier. In any event, it is important to make sure that all interfaces within and at the boundaries of the HE system are covered.

Additionally, all the functions associated with a given machine or system under study must be covered. Normal production operation, maintenance, setup, cleaning, jam clearing, die-setting, part loading/unloading, tool changing, and so forth must all be studied. All modes of a given machine must also be examined. Modes might include such things as normal, forward, reverse, backwash, self-clean, defrost, automatic, inch, and manual.

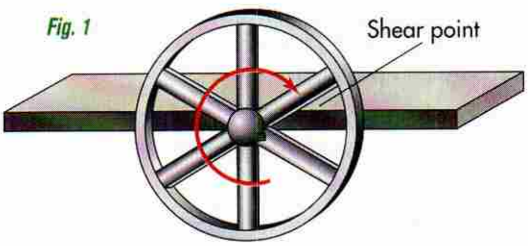


Fig. 1

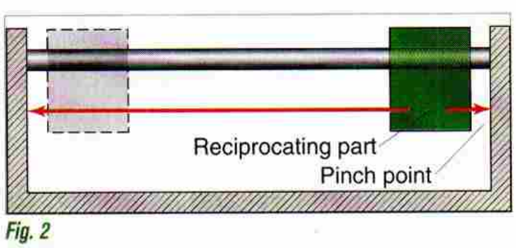


Fig. 2

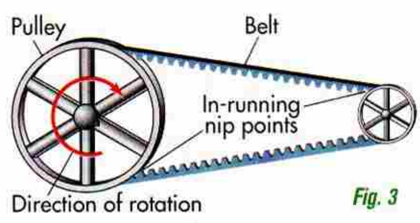


Fig. 3

## Step 2 - Identify hazards

Once the boundaries are defined, the next step is identifying all the hazards present within the study boundaries. A hazard can be defined as a potential for doing harm. There are many types of hazards found in a typical manufacturing environment. One class of hazard is mechanical. These include shear points (Fig. 1), pinch points (Fig. 2), nip points (such as between two in-running rollers, Fig. 3), and snag hazards (Fig. 4). A pervasive hazard is gravity. It causes objects and people to fall if not supported. Electrical hazards include not only exposure to voltage sources, but also overheated connections due to contact resistance and short circuits that can cause unintended actuation of machine parts or fires.

Chemical hazards include toxics that have both acute effects such as nausea and dizziness and chronic effects, such as cancer and damage to the central nervous system. Injury or illness from toxic exposure can result from both short-term or long-term exposure. Such exposure can be from contact, inhalation, or ingestion. Chemical hazards can also involve flammable, explosive, or reactive compounds.

Walking/working surfaces can also present hazards such as slip and fall, tripping, and other gravity hazards, such as falling through a hole, or objects falling from one surface to another. There are also ergonomic hazards, such as lifting too much weight, lifting incorrectly, and repetitive motion injuries. Compressed gases, including compressed air, are another common hazard.

As an example of identifying hazards, a press has an obvious pinch point hazard. A conveyor has nip point hazards. A machine employing a geared power train has nip point hazards. One way to identify these hazards is to carefully examine the entire system, including all boundaries established in Step 1, using a checklist (see table).

## Industrial hazard checklist

| | | | | | | |
|---|---|---|---|---|---|---|
| **Mechanical** | nip | shear | pinch | snag | flying particles | sharp objects |
| **Thermal** | hot surfaces | steam | cryogenic materials | flames | hot gases | |
| **Electrical** | high voltage | short circuits | burns | static charge | | |
| **Chemical** | toxic | flammable | explosive | reactive | corrosive | |
| **Pressurized materials** | compressed gases | hydraulic systems | pressurized grease | | | |
| **Radioactive** | sealed sources | x-ray generator | | | | |
| **Hazardous light sources** | arc welding | laser | | | | |
| **Ergonomics** | lifting | repetitive motion | | | | |
| **Walking/ working surfaces** | slip | trip | fall | openings | | |
| **Other** | gravity | noise | biohazards | indoor air pollutants | | |

### Step 3 - Identify failure modes

The third step is to identify the failure modes that will allow the hazards to cause injury. Using the system hazard list, examine the system for scenarios that could result in injury. A punch press has a pinch point at the point of operation. However, if the press has a fixed guard that provides complete protection, then a failure of the guard is required to allow injury at the point of operation. This might occur if the guard was removed for maintenance, or if the guard became broken. If the press has an interlocked guard, one failure mode would be an interlock failure.

### Step 4 - Evaluate exposure

Once the hazard and failure modes are identified, the next step is to evaluate the exposure. These are the people and property potentially exposed to the hazard by a given failure mode. Often this is the machine operator or maintenance man or a product user. However, a hazard at a major chemical processing facility might involve a toxic release that would affect thousands off site. Once the hazard and failure mode is identified, determining the affected population and property is often straightforward. If the failure mode is that a press operator places his hand in a closing die due to a missing guard, the exposure is the press operator.

Evaluation of exposure can require more thought than is expected, however, because the exposure sometimes only appears obvious. Consider a setup man installing a die in a horizontal press. It would appear that if he were to drop the die he is the exposure, along with some property damage. But what if he has a helper? What if there are bystanders and the falling die creates flying objects from loose tools?

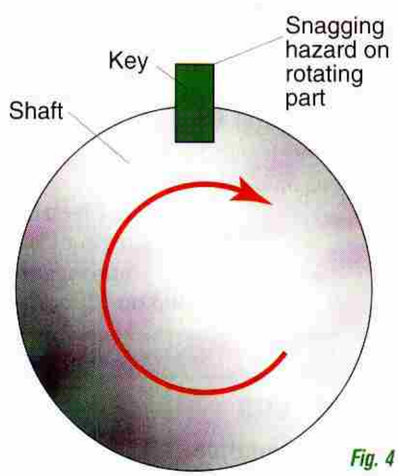

*Fig. 4*

### Step 5 - Identify consequences

The fifth step is to identify the consequences of the failure mode. Some failure modes have a range of potential consequences. For instance, tire tread separation might result in a mere flat tire, or rollover and multiple deaths, depending on circumstances. Use the worst consequence that is reasonably possible. Note that in-running nip points can be particularly dangerous. Typically, they only stop pulling the body in when the driving mechanism is shut off, or when the ingested body parts stall out the driving mechanism.

### More Info:

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