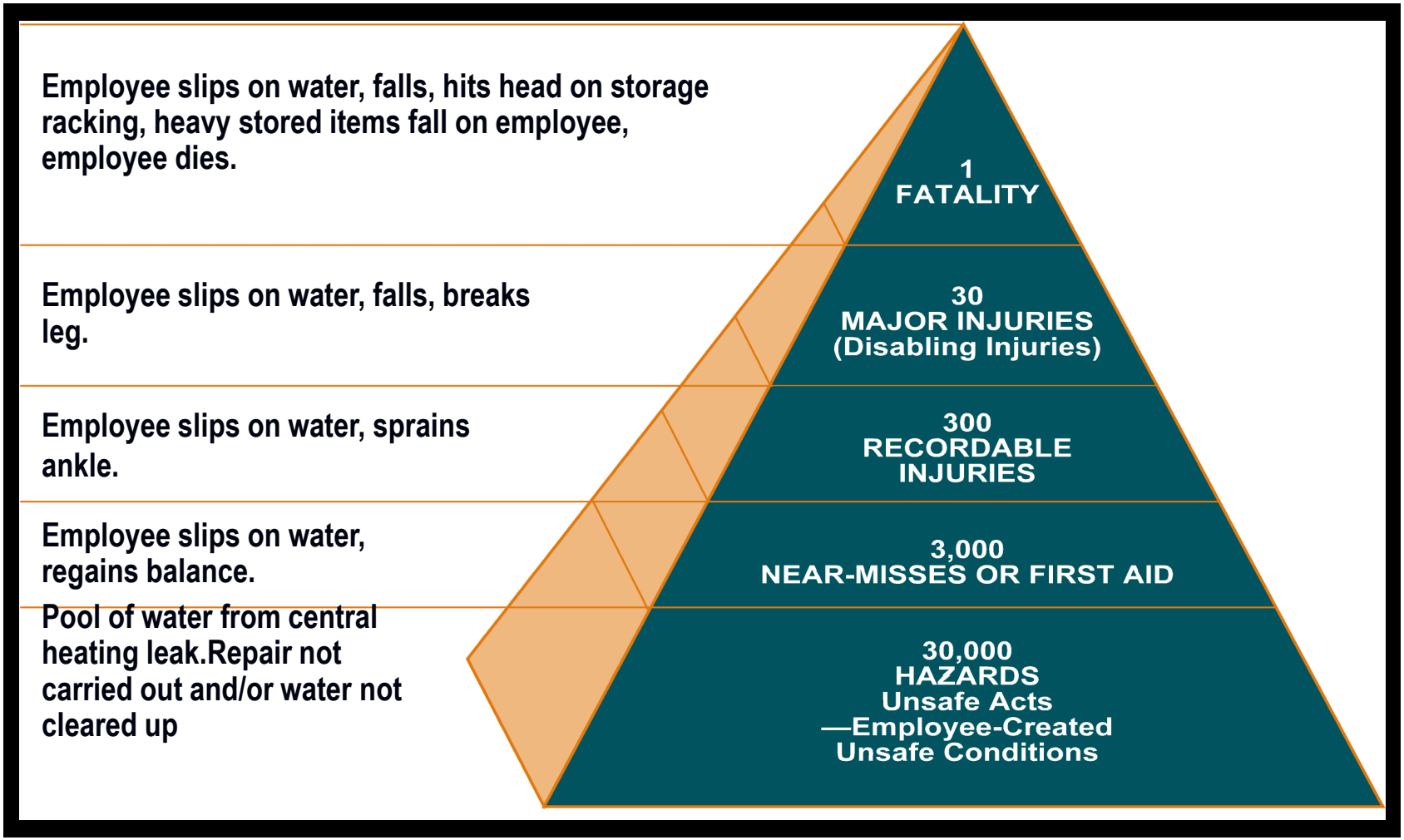
Injuries : A Matter of Probability



Definition of an Incident

An incident is an event that did result or could have resulted in

- **Injury or illness**
- **Significant property damage.**
- **Significant environment impact.**
- *Unavoidable impact on the public*
- *Business interruption*

Important definitions

- ***Occupational injury:*** Any injury such as a cut, fracture, sprain, or amputation that results from a work-related incident or an exposure involving an incident in the work environment is an occupational injury. Conditions resulting from insect, animal, or snake bites or one-time exposure to chemicals are injuries. Chemical burns resulting from one-time exposure are also injuries.
- ***First aid case:*** Any occupational injury or illness involving one-time treatment that does not require a medical professional is an FAC.
- ***Restricted work case (RWC) :*** Any occupational injury or illness that prevents the employee from doing any part of his or her regularly scheduled job on any subsequent scheduled shift is an RWC.
- ***Lost workday case (LWC):*** Any occupational injury or illness that prevents the employee from reporting to work on any subsequent scheduled shift is an LWC.

Important definitions

- ***Injury frequency rate:*** It is calculated based on number of injuries per million man hours worked. This measure is used as normalized unit to compare safety performance of industries with varying hazards and man power and is followed internationally.
- ***Man hours worked:*** Actual hours worked (as taken from payroll records) are to be used. This includes overtime if any, and excludes scheduled hours not worked because of vacation,illness,injury and voluntary absence.

  For personnel whose working hours are not strictly scheduled, an average of eight hours per workday should be assumed in computing employee hours.
- ***Lost time injury frequency rate (LTIFR):***

LTIFR = (No of lost time injury cases * 1,000,000)/Total man hours worked

For more information refer ***safety standard-Injury classification SS/GEN-03***

Why We Investigate Incidents?

1. Demonstrate our commitment to safety

   - Increase employee's confidence in safety

2. Spot deficiencies in safety management

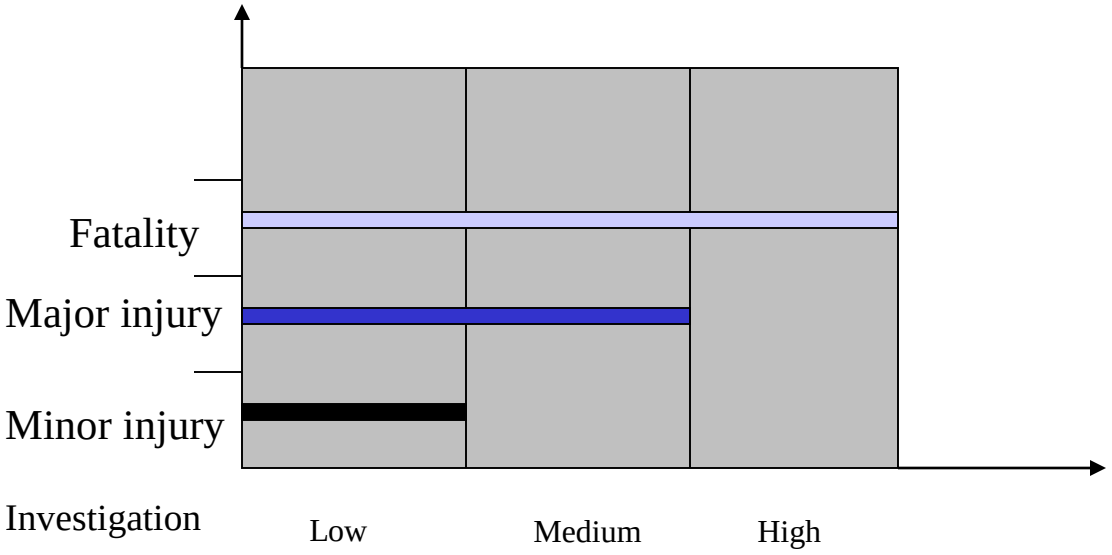
   - Identify systems and conditions that could contribute to other incidents

3. Prevent recurrence

   - Take appropriate action

   - Communicate lessons learned

The depth of the incident investigation and the Root Cause Analysis should be proportional to the loss (or potential loss):

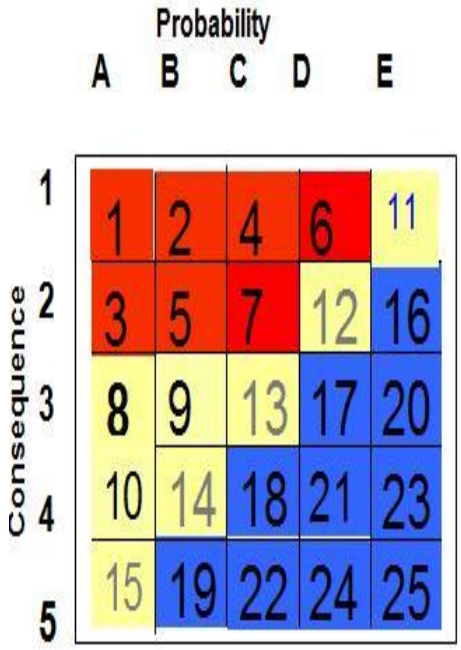


Risk score

- Risk assessment matrix based on probability of occurring and consequence of incident known as risk assessment matrix taken from PHA standard.

Depth of incident investigation should be proportional to the risk involved as shown

- Highest priority –Intolerable risk falls in red zone
- Medium priority-Substantial risk falls in yellow zone
- Low priority-Trivial risk falls in blue zone



Only those incidents that belong to red and yellow zones goes to evaluator for assessment.

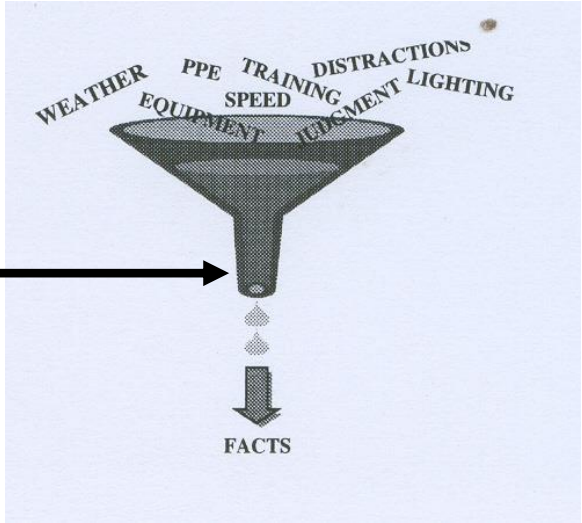
The Incident Investigation Process

- Make initial response and report
- Form investigation team
- Determine the Facts
- Determine the key factors
- Determine systems to be strengthened
- Recommend corrective and preventive actions
- Document and communicate the finding
- Follow up

Key Factors

- Circumstances that contributed to (or may reasonably be believed to have contributed to) the incident's occurrence, even though a clear connection can not be found
- Essential for developing effective recommendations to prevent recurrence.

Funneling information to obtain facts



Some Areas to Question?

Physical

- Weather
- Chemical
- Tools
- PPE

Human

- Employee attitude & motivation
- Supervision practices & Standards
- Company culture

Operating system

- Training
- Documentation
- Rules and procedures
- Preventive maintenance
- Job safety analysis
- Previous results (Audits &Observations)
- Communication

A physical cause which usually becomes apparent through observations - Hardware, Machines, Vessels, etc

Human causes :Acting inappropriately or failing to act,Intentional and unintentional behavior, Mistakes, Lack of awareness, Not knowing, etc

System causes :Communications, Procedures, Training,Documentation, Policies, Standards of performance, etc

What is Root Cause analysis?

- **Root Cause Analysis is a method of understanding why a loss occurred.**
- **Root Cause Analysis is a valuable tool to help determine failure in the Safety Management System.**

What is Root Cause Analysis?

Incident Analysis Tools (Root cause identification)

- **Why-Why analysis**
- **Barrier analysis**
- **Event and causal analysis**

The “Why” Tree

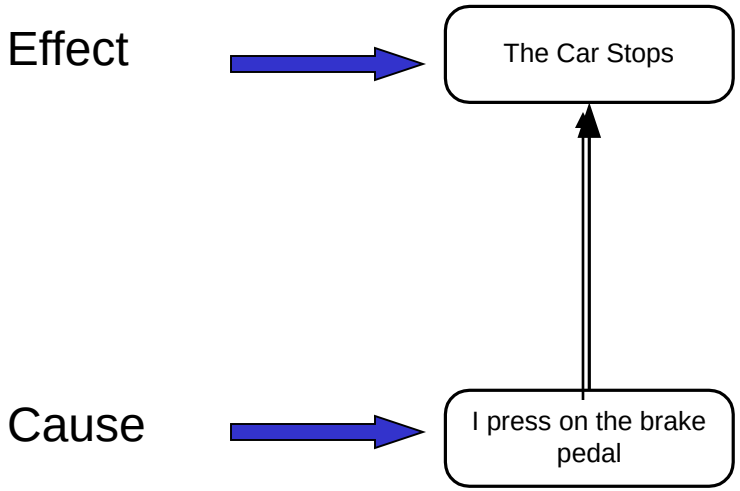
- In order drive root cause of a failure, whether chronic or sporadic, we use tool known as a **WHY – Tree**
- It’s called a “**Why** “ tree because we keep asking **“Why “** to get the root causes

The ‘Why’ tree provides focus for the investigation and direction toward a corrective solution.

Why Tree Construction

- Why Trees use the simple but powerful logic of Cause and Effect:

Use of cause and effect in why trees



***If* I press on the brake pedal**
***then* the car stops…..**

Or to put it another way…

***Why* did the car stop ?**
***Because* I pressed on the brake**

Why Tree Construction

- We apply cause and effect logic in why trees by starting with the effect and asking the question, why did it happen ? to arrive at the cause.
- *Why…*(Effect)*….because*…..(cause).
- To test your logic read it back as..*if* (effect)….*then* (cause), to see if it makes sense.
- We continue the Why Tree by making our new cause and effect and asking why again.

Steps in Building a "WHY" Tree

Step 1. Bring as much information as is available about the failure to the Why Tree meeting. Have photos, sketches, and/or samples of the failure.

Step 2. Show the team a sample Why Tree and give them an explanation of how one is built.

Step 3. Write a statement about the failure, describe it in some detail. Spend ample time up front discussing what the "failure" is, so all understand and agree.

Step 4. List the observations that have been collected on tear sheets (doing some of this in advance speeds up the process). Prioritize them based on their likely connection to the failure.

Step 5. Select a few (3-5) of the highest priority observations and put them on the Why Tree

Steps in Building a "WHY" Tree

Step 6. Starting with the highest priority one, hypothesize causes of these observations by asking "Why or How Can". You can also say "caused by" when moving down the tree from one cause to another.

Step 7. Verify the hypotheses as true or not. Strike through untrue hypotheses but keep them on the Tree to show they were considered and checked.

Step 8. Continue this process of generating, verifying, and ranking hypotheses. If the necessary information is not available in the meeting room, either stop the process and go validate the hypothesis or switch to another branch of the tree and validate later.

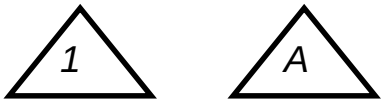
Step 9. Stop when you arrive at System Key Factors.

When choosing between asking "Why" and "How Can", use the one which links you back to, or which best leads toward a cause of, the original failure event.

Why Tree Symbols

AND **Both or All** causes directly below must be true for the preceding event to occur.

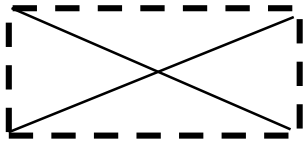
OR **One cause** directly below must be true for the preceding event to occur.



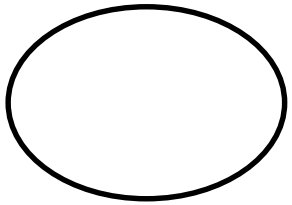
Used **to continue** Tree onto another piece of paper

- Failure
- Observation or Evidence
- Intermediate Cause

Hypothesis (possible cause still unexplained or not verified)
Changes to a solid rectangle when explained or verified



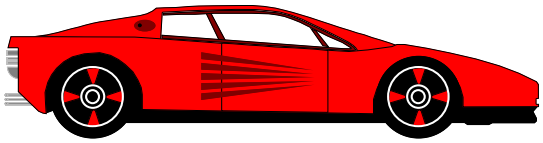
Has been verified, or proved, that it was **not the cause for the event to occur**



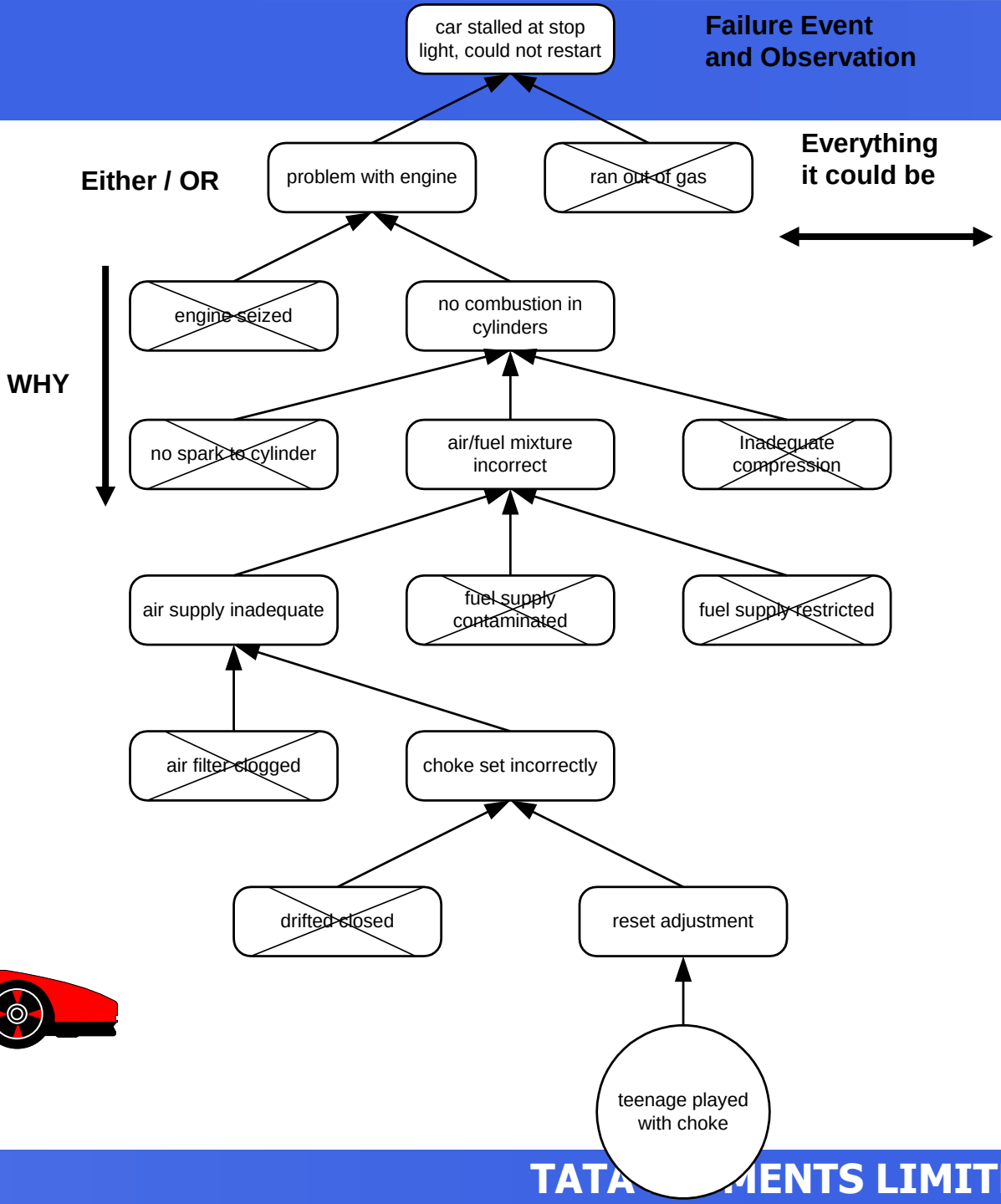
Key Factor :
- Physical
- Human
- Managing System

"Banana". All causes needed to produce the effect.

How Do We Use Why Trees?



Use the Process of Elimination



Building the "WHY" Tree

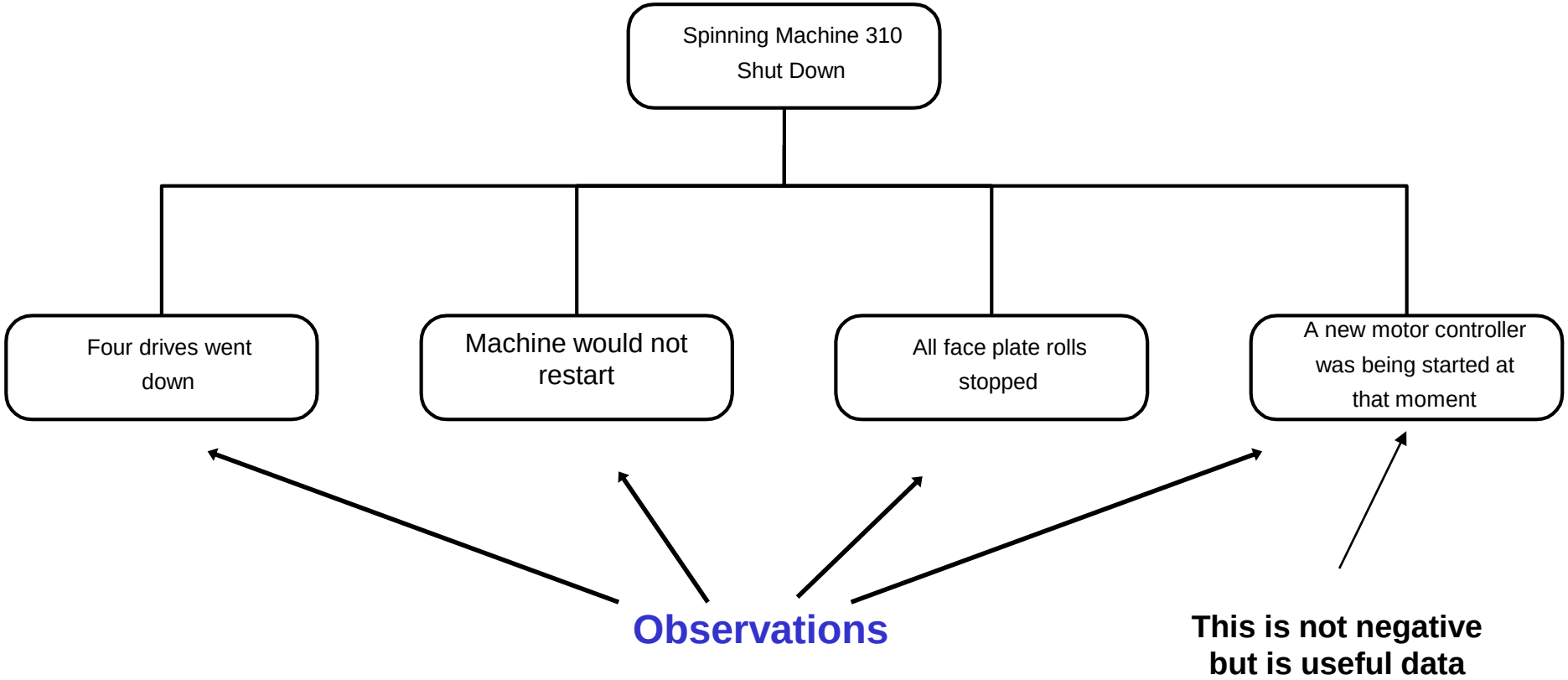
The following pages show the steps to build a WHY Tree using a real plant example.

Step 1. Define the Significant Event to Investigate

Significant Event → Spinning Machine 310 Shut Down

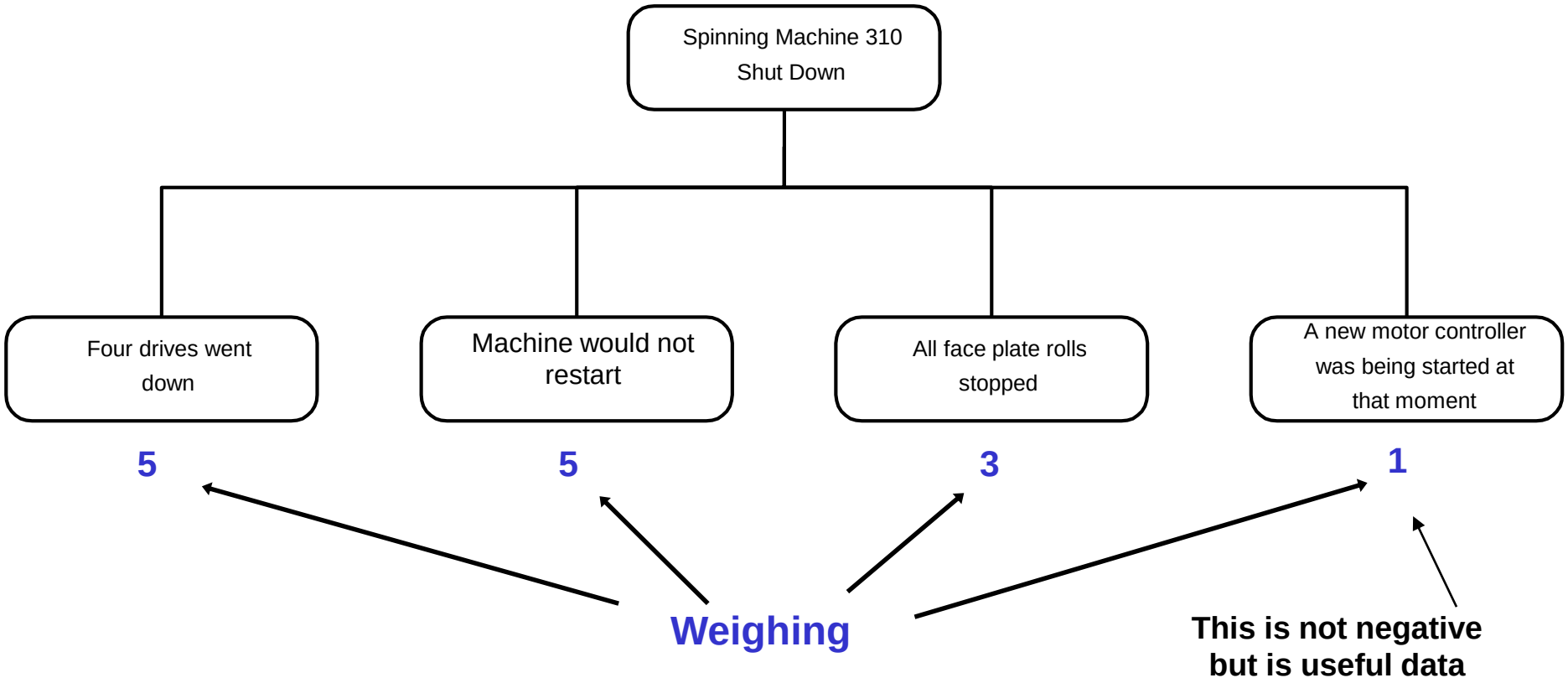
Building the "WHY" Tree

Step 2. **List the observations (facts: what was seen and heard)**



Building the "WHY" Tree

Step 3. **Choose an observation to pursue first, based on its impact on the failure event or its frequency of occurrence.**



How Do You Determine Which Block to Pursue First ?

5	High frequency or probability
3	Medium frequency or probability
1	Small frequency or probability
0	None

You Weight the Blocks with the 5, 3, 1 Technique

For Chronic Failures, the 5, 3, 1 addresses frequency.

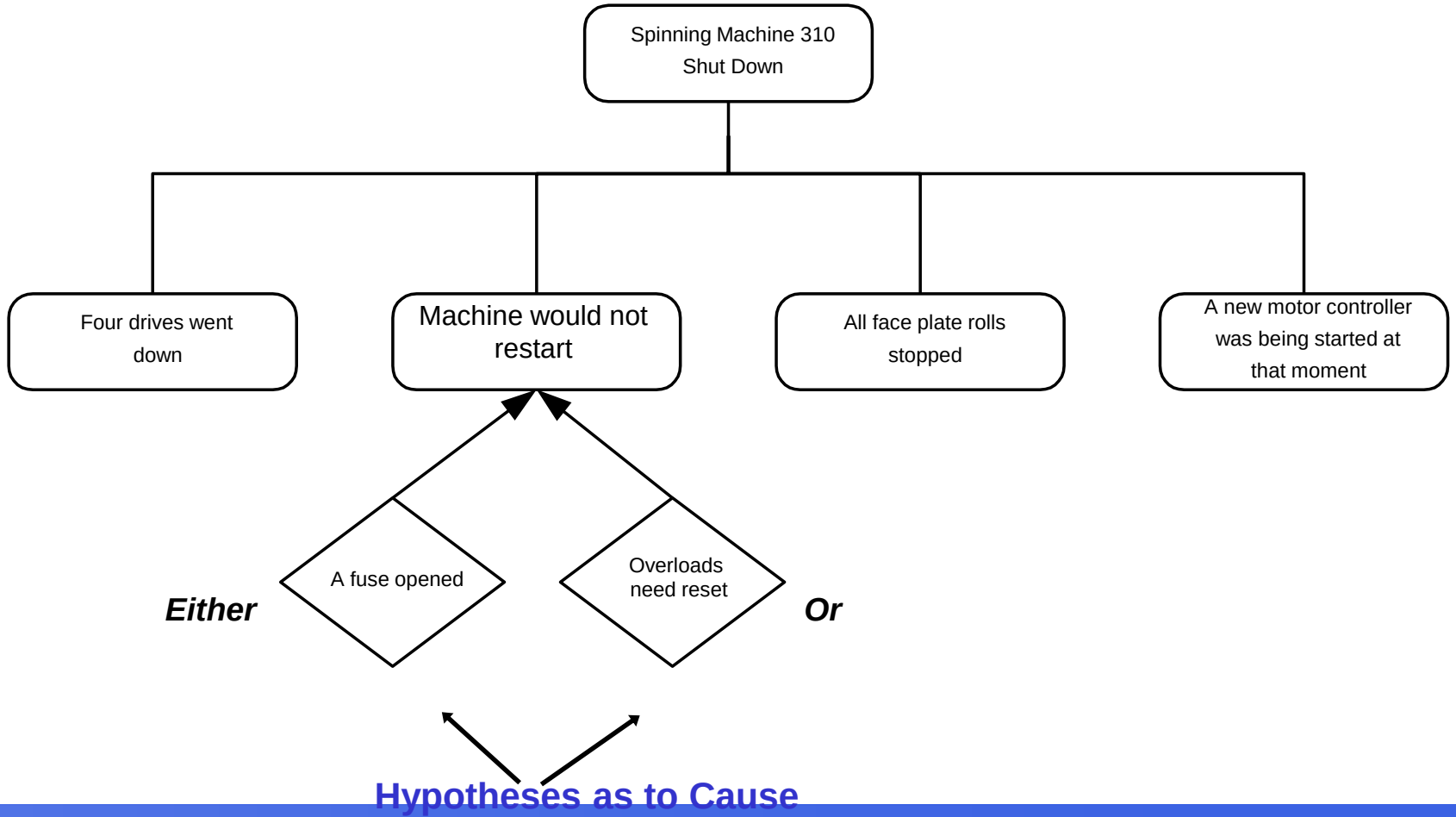
For Sporadic Failures, the 5, 3, 1 addresses probability

But ALL blocks will be investigated in time ……. this is only prioritizing them !

Building the "WHY" Tree

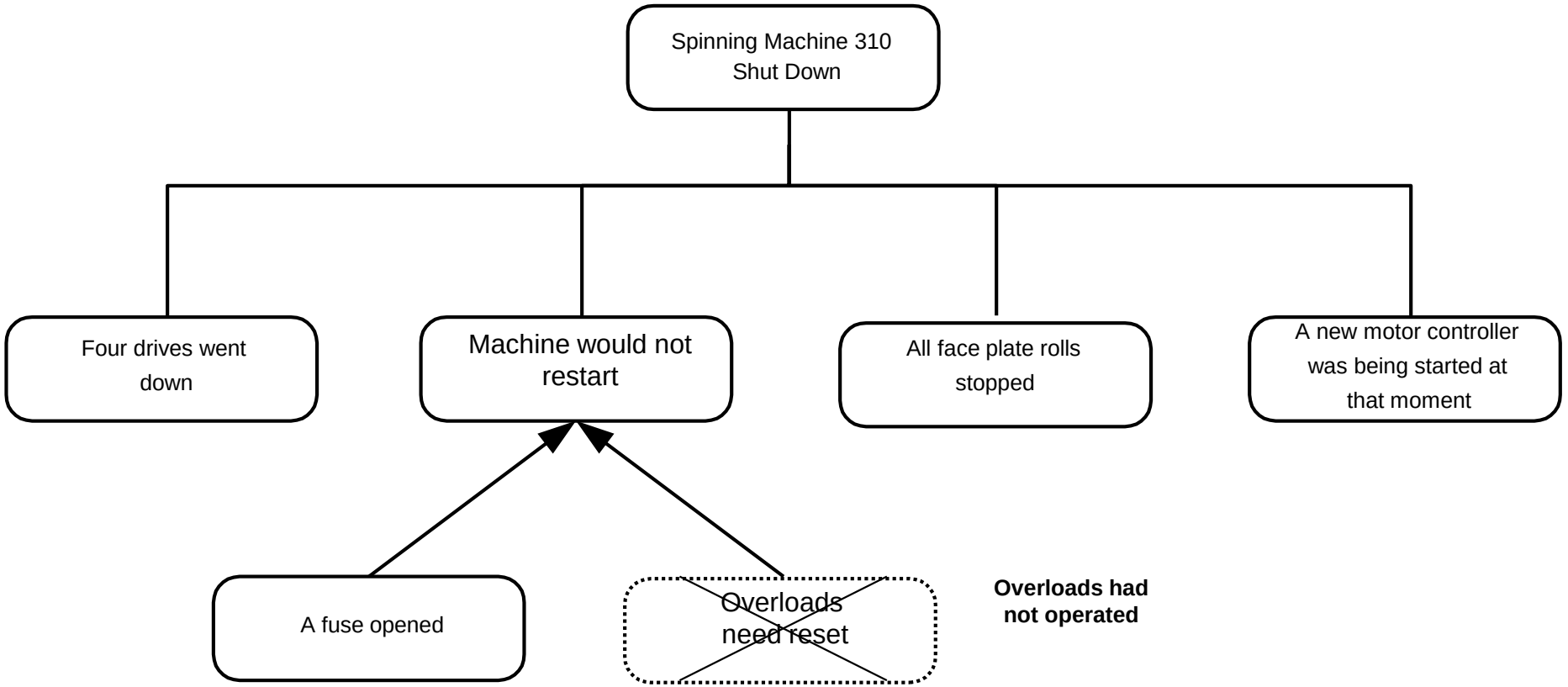
Step 4. **Hypothesize causes of the observation. Ask Why or How Can the observation have happened, using the question that makes the most sense.**

Include all reasonable possible explanations.

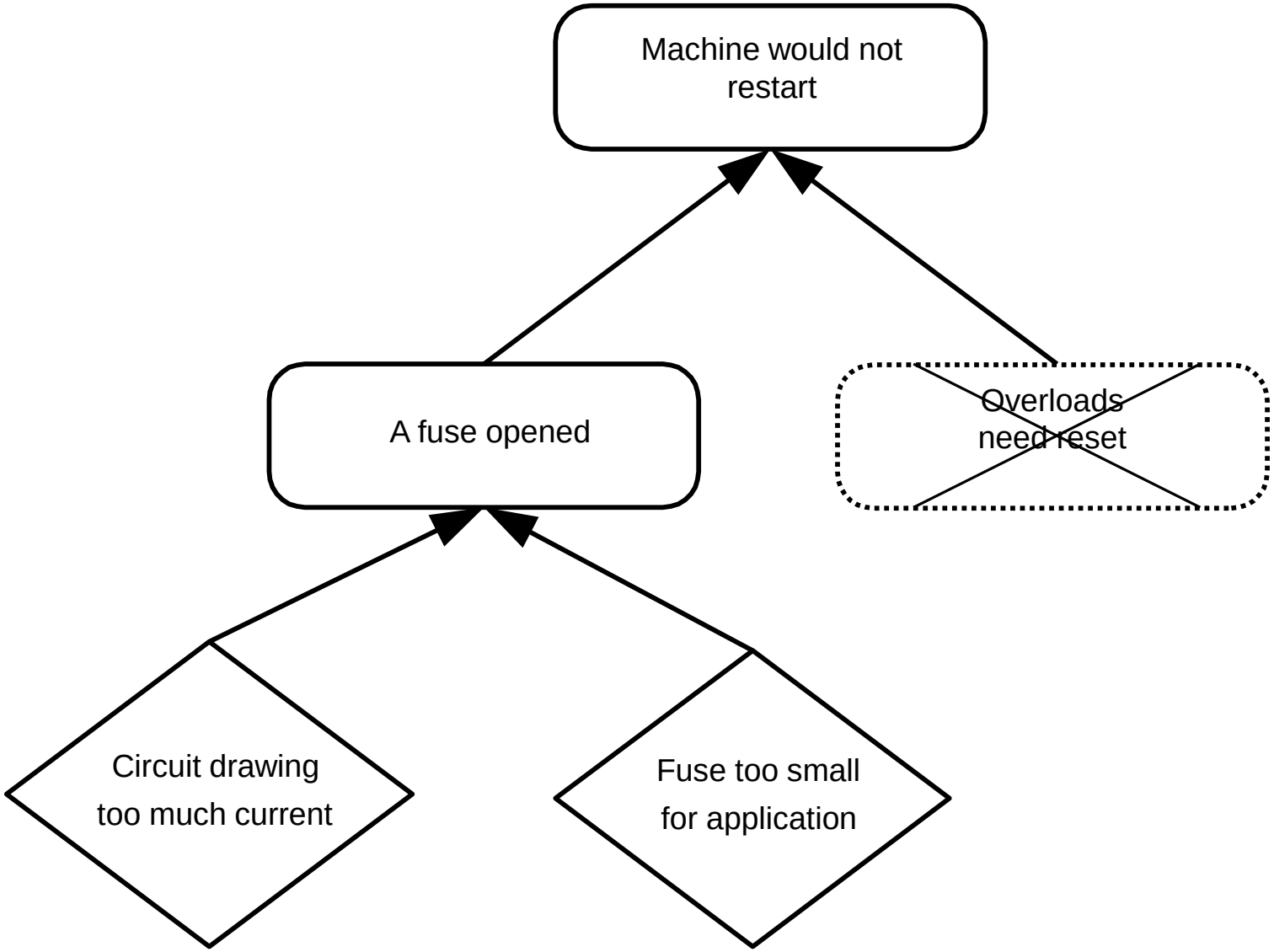


Building the "WHY" Tree

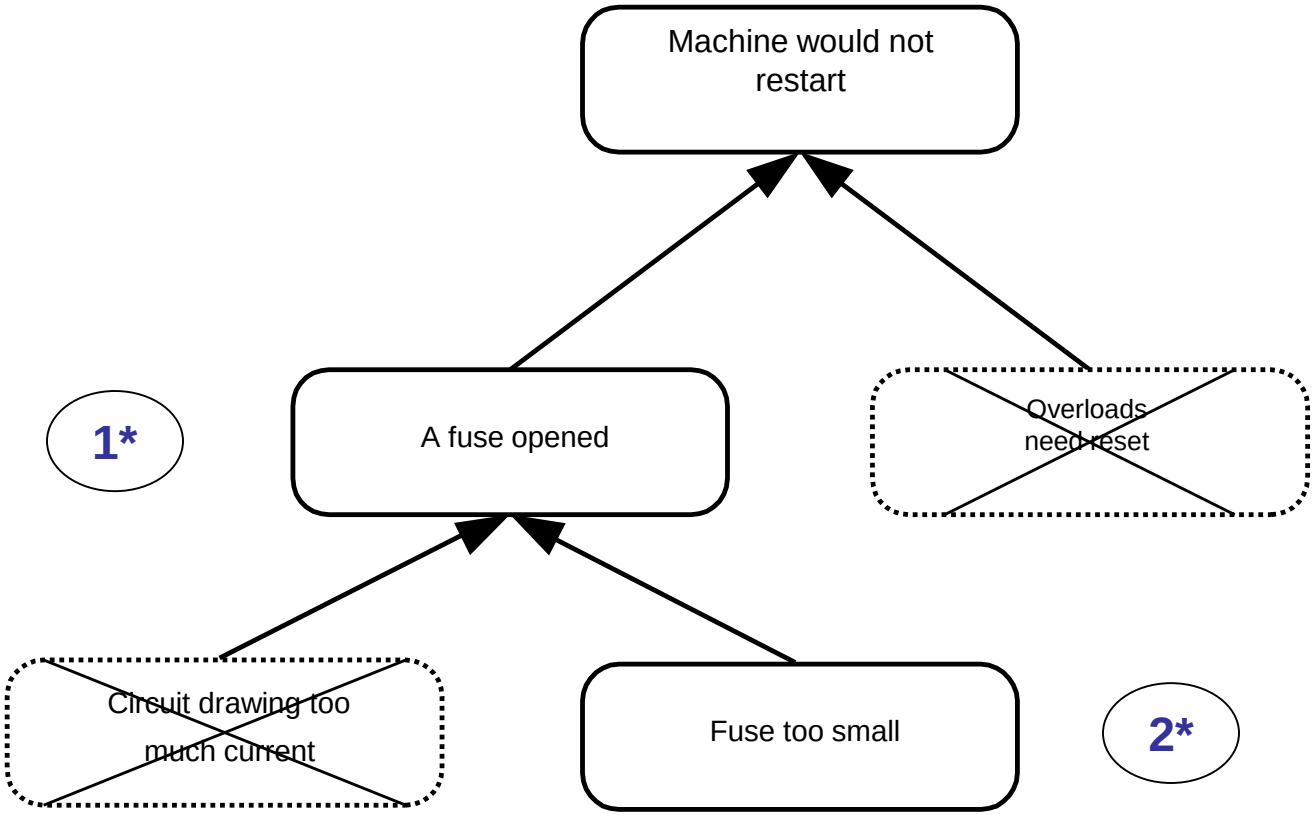
Step 5. **Verify the hypotheses as true or not.**



Building the "WHY" Tree



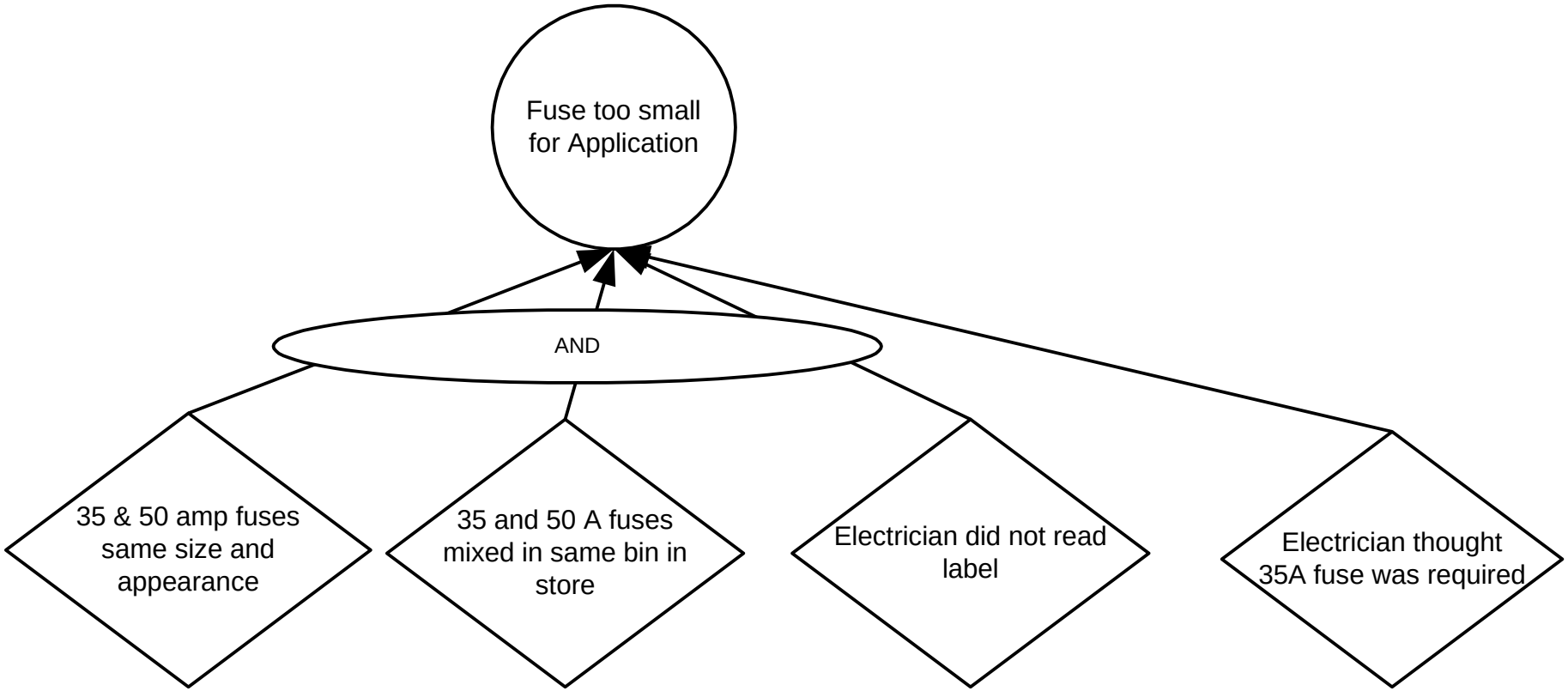
Building the "WHY" Tree



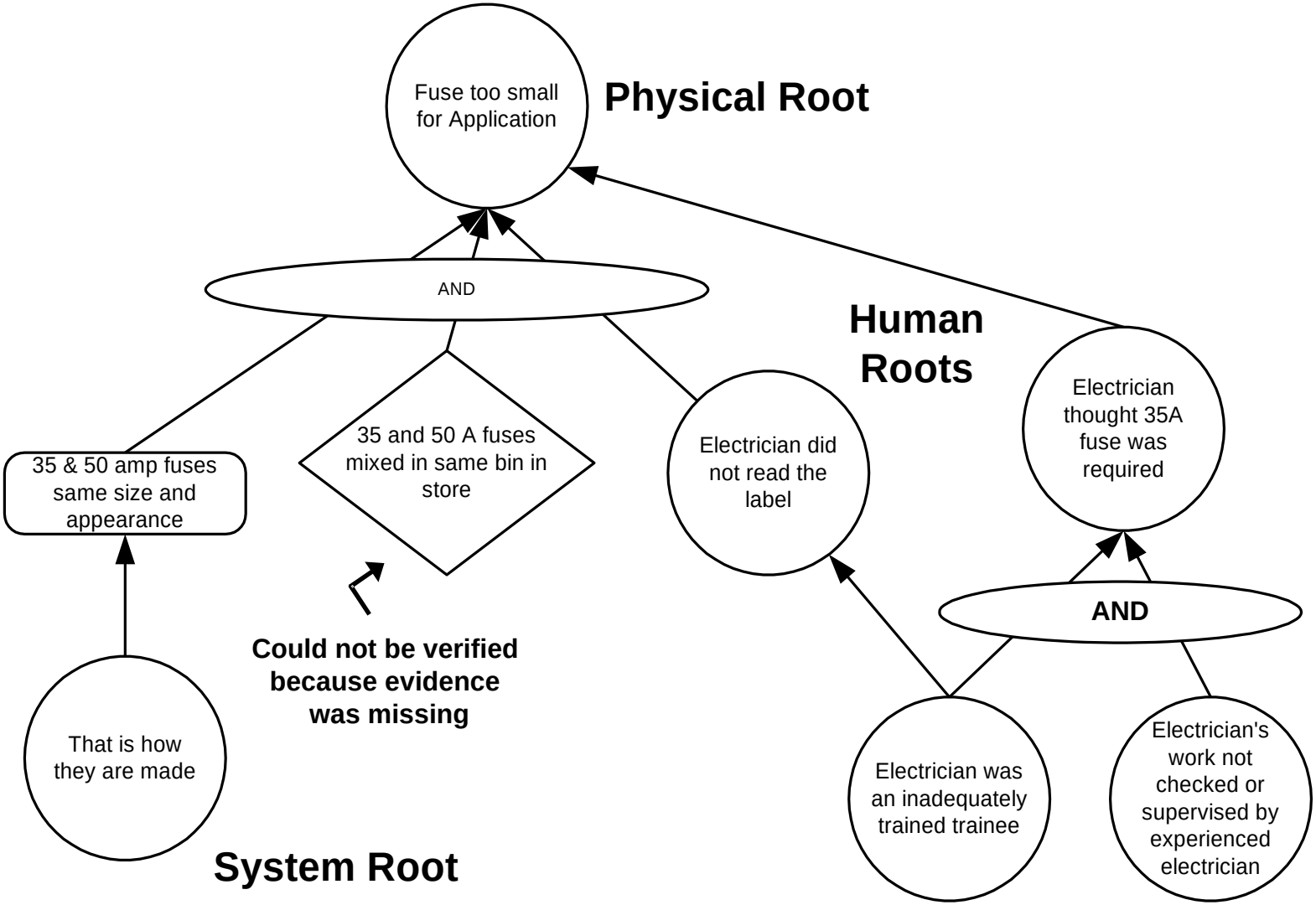
*1) **Motor controller was removed from service and the blown fuse was found when being repaired in the shop. There was no storm outside.**

*2) **In the shop, the circuit was found to be drawing the proper current. The blown fuse was verified to be a 35 amp fuse. The function required a 50 amp fuse.**

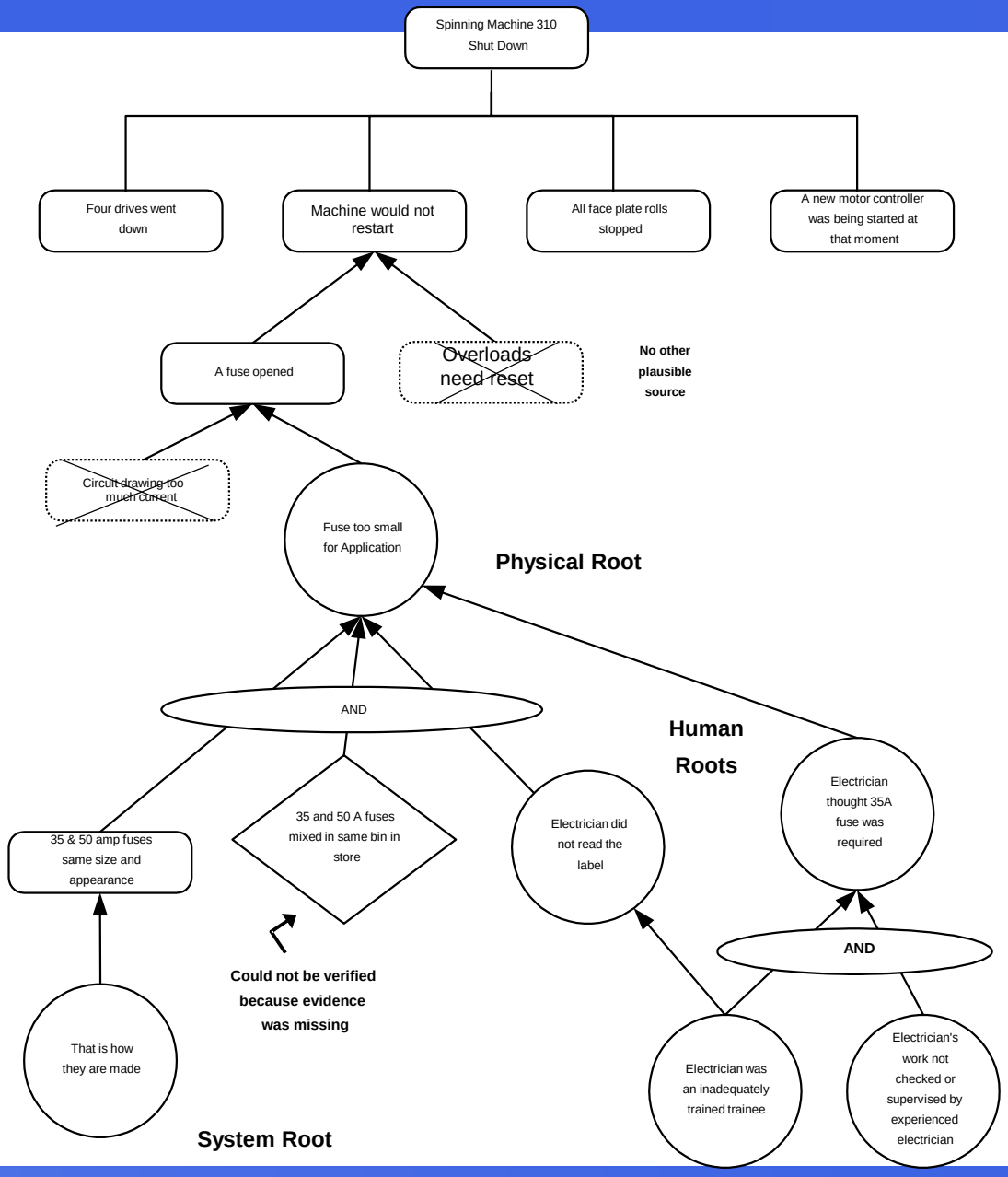
Building the "WHY" Tree



Building the "WHY" Tree



The "WHY" Tree is Built



Determine Causes for All Observations

- After determining root causes for one observation, go back and repeat the process for the other observations. Continue until you have explained all the observations to ensure you haven't overlooked some root causes.
- In the Fuse case, finding the root cause of one observation explained the other three.
- The fuse which failed and caused the 'Pop' was in the motor control center that was being started.
- When it failed, it took out several other fuses, interrupting power to the four drives.
- When the drives lost power, the motors they were controlling stopped, which caused the faceplate rolls that the motors were turning to also stop.

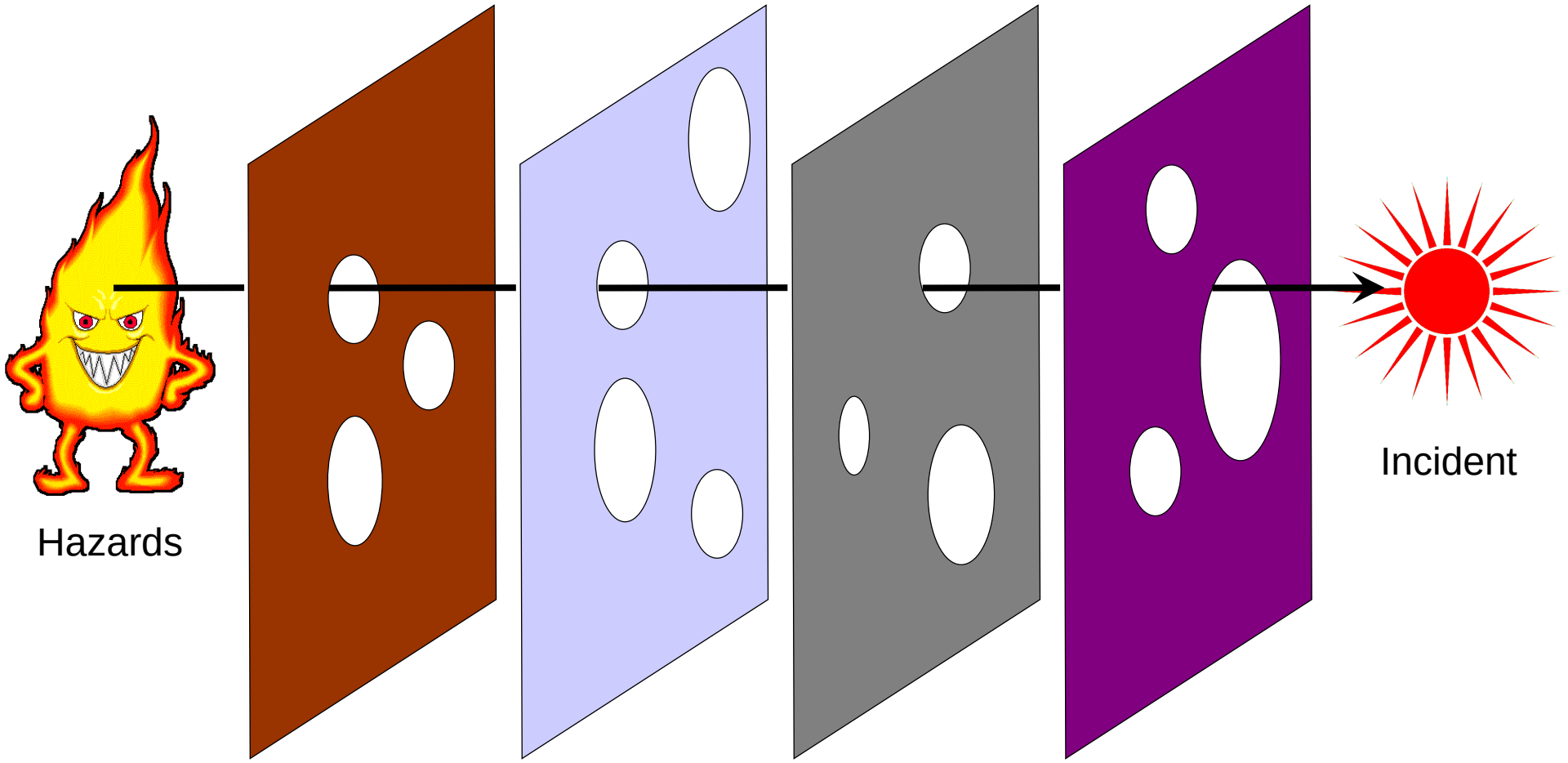
Barrier analysis

- Barrier analysis is used to identify hazards associated with an accident and the barriers that should have been in place to prevent it.
- A barrier is any means used to control, prevent, or impede the hazard from reaching the target.

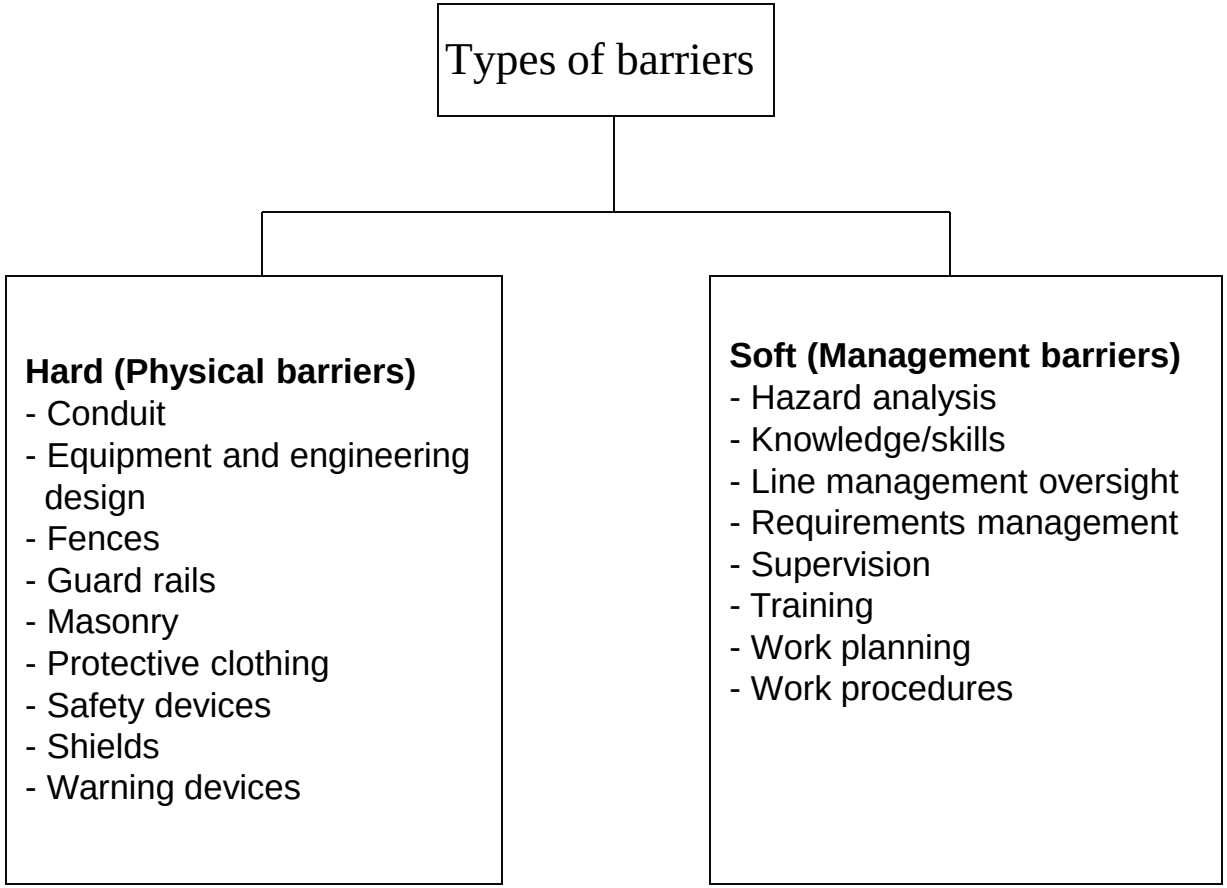
Barrier analysis addresses:

- Barriers that were in place and how they performed
- Barriers that were in place but not used
- Barriers that were not in place but were required
- The barrier(s) that, if present or strengthened, would prevent the same or similar accidents from occurring in the future.

Barrier Analysis



Barrier analysis



Physical barriers are usually easy to identify, but management system barriers may be less obvious

Barrier Analysis - Process

- Identify the harm or damage done or that could be done

• List the targets or things of value that have been (or may be) damaged. Multiple targets may be involved. List all potential targets. Eliminate those not affected later.
• Identify the source of the threat(s).
• Identify barriers, which will or should have prevented the event. Include both type and placement relative to both target and threat.

• Analyse their adequacy. What were they supposed to do, and to what extent did or did they not do that? Were the underlying risk assumptions valid?
• What other barriers or controls are needed?

Barrier analysis worksheet

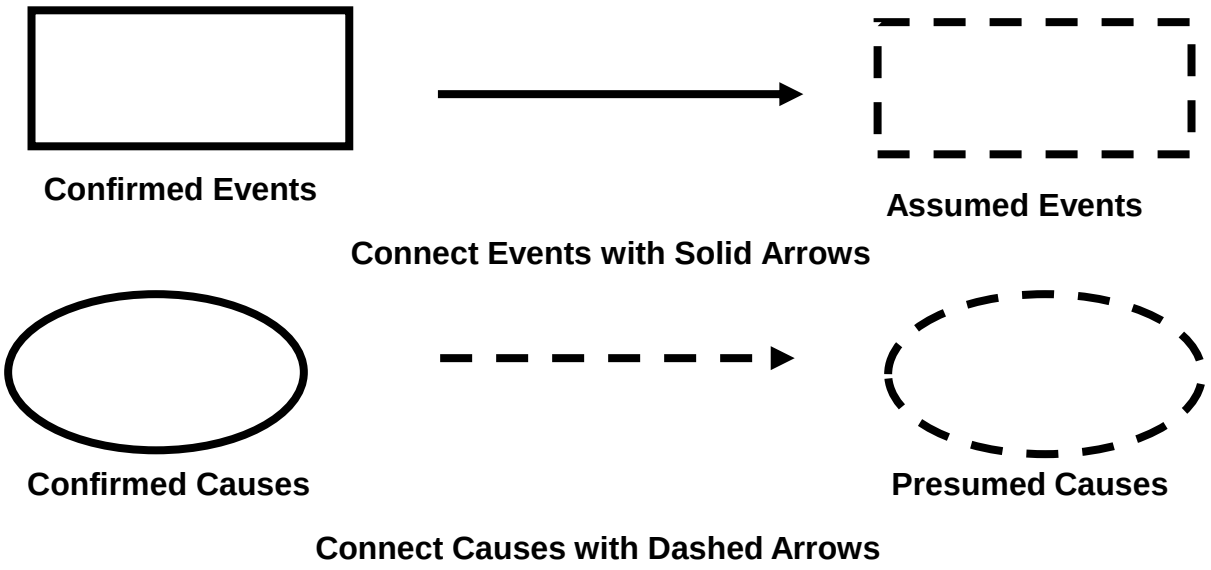
BARRIER ANALYSIS

THREAT	*TARGET*	*TRACE*	*BARRIER*	*TYPE*	*ANALYSIS*	*PROBABLE CAUSE*
Impact with Ground	Pilha Soren	Direct fall 25m	Training	Soft	Inadequate	Acceptance of low contractor standards
			Supervision	Soft	Inadequate	Acceptance of low contractor standards Poor supervision by Tata Low standards
			Job Safety Analysis	Soft	Inadequate	Procedure not followed Poor supervision by Tata Low standards
			Guard Railing	Hard	Absent	Design oversight Low awareness of risk Poor safety and hazard inspection/audit protocols Low standards
			Fall Arrest Harness	Hard	Not used	No attachment points Accepted practice not to wear Lack of Supervision Low awareness of risk Low standards

Events and Causal Factors Analysis- Process

- Collect & arrange events chronologically
- Decide which are relevant to the incident.
- Define the key event to be studied
- Select the scope of the analysis (Start & finish)
- Examine the event sequence for obvious problems
- Define and link contributing factors or causes to each event
- Define the key factors, systemic or root causes
- Look at highest factors to identify probable root causes

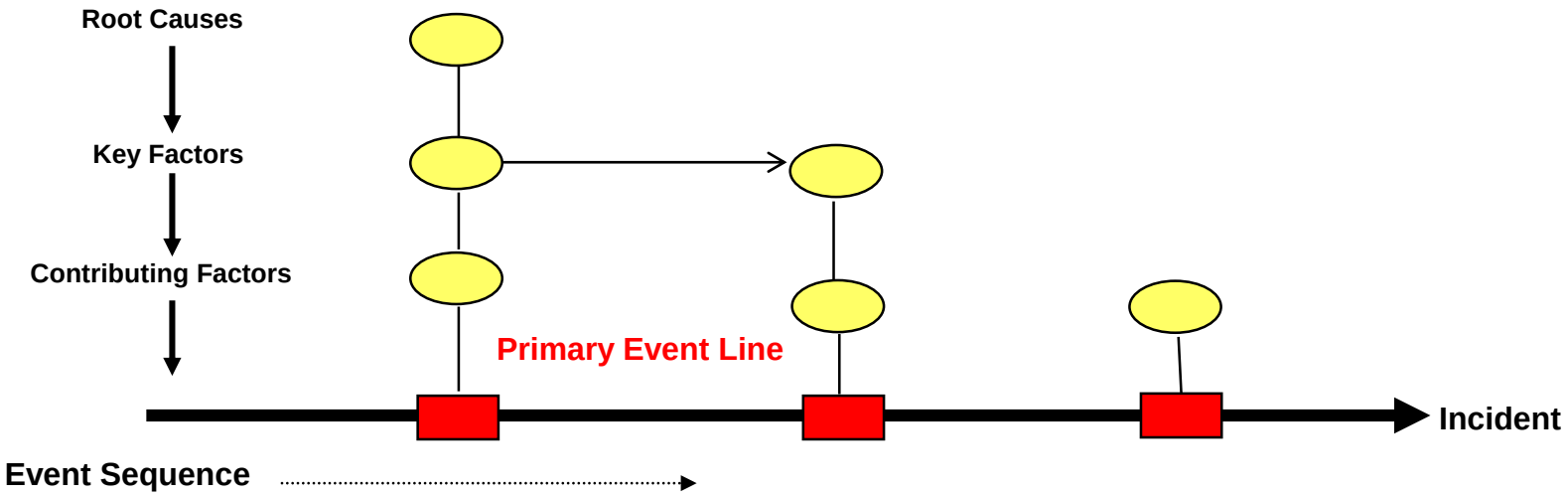
Events and Causal Factors - Symbols



Event & Causal Analysis

–Won't work well without constructing flow sheet. May be best when situation involves some sort of sequence over time and/or multiple steps.

Events and Causal Factors



Events and Causal Factors

- Before starting to analyse the events and conditions noted on the chart, an investigator must first ensure that the chart contains adequate detail. Examine the first event that immediately precedes the accident. Evaluate its significance in the accident sequence by asking:

"If this event had not occurred, would the accident have occurred?"

Definition of significant and insignificant events:-

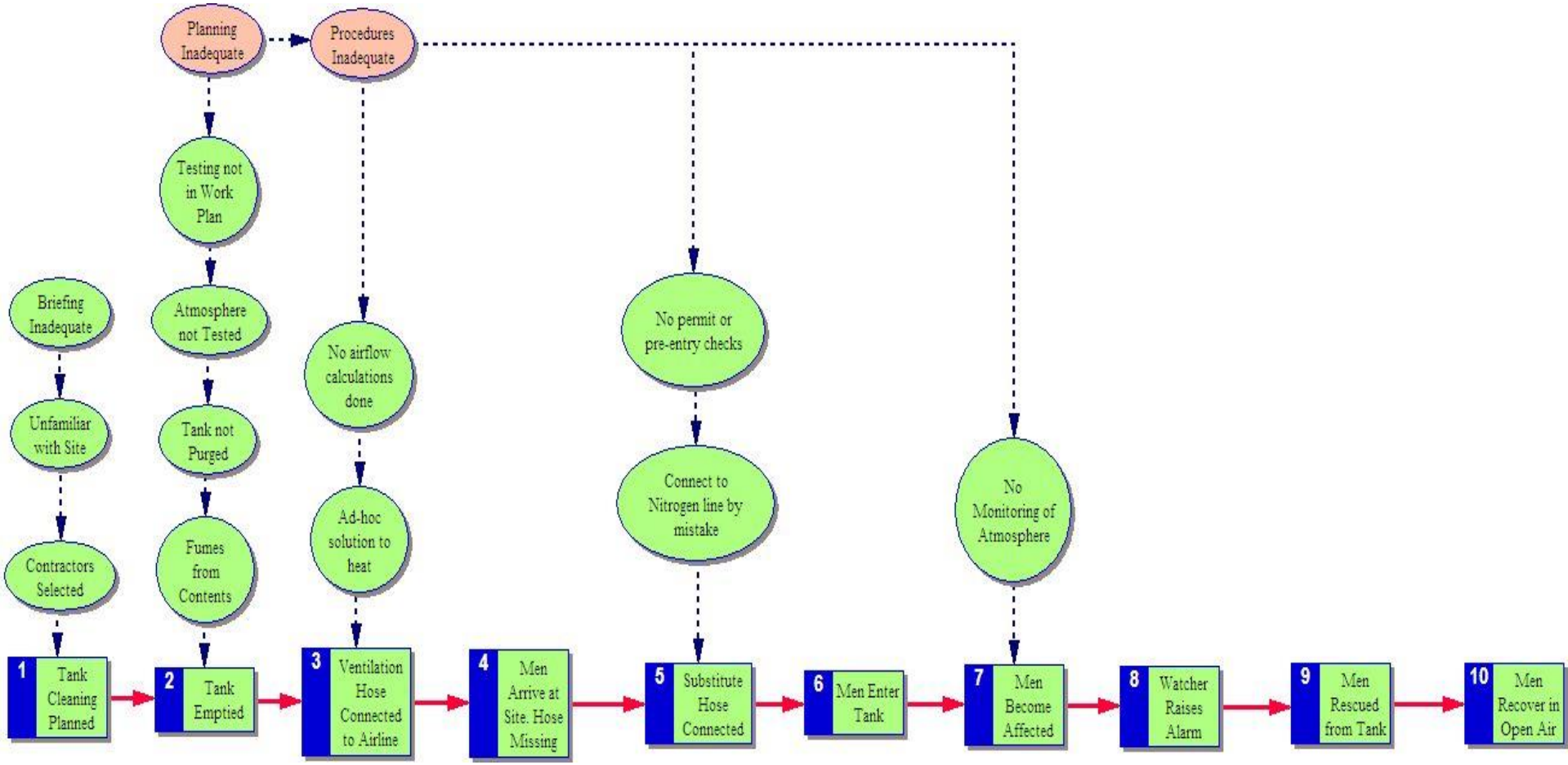
- If the answer is yes, then the event is not significant. Proceed to the next event in the chart, working backwards from the accident. If the answer is no, then determine whether the event represented normal activities with the expected consequences. If the event was intended and had the expected outcomes, then it is not significant.
- However, if the event deviated from what was intended or had unwanted consequences, then it is a significant event.

Events and Causal Factors

Carefully examine the events and conditions associated with each significant event by asking a series of questions about this event chain, such as:

- Why did this event happen?
- What events and conditions led to the occurrence of the event?
- What went wrong that allowed the event to occur?
- Why did these conditions exist?
- How did these conditions originate?
- Who had the responsibility for the conditions?
- Are there any relationships between what went wrong in this event chain and other events or conditions in the accident sequence?
- Is the significant event linked to other events or conditions that may indicate a more general or larger deficiency?

Events & Causal Factors



How they arrived at Conclusions

• Conclusions are significant deductions derived from the investigation's analytical result.

•Derived from and supported by the fact and the result from testing and various analyses conducted.

•Conclusions are statements that answer two of the questions: What happened and why it happened

•Conclusions may include concise re-capitulation's of the causal factors (direct, contributing, and root causes) of the incident.

What to look in Recommendations??

Corrective and preventive actions should address key factors and include the following:

- Description of actions - what will be done.
- Person responsible for implementation
- Completion date

Arriving at recommendations

Identify hazards

Eliminate hazards

Control hazards

Primary
Engineering solutions

Secondary
administrative solutions

Good Corrective Actions

Consider the hazard in terms of -

- Probability of Recurrence
- Severity & Consequence
- Cost to fix versus cost to leave
- Impact on the organization