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# QUANTIFYING HUMAN RELIABILITY IN SAFETY ANALYSIS HOW USEFUL IS IT?

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# Acknowledgement of Country

Acmena acknowledges the Traditional Owners and their custodianship of the lands on which we meet.

**Kaurna peoples**

I would like to pay my respects to their elders, past, present and emerging.

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# AGENDA

Where we are going

01

**WHAT IS THE PROBLEM?**

Are people in or out of the hazard boundary?

02

**HUMAN RELIABILITY ANALYSIS**

How do we give a person's reliability a number?

03

**CASE STUDIES**

How might you do this?

What can we learn from the past?

04

**CONCLUSION**

Principles and Caveats

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# 01

## WHAT IS THE PROBLEM?

Are people in or out of the hazard boundary?

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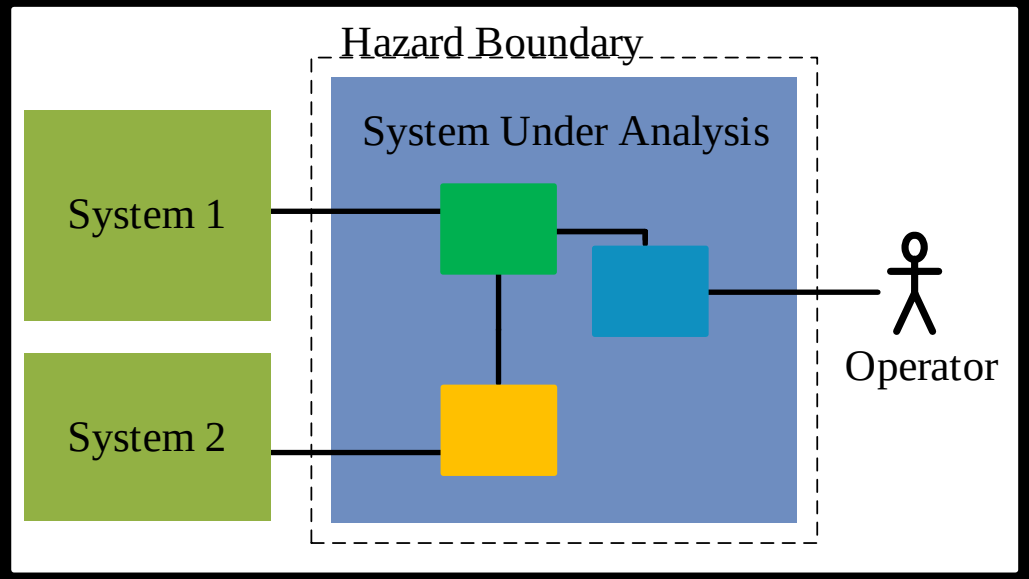
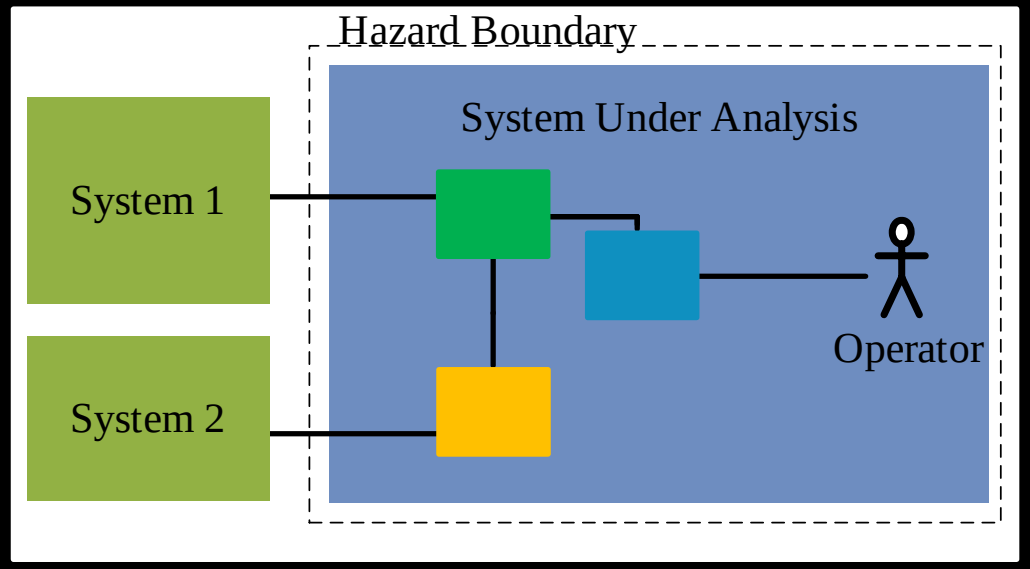
**Where should the boundary be?**




# WHAT IS THE PROBLEM?

Are people in or out of the hazard boundary?

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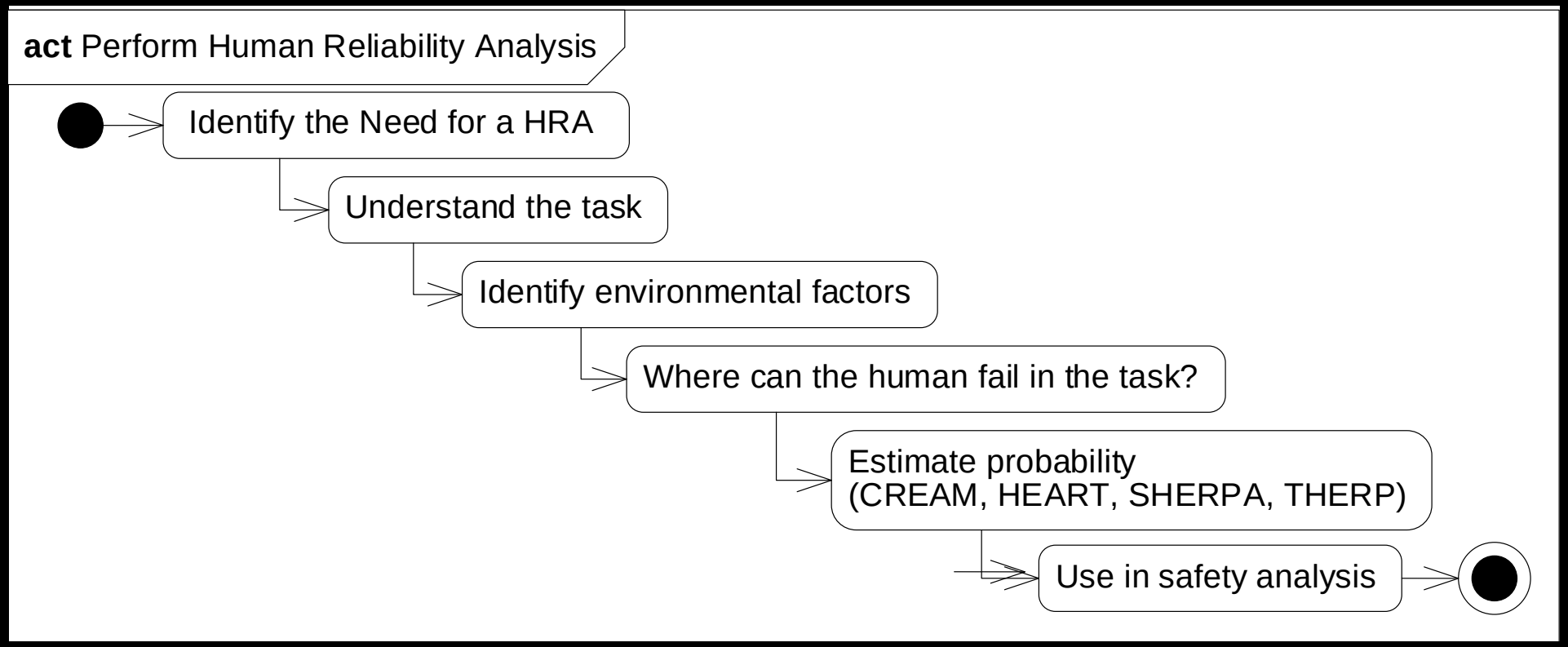
# 02

## HUMAN RELIABILITY ANALYSIS

How do we give a person's reliability a number?




# HUMAN RELIABILITY ANALYSIS

How do we give a person's reliability a number?

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# HUMAN RELIABILITY ANALYSIS

How do we give a person's reliability a number?

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# 3

## CASE STUDIES

How might you do this?

What can we learn from the past?

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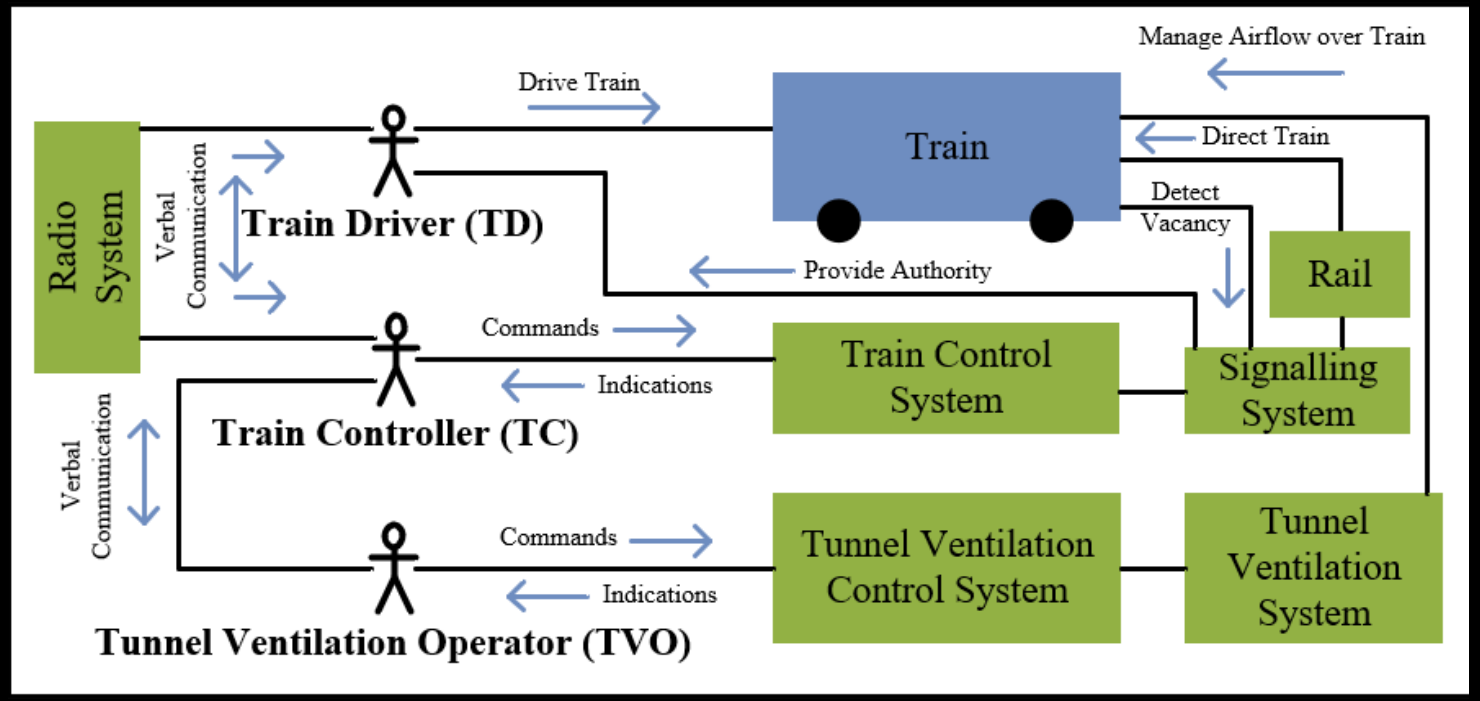
## Description

Introduction of a new Tunnel Ventilation System (TVS) to a control room. The TVS plays a key safety role in providing airflow in the event of a train is on fire and stopped in a tunnel.

## Assessment

- Task Analysis
- Manual Control HRA
- Automatic Control HRA
- Takeaways




# CASE STUDY 1

Tunnel Ventilation System

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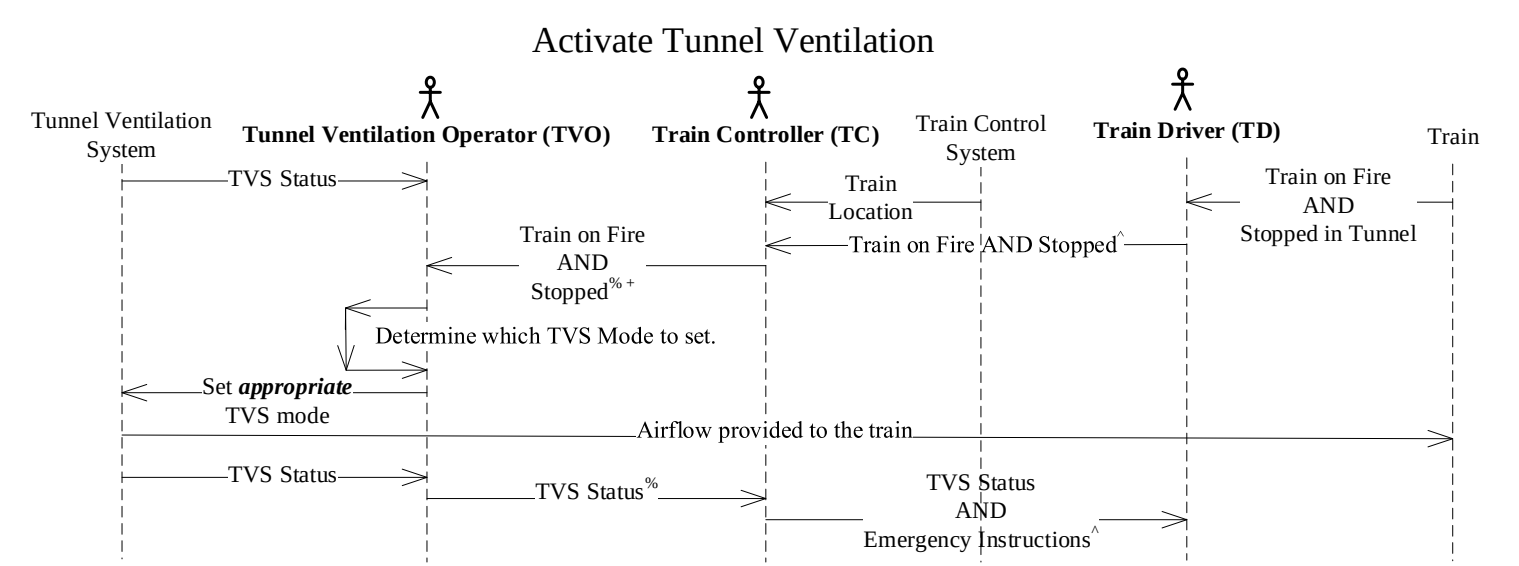
## Task Analysis

- TD reports the train fire (and location of fire on board the train) to the TC via train radio,
- TC reports details of the incident to the TVO,
- TVO communicates the status of the Tunnel Ventilation System to the TC, and
- TC reports status of the TVS to the TD and gives instructions on emergency response.




**Notes:**
^ TD to TC communications is via Train Radio
% TC to TVO communication is verbally across the room
+ TC provides the TVO information that a Train is on Fire and Stopped and also tells them where the train is stopped and what direction it was going.

# CASE STUDY 1

Tunnel Ventilation System

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## Manual Control HRA

- (1) TD fails to detect the fire alarm on board the train
- (2) TD fails to communicate the fire event to TC within the required time frame
- (3) TC misunderstands the information provided by the TD
- (4) TC communicates incorrect information to TVO
- (5) TVO misunderstands the information provided by the TC
- (6) TVO decides to operate the incorrect tunnel ventilation mode
- (7) TVO selects the incorrect mode on the TVS interface

# CASE STUDY 1

Tunnel Ventilation System

| Error | Generic Task Type (unreliability score) | Error Producing Conditions (maximum effect) | Est. Effect | Ass. Effect | HEP |
|---|---|---|---|---|---|
| 1 | Routine, highly practiced, rapid. Low level skill (0.02) | Channel capacity overload - failure to hear the alarm (6) | 0.01 | 1.05 | 0.021 |
| 2 | Fairly simple task performed rapidly or given scant attention (0.09) | Ambiguity in required performance standards - focus on dealing with emergency instead of communicating (5). | 0.3 | 2.2 | 0.198 |
| 3 | Fairly simple task performed rapidly or given scant attention (0.09) | Improvised quality of Info from person-to-person interaction | 0.1 | 1.2 | 0.108 |
| 4 | Complex task requiring high level of comprehension and skill (0.16) | Improvised quality of info from person-to-person interaction (3) | 0.4 | 1.8 | 0.288 |
| 5 | Fairly simple task performed rapidly or given scant attention (0.09) | Improvised quality of info from person-to-person interaction (3) | 0.4 | 1.8 | 0.162 |
| 6 | Complex task requiring high level of comprehension and skill (0.16) | Unfamiliarity with the situation which is potentially important but only occurs infrequently or which is novel (17) | 0.1 | 2.6 | 0.416 |
| 7 | Restore or shift system to original or new state following procedures, with some cross checking (0.003) | A mismatch between an operator's view of the world and that imagined by the designer (8) | 0.1 | 1.5 | 0.0045 |

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## Manual Control HRA

- (5) TVO misunderstands the information provided by the TC
- (6) TVO decides to operate the incorrect tunnel ventilation mode

| Error | Generic Task Type (unreliability score) | Error Producing Conditions (maximum effect) | Est. Effect | Ass. Effect | HEP |
|---|---|---|---|---|---|
| 5 | Fairly simple task performed rapidly or given scant attention (0.09) | Improvised quality of info from person-to-person interaction (3) | 0.4 | 1.8 | 0.162 |
| 6 | Complex task requiring high level of comprehension and skill (0.16) | Unfamiliarity with the situation which is potentially important but only occurs infrequently or which is novel (17) | 0.1 | 2.6 | 0.416 |

# CASE STUDY 1

Tunnel Ventilation System

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## Automatic Control HRA

- (5) TVO misunderstands the information provided by the TC,
- (6) TVO decides to operate the incorrect tunnel ventilation mode,

| Error | Generic Task Type (unreliability score) | Error Producing Conditions (maximum effect) | Est. Effect | Ass. Effect | HEP |
|---|---|---|---|---|---|
| 5 | Fairly simple task performed rapidly or given scant attention (0.09) | Improvised quality of info from person-to-person interaction (3) | 0.05 | 1.8 | 0.099 |
| 6 | Complex task requiring high level of comprehension and skill (0.16) | Unfamiliarity with the situation which is potentially important but only occurs infrequently or which is novel (17) | 0.01 | 2.6 | 0.186 |

# CASE STUDY 1

Tunnel Ventilation System

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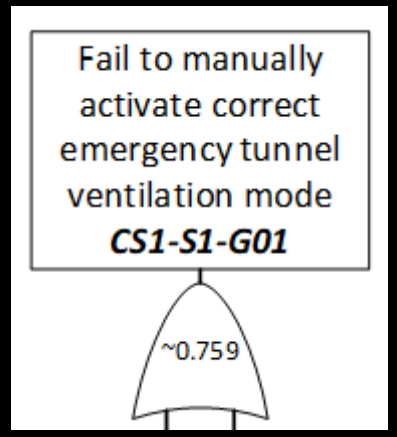
## Key Contributions to Risk

- Communication failures between TD, TC, and TVO
- TVO setting the incorrect ventilation mode.

## Manual vs Automatic Control

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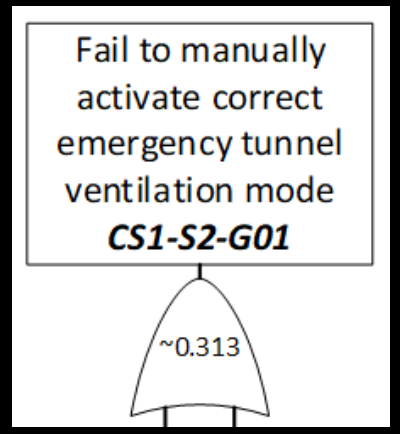


## Takeaways

- Showed the significance of human error to the hazard
- Conservatism/Assumptions in the predictive HRA
- Identified the areas where human error contributed to the highest risk
- Enabled the identification the best type of controls
- Allowed for comparison of multiple options

# CASE STUDY 1

Tunnel Ventilation System

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## Description

Introduction of new Train Control Systems. The Train Control System plays a key role in operating the railway and in some scenarios can be uses to instigate commands that bypass safety functions implemented by the interlocking

## Assessment

- Scenario Descriptions
- Example HRAs
- Takeaways

## Scenarios

- (1) Standard Railway Controls
- (2) Safety Bypass Controls
- (3) Axle Counter Reset Controls

# CASE STUDY 2

Train Control Systems

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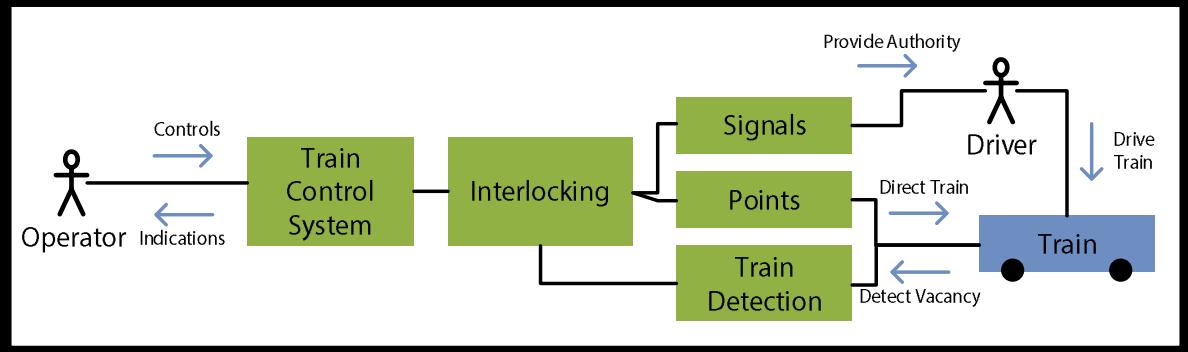
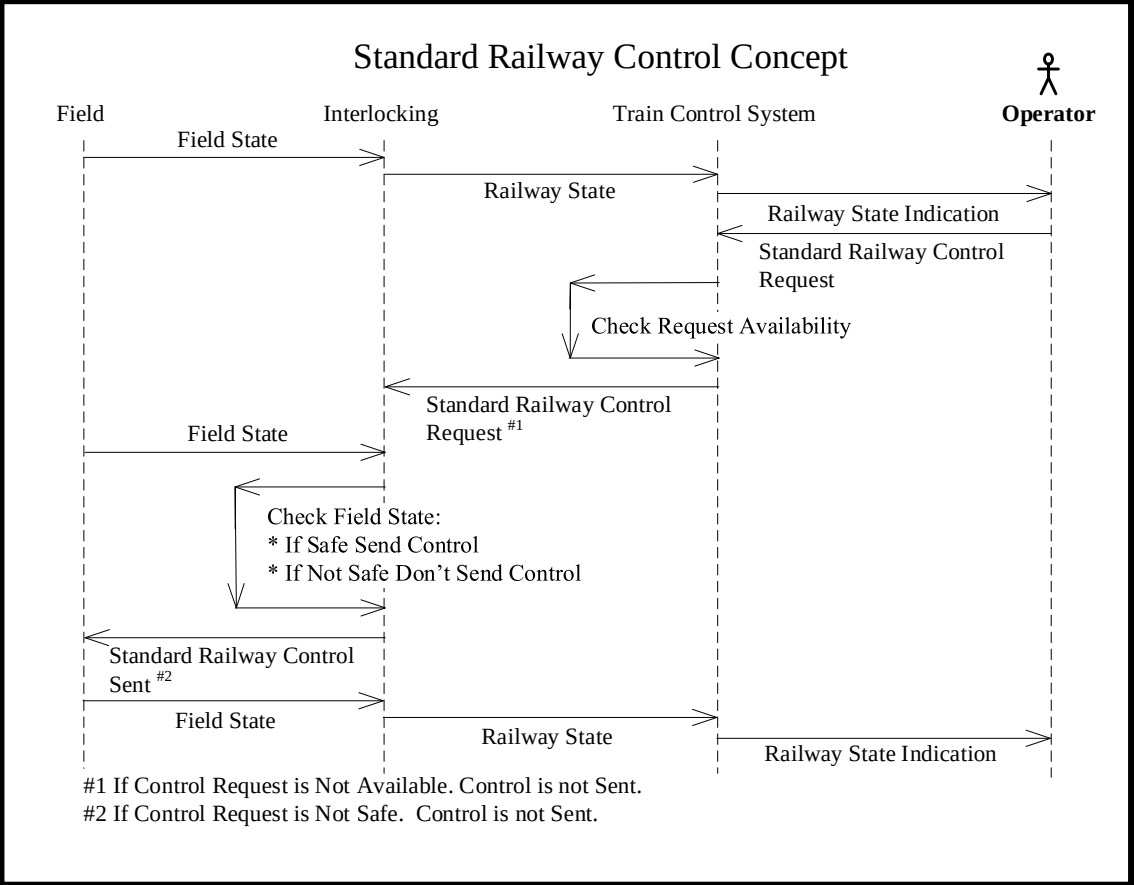
## Scenario 1 – Standard Railway Controls Description




# CASE STUDY 2

Train Control Systems

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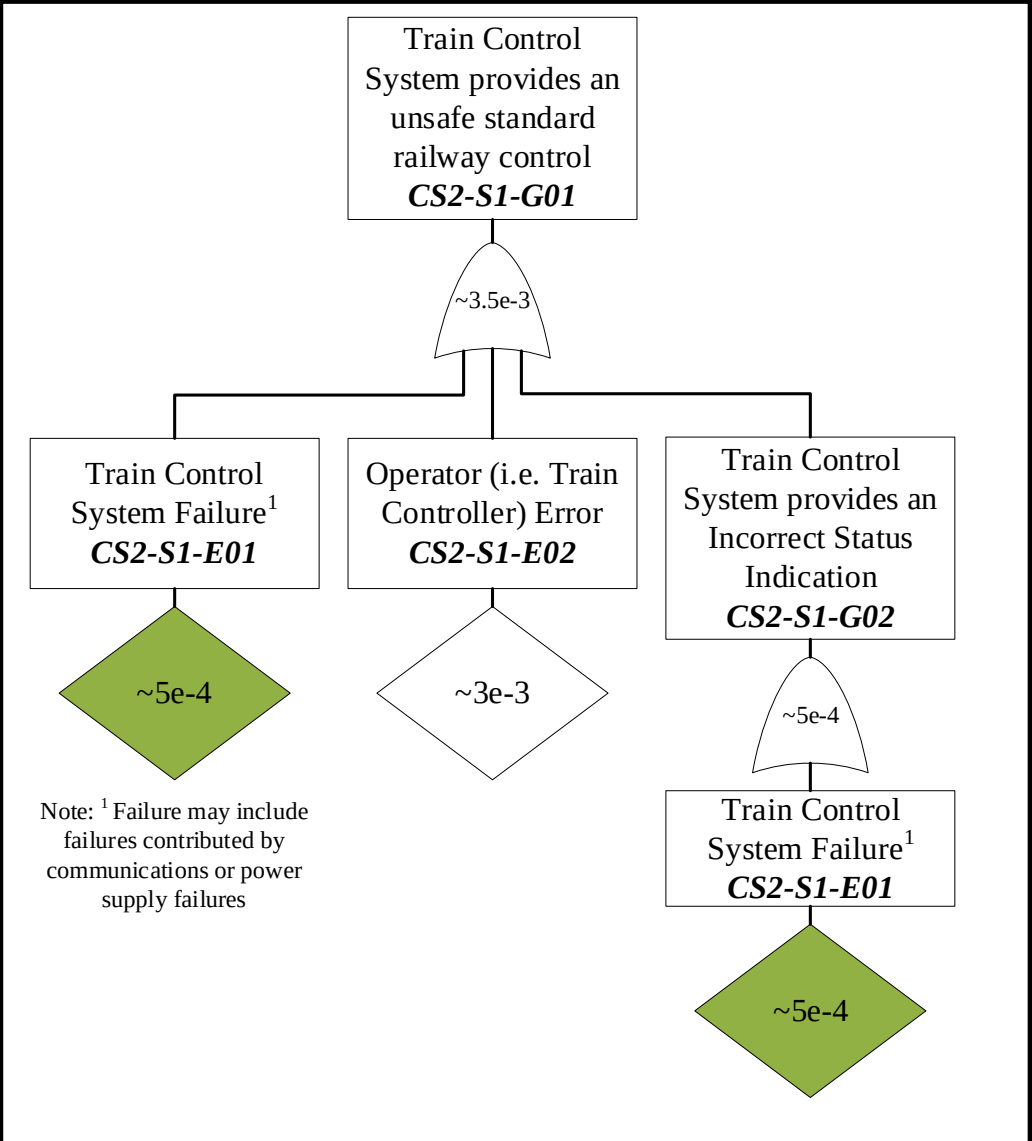
## Scenario 1 – Standard Railway Controls HRA

- Train Controller Error (e.g. set an unsafe route)
- RARA – Railway Action Risk Assessment (HEART)
  - R4 - Simple response to a dedicated alarm and execution of actions covered in procedures.

    OR
  - R6 - Restore or shift a system to original or new state, following procedures with some checking.




# CASE STUDY 2

Train Control Systems

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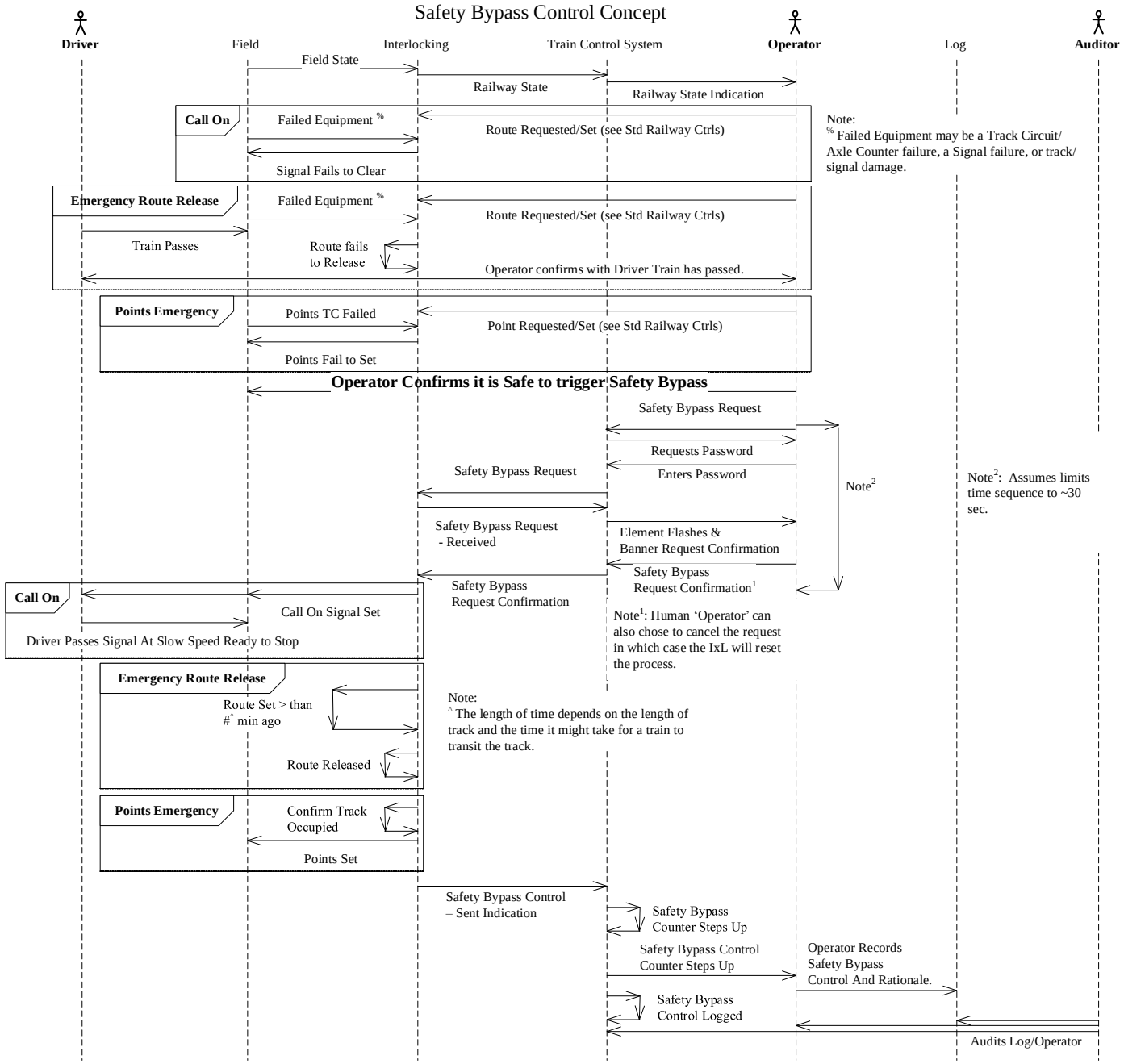
## Scenario 2 – Safety Bypass Description

- Call on function
- Emergency route release
- Points emergency




# CASE STUDY 2

Train Control Systems

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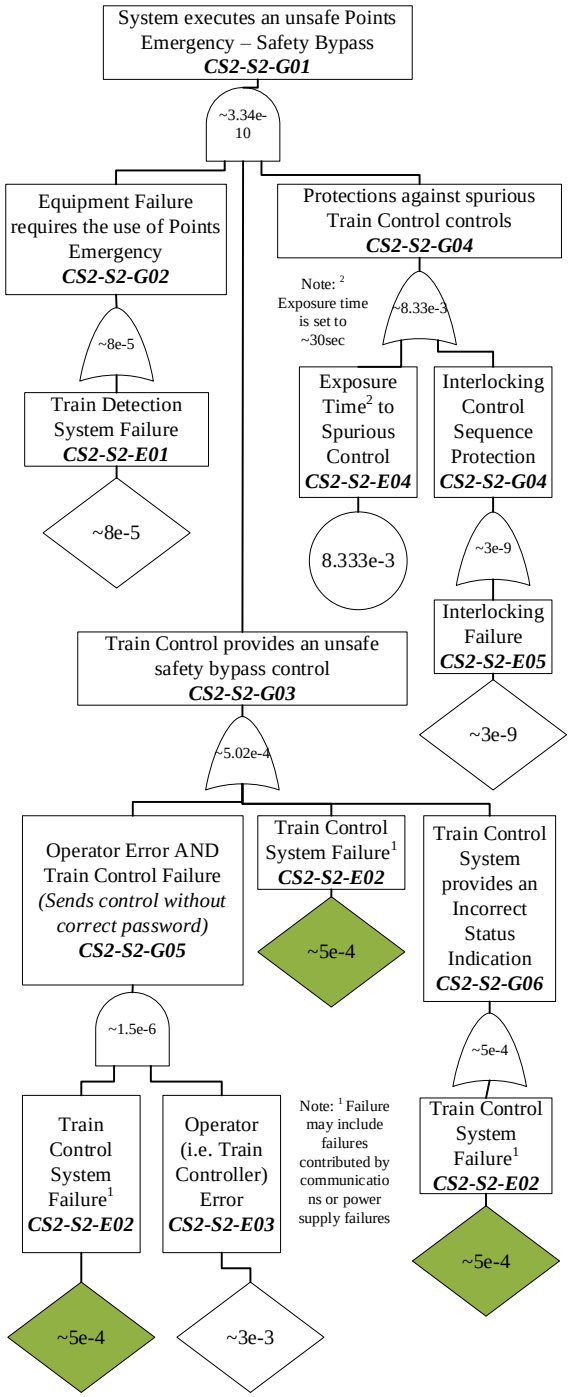
## Scenario 2 – Safety Bypass HRA

- Train Controller Error (e.g. set an unsafe route)
- RARA (HEART)
  - R4 - Simple response to a dedicated alarm and execution of actions covered in procedures.

    OR
  - R6 - Restore or shift a system to original or new state, following procedures with some checking.

# CASE STUDY 2

Train Control Systems



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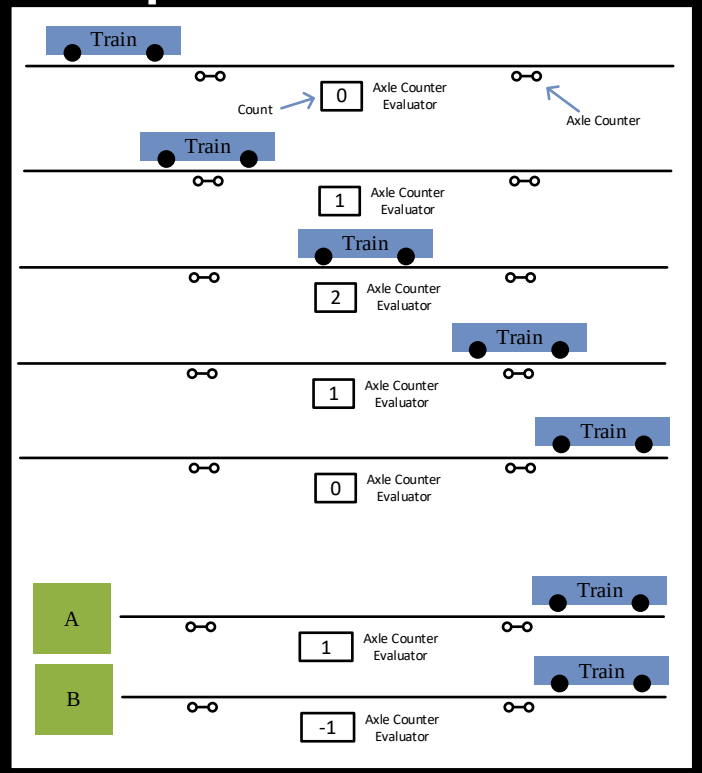
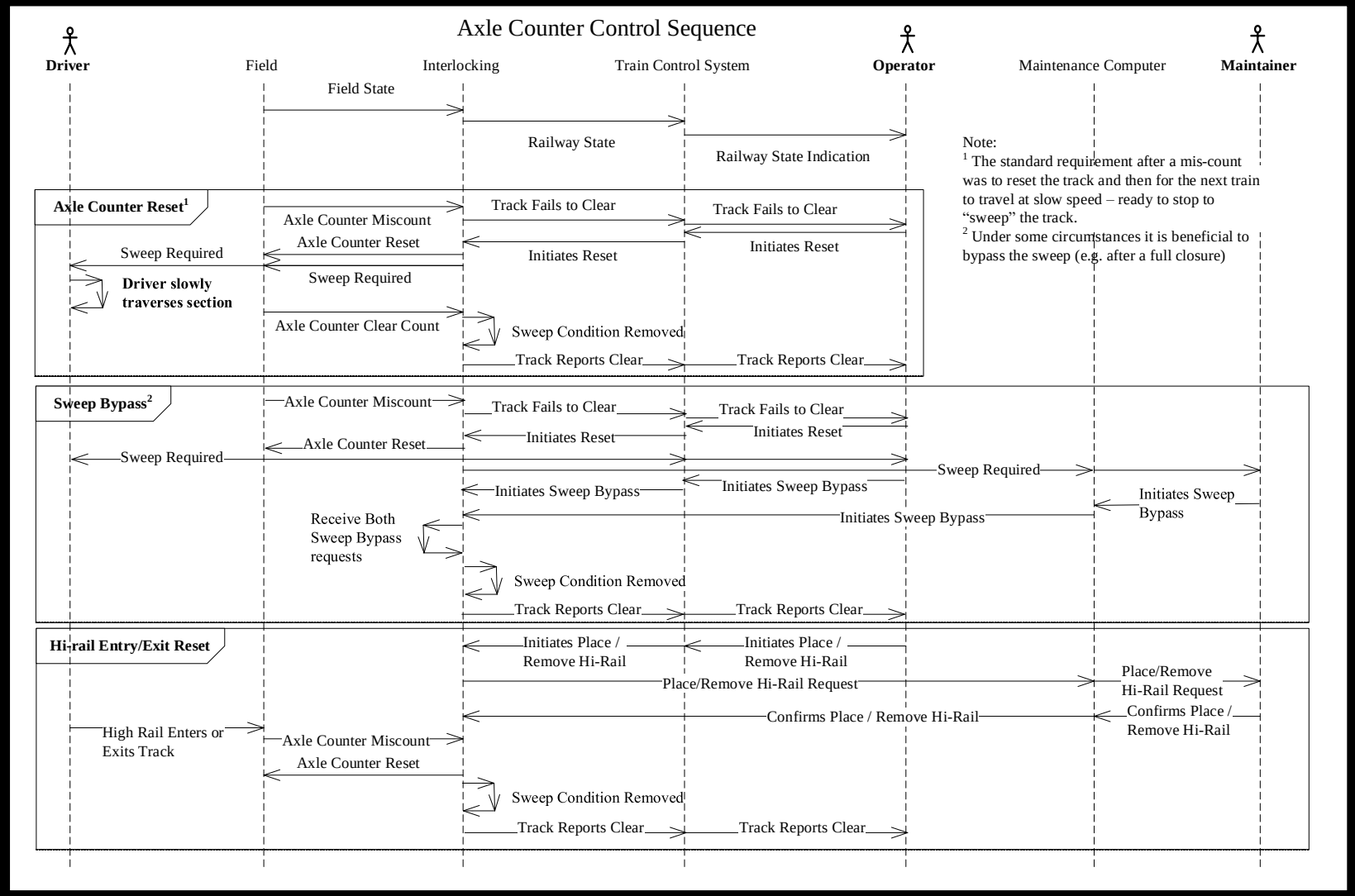
## Scenario 3 – Axle Counter Reset Description




# CASE STUDY 2

Train Control Systems

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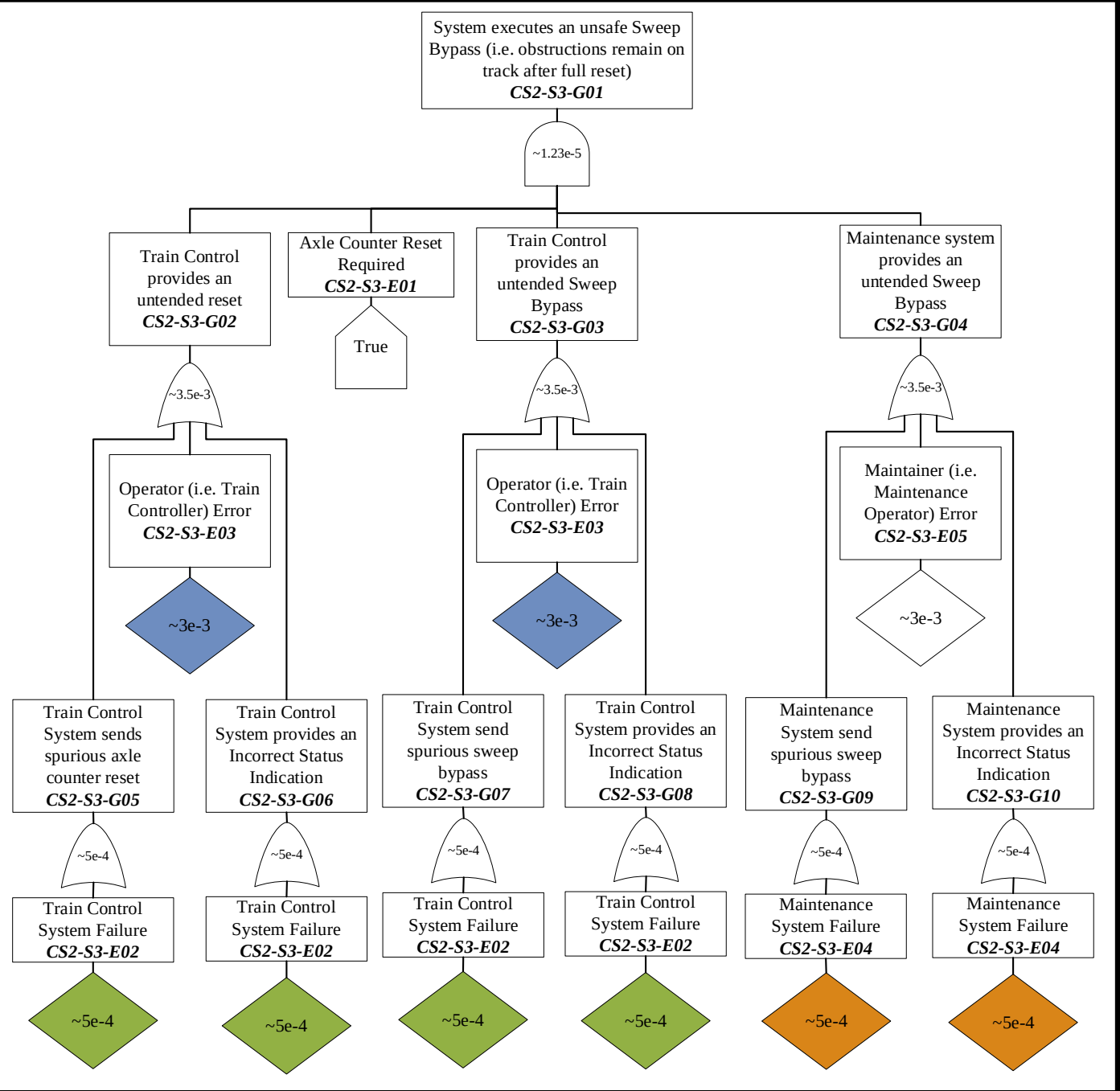
## Scenario 3 – Axle Counter Reset HRA

- Train Controller Error (e.g. set an unsafe route)
- THERP (derived)
  - Operator fails to carry out a step in a complex procedure.
  - Correct written procedure exists and is actually used.




# CASE STUDY 2

Train Control Systems

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**Takeaways**

- Ballpark estimate may be sufficient
- Involve input from an HF specialist for a better outcome
- Consider human error early so you have time to introduce engineering controls to reduce the risk
- Acknowledging the human in the loop limits need for gold plating system safety
- Take a risk based approach

# CASE STUDY 2

Train Control Systems

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# 04

## CONCLUSION

Takeaways and Caveats

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**Principles**

- Keep it simple
- Risk based approach
- Consult an HF expert
- Involve the end user
- Show your work
- Understand the activity
- Focus on error mitigation

**Caveats**

- Do not fixate on the number
- Do not over rely on the number
- Beware of human common cause failures
- Use common sense

# CONCLUSION

Principles and Caveats

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# QUESTIONS
& FOLLOW UP

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# Thank You

## CONTACTS


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