Operational and Human Factors Testing to Commission ERTMS Level 2 BL 3 in Denmark

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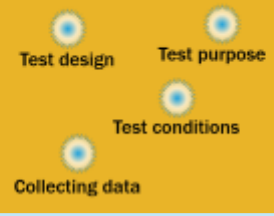
Design

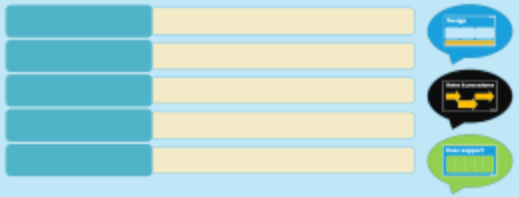
Rules & procedures

User support

Operational Testing



Improvement cycle



Communicating relationships between risks, human components and testing

Human Component Mapping

Challenge

Challenge

Ground work in Technical Specifications for Interoperability (TSI)…

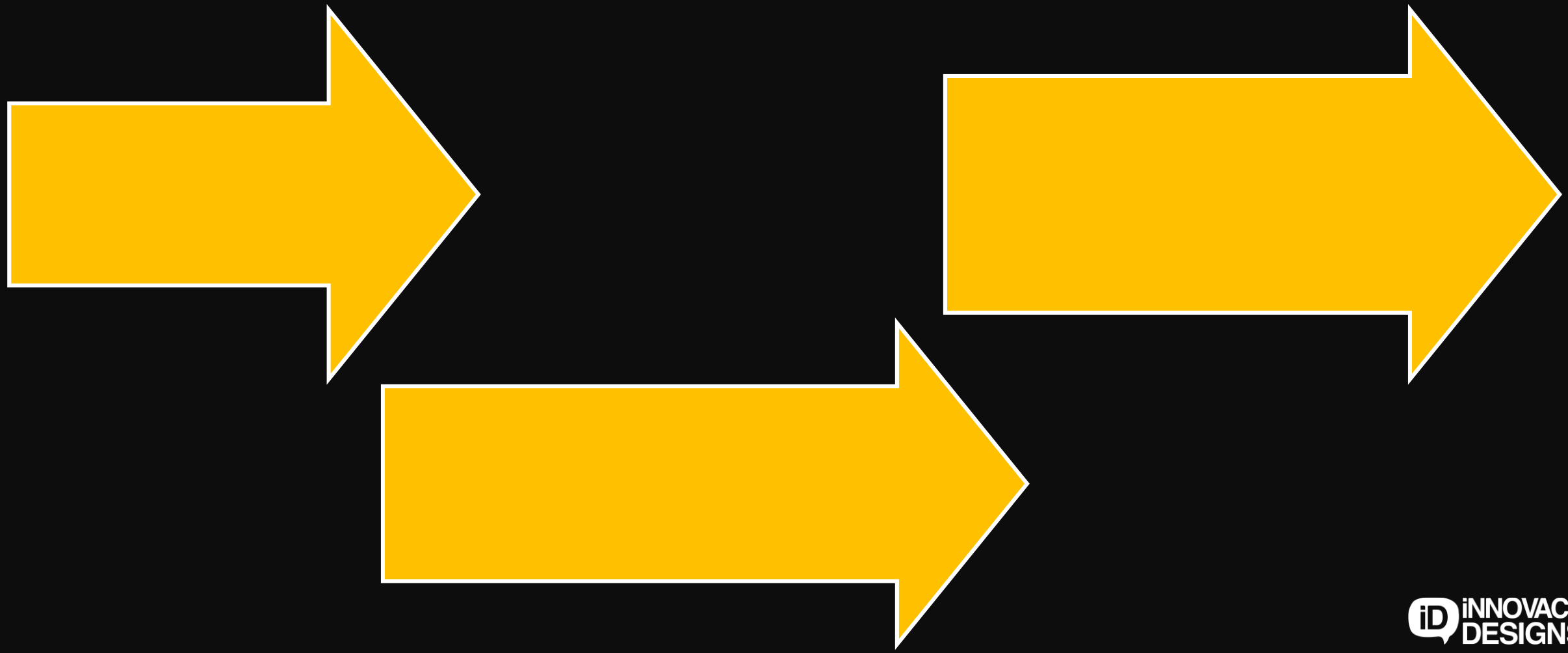
Control Command & Signalling (CCS)
Constituents developed individually for technical interoperability & compatibility of equipment.

Operation and Traffic Management (OPE) TSI:
Infrastructure Manager & Railway Undertaking responsible for development of Operational Rules (OR), Driver Rules & Route Book.

Authorisation for Placing in Service (APIS):
National Safety Authority (NSA) provide separate APIS for train-based equipment, signalling system infrastructure, OR-Fjernbane (ORF) & training separately.

No “All-Inclusive” Safety Approval – so how can we be sure there are no gaps in operational practice; where do we get the confidence from?

Change



Change

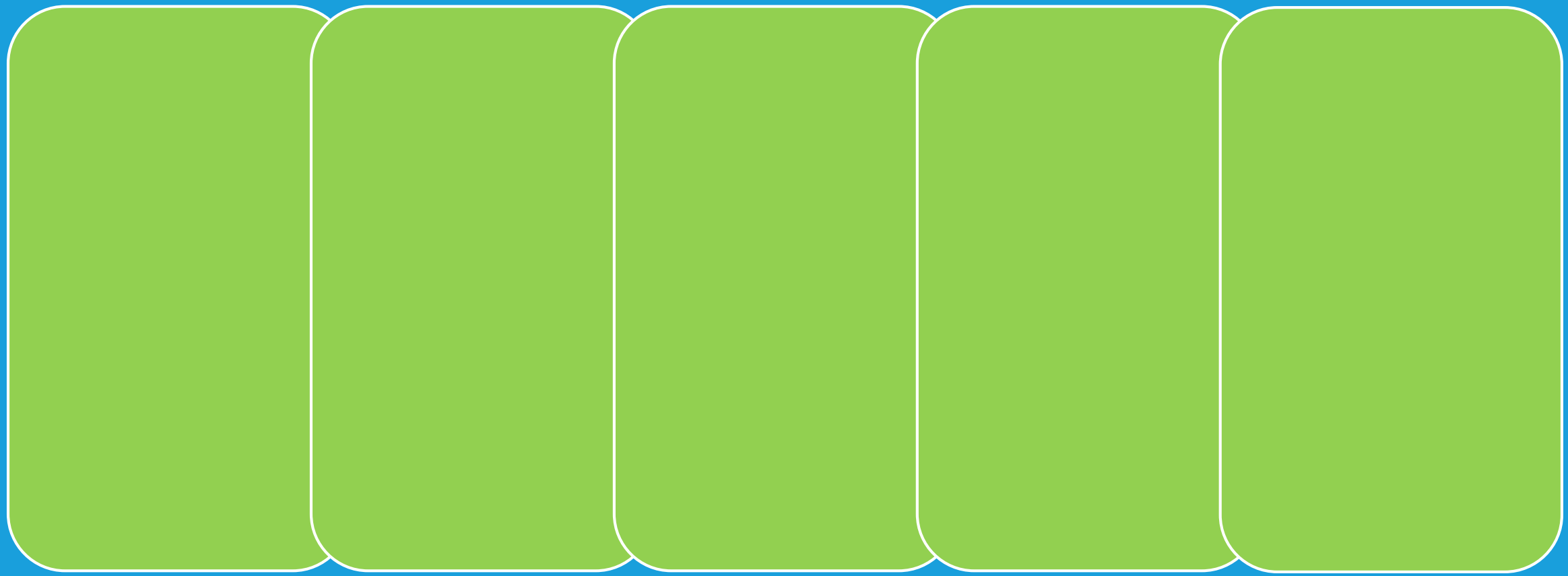
Getting the right direction…

On paper, an APIS for every item & personnel signed-off

Whole railway upgrade includes a change to the Safety Management System (SMS)

Obtaining confidence that we are prepared & ready for service, with no operational safety issues was essential

Evidence



Evidence

The need for confidence included:

- Proof of systems over a prolonged period, in a variety of conditions
- Proof that ORF can be applied in practice (not just training)
- Proof that competence does come from the training regime
- Proof of overall operational performance
- *Leading to evidence that can be accepted by independent assessment*

Operational HF Testing

Relevant

Well managed

Observed & recorded

Operational HF Testing

We develop a list of test cases.

1

Relevant

Development of test cases

	Normal	Abnormal	Emergency
1. Preparing systems & equipment for operations	x	x	
2. Exchanging operators	x	x	
3. Moving trains supervised entirely by the system	x		
4. Additional driver & signaller support to train movements	x	x	
5. Interaction with the legacy system	x	x	
6. All types of restrictions		x	
7. Maintaining the railway & moving maintenance vehicles	x	x	
8. Faults & failures		x	
9. Incidents and emergencies			x

Development of test cases

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Operational HF Testing

We develop a list of test cases.

Then complete a Task Analysis per role for each test case.

We identify the “Key Measure Questions” (KMQ)
that will tell us what we need to know about
the usability, the procedures/ rules & the training.

Development of test cases

	Normal	Abnormal	Emergency
1. Preparing systems & equipment for operations	x	x	
2. Exchanging operators	x	x	
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4. Additional driver & signaller support to train movements	x	x	
5. Interaction with the legacy system	x	x	
6. All types of restrictions		x	
7. Maintaining the railway & moving maintenance vehicles	x	x	
8. Faults & failures		x	
9. Incidents and emergencies			x

Operational HF Testing

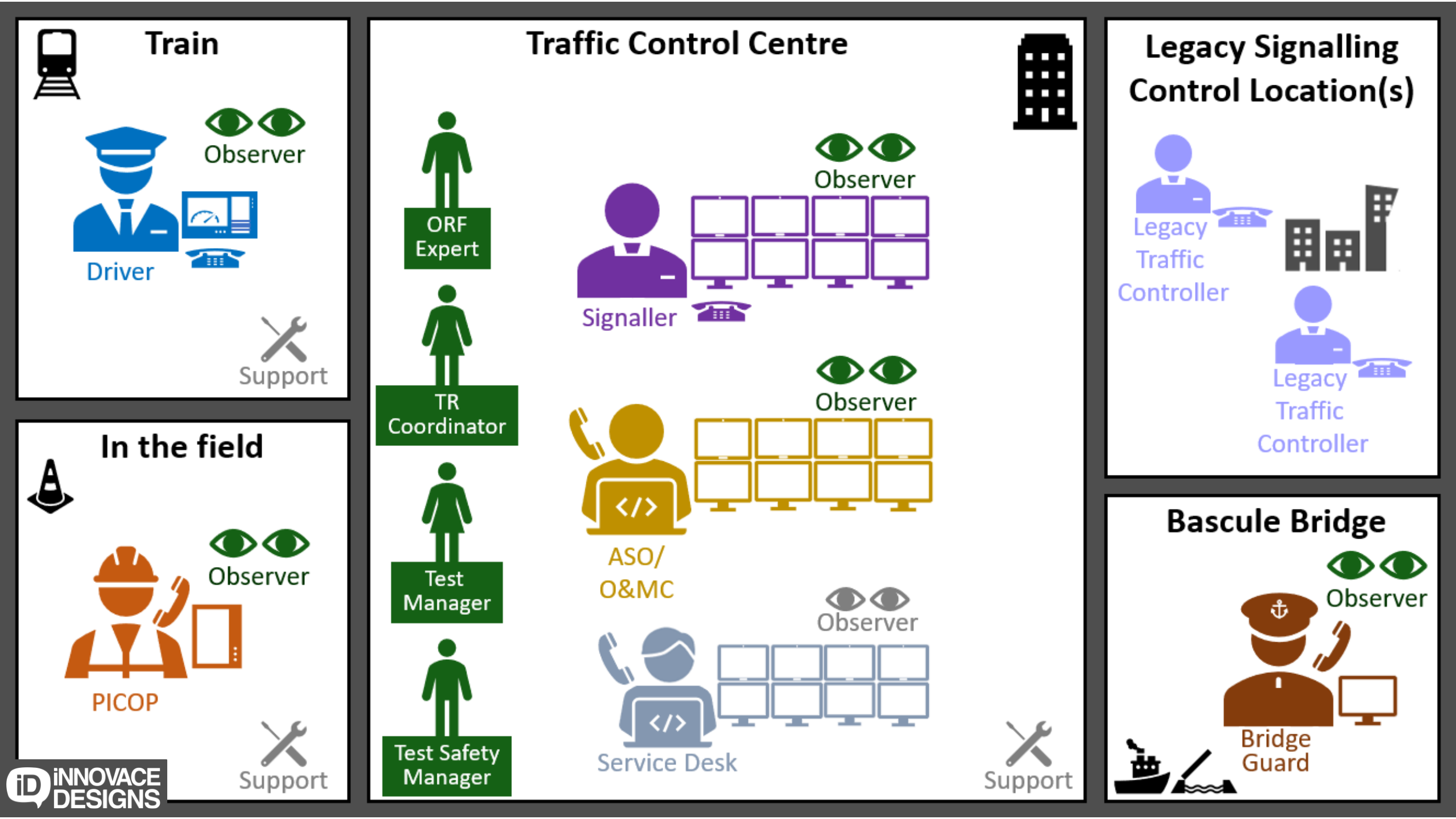
We run the railway as though operational.

Testing real life scenar[2]th safeguards in place.

Never put people or assets in a dangerous situation.

Well managed

We use simulation & trigger “for the purpose of the test”.


Train
Observer
Driver
Support
In the field
Observer
PICOP
Support
Traffic Control Centre
ORF Expert
TR Coordinator
Test Manager
Test Safety Manager
Observer
Signaller
Observer
ASO/ O&MC
Observer
Service Desk
Support
Legacy Signalling Control Location(s)
Legacy Traffic Controller
Legacy Traffic Controller
Bascule Bridge
Observer
Bridge Guard
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Operational HF Testing

We collect observations against what people *really do*

We use HF/ TR observers, trained in observational skills

& some ra[3] operations.

Mostly, they followed the observation sheets & KMQs.

Observed & recorded

We watch for actions, communications, team behaviours;

we ask for “talk-aloud” about options etc.

Answers are P, D, F, (TF).

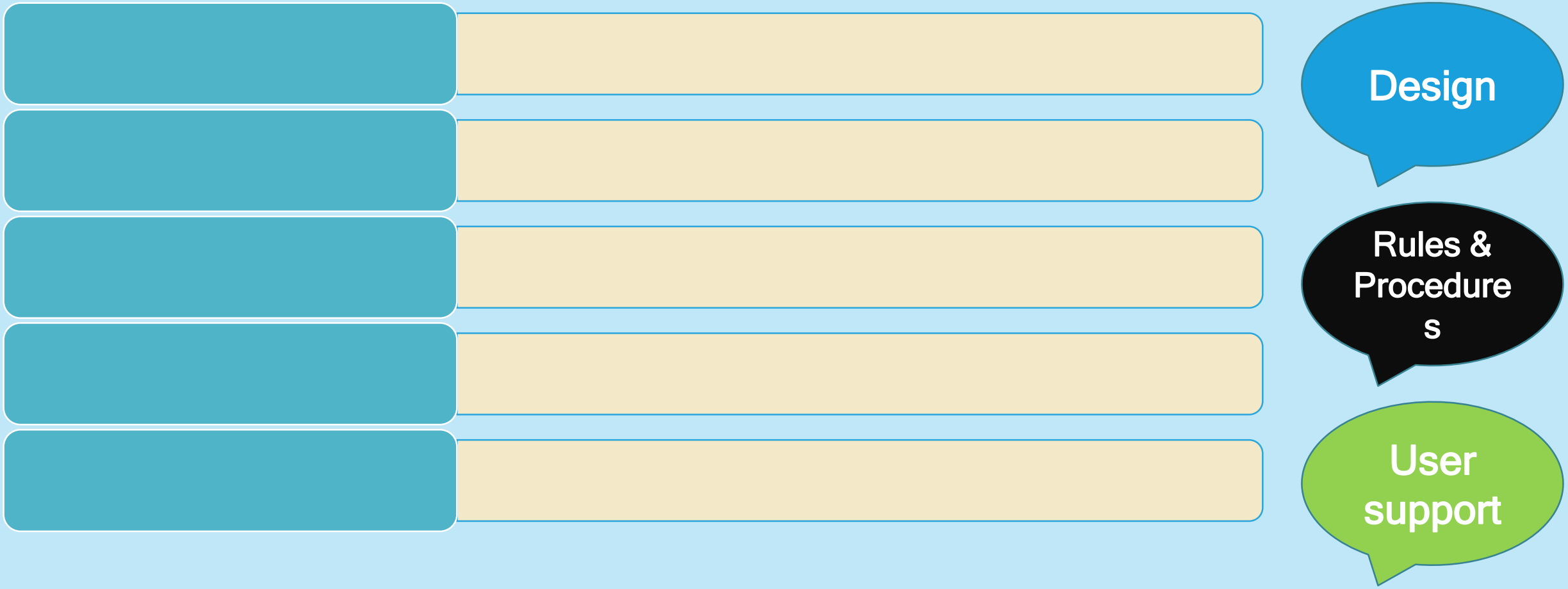
Operational HF Testing

Relevant

Well managed

Observed & recorded

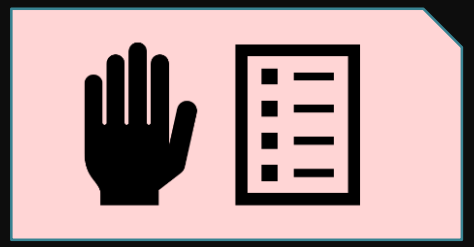
Improvement cycle

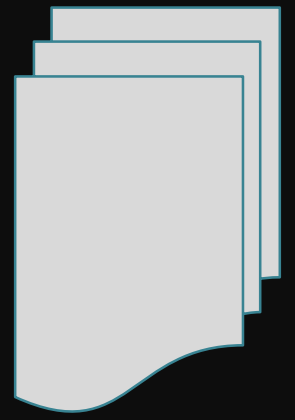


Improvement cycle

Collate Findings	• From all observations; critical tasks.
Debrief & Feedback	• Cross-party; non judgemental.
Improvement Items	• Investigate; consider solutions.
Retest	• Same KMQs; same & different tests.
Closure Evidence	• When confident with results.

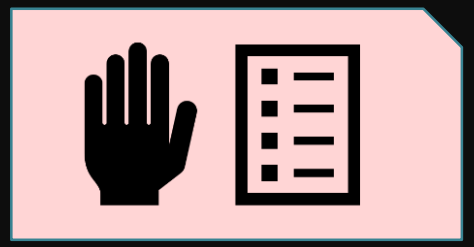
Railway Safety Package





Railway Safety Package

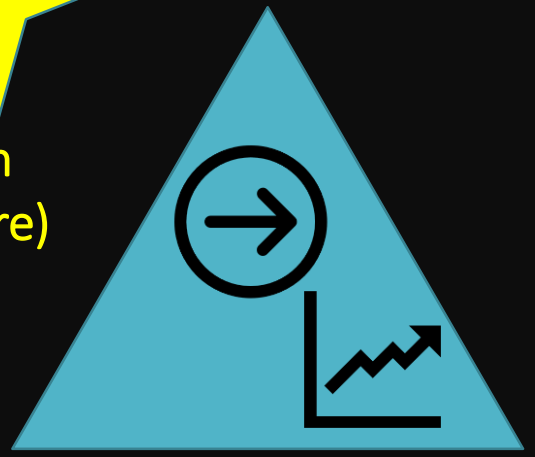
Safety Open Points (Closure)



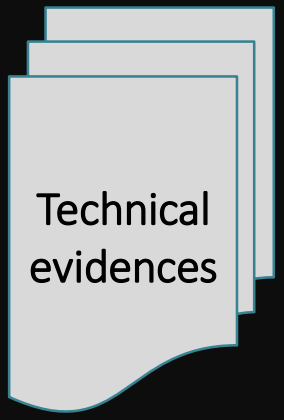
Limitation Items

Summary Test Report

Operational Hazard Record

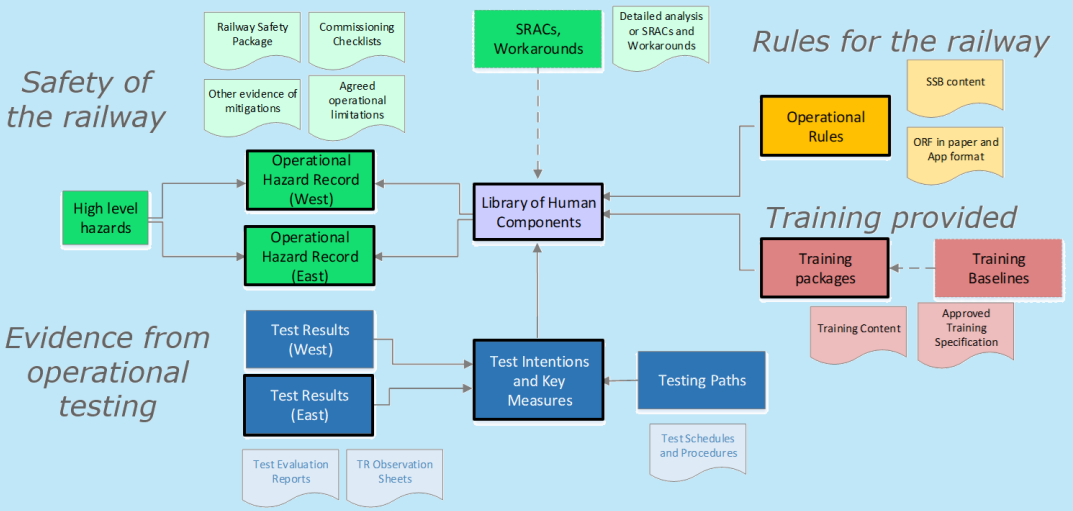


Improvement Items (Closure)

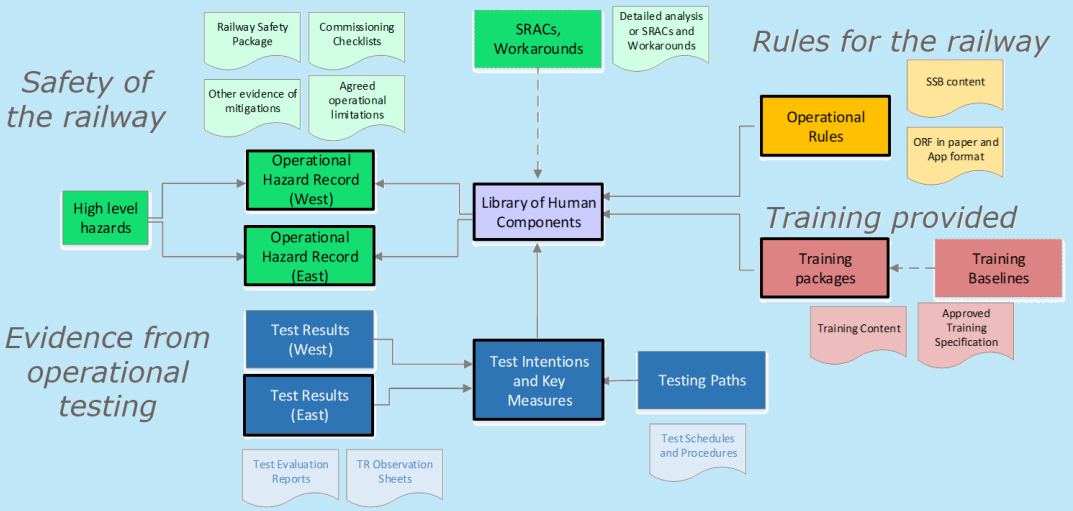


Technical evidences

Human Component Mapping



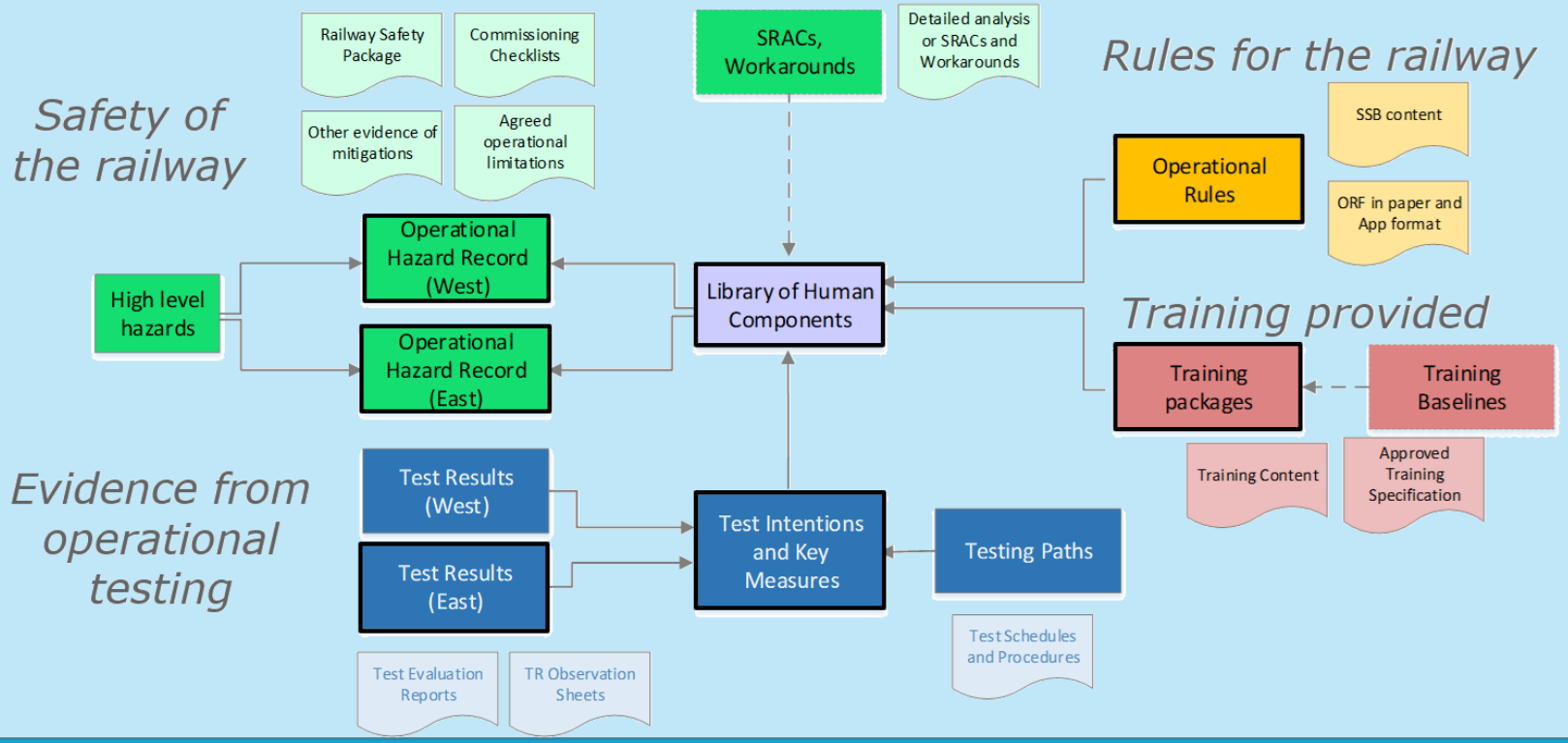
Human Component Mapping



Human Component Mapping

A central idea is that we can map certain Human Factors attributes between

* Operational Hazard Record
* Rules & procedures
* Training material
* HF tests (KMQs)



Human Component Mapping

Library of HC's links using:

* ***Product*** design & interaction.

* What the ***person must understand & apply***.

* Influence of ***communications***.

* How the ***organisation*** supports them.

Human Component Mapping

HCM uses a relational database.

The approach is to simply allocate HC's so that you can query the database and find the answer to any combination.

E.g. what tests provided closure evidence?

E.g. which training supports procedures?

E.g. what do we need to re-test if we change a rule?

Example findings

Understanding & Application

Different people interpreted the same (apparently clear) rules & procedures in a number of ways.

Noticeable differences between types of roles, instructors, locations, etc.

EXAMPLES:

(a) Train awaking and leaving a Permanent Shunting Area.

(b) Upgrading from Written Order to supervision.

Habits & perceptions

Changing from “old ways” to “new ways” is not always easy for tasks that are equivalent.

Difficulty unlearning habits from Legacy systems; or some already developed using the new system (1 year on).

EXAMPLES:

(a) Location of the train – who reports & what information is allowed to be used.

(b) Use of phonetic alphabet & single digit numbers.

(c) Use of verbal and written authorities to check a nonconformity in the track.

Confidence & support

People wanted reassurance from others & from paperwork.

"Real life" TR presented stressors that resulted in lack of confidence/ need for support.

Beneficial to explain that it's OK to use support, & much better to be correct!

EXAMPLES:

(a) Actions creating Trip-Mode & follow-up options.

(b) Setting a Temporary Speed Restriction, depending on who reports.

(c) Remembering to add in additional information to Written Orders.

Conclusion...

Most everyone taking part said that the HF testing environment was a ***positive supplement to training***. Even simulations, managed in the correct way, provided results that have made a big difference, with a lot of ***improvements executed prior to commissioning***.

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