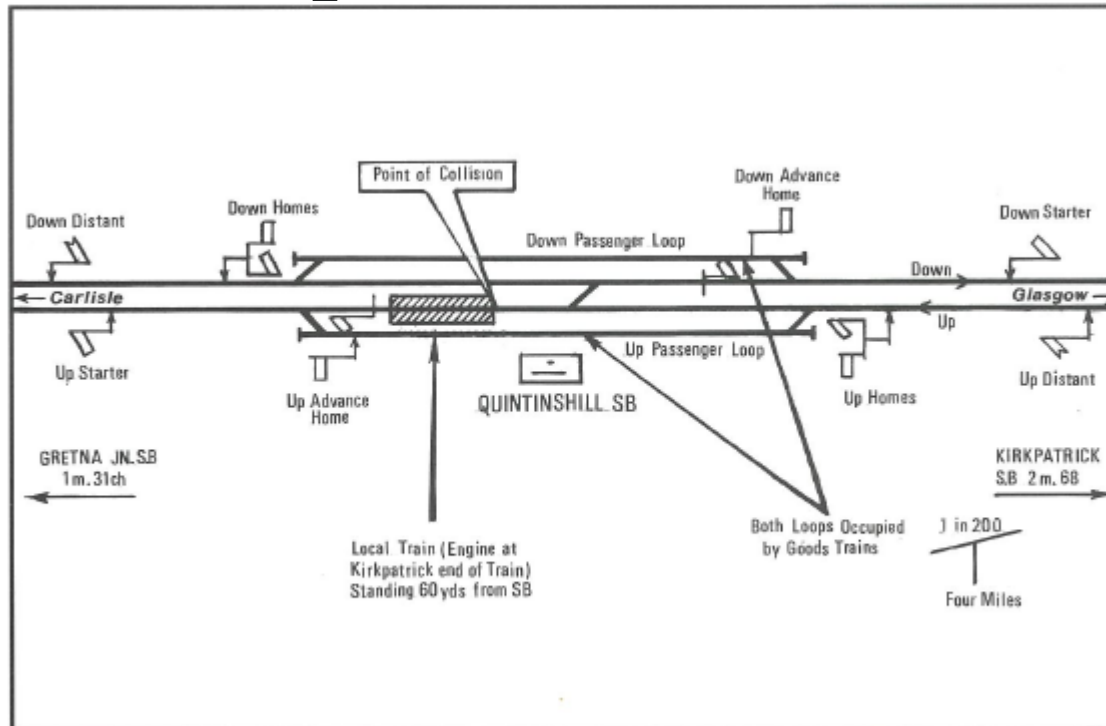


Sleeves, Blocks & Keys

PYB Consulting

Incident at Quintinshill UK 1915



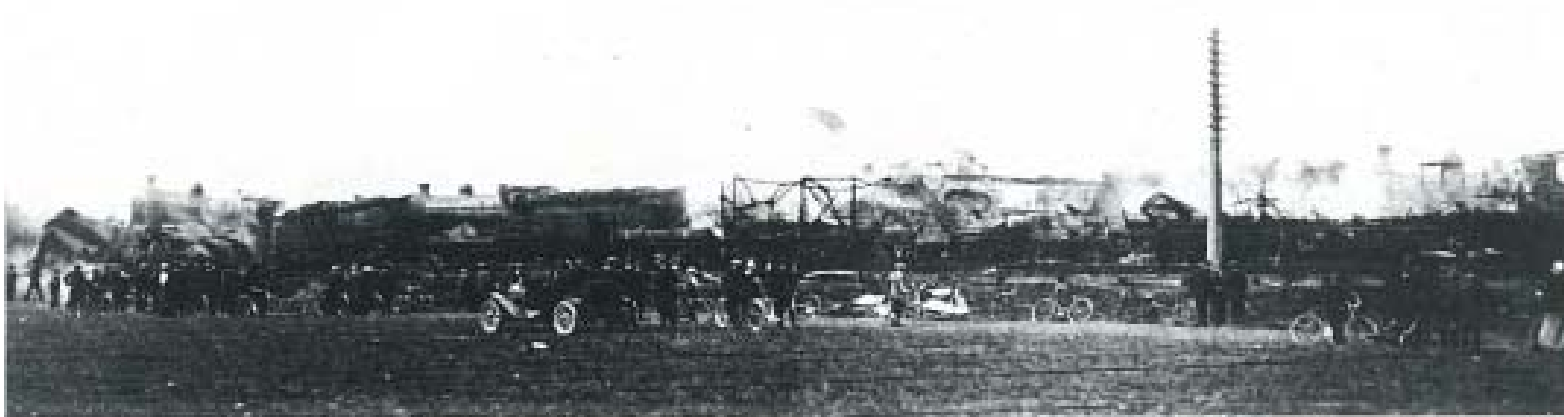
- **Early morning WW1 (22 May 1915)**

- This incident occurred at a busy junction around the time of a shift changeover. A local train had been shunted onto the “wrong line” waiting departure of another train. This was a common practice which required the placing of a protective collar (signaller reminder device – UK equivalent of our “sleeve”) on the lever controlling the protecting signal for that line.

Incident at Quintinshill UK 1915

- **The role of human error**

- The signaller neglected to place the collar. Following the shift changeover the incoming signaller accepted an express train and cleared the signals which allowed it to collide with the temporarily shunted local train. Many lives were lost.
- This incident illustrates the role of human error in such accidents. Modern signalling would provide a track circuit interlocked with the signalling to protect a train sitting wrong-line, but may still require the placing of the collar in some circumstances.



Not really signalling?

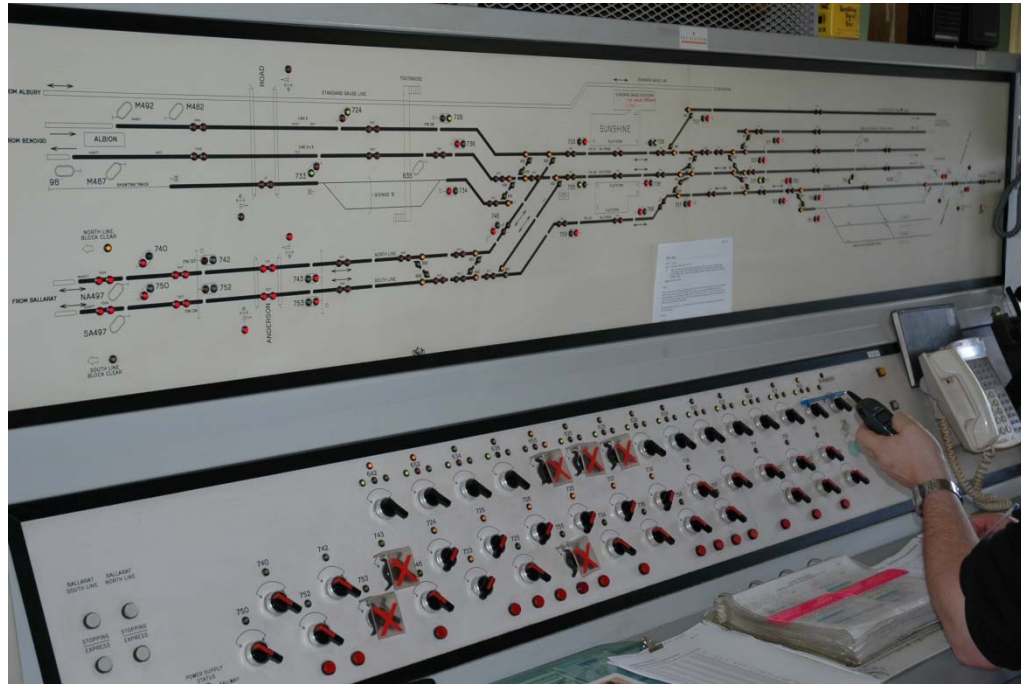
- **Minimal reference in Victorian Rule Book**
 - Section 5, para 10(f)
 - When signalling is out of service (**sleeve to be applied**)
 - Section 30, paras 12(f) and (g)
 - Working of track machines (**sleeve to be applied**)
- **Called up in VRIOGS 012.1 (REV B) Para 6.10.5 (b)(iii)**
 - *“Provision shall be made to enable signals and/or points to be **sleeved** or **blocked** by implementation in the interlocking functions for the purpose of allowing track and signalling maintenance to be carried out. The design shall be such that any **blocked** objects shall continue to be **blocked** on system start-up without any operator intervention.”*
- **A device in search of a requirement?**
 - “Reminder Device” To remind myself or another signaller, perhaps next shift;
 - A “tag” as seen in the mining industry; To protect myself (technician control).







Historic perspective



- **A Sleeve is a “reminder device”**
 - Called a “Collar” in the UK
 - Sometimes less elegant than the one shown here
 - One sleeve = one lever function (ie signal or point)

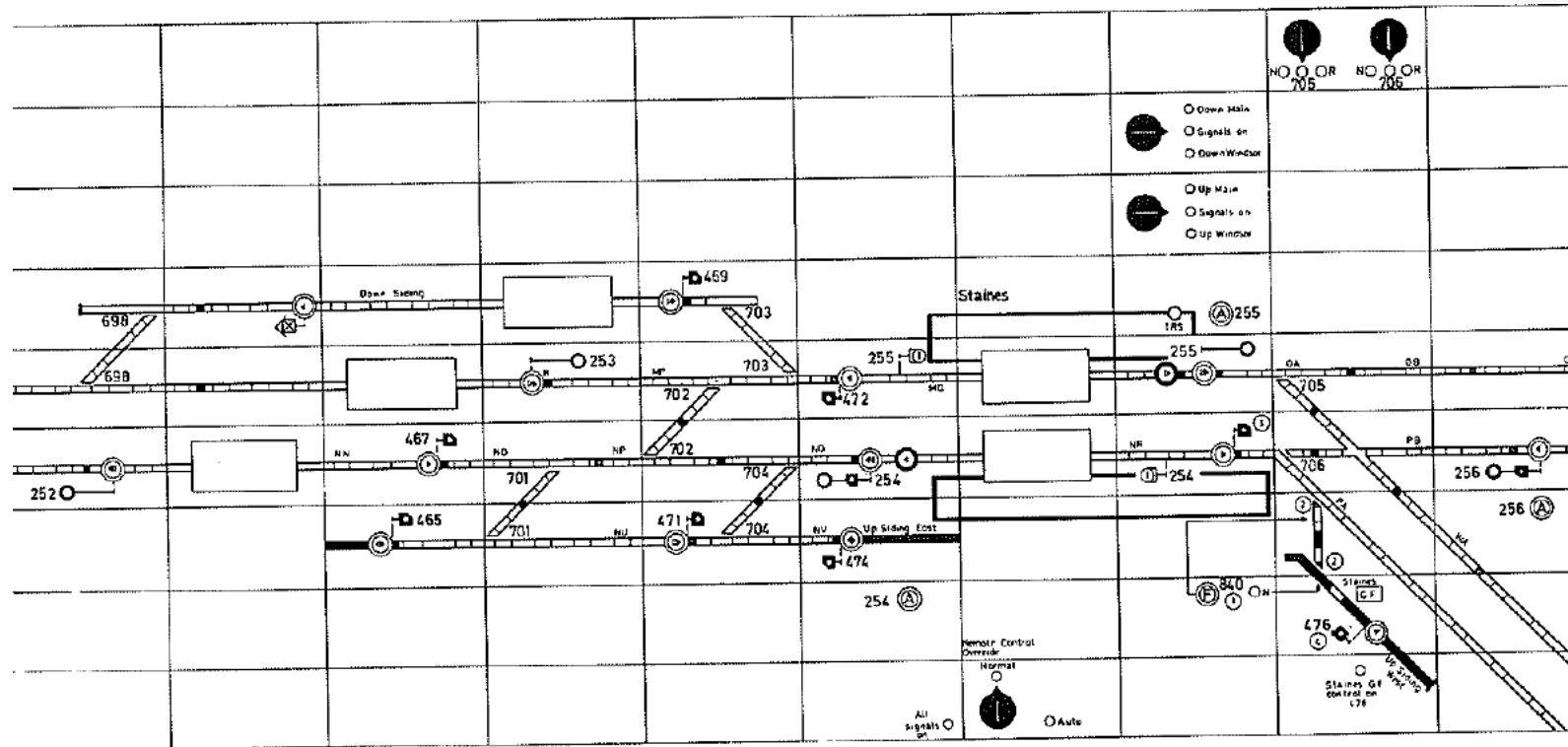
More modern unit lever



Condition	Displayed	Detailed
Normal (Cancelled)	Red Aspect	
Reverse (Clear)	Green Aspect	
Approach Operated	Flashing Green Aspect	
Approach Locking Release	Flashing Red Aspect	
Signal Blocked	Block Indication	
Signal Label Off	Detailed Text Absent	

- **Specific form was left to the designer**
 - Lever sleeve fits over the key-switch
 - Perspex with red cross was modern version
 - VDU implementation depends on supplier
- **Point levers 2-position**

Route Setting Panel



- **Innovation occurs**

- Sleeves fit over buttons (entrance or exit)
- Maintainer can apply blocks in the interlocking
- Point levers are 3-position (centre position introduced)

Control System or Interlocking?

- **Control System**
 - Cannot set route (based on parameter)
 - Cannot operate points (key and sleeve)
- **Interlocking System**
 - Technicians Control
 - Technicians terminal for SSI;
 - Technician's keys input to interlocking (NSW)
 - Key
 - "Vital" Blocking

Type of Object Restricted	Control System concept	Interlocking system concept
Route	Route cannot set	Route cannot set
Signal	No route from (or to)	No Proceed Aspect
Track	No route including	Occupied
Points	Locked in position	Locked in position

Many variants available on a theme

- **Signal Block**
 - Can set route but not clear signal (SSI technician's control)
 - Cannot set route from signal (Phoenix, Sigview, Westcad)
- **Route Block**
 - Cannot set route (all systems)
- **Track Block**
 - Can set route but not clear signal over track (SSI technician's control)
 - Cannot set route over track (Phoenix, Sigview, Westcad)
- **Point Lock**
 - Cannot move points from locked position (SSI technician's control)
 - Cannot move points from locked position (Phoenix, Sigview, Westcad)
 - Cannot set route over points (Phoenix WA version)
- **Point Key**
 - Can only set route over points in keyed position (general route setting)
- **Signal Stop Key**
 - Can set route but not clear signal (route setting with signal replace control)

Many attributes to choose from

- **Integrity**
 - A measure of the degree to which the (sub)system reliably issues the required commands and accurately processes the required inputs; including that uncommanded requests are not issued
- **Persistence**
 - The requirement that relevant (sub)system states present at (sub)system shutdown are accurately restored when the system is re-started prior to recommencing its normal operating function
- **Vitality**
 - SIL-4?
 - Is the information stored in the interlocking, the control system, or both
- **Functional**
 - Is the control applied by the signaller or the maintainer
 - Where does it act (route level, aspect level, lock points)?

“Vital Blocking” – Impact on complexity

- **Low Complexity**
 - Interlocking blocks in interlocking
 - Control system blocks in control system
- **High Complexity**
 - Control system blocks in interlocking
- **Highly challenging**
 - Interlocking blocks in Control System

VIXL	Total latches	Vital Block latches	Percentage
MYD RL	491	163	33%
MYD SKN	442	86	19%
MYD SPJ	535	221	41%
MYD WEST	741	276	37%
Total	2209	746	34%

Historic Incidents and Hazards

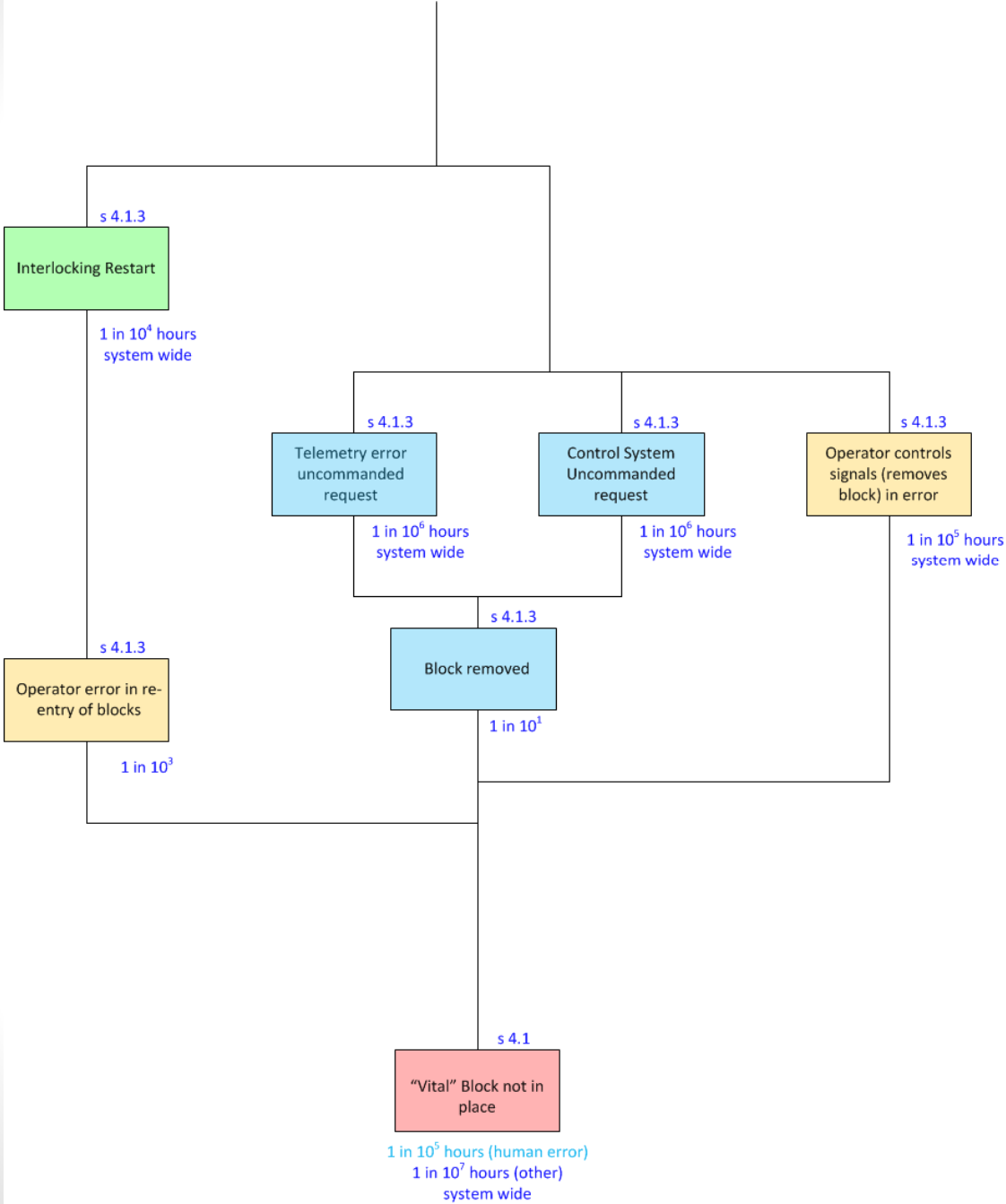
- **Quintinshill (1915 - UK)**
 - Train was shunted onto “wrong line” waiting departure of a train
 - Signaller neglected to place “collar” on home signal lever
 - Shift changeover occurred
 - Troop train was accepted and collision occurred. Many deaths.
- **Metrol TDS (Federation Square - 1990s)**
 - Sleeves were stored in JZA 715 for occupation
 - JZA system restart occurred
 - Sleeves were not restored
 - ARS signalled train towards Occupation protected zone
- **South Kensington failure mode (potential)**
 - Sleeves are stored in JZA 715 for occupations
 - If comms link fails, SSI implements “emergency mode” working
 - Points are switched to normal and signals clear
 - Train can be signalled towards Occupation protected zone

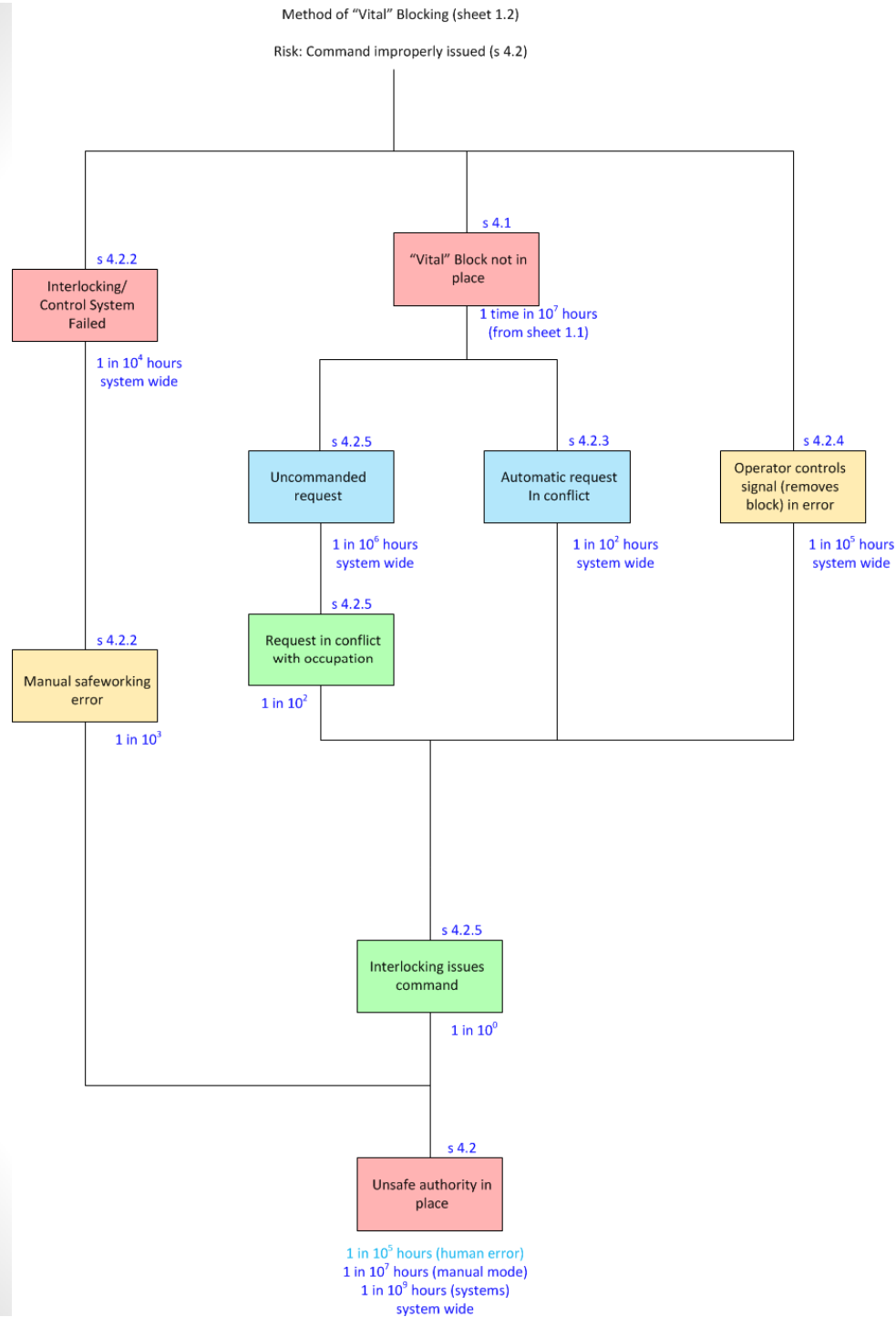
Risk model – Hazard Identification

- **One size does not necessarily fit all**
 - Attributes can be mixed and matched
 - Different brands, configurations favour different mix
 - No one right answer
 - KISS principle applies
- **Identified sources of hazard**
 - Human error (sleeve not applied or signaller action in error)
 - System restart
 - systems and processes cause incident
 - Incident due to use of manual safeworking
 - Uncommanded actions within systems
 - System causes train to challenge occupation unnecessarily
 - Data complexity in Vital Systems
- **Risk model (following pages)**
 - Vital blocking vs
 - Non vital sleeving

Method of "Vital" Blocking (sheet 1.1)

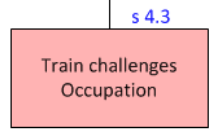
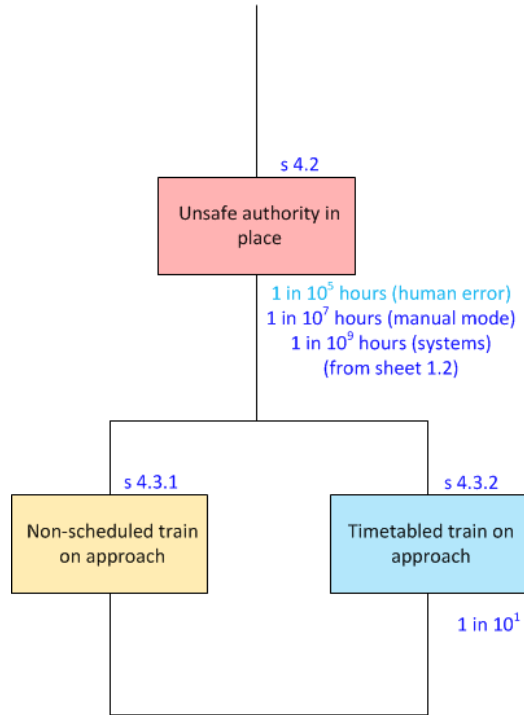
Risk: Block not in place (s 4.1)



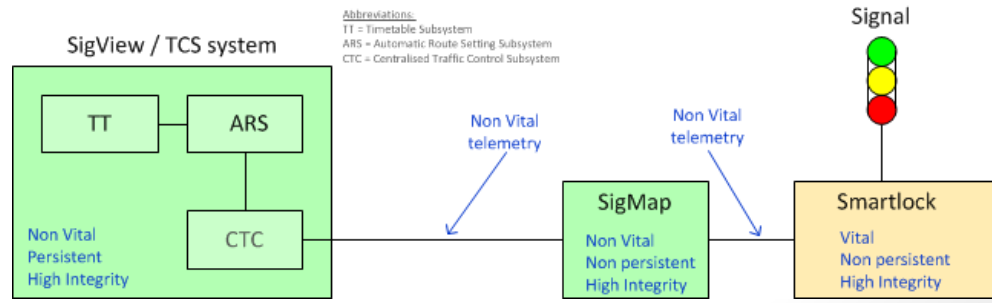


Method of "Vital" Blocking (Sheet 1.3)

Risk: Train on approach to Occupation (s 4.3)

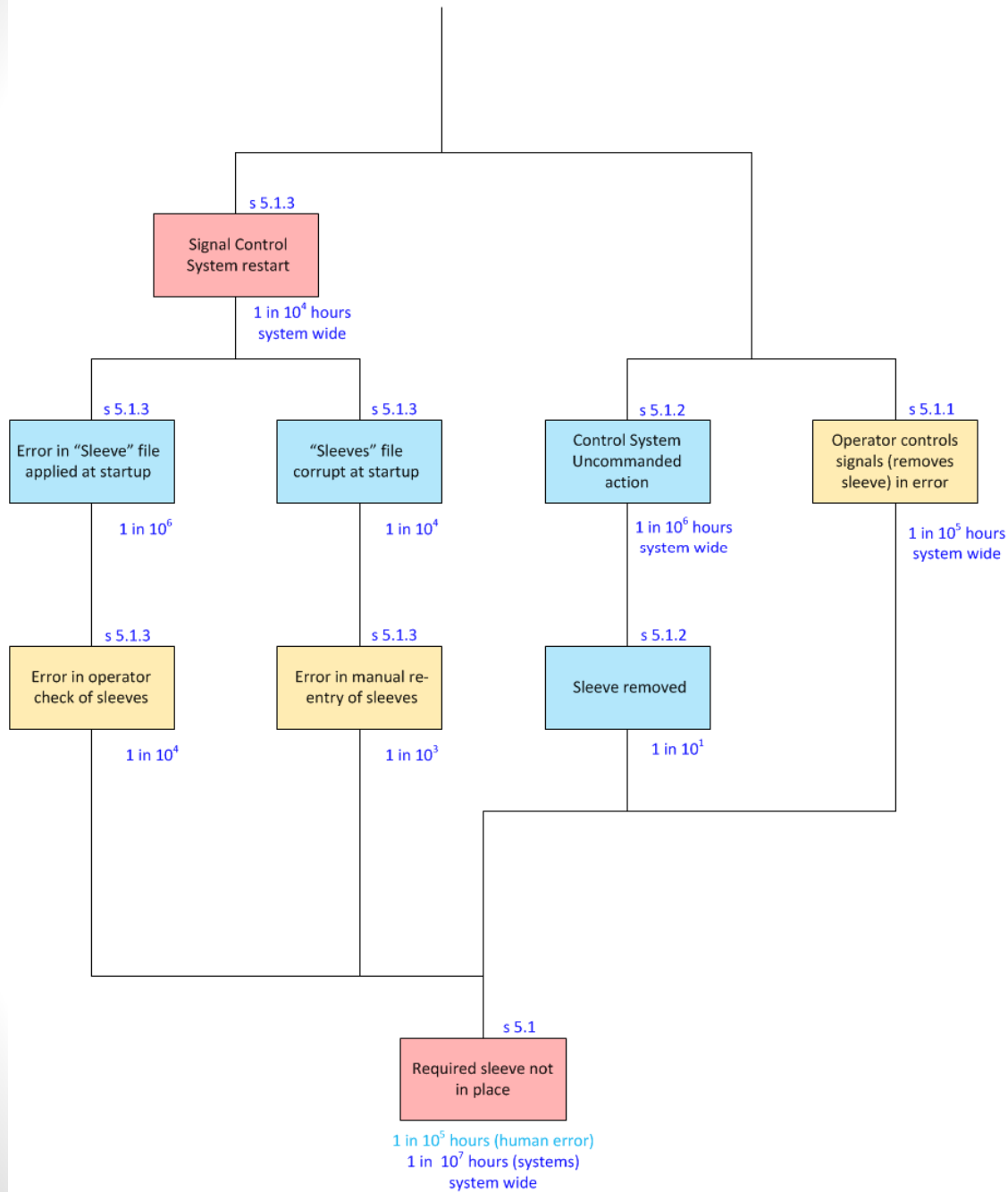


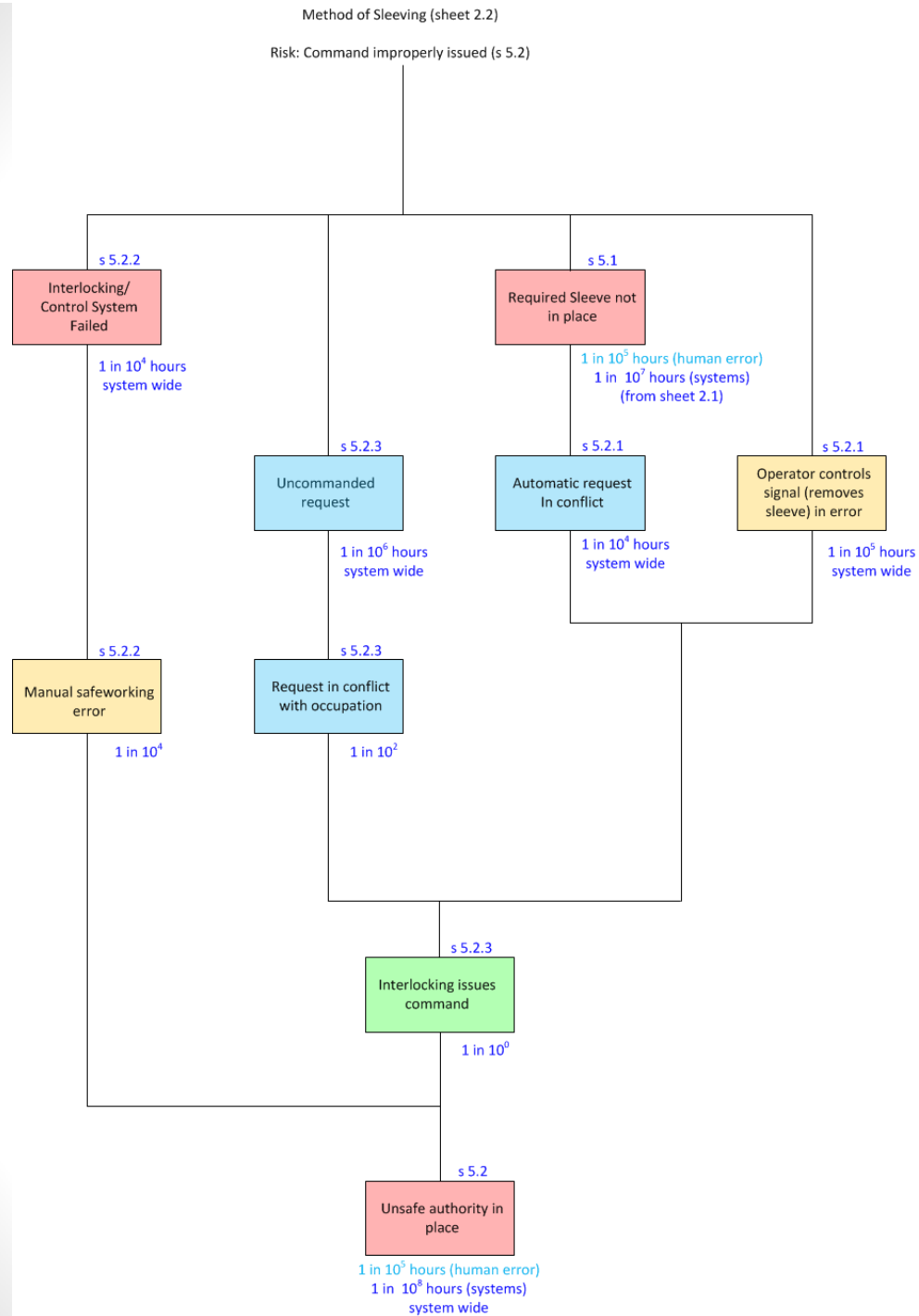
1 in 10⁶ hours (human error)
 1 in 10⁸ hours (manual mode)
 1 in 10¹⁰ hours (systems) system wide



Abbreviations:
 TT = Timetable Subsystem
 ARS = Automatic Route Setting Subsystem
 CTC = Centralised Traffic Control Subsystem

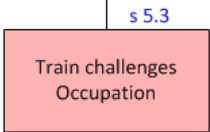
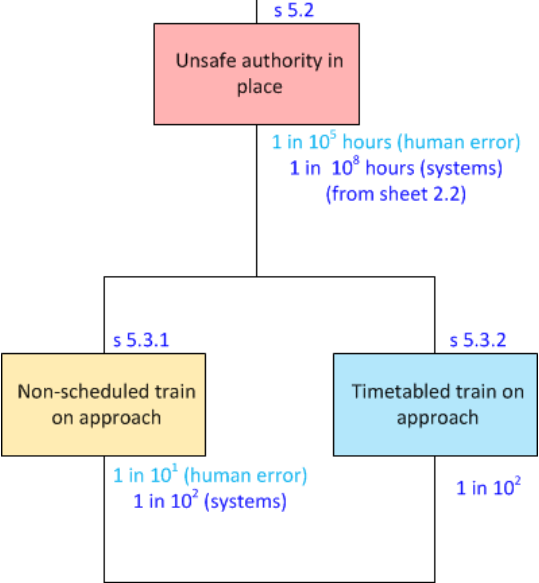
Sleeves, Blocks & Keys



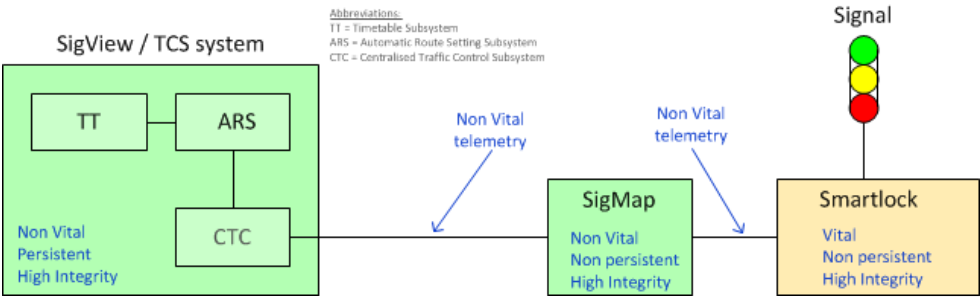


Method of Sleeving (sheet 2.3)

Risk: Train on approach to Occupation (s 5.3)

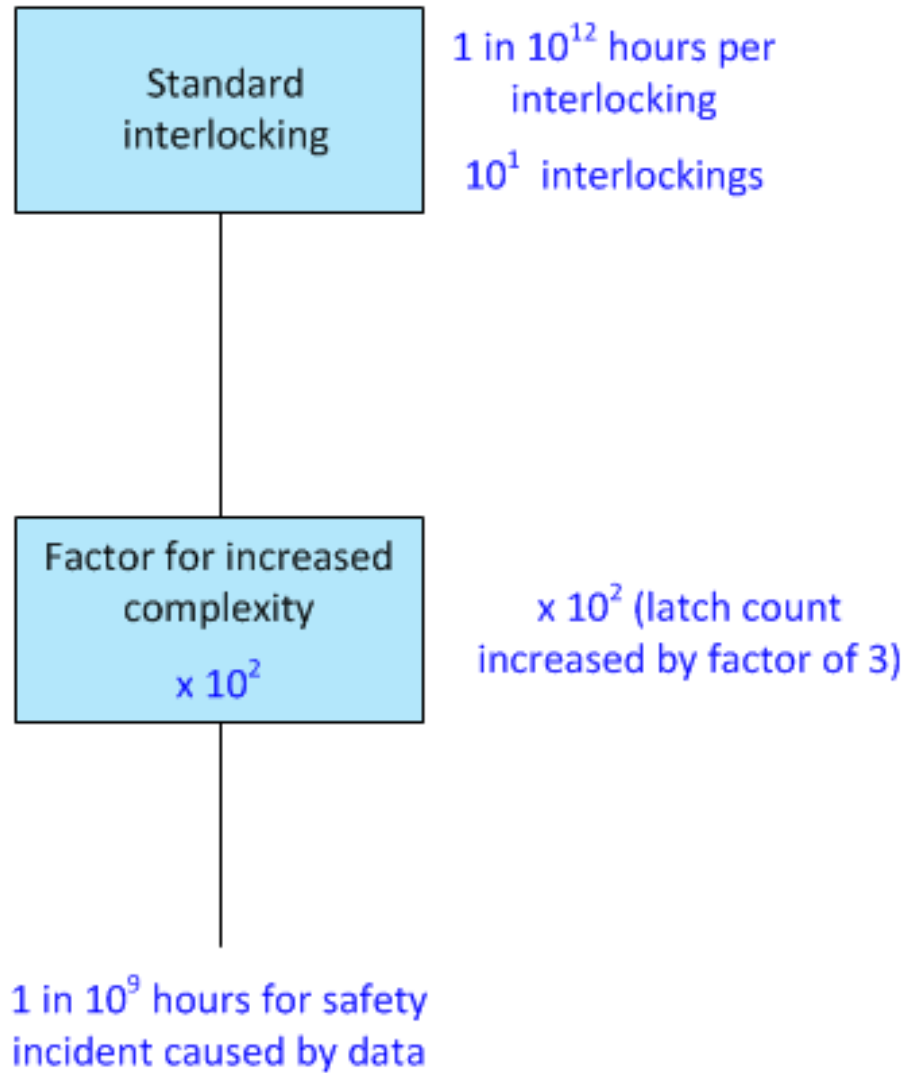


1 in 10⁶ hours (human error)
1 in 10¹⁰ hours (systems)
system wide



Abbreviations:
TT = Timetable Subsystem
ARS = Automatic Route Setting Subsystem
CTC = Centralised Traffic Control Subsystem

Risk Analysis – Safety Incident due to interlocking data complexity



Our Responsibility

- **Responsibility of experts**

- Sheppard J:
 - “... the court will nevertheless take into account evidence given by persons experienced in the particular profession involved as to standards which are considered appropriate within a profession.”
- Hochfelder v Ernst & Ernst:
 - “... we are not constrained to accept faulty standards of practice otherwise generally accepted in an industry or profession.”
- There is a need for a profession to ensure that standards are “up to date” and have taken account changing circumstances and technology

