

Degraded mode working

PYB Consulting

What is degraded mode?

- **AS 61509 (Pt 7) Functional safety for electrical/ electronic/ programmable electronic safety related systems**
 - C.3.11 Graceful degradation
 - This technique gives priorities to the various functions to be carried out by the system.
 - Recommended for SIL 3 & 4
- **Obtaining the “protection of the interlocking”**
 - Victorian Rule Book, Section 2, clause 18(m)
 - “The competent employee must use the applicable signal lever to ensure the **security of the interlocking**. However, if the line is track circuited, the signal itself will remain at “stop”.
 - “The competent employee in charge of the platform directing the movement must take up a position convenient for controlling the operation by hand signal.”

Safeworking modes

- **Normal Working**

- Train movement occurs with proceed authority
 - Signal displays a proceed aspect
- Risk level minimal with proceed aspect displayed

- **Degraded Mode**

- Train movement occurs with route set but no proceed aspect
 - Authority to move is by “Caution Order”
- Risk level similar order to normal working, with reduced train speed

- **Manual Safeworking**

- Train movement occurs without route set (“unsignalled move”)
 - Authority to move is by “Caution Order”
- Risk level higher than for normal working or degraded mode

What happens after the train stops?



Why not just remove all the points?

- **Tokyo**
 - Home of “group running”
 - Even the trains are colour coded



Why not just remove all the points?

- Tokyo
 - Home of “group running”
 - Still makes good use of points

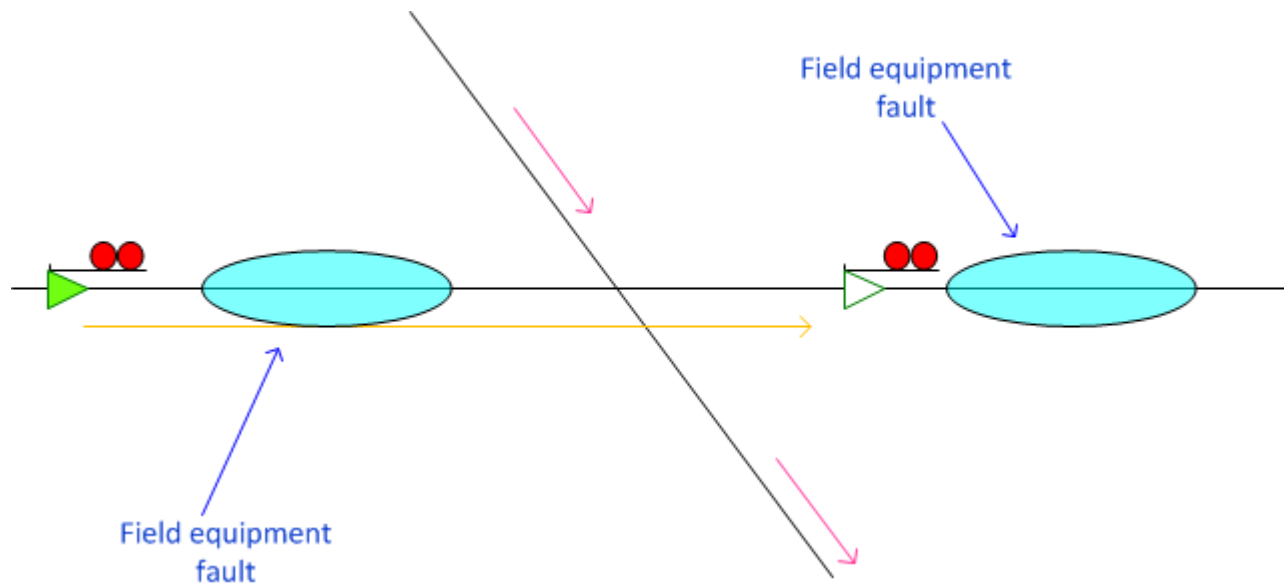


15 April 2015

Degraded mode working

Moving trains under fault conditions

- Without the “protection of the interlocking”
 - Equipment fault occurs in the field.
 - Train movement occurs using “caution order” assisted by people in the field
 - “Unsignalled move” carries risk of unprotected conflict



Back to the future

- **IRSE Proceedings 1925: Sadler**

- “Continental practice in the working of points and signals by the compensated double wire transmission system”.
- Route lever put to position first before moving point levers
- Route lever is locked by other route levers
- Point levers are locked by route levers

- **UK: May 1933**

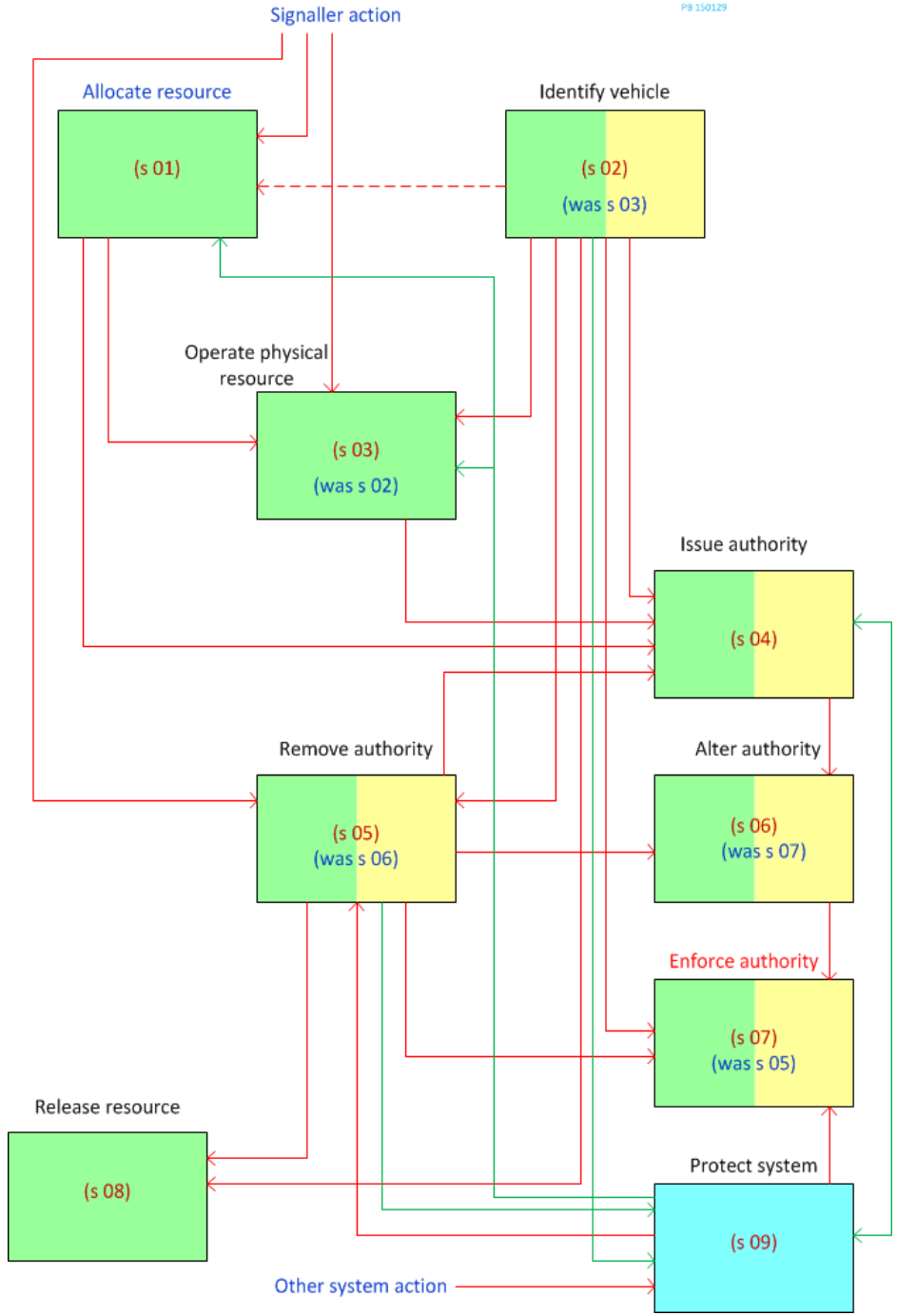
- First relay interlocked control panel - at Goole Bridge signal box in the North Eastern Region
- Route lever is locked by other route levers

- **UK: 1962**

- Route Relay interlockings utilising N-X panels
- Route setting interlockings use route setting principles

Generic Signalling Processes

PB 150129



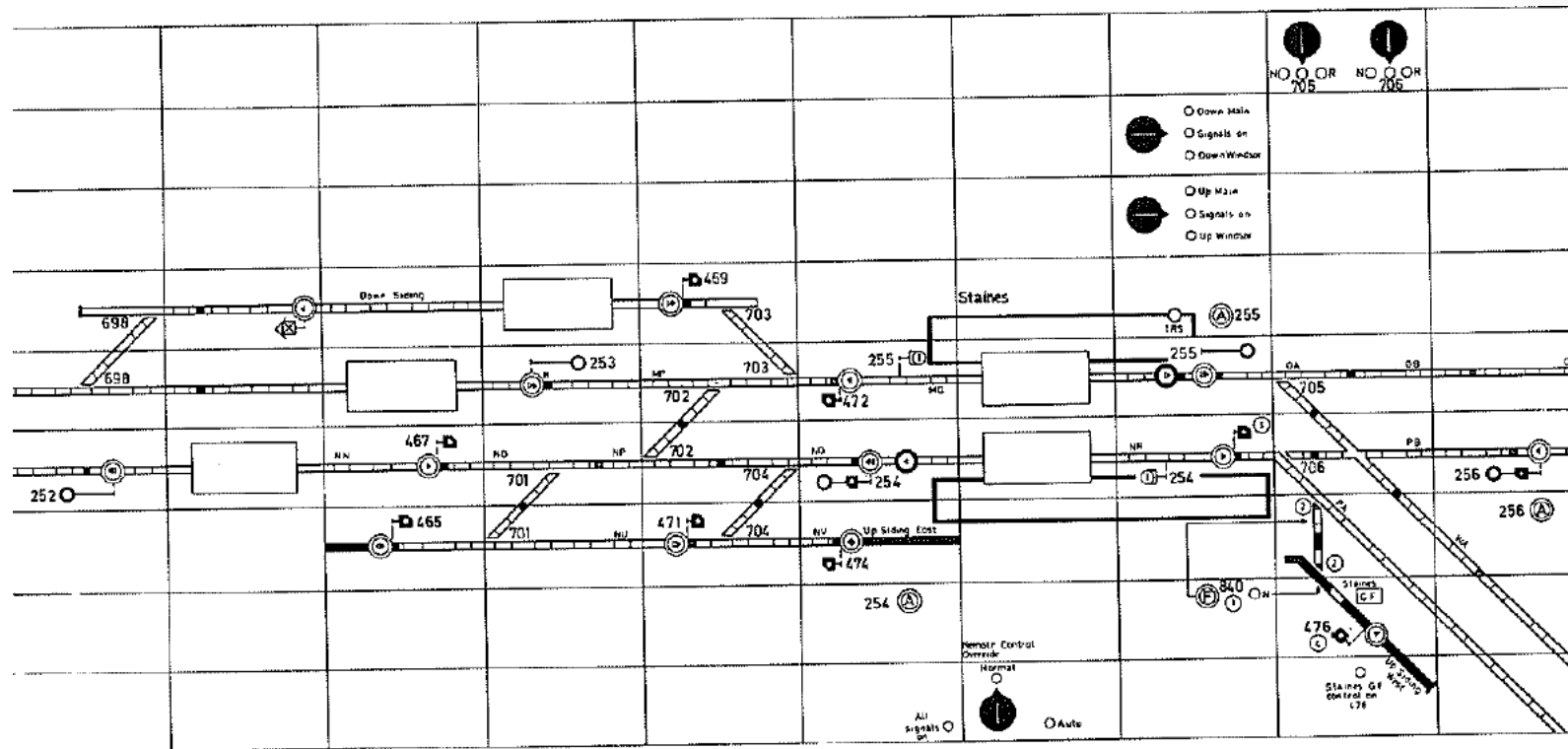
Signalling framework

- **Section 1 = Allocation of resources (setting of route)**
 - Follows IRSE News March 2015 Tech Paper (Pascal Poisson & Jacques Pore)
 - Resource may be allocated if not allocated to a conflicting purpose
 - Variables are at level of signaller intentions (own or other signaller)
 - Allocation and release are not symmetrical
- **Section 4 = Issue of authority (display of proceed aspect)**
 - Authority can be given if:
 - Required resources are allocated
 - Field conditions required are present
 - Release and removal of authority may be symmetrical or not symmetrical
- **Section 8 = Release of resources (route locking released)**
 - Resource may be released when no longer required for a purpose
 - Train has passed clear of resource and it is no longer required
 - Authority has been removed and no train is approaching
 - Train has responded to removal of authority and does not require resource

Conditions tested at appropriate levels

- **Route level: internal states controlled by the Signaller**
 - Interlocking is functioning
 - Opposing routes not set and not in progress
 - Points controlled to position or called in sequence
 - Local control and slot controls not given
 - Route level blocks not applied
- **Aspect level: conditions in the field (may be continuous)**
 - Points in correspondence
 - Track circuits clear
 - Cross boundary conditions normal
 - Aspect level blocks not applied
- **Swinging overlaps (facing points)**
 - Risk of signal dropping to stop during transition must be managed
 - Point transition timer provided
 - Aspect maintained till correspondence achieved or timer expires
 - Aspect step up prevented during transition

Route Setting Panel



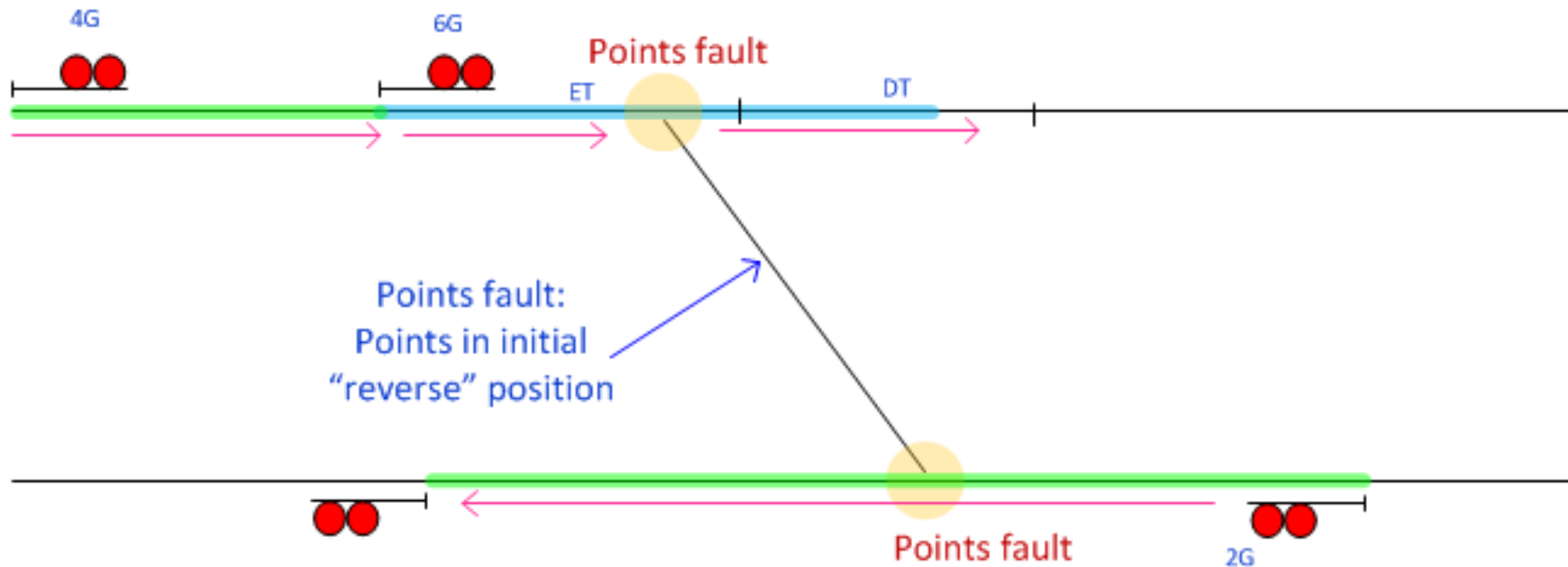
- **Innovation occurs**

- Signaller signals intent by pushing buttons (entrance or exit)
- Command is sent and route sets as points are commanded to position
- No proceed aspect can be displayed until points are in correspondence

Route setting panel with routes set

- **The signallers view**

- “Green bar” or equivalent confirms “protection of interlocking”.
- Any points not yet in position flash “out of correspondence”
- No proceed aspect can be displayed till all field conditions are met
- Conflicting routes are fully locked out



What can go wrong?

- **Train must always pass a red signal to reach failed points**
 - Points will flash out of correspondence
 - Caution order will not be issued without somebody on the ground confirming that the points are secure
- **Low speed collision**
 - Both trains proceeding at “extreme caution”
 - Collision at combined 30kph, crumple zone per train >300mm
 - Passenger impact <3g
 - This experiment is done in trams not infrequently
- **Low speed derailment**
 - Derailment at less than 25kph
 - This experiment has been done, if less frequently
- **“Start against Stop” (deus ex machina) scenario**
 - Probability is not increased by having the route set
 - **It is the change in risk caused by the action which is important**

Some of the details

- **J-bits**
 - It is an external input from the field
 - Test at aspect level only
 - Do not use to lock points
- **Flank points (when tested)**
 - Are points!
 - Test controlled to position at route level
 - Test in correspondence (or initially in correspondence) in aspect
- **Points in overlap**
 - May not be required for low speed (c light) moves
 - Multiple route classes are required to support this requirement
- **Point handles (lessons learned)**
 - Turning off all the signal lamps is not recommended
 - More than one point handle is needed to run trains

Other opportunities

- **Trailable points**
 - Standard practice on Continent (IRSE paper 1925)
 - Signalled authority requires points in correspondence
 - All other moves are at low speed suitable for trailing
 - Only facing points require to be secured by clip
- **Time of operation locking**
 - Should not prevent the setting of any route
 - Potential for pre-locking style faults with route level locking
- **Eppur si muove**
 - Observation by Galileo about the earth
 - (under his breath)

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

