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Level 2

System Specification

Design of Switches and Crossings

Endorsement & Authorisation

Endorsed by:



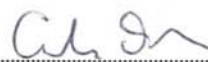
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Issue record

Issue	Date	Comments
0.1	28 July 2006	Stakeholder review comments incorporated, but this issue not published through Business Standards
I	08 Aug 2007	Revised section 16.3.2; Table 3 reviewed; run through requirements finalised

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 31 August 2007.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

See pages 4-5

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1 Purpose

This specification establishes the technical requirements for the development of Switch and Crossing (S&C) systems for use on routes with line speeds up to and including 140mph.

This specification enables the development of system-specific design configurations to be applied to individual product or configuration specific scenarios.

The system specification is to be used by system designers to produce particular designs addressing the requirements of this specification

2 Scope

This specification is applicable to plain lead switch and crossing systems requiring generic approval.

Future developments will build on this specification as required to define configuration specific design specifications (eg NR60/ HPSS and NR60 / Hydrive)

3 Reference documentation

Ref.	Identity Ref.	Issue/Date	Title
1	NR/SP/OHS/069	Issue 2 February 2005	Lineside Facilities for Personnel Safety
2	NR/WI/ELP/27237	Issue 4 April 2006	Overhead Line Work Instructions Module NR/OLE/F04 Issue I December 2005 The Installation and removal of traction bonding on all electrified lines
3	NR/SP/ELP/21085	Issue 2 April 2006	Design of Earthing and Bonding Systems for 25kV AC Electrified Lines.
4	NR/GN/ELP/27022	Issue 2 April 2006	Design and Installation of Negative Bonding and Associated Equipment for electrified lines.
5	NR/SP/ELP/21104	Issue 2 April 2006	Design and Installation of Electric Track Equipment for DC Electrified Lines
6	NR/GN/ELP/27021	Issue 2 April 2006	Electric Track Equipment Layout Design for DC Electrified Lines
7	NR/SP/TRK/032	Issue 2 February 2003	Joining of Rails by Aluminothermic Welding
8	NR/SP/TRK/024	Issue 1 March 1996	Component Kits for BR Mk1 I I, 4- and 6- hole Glued Insulated Joints
9	RT/CE/S/130	Issue 1 August 2003	Flash-welded rails – site-welded

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10	NR/SP/SIG/11752	Issue 2 August 2001	Train Detection
11	RT/E/G/11720	Issue 1 August 2000	Signalling Installation Handbook
12	NR/SP/ELP/21104	Issue 2 April 2006	Design and Installation of Electric Track Equipment for DC Electrified Lines
13	NR/GN/ELP/27021	Issue 2 April 2006	Electric Track Equipment Layout Design for DC Electrified Lines
14	NR/SP/TRK/9039	Issue 1 December 2005	Business Process Document Formation Treatments
15	EN50125	March 2003	Railway applications – Environmental conditions for equipment. Part 3: Equipment for signalling and telecommunications
16	RT/CE/S/102	Issue 5 February 2002	Track Construction Standards
17	EN50121	December 2000	Railway applications. Electromagnetic compatibility. Part 4: Emission and immunity of the signalling and telecommunications apparatus
18	GC/RT/5212	Issue 1 February 2003	Requirements for Defining and Maintaining Clearances
19	GE/RT8000 Module T7	Issue 2 April 2005	Safe systems of work when walking or working on or near the line
20	GC/RT5021	Issue 2 October 2003	Railway Group Standard. Track System Requirements.
21	BRS-SM440 03	Issue A September 1995	Standard Apparatus Case GA of Large Case Framework Example of SSI Equipment
22	SSI 8500 H	Issue 5 February 2002	SSI 8500 Specification for the Design of SSI Signalling Schemes
23	RT/CE/S/132	Issue 3 February 2003	Weld repair of rails

4 Definitions

Throughout this specification, key words are written with a capital first letter and a definition of the word is contained in this section.

4.1 Abbreviations and acronyms

ALS	Axle Load Survey Equipment
APC	Automatic Power Control
ATP	Automatic Train Protection
AVI	Automatic Vehicle Identification
AWS	Automatic Warning System
BIT	Built In Test
CWR	Continuously Welded Rail
DC	Direct Current
EMGT	Equivalent Millions of Gross Tonnes
EMGTPA	Equivalent Millions of Gross Tonnes Per Annum
FMEA	Failure Mode & Effect Analysis
MRU	Modular Replaceable Unit
MTBAF	Mean Time Between Attributable Faults
MTTR	Mean Time To Repair
S&C	Switch and Crossing
SSI	Solid State Interlocking
WILD	Wheel Impact Load Detector

4.2 General Definitions

FMEA (Failure Mode & Effect Analysis)

A process for hazard identification where all known failure modes of components or features of a system are considered in turn and undesired outcomes are noted. as an MRU.

Modular Replaceable Units

The term 'Modular Replaceable Units' (MRUs) is used to define any unit that is designed to be replaced as a complete unit in the field. Track Support is not categorised as an MRU.

Personnel

The term 'Personnel' includes:-

- Operators - who are required to operate locally (including manually) and remotely the S&C system.
- Technical staff - who are required to install, test, inspect, commission, maintain and operate the S&C system or components thereof.

Primary requirement

A requirement needed for the S&C system to fulfil its purpose (as defined in section 5) at an acceptable performance level. Note that this can include requirements on the interfaces between the S&C system and other systems.

Interface requirement

A requirement of an interface on the S&C system with a system (eg Train Detection system) which is external to the S&C system as defined in Section 6

Signalling Control System

The train management system which establishes routes to be taken by vehicles, manages interlocking and ultimately instructs vehicles to proceed.

Supplementary requirement

A requirement not necessary for the system to fulfil its purpose, but which has been placed on the system for expediency, or to gain additional benefit or functionality from the system, or because other controls are inadequate.

4.3 Technical Definitions

The definitions of the following terms apply to this document regardless of how they may be defined elsewhere.

Apparatus Case

Apparatus Case defines the boundary between the S&C system and the signalling control system. This is adjacent to the S&C system and may contain some or all of the following:-

- electrical power supplies
- Communication systems concerning the command, detection and condition information from the S&C system
- Points heating supply and control systems.

Detection

This is used in two distinct activities

- Proving the position and securing of the Moveable Rails
- Identification of critical obstructions between the moveable and fixed rail in the closed position

Formation

The term 'Formation' is defined as the uppermost layer of naturally occurring soil or the man-made structure on which the Track Support rests.

Free Wheel Passage

- The dimension between the back of the open Movable Rail and the gauging point on the opposite Movable Rail
- The dimension between the gauging point on a rail and the face of the opposite check/wing entry
- The dimension between the active faces of the check rail and of the opposite wing rail

Lateral

The term 'Lateral' is used to denote any horizontal axis that is perpendicular to a Longitudinal axis.

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Longitudinal

The term 'Longitudinal' is used to denote any axis parallel to the length of adjacent running rails that form part of the Track.

Movable Rail Detector

The term 'Movable Rail Detector' used in this specification defines the mechanism used to confirm the correct positioning of the Movable Rail and to provide the means by which the Apparatus Case can identify that the correct Movable Rail positions are achieved.

Movable Rail

The term 'Movable Rail' is used in this specification to denote any rail (along which Rail Vehicles travel) that is moved by one or more Movable Rail Actuators.

Movable Rail Actuator

The term 'Movable Rail Actuator' used in this specification defines the mechanism used to move the Movable Rails to their required positions.

Movable Rail Lock

The term 'Movable Rail Lock' used in this specification defines the mechanism used to lock the Movable Rails in the required position and provide the means by which the Apparatus Case can identify whether the Movable Rails are locked.

Nipping Force

The term 'Nipping Force' refers to a holding force exerted by the Movable Rail Actuator and/or Movable Rail Lock that may be applied to maintain the Movable Rail in the fully closed position

Normal and Reverse Positions

The terms 'Normal' and 'Reverse' position are used to describe the two positions of the Movable Rails in which train movements are permitted. Commonly, but not always, the Normal position corresponds to the higher speed or most frequently used route of the S&C system.

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Rail Vehicles

The term 'Rail Vehicles' used in this specification includes all of the following types of rail supported vehicles:-

- Passenger Carrying Vehicles and Derivatives
- Traction Units
- Freight Carrying Vehicles
- Installation and Maintenance Vehicles
- Track Inspection Vehicles

Run-Through

A trailing movement of a Rail Vehicle over the S&C system in a direction that is incompatible with the position of the Movable Rails.

Stagger

Stagger occurs where two insulated joints in a pair of rails are not exactly opposite each other, thus creating a dead section between track circuits or within a track circuit.

Switch and Crossing System

The term 'Switch and Crossing System' is defined as being a plain lead - The definition in terms of its major components is given in section 6.

Track

The term 'Track' in this specification includes all those components laid on the Track Support that guide Rail Vehicles and transmit the forces from Rail Vehicles to the Track Support. In existing systems, the Track is represented by the rails, bearers, crossings, and includes all interconnecting items.

Track Support

The term 'Track Support' in this specification represents the medium that transmits the Vertical, Longitudinal and Lateral forces from the Track to the Formation. In existing systems, the Track Support is represented by ballast or concrete slab.

Track System

The definition in Reference 20 shall apply, noting that this includes both plain line and the S&C system.

Traction Power System

The term 'Traction Power System' within this specification is used to mean the electrical system and its associated physical structure used to provide suitable Rail Vehicles with electrical motive power.

5 S&C System Purpose

The primary function of S&C systems is to permit, as part of a train control system, Rail Vehicles to travel on a converging or diverging route at the same level.

6 S&C System Definition

This specification defines S&C systems in terms of five major components:

- Track Support - providing the interface between the Track and the Formation.
- Track - providing the structure along which the Rail Vehicles travel and by which it is guided.
- Movable Rail Actuator - providing the necessary actuation to enable the Track to be configured to the route required.
- Movable Rail Lock - providing the means to secure the Movable Rails in the route position selected and providing the necessary feedback to confirm the Movable Rails are locked.
- Movable Rail Detector - providing the necessary feedback on the position of the Movable Rails to indicate that they are in the correct position to allow the train to be safely routed through the S&C system, relative to the fixed rail.

The relationship between the components within the S&C system is shown in Figure I

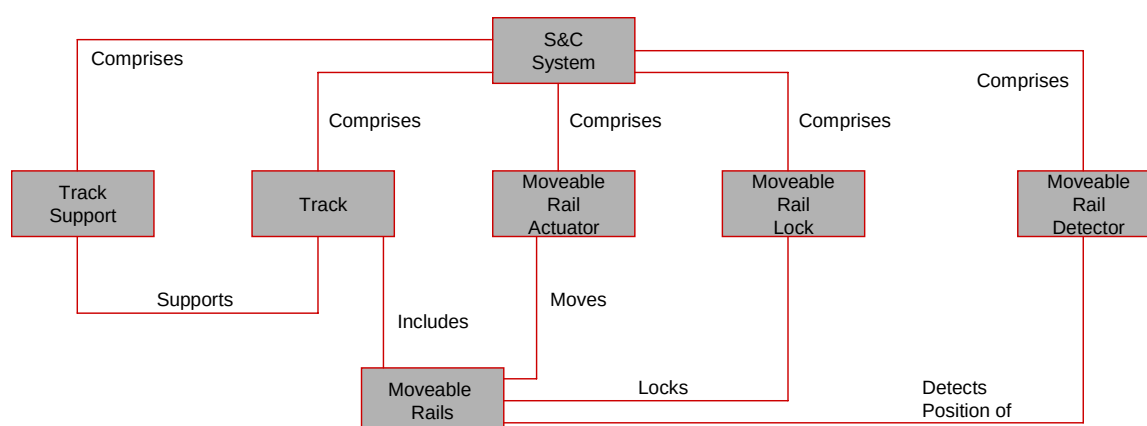


Figure I S&C Internal Interfaces

7 S&C System Interfaces

The systems and components listed in Table 1 and Table 2 interact with the S&C system. Table 1 lists those interfaces that any S&C system design requires in order for the S&C system to fulfil its purpose. Primary Requirements arising from the interfaces detailed in Table 1 are listed in section 9.

Table 2 lists interfaces which the S&C system design shall accommodate. The Interface Requirements in table 2 are listed in section 10.

The relationships between the S&C system and external interfaces are shown in Figure 2. The S&C System and several of the above interfaces are part of the wider Track System which is illustrated in Figure 3.

Interface	Nature of interface with S&C system
Rail Vehicles	These travel over the S&C system
Plain Line	The structure along which the Rail Vehicles travel prior to entering, and after leaving, the S&C system
Signalling Apparatus Case	Provides the electrical power control and monitoring interfaces for the S&C system. (NB The Apparatus Case is not always present. In these instances the interface would be made directly with the Signal Box, Equipment Room or Control Centre).
Point Heating	Facility to support operation in freezing weather conditions
Drains	The routes for water to pass under and/or around the S&C system.
Formation	The ground upon which the Track Support is laid.

Table 1 S&C External Interfaces Required by the S&C System Purpose

Interface	Interface with S&C system
Cess	A walkway adjacent to the Track
Train Detection systems	Shall accommodate widely deployed methods of train detection such as axle counters and track circuits
Traction	Physical support, and relative position to the S&C system inc gapping,

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Power Systems	gauging and bonding requirements
Support Equipment	The equipment and tools required to install, test, commission and maintain the S&C system, including On-Track Machines.
Personnel	Installing, testing, commissioning, maintaining and operating the S&C system (including manually)
Ducts	Passage-ways for cables to pass through the S&C system
Other systems (see section 10.2.6)	A variety of additional systems require an interface with the S&C system. This is predominantly the ability to attach to and within the system (eg AWS,)

Table 2 External Interfaces additional to those in Table I

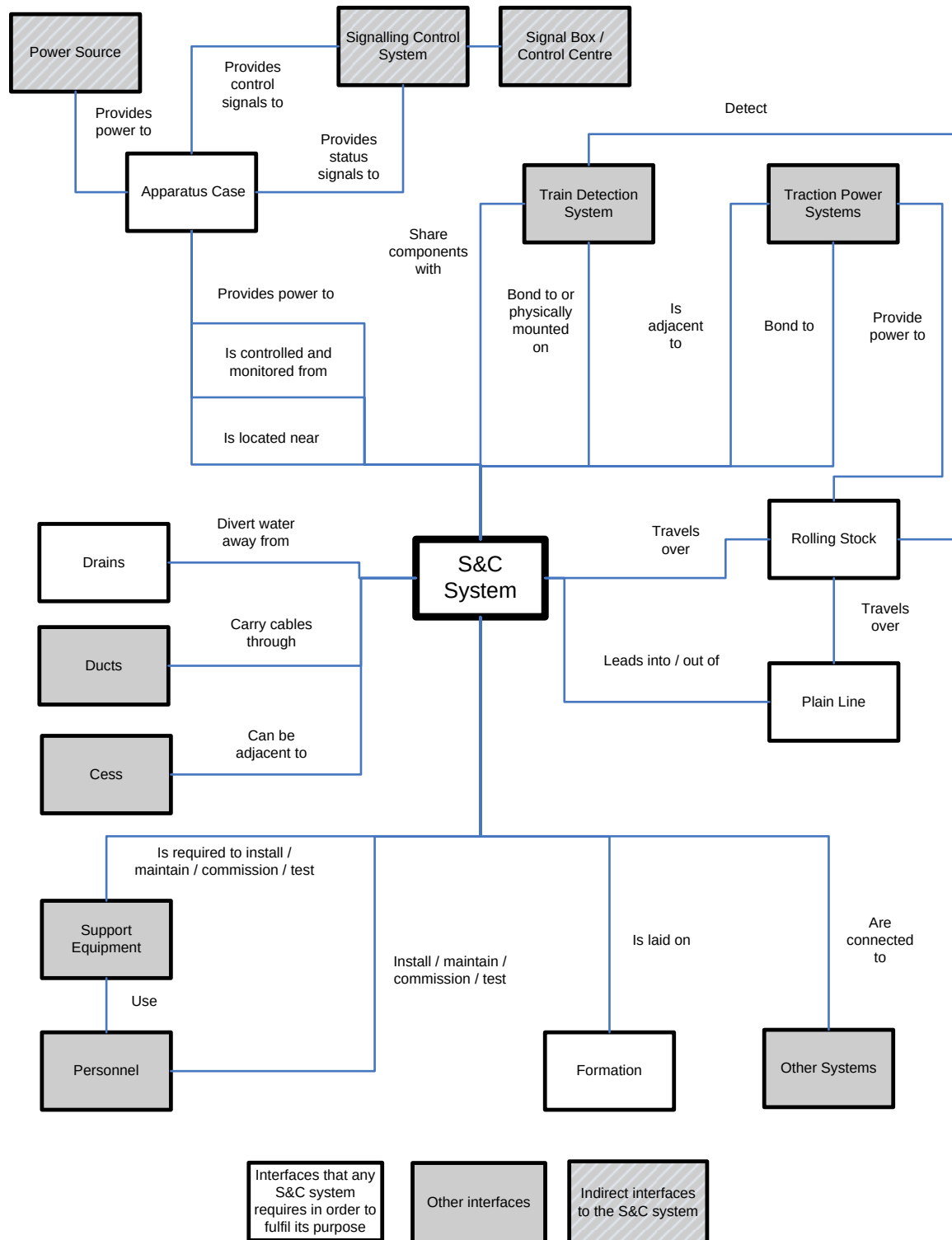


Figure 2 S&C External Interfaces

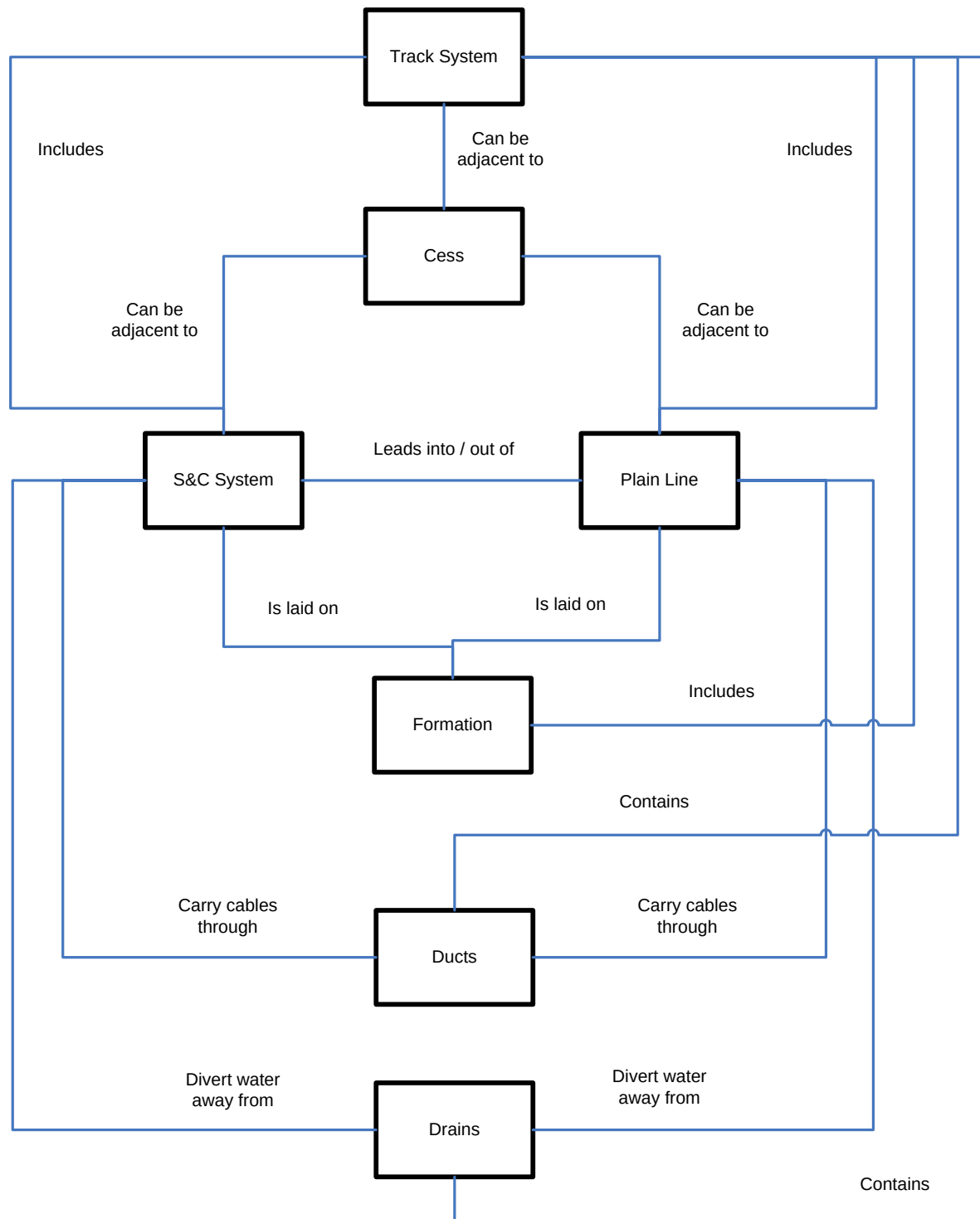


Figure 3 Interactions of Relevant Track System Components