

SSI Data Preparation - Simulator

Chapter C: Train Simulation

Chapter C

I. Train Simulation Principles

Simulation of train movements does not form a normal part of SSI testing, but the facility is used to assist testing of IECC systems, to train Signalmen prior to the commissioning of a new Control Centre, and to demonstrate the operation of the signalling system to potential overseas customers for SSI equipment.

When the additional train simulation data described in Section 2 below has been compiled, each SSI Simulator MPM is capable of simulating the movement of up to sixteen trains by amending the input telegram bits which it sends back to the Interlocking MPM in a sequence which represents a realistic sequence of track circuits being occupied and cleared. The IECC simulator behaves in a similar manner, but there is no restriction on the number of trains which may be present in each SSI area. The trains stop and start in response to the output telegram bits controlling signal aspects and are routed by the input telegram bits representing points detection. A train will also stop if the track circuit (or track unit - see Section 2.2) in front is occupied for any reason.

If a train is standing at a red signal on a section of line where reversal is permitted, it will reverse and move off in the opposite direction if a signal for such a move clears behind the train and the track units between this signal and the rear of the train are clear. Depending on the data which has been written, at the edges of the controlled area trains will either stop on the last track circuit, disappear and re-emerge later in the opposite direction on the same track or elsewhere, or transfer to another Simulator MPM to simulate the movement of the train across the Interlocking area boundary during a multiple Interlocking simulation.

In the SSI simulator, such cross-boundary train movements are only possible if the Simulator MPMs concerned are connected to the same Technician's Terminal. Attempting to test such movements on the SSI Design Workstation simulation system will result in the trains becoming immovable at the boundary, and temporary "loop-back" data (see below) may have to be prepared to avoid this if the testing of the rest of the train simulation data has to be done using the Design Workstation prior to being installed on-site.

In the SSI simulator it is possible to define the initial positions of up to eight trains in each Simulator MPM to be created at the start of the simulation, and these trains may then be moved around the controlled area simply by the Signalsman setting routes. In addition the Simulator MPM can accept instructions over its serial interface to create new trains and amend or delete existing trains (see Appendix C1). For this purpose each train is allocated an identity number in the range 1-255 which is retained if the train passes across an Interlocking area boundary between Simulator MPMs. These instructions may be typed in via the Technician's

SSI Data Preparation - Simulator

Chapter C: Train Simulation

Terminal. The IECC simulator ignores any initial-train data, and is controlled by means of the user interface, or according to a timetable.

Each train is defined as stopping or non-stopping, with a fixed length and maximum permitted speed. The geographic data contains different speed profiles for stopping and non-stopping trains, and the stopping profile defines station stopping points. Once a stopping train has stopped at a station, it must be re-defined as a non-stopping train to force it to restart. The eight trains which may be created automatically in each Simulator MPM at the start of the simulation are initialised as non-stopping trains, and their identity numbers are allocated in the block of 8 starting at $I*8$, where "I" is the Central Interlocking identity number for this Simulator MPM (e.g. Simulator for Interlocking identity 6 is initialised with trains allocated identities 48-55).

2. Train Simulation Data

The data described in Chapter B Sections 2 & 3 is generated automatically from the information which already exists in the database with a minimum of effort required by the data preparer, but if a train simulation is required the extra data in the SIM source text file described below needs to be prepared. The style of this data is similar to the Interlocking MAP data file, and defines the sequence of track circuits and signals seen by a train running through the controlled area, with conditional and unconditional "continue at" data types and labels used to define where points are encountered.

The order of track circuits and signals in the data will be the reverse of that in the Interlocking MAP data, as the SIM data defines the routes for forward movement of trains instead of the look-back required in the MAP data to search for approaching trains. In addition, the SIM data has to define the length of each track circuit and the speed limits which apply for movements over it, and other information required to carry out a realistic simulation, such as positions where trains may reverse and dummy track circuits and signals to enable trains to move through non-track circuited areas such as sidings. The various elements which make up the data are described below, and an example of the data for the layout (based on Skelton Junction) illustrated in Figure C1 is shown in Figure C2.

2.1 General Layout of Data

The overall form of data is based on the Interlocking data. In particular, the conventions for comments (commencing with "/") and labels (commencing with ":") are the same. Unlike the Interlocking data, however, only one data item is allowed per line, although any item may be preceded by a label and followed by a comment on the same line. The permitted types of data item are defined in the following Sections. The first data item in file must be a "units declaration" statement, to define the units used to measure distance and speed in the subsequent data. This takes the form:

distance = metres , speed = MPH

SSI Data Preparation - Simulator

Chapter C: Train Simulation

The distance options are "metres", "yards" or "chains", the speed options are "KPH" or "MPH". The examples in this document use units of metres and MPH.

It is recommended that, before any data is written, a Simulated Train Label Diagram is prepared, based on the scheme or numbering plan, showing the exact position and direction of each label. This minimises the total number of labels used, thus simplifying the data and reducing the chances of errors, and is also useful should the data ever need to be modified. Figure C1 is an example of this diagram.

At certain positions it is necessary for trains to continue either conditionally or unconditionally at another part of the data - usually because of facing or trailing points respectively. Where this is the case, a label must be defined at the position in the data where the train is to continue.

Any label names can be used (up to 20 characters) but the following convention is recommended:

- (i) Where a label represents a divergence at a set of facing points lying in the reverse position, the label is the name of the point end (e.g. P841B in Figure C1). Labels relating to points lying in the normal position will not normally be used, but if one is required, the suffix "N" should be added to the name of the point end (e.g. P842N in Figure C1).
- (ii) Where the label represents a convergence of several routes via trailing points, where possible only one label should be defined for each track circuit in each direction. The number of track units is minimised by placing the label level with the start of the shortest of the converging sections of the track circuit. The name of this label should be the name of the track circuit with "U" or "D" appended according to the direction of travel (as in the MAP data). Label TDVU in Figure C1 is an example of this.
- (iii) A label defined in connection with reversal from a signal should be formed by taking the name of the signal and adding "U" or "D" according to the direction the train would be travelling in if it reversed, e.g. S31IU in Figure C1.

A previous naming convention, based on the use of sub-route names, has proved likely to lead to data errors where there are trailing and facing points in the same track circuit.

The data should take the form of a continuous block for each major running line passing through the Interlocking, generally following the normal direction of each set of facing points. This block of data should be followed by a series of shorter blocks. Each short block should contain the data for a route diverging from or reversing along the running line, and

SSI Data Preparation - Simulator

Chapter C: Train Simulation

continuing until the route converges with another running line or leaves the Interlocking area.

2.2 Track Unit Data

A track unit is a piece of track which is all or part of a single track circuit (or a length of non-track-circuited track). It has a uniform speed limit, contains no signals or points, and may only ever be occupied by a single train. For a bi-directional piece of track, separate track units are defined for each direction of travel.

The maximum length of a track unit is 1275m. If a track data item is declared to be longer than this, the compiler will automatically generate two or more track units. However in every other case there will be one track unit per track data item, and the terms are considered to be interchangeable in the rest of this Section.

For each track unit along a line of route it is necessary to define two speed limits and a length. The first speed limit is the line speed to be applied to non-stopping trains and the second is a speed limit to be applied to stopping trains braking to a stand at the next station. The format of the data is:

TCF 100,100,840

This defines a line speed of 100 MPH for non-stopping trains, the same limit for stopping trains as these have not yet reached the braking point for the next station stop, and the length of the track unit as 840 metres. This track unit forms part or all of track circuit CF. The length and speed must be defined as a whole number of the selected units of measurement; fractions and decimals are not allowed.

The track circuit name used must be a track circuit input defined in the Trackside Modules database, i.e. with "Identity" and "Description" fields both commencing with "T".

Each data item in the SIM file is associated with one track unit, but more than one data item may refer to the same track circuit name. Bi-directional lines will require separate data items for each direction. If a speed limit change, signal or point is located within a track circuit, separate data items will have to be defined for the parts of the track circuit, thus locating the signals, points and speed limit changes between track units.

In locations such as station platforms where a single track circuit may be occupied by several trains, enough track units must be defined to ensure that no track unit requires to be occupied by more than one train. Similarly, at any location where trains may be split by the IECC simulator, the track units must be short enough to ensure that a train about to be split will be occupying at least two track units. At a location where reversal is permitted, the track unit boundaries for opposite directions of travel must coincide.

SSI Data Preparation - Simulator

Chapter C: Train Simulation

To define a position at which a stopping train will make a station stop, the second speed limit figure should be set to zero, and (in the SSI simulator) the simulated train will then aim to enter this track unit at 20MPH and stop when it reaches the end.

When calculating the sequence of speed limits to bring the train to a stand at the required position, it is helpful to understand the rules which the train movements follow in the SSI simulator. Running under clear signals, each train has a target speed limit which is the lowest of the speed limits for all the track units currently straddled by the train, and the next track unit ahead. Thus when a train enters a new track unit, it "sees" the speed limit for the track unit ahead for the first time and has the length of the track unit which it has just entered to brake to this new speed limit.

The simulated braking rate is approximately 2KPH/second, so if a short track unit precedes a severe speed restriction it will be necessary to reduce the speed limit over this track unit to slow the trains down. Appendix C2 lists some typical braking distances as a guide. The target speed may also be amended by the aspect of the signal in advance; the previously calculated target speed is halved for a yellow aspect and reduced to 20MPH for a position light shunting signal or a position light associated with a main aspect. For a red aspect the train aims to stop at the signal.

The IECC simulator is more tolerant, since each train regularly calculates the braking distance from its current speed, and examines the state of the line ahead for this distance. Any speed limits, stations (when the train is stopping), or restrictive signal aspects found will lead to a reduction in speed. The stopping speed limit is ignored unless it is zero. It is therefore never necessary to include a braking curve in the track data preceding a station or speed limit.

If it is necessary to simulate the movement of trains through non-track circuited areas, it is possible to define "dummy" track units. The data for a dummy track unit is identical to that for a real one, except that the word "TRACK" is used in place of the track circuit name, e.g.:

TRACK 75, 50, 300

This defines a dummy track unit with speed limits of 75MPH for non-stopping trains and 50MPH for stopping trains, and 300 metres long.

2.3 Points Data and other Conditional Statements

At trailing points a simple "continue at" statement on its own line is required to indicate the label in the data for the track circuit including the points. For all but the shortest of the converging sections of this track circuit, an additional track unit is defined before the continue-at statement, with its length being the distance from the start of the track circuit on this route, to a position parallel with the label (e.g. track circuit DV in Figure C1). If the trailing connection is speed-restricted, the track

SSI Data Preparation - Simulator

Chapter C: Train Simulation

unit just before the continue-at statement should be given the relevant speed limit. This slight inaccuracy in speed is not noticeable.

At facing points, the direction in which the points are detected must be tested by means of conditional statements. These are similar to the conditional statements used in the Interlocking MAP data, except that only one test is permitted per statement, and the test is carried out on the name of a points detection input as defined in the Trackside Modules database file. The full name of the input must be specified, i.e. Identity+Qualifier+Description.

For points it is usual to test the reverse detection input. It is not generally necessary to test the normal detection input as well, since the only time both tests fail is while the point is actually swinging.

The conditional statement for the first set of facing points in a track circuit is placed directly after the label defined in connection with any prior trailing points on the track circuit. If there are no prior trailing points on the track circuit, the conditional statement is placed before the track unit data for that track circuit.

The data for the route over the points lying normal should be placed immediately after the conditional statement. That for the route over the points lying reverse is placed after the label to which the conditional statement refers. Data for either route takes the form of a conditional statement for a further set of facing points, or a track unit if there are no further facing points. Hence, there will be one track unit for each of the diverging routes. Its speed limit should reflect the permitted speed over that route, and its length should be the distance from the position of the conditional statement to the end of the track circuit over the route chosen. In the unusual case of the facing points coming before the trailing points, as in track circuit CV in Figure C I, the conditional statement is placed at the beginning of the track unit and the label placed before the trailing points.

The following is a typical conditional statement:

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if P103RWK then ^P103D \
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"STOP" is a special label which is a "buffer stop" pre-defined by the compiler and must be used where there is no valid route over one direction of the points.

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if P104RWK then ^STOP \
```

No labels are required in relation to a diamond crossing. However a switched diamond may include conditional statements causing a "STOP" if the diamond is wrongly set.

Conditional statements can test any Trackside Functional Module input or output (not only points detection), and so they can be used to route trains

SSI Data Preparation - Simulator

Chapter C: Train Simulation

over points controlled by ground frames by testing suitable inputs and outputs which indicate the Signalman's intentions. Care should be taken to ensure that the result of the test cannot change while the train is straddling the track units in the geographic data before and after the conditional statement.

This has disastrous consequences (in the SSI simulator only) which are similar to those resulting from points being moved under a real train, with the derailed train severing the Trackside Data Link cables, i.e. the Simulator MPM ceases to reply to telegrams on the Trackside Data Links. The reason for this is that to determine the speed limit to be applied the program in the Simulator MPM has to search through the data starting at the track unit occupied by the rear of the train and continuing until it finds the track unit occupied by the front of the train. If a conditional statement diverts the search elsewhere in the data, the program will simply continue searching without ever finding the front of the train. Similar considerations apply to the location of signals: the program must search ahead of the train to find the next signal, and this search will continue forever if no signal is found.

2.4 Signal Data

The data for a signal is made up of the signal name, optionally followed by a "continue at" data type. The "continue at" is used on bi-directional lines where there may be a requirement for a train standing at the signal to reverse and move off in the opposite direction.

The "continue at" refers to a label which is placed in the track unit data for the opposite direction, at the same position as the signal. A typical example is as follows:

S12 ^S12U

The train will only reverse if it is standing at a red signal, and the first signal for the opposite direction behind the tail of the train is not red, or (in the case of the SSI simulator only) there is an Interlocking boundary before the first signal in the opposite direction.

The signal name used in the data must match the "Identity" fields defining the outputs driving the signal aspects in the Trackside Modules database file. The compiler searches this database for these outputs and generates data which allows the simulated trains to determine which aspect the signal is showing. The following values in the "Qualifier" fields in the database are recognised by the compiler:

Aspect	Qualifier
position light	(SUB) or (OFF)
red	(ON) or R
bottom yellow	H
top yellow	HH
green	D