BRAKING CURVES ANALYSIS

WP3 – G1

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GENERAL POINTS

Color code

Blue: External input from track

Green: External input from another WP3 box (train location, Database,...)

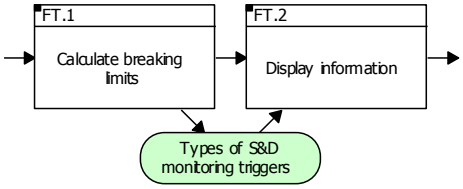
Yellow: External input from train

Light green: internal item

Steps

Step indicate in which W3-G1 step the function will be modelised.

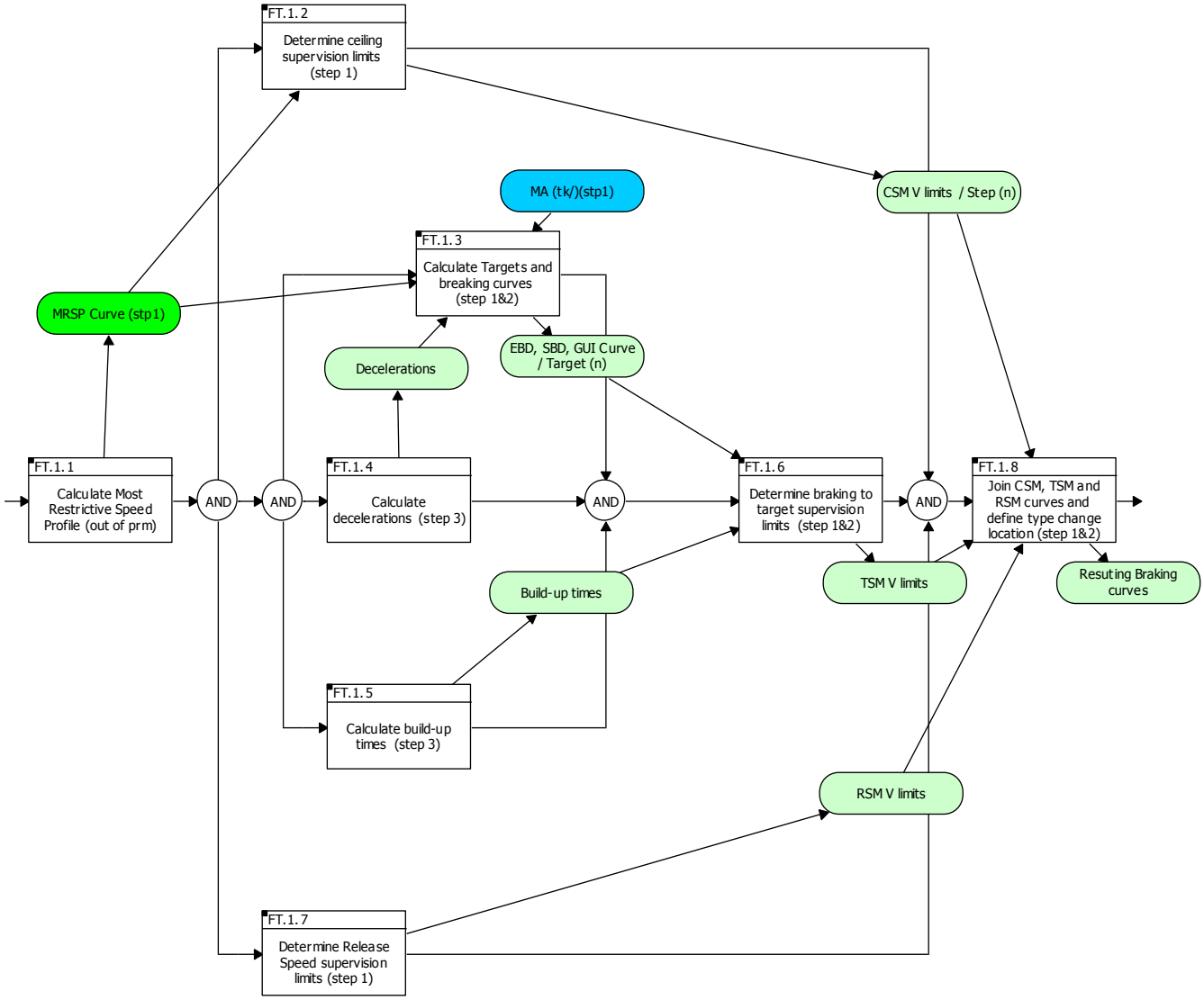
FT - SPEED AND DISTANCE MONITORING



Description

The speed and distance monitoring calculates the braking curves and sends display information to the DMI.
This model, as a first step, do not take in account display information.

FT.1 - CALCULATE BREAKING LIMITS

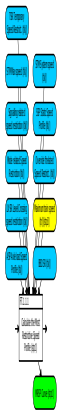


Description

On-board shall always calculate breaking limits:
- ceiling limit, used when the speed is constant and if no target as to be taken in account (P, W, FLOI, EBI,)
- target limit, used if at least one target (change of speed, EOA) as to be taken in account
- release speed, used when the train is near an EOA and needs to approach this EOA.

These on-board limits shall be linked as explained in figures 55 and 56
Breaking limits are related to an absolute point (LRBG for example), not to the front end of the train.

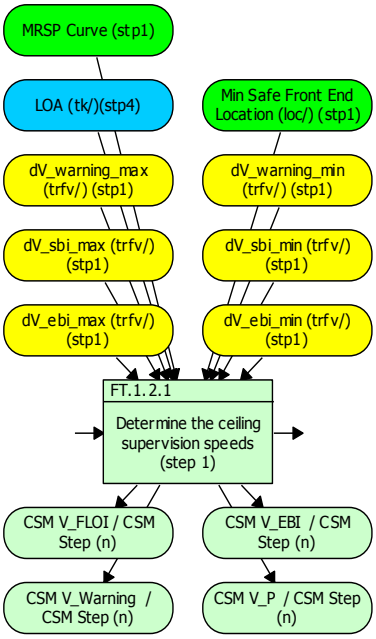
FT.1.1 - CALCULATE MOST RESTRICTIVE SPEED PROFILE (OUT OF PRM)



Description

The Most Restrictive Speed Profile (MRSP) is a description of the most restrictive speed restrictions the train shall obey on a given piece of track.
The Most Restrictive Speed Profile shall be computed from all speed restrictions (see 3.13.2.2.13 & 3.13.2.3.2) by selecting the most restrictive parts of each element, some elements being compensated by the train length if requested by trackside (see 3.11.3.1.3 for SSP, 3.11.4.6 for ASP and 3.11.5.3 for TSR).
The Most Restrictive Speed Profile shall be recalculated when any of the elements it is built of is changed.This function is out of W3-G1 perimeter.

FT.1.2 - DETERMINE CEILING SUPERVISION LIMITS (STEP 1)

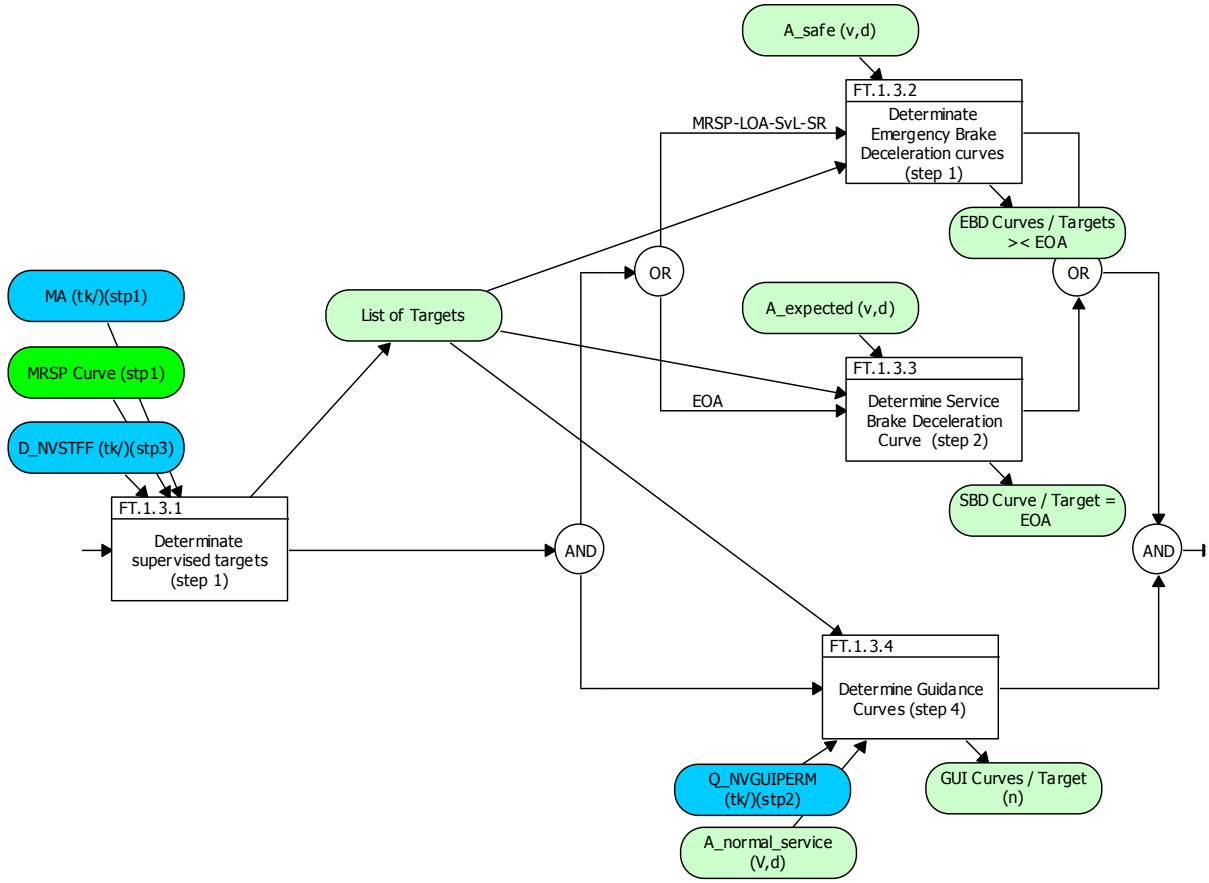


Description

For each MRSP step or LOA, the on-board calculates:

- one EBI limit
- one FLOI limit
- one W limit
- one P limit

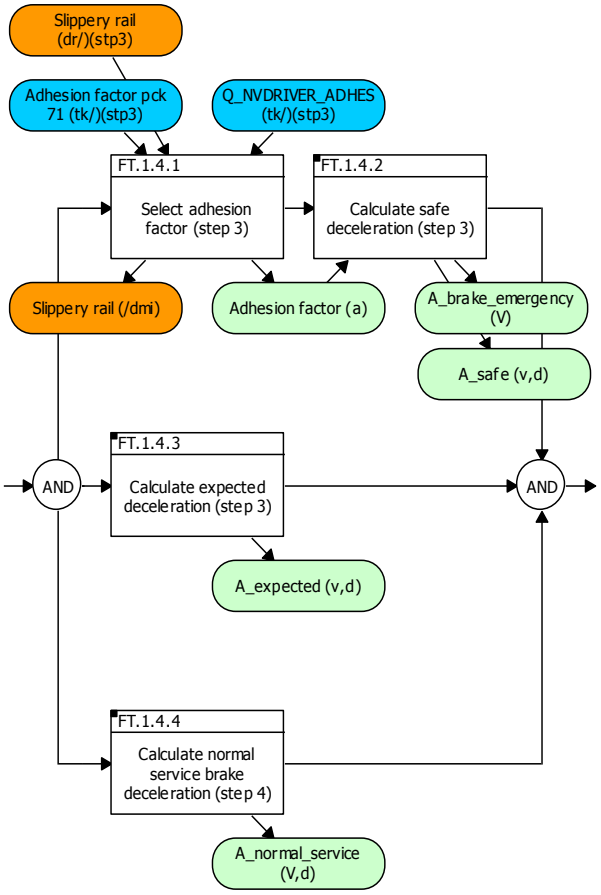
FT.1.3 - CALCULATE TARGETS AND BREAKING CURVES (STEP 1&2)



Description

The on-board calculates braking curves EBD or SBD for each target:
- decrease of the MRSP
- Limit of Authority (LOA), if the target speed at the EOA/LOA is not equal to zero
- End of Authority (EOA) and the Supervised Location (SvL), if the target speed at the EOA is equal to zero
- the location deduced from the maximum permitted distance to run in Staff Responsible, with a target speed zero

FT.1.4 - CALCULATE DECELERATIONS (STEP 3)

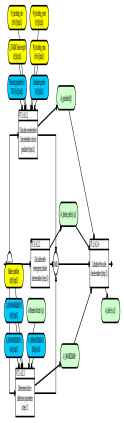


Description

On-board calculates:

- Safe deceleration (safety relevant), used to calculate Emergency Breaking Curve EBD,
- Expected deceleration (not safety relevant), used to calculate Full Service Breaking Curve SBD,
- Normal service brake deceleration (not safety relevant), used to calculate Guidance Curve GUI.

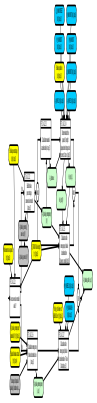
FT.1.4.2 - CALCULATE SAFE DECELERATION (STEP 3)



Description

The safe deceleration is used to calculate the emergency braking curve.
It shall take in account:
- the train emergency brake deceleration,
- the gradient,
- the state of the rail (slippery or not).

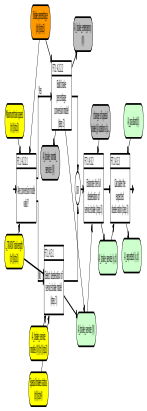
FT.1.4.2.2 - CALCULATE SAFE EMERGENCY BRAKE DECELERATION (STEP 3)



Description

There are two ways to elaborate the safe emergency brake deceleration:
- by calculation: a conversion model is made from the brake percentage and correction factors (given by the track) are added.
- by pre-registered curves. In this case rolling stock correction factors shall be taken in account.

FT.1.4.3 - CALCULATE EXPECTED DECELERATION (STEP 3)



Description

Since the expected deceleration is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.

The speed dependent deceleration model(s) for the full service brake is acquired as part of Train Data (see 3.13.2.2.3.1) or is derived from the brake percentage using the conversion model (see 3.13.3.3)

A_brake_servicex(V) is equal to the full service brake model, A_brake_service, applicable for the concerned combination of brake.

FT.1.4.4 - CALCULATE NORMAL SERVICE BRAKE DECELERATION (STEP 4)

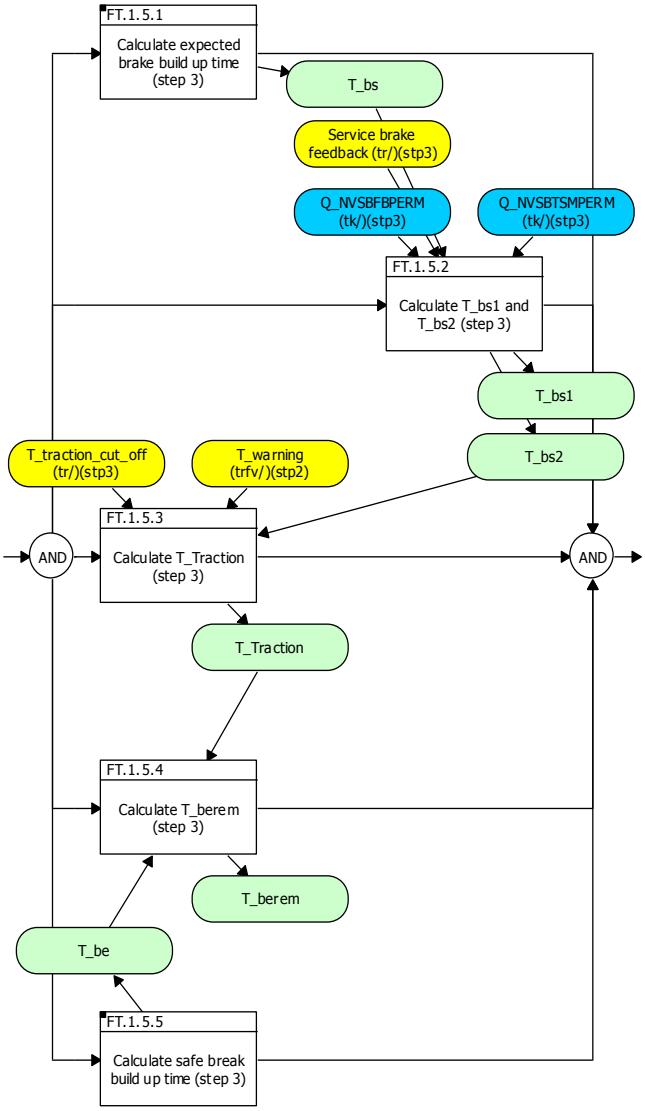
Description

*Since the normal service brake deceleration is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.

* The speed dependent deceleration model(s) for the service brake is acquired as part of Train Data (see 3.13.2.2.3.1) or is derived from the brake percentage using the conversion model (see 3.13.3.3) ?

A_brake_normal_servicex (V) is equal to the normal service brake model applicable for the concerned combination of brake position and of the value of A_brake_service(V=0) between dx-1 and dx (see 3.13.2.2.3.1.9 and 3.13.2.2.3.1.10).

FT.1.5 - CALCULATE BUILD-UP TIMES (STEP 3)



Description

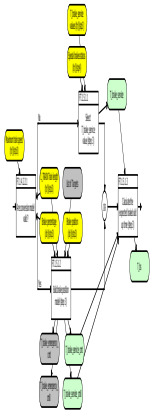
On-board calculates following build-up times:

- T_bs, T_bs1, T_bs2: time between the service brake command and the full application of the service braking, used to calculate SBI1 and SBI2 (not safety relevant)
- T_be: time between the emergency brake command and the full application of the service braking, used to calculate EBI (safety relevant), split in:

T_Traction: time between the brake emergency command and the end of the traction

T_berem : time between the end of the traction and the full application of the emergency braking

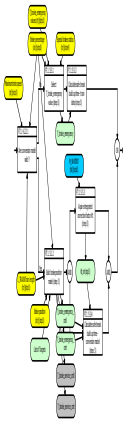
FT.1.5.1 - CALCULATE EXPECTED BRAKE BUILD UP TIME (STEP 3)



Description

The values of T_brake_service acquired as part of Train Data (see 3.13.2.2.3.2.8) or the value(s) of T_brake_service derived from the conversion model (see 3.13.3.4) using the brake position and train length acquired as Train Data).
Since the expected brake build up time is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.
The expected brake build up time T_bs shall be equal to the brake build up time of the full service brake:
T_bs = T_brake_service, with T_brake_service corresponding to the combination of special brakes currently in use

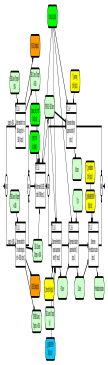
FT.1.5.5 - CALCULATE SAFE BREAK BUILD UP TIME (STEP 3)



Description

The values of T_brake_emergency acquired as part of Train Data (see 3.13.2.2.3.2.8) or the value(s) of T_brake_emergency derived from the conversion model (see 3.13.3.4) using the brake position and train length acquired as Train Data.

FT.1.6 - DETERMINE BRAKING TO TARGET SUPERVISION LIMITS (STEP 1&2)



Description

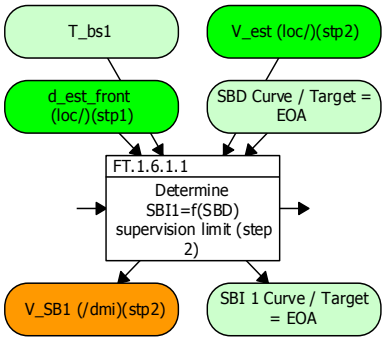
The braking to target supervision limits are derived from the EBD and SBD curves.

The on-board calculates:
* for each EBD curve: an Emergency brake intervention (EBI) and a Service brake intervention 2 (SBI2)(see Figure 45)
* for the SBD curve (if existing): a Service brake intervention 1 (SBI1) (see Figure 46)

Then the on-board calculates the most restrictive SBI curve with SBI1 and SBI2 curves and defines the FLOI.
Then Warning (W), Permitted speed (P) and Indication (I) supervision limits are defined (see figure 45 or 46)

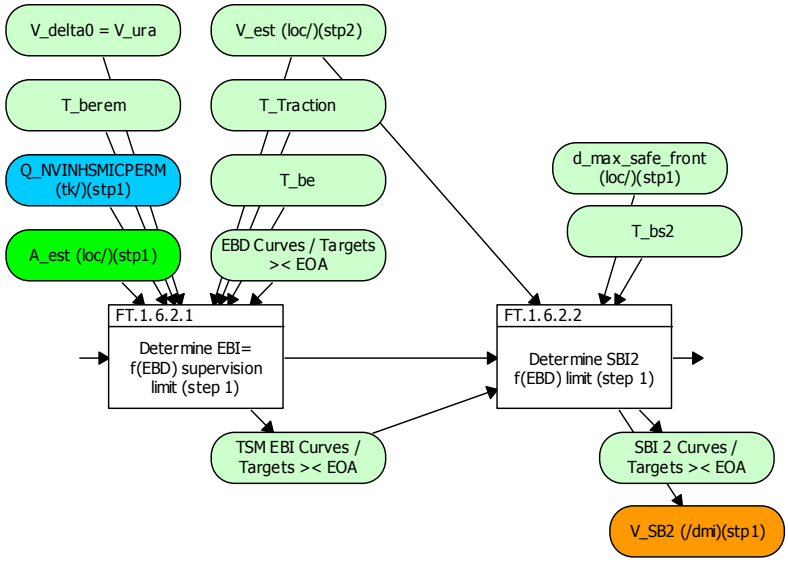
N.B. No specific supervision limit is calculated from the GUI curve: it is only used to adjust the Permitted speed (P) supervision limit, which is obtained either from the EBD or the SBD curve.

FT.1.6.1 - DETERMINE LIMIT FOR AN EOA TARGET (REF = SBD) (STEP 2)



Description

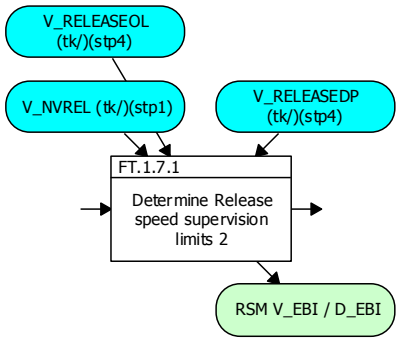
FT.1.6.2 - DETERMINE LIMITS FOR THE OTHERS TARGETS (REF = EBD) (STEP 1)



Description

For an EBD based target, the on-board shall calculate the location of:
- the Emergency Brake Intervention which takes in account the delay between the command of the Emergency Brake and its full application (without EBD curve overpassing).
- the Service Brake Intervention (SBI2) which takes in account the delay between the command of the Service Brake and its full application (without EBI curve overpassing).

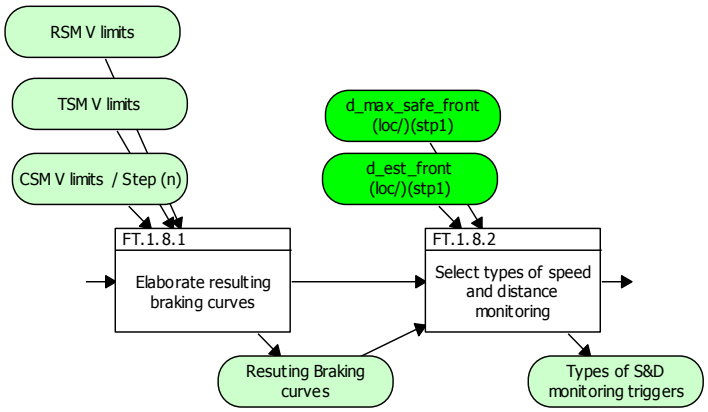
FT.1.7 - DETERMINE RELEASE SPEED SUPERVISION LIMITS (STEP 1)



Description

In the vicinity of the EOA, on-boad calculates one release speed used by the train to approch the EOA.

FT.1.8 - JOIN CSM, TSM AND RSM CURVES AND DEFINE TYPE CHANGE LOCATION (STEP 1&2)



Description