Chapter 5:
AUXILIARY FUNCTIONS

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5. AUXILIARY FUNCTIONS

5.1 INTRODUCTION

5.1.1 Scope

This document specifies the following STM functions:

- Brake pressure measurement
- Service and emergency braking
- Balise reading and testing
- Start/stop functionality
- Rolling detection
- Deceleration measurement

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5.2 STM SERVICE BRAKING

5.2.1 General

The STM has no direct interface to the brake system for ordering service braking, however, it needs feedback from the brake system.

The pressure figures given in the following refer to $P_{INT,}$ the internal representation of brake feedback. P_{INT} should give a correct representation of brake status, regardless of brake system type.

ETCS provides only one level of service braking (full). This means that for "soft" supervision, the brakes will be applied earlier, but still with full braking.

Full service braking (150 kPa pressure reduction in the main pipe, or corresponding cylinder pressure) can be ordered by the STM and then executed by the ETCS when the train runs too fast, or for other reasons. In the following text, it shall be understood that the ETCS performs the actual braking on request from the STM.

The service brake function is tested according to [5.6.4]. [Table CP] tells whether the ETCS performs an approved service brake test or not.

Note: A test is considered approved if it provides a comparable protection against service brake failures. This decision is handled by the authorities.

5.2.2 Full service brake intervention

The STM requests **full service braking** in the following cases:

a) The maximum permitted speed is exceeded by 10 km/h or more, [4.5.4]

b) The train has passed a BSK landslide group without permission, [3.11.3].

c) With high (normal) adhesion:

   1. The full service brake intervention curve (interval D) is reached with insufficient brake application (as given by brake feed-back input), [4.9.8]
   2. The normal full service brake deceleration curve is reached (interval E), [4.9.9]

d) With low adhesion:[1]

[1] Differs from [ATC2]

1. The "soft" service brake application curve (interval D) is reached with insufficient brake application (as given by brake feed-back input), [4.9.8]
2. The "soft" service brake deceleration curve is reached (interval E), [4.9.9]

e) At detection of a safety-affecting balise error (BF2 or BF3), [3.3.4]

f) When the STM has ordered emergency braking, [5.3]

g) When the STM brake test has not been performed over a 32 hours period (time out) [5.6.4] [2]

h) When the train moves a few m from stationary with the direction controller in neutral position [5.6.6] [3]

i) Passive Shunting.

j) The driver does not acknowledge an STM area transition.

5.2.3 Indications on the DMI

When full service braking is applied, a corresponding indication will appear (BROMS).

F5001. Reserve.

F5002. When the brake may be released the LOSS button shall become available.

5.2.4 Releasing full service brake

Service braking can normally be released reciprocally with brake intervention, ie. when the train is in a situation such that the brake would not be applied, it will be possible to release it.

The driver requests brake release by pressing the LOSS button. In certain cases an additional driver action may be needed to be able to proceed.

F5003. a) An STM-ordered service brake shall not be released before the driver has requested this.

[2] Differs from [ATC2]
[3] Differs from [ATC2]

b) When there is no need for braking anymore, the brake shall be released when the driver requests this by pressing the LOSS button.

c) If the LOSS button already was pressed beforehand, the brake shall not be released. The button activation shall only be registered at the moment it changes to a pressed state.

F5004. During deceleration supervision the STM shall allow the full service brake to be released when the train is in a situation such that the brake would not be applied:

a) Expect Stop, the train has slowed down below the release speed [4.9.11]

b) Expect Proceed, the train has slowed down below Vtarg + 10 km/h [4.9]

c) The train has slowed down "back" through the braking curve intervals, to a point before the intervention curve [4.9].

Note. The STM allows the full service brake to be released in these cases too:

1. When a previous STM emergency braking has been released and $V_{TRAIN} < V_{MAX} + 5$ km/h (i.e. < 45 km/h) after an unexpected stop passage (not aimed at by an Expect Stop distant signal) [3.4.4]
2. When the train has come to a halt after passing a stop signal [3.4.4]
3. When the train has come to a halt after passing BSK [3.11.3]
4. After balise error alarm with STM braking, when the train speed has slowed down to 80 km/h (or after 2 s, if $V_{TRAIN} \leq 80$ when the braking started), [3.3.4]
5. With max speed supervision, at the train speed $V_{TRAIN} < V_{MAX} + 5$ km/h, [4.5.4]
6. When rolling from stationary with the controller in neutral position, immediately, [5.6.6]
7. At brake test time-out, when the brake test has not been performed during the past 32 hours or more, and the driver requests such a test [5.6.4]. [4]

5.2.5 Service brake supervision

F5004A. a) The service brake function shall be considered faulty if, when service brake is requested,

[4] Differs from [ATC2]

1. After the set delay time (max 10 s), a drop in pressure (P_{INT}) of at least 60 kPa has not been achieved, or
2. If the ETCS does not acknowledge that a service brake order has been given by the STM.[5]

b) If the service brake is faulty:

1. The error message 'DRIFTBROMSFEL' shall appear.
2. The emergency brake shall be activated, while still retaining the service brake request.
3. In this case the emergency braking shall be released according to the same rules that applied to the corresponding service braking.

Note. During the brake test sequence [5.6], full service brake will be applied and the STM waits until:

– At least a 25 kPa pressure drop in P_{INT} is achieved.

Note. The pressure reduction is measured in relation to the initial value measured before the service brake was applied.

[5] Differs from [ATC2]

5.3 STM EMERGENCY BRAKING

5.3.1 General

This section deals mainly with the optional direct interface to emergency brake. STM emergency brake orders are given to this interface, but also to the ETCS as an extra safety measure.

The direct emergency brake interface is installed when the emergency brake test of the connected ETCS system does not reach the same standard as the STM's own brake test or the emergency brake response time via ETCS is too long. This decision is handled by the authorities.

For STM's without this interface, emergency braking is performed via ETCS commands.

The emergency brake function is tested according to [5.6.5], and [Table CP] tells about its installation status.

5.3.2 Physical connection

5.3.2.1 Connection to the vehicle – UIC air brake

F5004B. a) The emergency brake output of the STM:

1. Shall feed an emergency brake valve (SIFA) connected to the main brake pipe,
2. Alternatively it shall control a security loop or corresponding circuit in a trainset.

b) When emergency brake is required, the STM shall interrupt the feeding of the SIFA valve.

Note. The valve coil is then de-energised, the valve opens, the main pressure pipe is emptied and the emergency brake is applied. For installations without main pipe, the brake cylinders will be pressurized with maximum pressure.

Note. The SIFA valve may also be used as a brake valve for the vigilance control. Refer also to the [GRS].

Note. In most installations the STM emergency brake output will also control the magnetic valve for blocking of brake pipe charging. This serves to block feeding of the brake pipe during emergency braking.

F5004C. In the following cases the emergency brake valve (or security loop) shall be fed independently of the STM emergency brake output:

a) When the STM is disabled with the STM isolation switch.

b) When the STM is in a non-operative state as controlled from the ETCS.[6]

Note. When the STM is in No Power (NP) or Failure (FA) state it may be isolated to avoid emergency braking [4.3.10-11].[7] [8]

Note. The vigilance control must be unaffected by this.[9]

Note. With loss of power, the emergency brake may be applied anyway.

5.3.2.2 Connection to vehicles with EP brake system

F5005. The security loop or corresponding circuit in the train shall be controlled by the STM:

a) Normally by the STM emergency brake output,

b) Alternatively via commands from STM to ETCS.[10]

5.3.2.3 Emergency brake control

F5006. At the same time as the STM applies the emergency brake, the following actions shall be taken as extra safety measures:

a) Full service braking shall be requested (to be made by ETCS).

   1. Exception: This shall not be done during brake test [5.6.4]

b) ETCS emergency braking order shall be given.[11]

   1. Exception: This shall not be done during the brake test if the direct emergency brake output is connected [5.6.4]

Note. The exceptions for brake test serve to avoid hiding of a faulty emergency brake output by the redundant brake functions.

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[6] This requires emergency brake inhibition, or an active emergency brake output
[7] This requires emergency brake inhibition, or an active emergency brake output
[8] Emergency braking can occur in states NP or FA (contradicting to the [ESTM])..
[9] Installation requirement
[10] Differs from [ATC2]
[11] Differs from [ATC2]

5.3.3 Emergency brake intervention

The STM applies emergency braking if:

a) The leading engine passes a main signal at stop [3.4.4].

   1. Exception: Stop passage is permitted and $V_{TRAIN} \leq 40$ km/h

b) The max speed is exceeded by ≥ 15 km/h [4.5.4].

   1. Exception: supervision of V_{MAX} = 40 km/h before the brake has been released after an unexpected stop signal passage [3.4.4].

c) The emergency braking curve is passed during deceleration supervision [4.9.10]

d) Balise group End of Shunting (SX), is passed during shunting, [3.11.4][12]

e) During full service braking, if the service brake function is considered faulty by the STM [5.2.5]

f) Exceptions to a-c: Active Shunting mode or Installation area.

When a balise failure occurs, the dark speed (if applicable) is not imposed until the speed has been reduced to 80 km/h, this is to avoid emergency braking at higher speeds.

5.3.4 Indications on the DMI

F5007. Reserve.

Note. The ETCS ensures that, when emergency braking has been applied, a corresponding indication is displayed.

F5008. When the emergency braking can be released, the LOSS button shall become available.

5.3.5 Releasing the emergency brake

5.3.5.1 General

Emergency braking can, in most cases, be released reciprocally with brake intervention, ie. when the vehicle is in a situation such that the brake would not be applied, it will be possible to release it. Special rules apply in some cases, see further below.

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[12] Differs from [ATC2]

The driver requests brake release by pressing the LOSS button. In some installations an additional driver action may be needed to allow the train to proceed.

When the driver requests brake release while the train is running below the emergency brake speed limit, but above the service brake speed limit, only the emergency brake will be released.

When the driver requests brake releasing while running below both speed limits, the emergency brake and the service brake will be released at the same time.

F5009. a) An STM-ordered emergency brake shall not be released before the driver has requested this.

b) When a request for braking has ceased, the brake shall be released when the driver requests this by pressing the LOSS button.

c) If the button already was pressed beforehand, the brake shall not be released. The button activation shall only be registered at the moment it changes to a non-pressed state.

Note. If possible, the driver should not be forced to perform more than one action in order to release the brake. This includes all necessary actions (required by the STM, the ETCS or any other trainborne system) to achieve brake release.

F5010. After emergency braking caused by overspeed during max speed or deceleration supervision: The STM shall allow brake release reciprocally with brake intervention, i.e. when the train is in a situation such that the brake would not be applied, it would be possible to release it.

5.3.5.2 After BSK, SX or a stop signal

Emergency braking caused by passing a stop signal (which was not aimed at by a preceding Expect Proceed distant signal) or a BSK or an SX group cannot be released until the train has stopped. [3.4.4, 3.11.3-4]

5.3.5.3 After an unexpected stop signal

When passing a stop signal where the previous distant signal indicated Expect Proceed (alternatively an extended Expect Stop that aimed past the stop signal and was not combined with a Stop signal), the emergency braking shall be released according to the following rule.

After a deceleration $R \geq 0{,}7 \bullet b$ has been measured (where b = full service brake deceleration), the emergency brake – but not the full service brake – shall be releasable (able to release when the LOSS button is pressed).

Full service braking shall remain, and become releasable (as usual) when the train speed is below 45 km/h (as with max speed supervision of 40 km/h).

Refer to [3.4.4].

5.3.6 Emergency brake supervision

F5010A. If the STM has its own emergency brake interface, and has applied emergency braking, and ...

a) 60 kPa pressure reduction in P_{INT} has not been achieved within required time (T_{EBCHK}) since the braking started (was ordered), or

b) An electrical failure is detected in the emergency brake output circuitry,

c) Then an error message 'NÖDBROMSFEL' shall be given and the STM shall enter Failure state.[13]

Note. For brake pipe systems (UIC) the required time (T_{EBCHK}) is 1,25 seconds.

Note. For systems where the brake response signal is fetched from cylinder pressure, directly or indirectly, the required time (T_{EBCHK}) is 3,25 seconds.

F5010B. For STM emergency braking via the ETCS interface (and the STM is not equipped with a direct emergency brake of its own), the following shall apply.

a) The STM shall compute and use this ETCS emergency brake check time limit, $T_{ETCS\text{-}EBCHK} = T_{EBRE} + T_{EBCHK}$.

b) Error shall occur if 60 kPa pressure reduction in P_{INT} has not been achieved within the required time ($T_{ETCS\text{-}EBCHK}$) since the braking started (was ordered).

c) If error was detected, the message "NÖDBROMSFEL" shall be indicated.

d) If error was detected, the STM shall enter the Failure state FA.

5.3.7 Emergency brake test

The emergency brake test sequence is defined in [5.6.4]. This brake test sequence will halt if:

– 60 kPa pressure reduction in P_{INT} is not achieved,

– within a predetermined time after the emergency brake valve has been opened.

The brake response is measured relative to the momentary status measured at the start of the emergency braking.

For testing of the emergency brake function via the ETCS (when there is no specific STM emergency brake interface), refer to [5.6.4].

[13] Differs from [ATC2]

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5.4 BALISE READING AND TRANSMISSION TEST

5.4.1 Information points

An information point can "legally" consist of 2...5 balises. During fault conditions, lone balises may occur. At least two balises are required for transmission of safety information. An information point can be intended for one or both directions, depending on function.

The balise reading function must be able to handle two main types of balises [F5025]:

a) Information balise, sends synchronized telegrams with three 8-bit code words and one synchronization word. Every accepted telegram must be surrounded by two synchronization words.
b) Marker, sends a continuous unsynchronized stream of zeroes. Is mostly used as B-balise, see below. A faulty information balise can sometimes appear as a marker.

5.4.1.1 Telegram composition

F5011. The STM shall handle information from the balises given in the form of logical zeroes and ones, which are put together to information words consisting of 8 bits.

Note. One bit is the smallest unit and can be a one or a zero.

Note. Zeroes are transmitted actively in the airgap. This means that when no balise is present, a stream of logical ones will be received.

F5012. The STM shall handle every synchronized telegram with three information words that are called X, Y and Z.

Note. The information is differently interpreted for the X-, Y- and Z-words [Chapter 3].

5.4.2 Amount of information transferred

F5013. Telegrams shall be received by the STM while passing an information balise:

a) This will continuously repeat a telegram of 32 bits length,

b) With the bit frequency 50 kbit/s.

Note. A telegram is thus transmitted every 640:th μs.

Note. The received number of telegrams can vary considerably (from about 8 at 300 km/h to about 300 at 10 km/h, or an unlimited number while the train is stationary) depending on the train speed and the transmission conditions (damp iron ore concentrate on the balise and similar).

F5014. Transfer rate and contact distances shall give a theoretical number of at least 8 telegrams from one balise to be received at speeds up to 300 km/h.

Note. In practice, the number of correctly received telegrams may be down to 4, but not less.

F5015. The STM shall handle telegrams that have the following structure.

a) Every telegram contains a synchronization word, that is inverted every second telegram cycle.

b) One telegram shall only be accepted when the synchronization word (S) and its inverse (S^*) are located on each side of the data bits.

c) The telegram is disposed according to the following table.

Table 5.4-1. Telegram composition

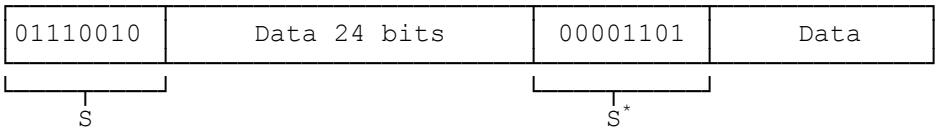
	NAME	BITS	FUNCTION
a)	S and S^*	8	Synchronization word (every second sync word is inverted)
b)	X	8	Balise category, coded in M(8,4) which gives totally 16 different combinations [1)]
c)	Y and Z	2 * 8	Data words, coded in M(8,4), which gives $(2^4)^2 = 256$ different combinations [1)]
d)	YZ	16	Data word coded in M(16,11) which gives $2^{11} = 2048$ different combinations [1)]

1) *Note*. Only a subset of these combinations is permitted.

Note. About the meaning of the balise information and the configuration of different information points, see [Chapter 3].

F5016. The STM shall handle telegrams with contents and location of the synchronization words according to the following figure:

Figure 5.4-1. Synchronization words in a balise telegram



F5017. The STM shall handle telegrams where only 7 of the 8 bits in the synchronization word shall be inverted, so that a faulty inverting of the whole telegram shall be discovered.

5.4.3 Transmission test (TEST1 or other)

F5018. When using a dedicated STM antenna:

a) Every 50:th ms the transmission functions shall be checked, i.e. the balise reading ability.

b) There shall be a special test function for this purpose, TEST1.

c) TEST1 shall check that:

1. The output level from the transmitter is enough to activate passed balises, and
2. That the sensivity of the receiver is enough to detect passed ATC-2 balises.

Note. If the transmitter is turned off, TEST1 will not work.

F5019. When using a dedicated STM antenna:

a) The STM shall ensure that TEST1 works at the proper points of time.

b) If the transmitter is "on" and one or more TEST1 replies are lacking, the error shall be handled as stated below.

1. A transmission error text message shall be sent [4.8.4.3].
2. The STM shall always order full service braking [3.3.4].
3. The STM shall erase all balise information.
   a. This shall not cause any STM emergency braking.[14]
4. The STM shall allow brake release when the train stops.[15]
5. Failure state (FA) shall be entered if the problem persists when the driver presses the LOSS button.

Note. A transmission test (TEST1 or similar) reply could be interpreted as a marker balise.

F5020. When using a dedicated STM antenna, the STM shall distinguish between a transmission test and a marker.

[14] Because Vdark = 130 km/h.
[15] To avoid ETCS emergency braking.

5.4.4 ”Long balises”

F5021. a) The system shall check that no balise contact persists for more than 80 m.

b) In case of too long contact distance, the error shall be handled as stated below.

1. A transmission error text message shall be sent [4.8.4.3].
2. The STM shall always order full service braking.
3. The STM shall erase all balise information.
   a. This shall not cause any STM emergency braking.[16]
4. The STM shall allow brake release when the train stops.[17]
5. Failure state (FA) shall be entered if the problem persists when the driver presses the LOSS button.

5.4.5 Transmitter On/Off

F5022. When using a dedicated STM antenna, the transmitter shall be in operation (active) when any of these conditions apply:

a) The cab is active and the direction controller = Forward/Reverse (not in Neutral), or

b) The train is rolling, or

c) There is balise contact.

F5023. Reserve.

F5024. When using a dedicated STM antenna, the transmitter shut-down function shall be delayed by 10 seconds.

5.4.6 Balise classification

F5025. The balises shall be classified by the STM software according to the number of correctly received and synchronized telegrams, as shown in this table:

[16] Because Vdark = 130 km/h.

[17] To avoid ETCS emergency braking.

Table 5.4-2. Balise classification

	No. of telegrams	Balise type
a)	0	Marker
b)	1...3	Faulty information balise
c)	≥ 4	Information balise

F5026. If a faulty information balise, intended for the present or the opposite direction, is found, balise error alarm shall be given [3.3].

5.4.7 Balise density

F5027. Reserve

The STM is able to manage at least 4 balise groups per second [3.2.5].

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5.5 HANDLING OF BRAKE PRESSURE

5.5.1 General

The brake pressure handling is generally the same as for [ATC2].

The STM handles two types of pressure:

P_{REF} Reference pressure in kPa. The reference pressure corresponds to the 'A' chamber pressure in the KE (brake control) valves, which makes it suitable for comparison with brake pipe pressure to determine the current braking effort. This is an internal "normal train running pressure" value (neither braking nor any other pressure-affecting actions). Is not affected so much during braking.

P_{INT} Brake pressure in kPa. This is the current pressure of the train's main pressure pipe, or a converted cylinder pressure.[18] Decreases during braking with a rate that depends on the train type (brake delay time).

By comparing these two, the STM can decide whether braking is in progress or not.

5.5.2 Transducer in the vehicle

A pressure sensor measures the pressure in the main brake pipe. The range of the sensor is 0-700 kPa. [GRS]

F5028. The STM shall interpret the following signal from the pressure sensor in the following table:

Table 5.5-1. Pressure signal

	Pressure		Signal
a)	0 kPa	⇔	4,0 mA
b)	500 kPa	⇔	15,4 mA
c)	Δ100 kPa	⇔	Δ 2,28 mA

[18] If the train lacks a main pressure pipe, the brake pressure must be obtained from another source and then converted to a suitable pressure value

F5029. a) The STM shall have this accuracy for the pressure measurement:

1. ± 20 kPa absolute value.
2. ± 10 kPa relative (measured over 1 s).

b) Resolution: ≤ 5 kPa.

Note. If the pressure input represents cylinder pressure ("EP brake active"), the input data must be recomputed to be usable in the internal calculations, which assume a brake pipe pressure.

F5030. Cylinder pressure recalculation.

a) If pressure input represents brake pipe pressure:

1. Then $P_{INT} = P_{EXT}$ (no conversion),
2. except that P_{INT} shall be limited to $0 \leq P_{INT} \leq 550$ kPa.

b) If pressure input represents cylinder pressure then

$$P_{INT} = 500 - P_{EXT} / P_{FULL} * 150 \quad \text{(kPa)}$$

where

- P_{EXT} is input value in kPa, set to 0 if negative value.
- P_{INT} is internal pressure value in kPa
- P_{FULL} is cylinder pressure in kPa, when full service braking is applied (brake feedback parameter).

Note. This conversion provides a synthetic brake pipe pressure, which should correspond to the behaviour of a real main pipe, i.e. 500 kPa for no brake and 350 kPa for full braking. By using a variable parameter P_{FULL} the calculation will be more accurate than in ATC-2, where P_{FULL} is always assumed to be 300 kPa.

Note. P_{FULL} is defined in an installation dependent configuration memory [F4002].

5.5.3 Calculation of reference brake pressure

The reference pressure is an internal value which is designed to imitate the A chamber pressure in the KE valves. It can thus be used by the STM to determine how much braking that has been applied.

F5031. The pressure measured at start shall be used as reference pressure and shall thereafter be adapted to the current pressure according to the following table (which applies if the calculation is performed once per second):

Table 5.5-2. Reference brake pressure

	CONDITIONS:	ACTION:	REMARKS
a)	$P_{REF} = P_{INT}$	No change	Constant pressure
b)	$P_{REF} < P_{INT}$	$P_{REF} = P_{REF} + 1,5$	Increasing pressure
c)	$P_{REF} > P_{INT} + 30$	No change	Braking
d)	$P_{INT} + 30 \geq P_{REF} > P_{INT}$	$P_{REF} = P_{REF} - 0,5$	Sinking pressure

Where:

- P_{REF} is the reference pressure.
- P_{INT} is internal representation of brake feedback in main pipe pressure format, limited to max 550 kPa.
- Values given in kPa.

5.5.4 Initializing the reference brake pressure

F5032. The reference pressure shall be set on starting the STM:

a) To the first stable P_{INT} value between 400-550 kPa achieved.

b) Stable in this instance means that the pressure has not varied more than ± 20 kPa over 3 seconds.

Note. This begins with saving the pressure (= P_0) and starting the 3 s timer. If the pressure P_{INT} then deviates more than ± 20 kPa from P_0 before time-out, a new pressure P_0 is saved and the timer is restarted. This goes on until the pressure becomes enough stable.

5.5.5 Error indications

F5033. The error message 'TRYCKGIVARFEL' shall be given if:[19]

a) The pressure measured (P_{EXT}) is < –50 kPa (2,9 mA).

   1. Simultaneously the P_{INT} pressure value shall be set equal to the reference pressure.

b) The pressure measured (P_{EXT}) is > 955 kPa (25,8 mA).

[19] Differs from [ATC2]

Note. This check serves to detect hardware failures in the brake status input, and should not react to normal or abnormal pressure variations.

5.5.6 Brake test

F5034. The brake test sequence shall wait before the braking starts if:

a) The converted pressure (P_{INT}) is not between 400-550 kPa.

b) The converted pressure (P_{INT}) does not remain steady within ±20 kPa for 3 s.

5.6 STM START OR STOP

5.6.1 General

The operating status of the STM equipment is determined by the ETCS according to cab status, and directly by the STM isolation switch.

The STM can be isolated by setting the STM isolation switch to Off. In this Shutdown state the supply to the STM brake circuits is interrupted, at the same time as the emergency brake valve is fed independently of the STM. The STM computers, however, are still powered.

With the STM isolation switch in position On, the connection of the system is determined by the ETCS according to cab status (A/B/Off). This selects the adequate antenna in some engines. When a cab is activated, the ETCS will request the STM to begin its start test, see below.

5.6.2 STM self test

The following items are tested:

a) Internal STM functions

b) STM - ETCS communication[20]

The self test is halted on detecting an error, and the nature of the error is indicated.

F5035. a) The STM self test shall be performed in Power On state (PO) during the Start of Mission procedure [4.3].

b) Parts of this test are also performed during normal operation (all states except NP and FA). Refer to supplier specification.

F5036. a) The self test shall halt if a failure is detected.

b) The current self test position (test number) shall be displayed as specifically as possible.

Note. Refer to the supplier specification.

F5037. The STM shall ensure that these functions are correctly working:

a) Internal STM functions.

b) The STM - ETCS communication.[21]

Note. This test will be specified by the supplier.

F5038. The STM shall establish communication with the ETCS and ensure that this communication works correctly.[22]

[20] Differs from [ATC2]
[21] Differs from [ATC2]
[22] Differs from [ATC2]

5.6.3 STM start test

The STM start test is equivalent to the ATC-2 startup test position 3 [ATC2] and is accomplished with help by the STM Specific Test Procedure [ESTM].

The start test is executed once during each Start of mission procedure (Data Entry), but only if there is a separate STM antenna. The following test is performed:

– STM transmission test.

F5039. The following applies if there is a separate STM antenna:

a) An STM specific test procedure shall be requested to the ETCS while the STM is in the Data Entry state.

b) The STM shall carry out the start test even if the antenna is positioned directly above a balise.

Note. In this case however, the transmission test uses a slightly different algorithm than usual (specified by the supplier).

F5049. With a separate STM antenna, the **transmission test** shall ensure:

a) That TEST1 functions with the transmitter = On.

b) That TEST1 does not function with the transmitter = Off.

F5041. If the STM start test fails:

a) An error indication shall be given.

b) After that, the STM shall enter the Failure state.[23]

[23] Differs from [ATC2]

5.6.4 STM service brake test – Brake test A

5.6.4.1 General

STM service brake test sequence (brake test A):

A1. STM brake feedback test.

A2. STM service brake test (via ETCS).

The STM brake test is equivalent to the ATC-2 startup test positions 4, 5 and 6 [ATC2].

The brake test will only be carried out on request from the driver. The brake test should be executed during every mission.

Every test is halted on detecting an error, and the nature of the error is indicated.

The STM uses the ETCS brake interface for full service braking. But the service brake test is still regarded as necessary because the deceleration supervision is based upon the ATC2 brake curve model, which relies heavily on the service brake function.

The STM brake test A is equivalent to the corresponding ATC-2 service brake startup test positions.

5.6.4.2 Starting Brake test A

Note. The STM brake test is only performed on request by the driver.

F5042. If the ETCS service brake test does not fulfill the requirements according to [Table CP row l], then the STM shall remind the driver to request Brake test A in the following cases:: [24]

a) The train is stationary and has entered Data Available (DA) during the Start of Mission procedure.

   Note. This applies to cold start as well as change of cab.

b) The train becomes stationary in state Data Available (DA) and Brake test A was not performed in connection to the last ETCS Start of Mission procedure.

Note. A train travelling between two ETCS areas with ATC-2 infrastructure in between may have problems running the brake test unless there is a stop in the ATC-2 area.

[24] Differs from [ATC2]

F5042A. The STM shall start Brake test A under the following premises:

a) The train is stationary, and

b) The train is in state Data Available (DA), and

c) The driver presses the BRAKE TEST button.

F5042B. The STM shall execute Brake test A in the following way:

a) The driver shall be informed when the test starts.

b) Perform STM brake feedback test (A1) according to [5.6.4.5] below.

c) If the previous test was accepted, perform the STM service brake test (A2) according to [5.6.4.3] below.

5.6.4.3 Perform the Service brake test (A2)

F5042C. The service brake test shall be initiated by a service brake request from STM to ETCS.[25]

F5043. a) The STM shall indicate the brake test results on the DMI.

b) If the test was successful this shall be shown on the DMI, but no acknowledgement from the driver shall be required.

c) If any problem was detected, diagnostic information (train position and error indication) shall be shown according to supplier specification, and this information shall remain at least until acknowledged by the driver.

d) The test result shall be handled according to [5.6.4.4] below.

5.6.4.4 Additional brake delay time

Depending on the results from Brake test A, an extra delay time (T_X) of 5 s can be added to the full service brake delay time parameter (T_B) for deceleration supervision. But this should not alter the originally entered delay time parameter T_B.

[25] Differs from [ATC2]

F5043A. An extra brake delay time T_X of 5 s shall be added to the full service brake delay time (T_B) if:

a) The last brake test failed, or

b) No brake test has been performed since the last Start of mission procedure.

Note. This means that in case of STM service brake failure, the resulting emergency brake application will occur 5 s earlier, i.e. at the latest 5 s before the deceleration curve is passed.

F5043B. The temporarily increased full service brake delay time shall affect the deceleration supervision.

a) Exception: after the brake pressure has been decreased by 60 kPa or more.

Note. This means that the S_{BRAKE} moves towards the deceleration curve in a normal way, which makes it possible for the driver to avoid STM brake intervention when there is a short target distance.

F5043C. The extra brake delay time T_X shall be set to 0 s (return to the original delay time parameter T_B) when:

a) After a successful Brake test A.

5.6.4.5 Brake feedback test (A1 or B1)

F5044. a) The STM brake feedback test shall be started at the same time as Brake Test A or B [5.6.4.2, 5.6.5.2.].[26]

b) The test shall not be accepted if:

1. The pressure measured (P_{EXT}) is < –50 kPa (2,9 mA).
2. The pressure measured (P_{EXT}) is > 955 kPa (25,8 mA).

Note. This check serves to detect hardware failures in the brake status input, and should not react to normal or abnormal pressure variations.

c) The STM service brake test shall be started as soon as the brakes are almost released.

[26] Differs from [ATC2]

Note. Refer to [5.6.5.25] below.

d) The criterion for starting the brake test shall be:

1. P_{INT} shall be ≥ 400 kPa and
2. P_{INT} has varied ≤ 20 kPa during 3 s.

e) Reserve.

5.6.5 STM emergency brake test -- Brake test B

5.6.5.1 General

This sub-section applies only for trains equipped with a direct STM emergency brake interface.

The STM emergency brake test sequence (brake test B):

B1. STM brake feedback test.

B2. STM emergency brake test (own interface).

There is no specific brake test for an STM which is only equipped with ETCS emergency brake interface. This type of braking is supervised every time that the STM orders emergency braking.

The STM brake test B is equivalent to the ATC-2 emergency brake startup test positions.

The brake test should be executed during every mission, or at least once within 24 hours.

Every test is halted on detecting an error, and the nature of the error is indicated.

5.6.5.2 Starting Brake test B

F5045. If the train is equipped with a direct STM emergency brake interface [Table CP] then the STM shall remind the driver to request Brake test B, alternatively automatically perform this brake test in the following cases:[27]

a) The train is stationary and has entered Data Entry (DE) right after each cold start.

b) At change of cab, if there was more than 24 hours since last time.[28]

Note. It is allowed to make the test more frequently.

F5045A. The STM shall start Brake test B under the following premises:

a) The train is stationary, and

b) The train is in state Data Entry (DE), and

c) The ETCS is not performing its own emergency brake test at the same time, and

[27] Differs from [ATC2]

[28] Reserve.

d) The driver presses the BRAKE TEST button, or the brake test starts automatically.

Note. This means that it is possible to request Brake Test B every time that the STM enters state DE, either during a mission or while starting one.

F5045B. The STM shall execute Brake test B in the following way:

a) The driver shall be informed when the test starts.

b) Perform STM brake feedback test (B1) according to [5.6.4. 5] above.

c) If the previous test was accepted, perform the STM emergency brake test (B2) according to [5.6.5.3] below.

d) The STM shall not leave the Data Entry state until Brake Test B has been performed (if the test has been started).

Note. ETCS performs "Standstill supervision" until the Start of Mission procedure has been completed.

5.6.5.3 Perform Brake test B

F5045C. Starting the emergency brake test.

a) The emergency brake test (B2) shall be initiated by an emergency brake request direct from the STM to its own emergency brake interface.

b) No emergency brake order shall be given to the ETCS.

F5046. Requirements for the emergency brake test**,** when the STM is equipped with an interface of its own**:**

a) For brake pipe measurement:

1. The valve shall be opened and closed again after 1 s.
2. The pressure (P_{INT}) shall drop within 1,25 seconds after opening of the valve by at least 60 kPa below the momentary pressure measured before opening of the valve, or else the brake test shall halt.

b) For cylinder measurement:

1. The valve shall be opened and closed again after 2,5 s.
2. The pressure (P_{INT}) shall drop within 3,25 seconds after opening of the valve by at least 60 kPa below the momentary pressure before opening of the valve, or else the brake test shall halt.

Note. An unpowered valve is assumed to be open.

c) The STM shall also ensure that the emergency brake output circuits are electrically correct during emergency braking.

d) For any standby computers, only the relay functions shall be checked.

Note. c) and d) may be specific for each manufacturer.

F5047. Results of Brake test B.

a) The STM shall indicate the brake test results on the DMI.

b) If the test was successful this shall be shown on the DMI, but no acknowledgement from the driver shall be required.

c) If the STM fails the test, diagnostic information according to supplier specification shall be shown until acknowledged by the driver.

d) After acknowledgement by the driver, the STM shall proceed to the Failure state (FA).

5.6.6 Roll-away protection

This function prevents a train from rolling away without a driver.[29]

5.6.6.1 Normal roll-away protection

F5048. Full service braking shall be applied if all following conditions are fulfilled:

a) The train was stationary during ≥1 second,[30] and

b) Then begins rolling up to 5 m, and

c) The direction controller is in the Neutral position.

F5049. The message 'RULLNINGSVAKT' shall be indicated while the full service braking is applied.[31]

F5050. The full service braking shall immediately be released when the message is acknowledged.

5.6.6.2 Strict roll-away protection after passing stop

F5050A. The strict roll-away protection applies only when:

a) There has been an unpermitted stop or landslide passage, and

b) The driver has not yet acknowledged the "Bekräfta...." message.

F5050B. During strict roll-away protection, emergency braking shall be applied if both conditions are fulfilled:

a) The train is really stationary (not moving slowly), and

b) Then moves 1 m (or more).

Note. The direction controller can be in Forward, Neutral or Reverse.

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[29] This function can also detect errors in the direction controller inputs, which could cause the STM system's transmitter to fail until the train has started moving (the transmitter starts normally when the direction controller is set to Forward or Reverse). If this error remained undetected and an odometer error subsequently occurred, then it is possible that neither speed measurement nor balise detection would function without any warning to the driver.

[30] Reserve.

[31] Differs from [ATC2]

5.6.7 Change to resting mode (de-activated cab)

In a de-activated cab, all indications on the DMI are extinguished and no supervision or braking is performed. This is mainly managed by the ETCS.

Refer to [4.3.13] and to the ETCS specifications.

5.7 DECELERATION MEASUREMENT

5.7.1 General

The deceleration of the train will be measured during every braking process. A new brake percentage is then computed according to the achieved result. This makes it possible for the driver to verify that the entered brake percentage is resonable.

This function has no other implication on the STM. Train parameters, deceleration supervision etc. are not affected.

In the following description, and the associated requirements, all references to brake pressure assume a UIC brake pipe system. For systems with e.g. cylinder pressure measurement the given values are adapted by using the internal pressure variable (P_{INT}).

5.7.2 Measurement

As soon as the brake pressure has decreased with more than 60 kPa, and when the brake delay time has passed, the STM starts measuring (logging) pressure, speed and time.

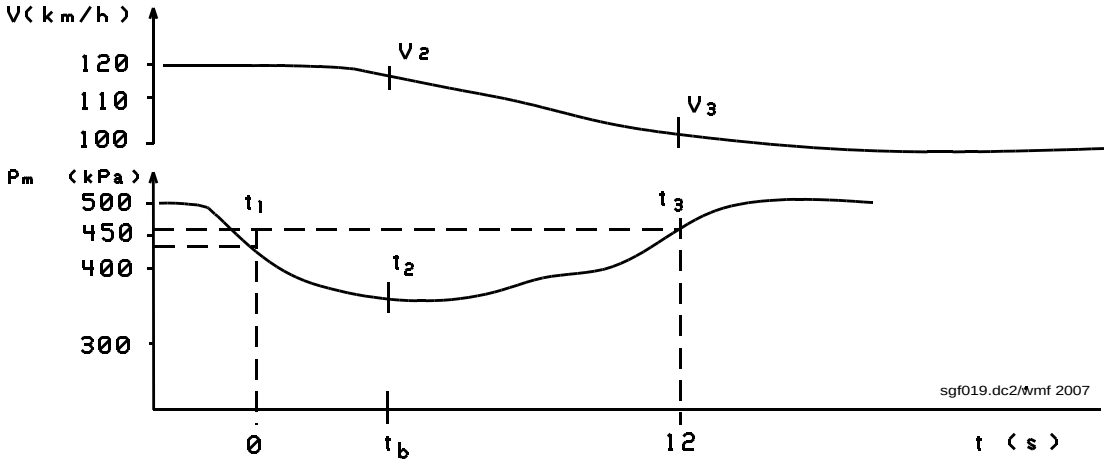
This measurement continues until the difference between the reference pressure and the main pipe pressure becomes less than 40 kPa, or until the train has slowed down below 25 km/h.

The STM calculates the average pressure reduction and the average train deceleration during this period.

Should the average pressure reduction become smaller than 150 kPa, the average deceleration will be recalculated to represent full service braking.

The following figure shows the measurement principles. The following values are assumed: $T_B = 4$ s, $P_{REF} = 500$ kPa.

Figure 5.7-1. Deceleration measurement



F5051. The deceleration measurement shall be started if

a) $V_{TRAIN} > 25$ km/h, and

b) The brake pressure (P_{INT}) < P_{ref} - 60 kPa (at time t_1), and

c) At least 15 seconds has elapsed since the previous measurement was finished.[32]

F5052. When the delay time is passed after t_1, i.e. at time t_2, the train speed shall be measured (V_2).

F5053. a) During the time interval between t_2 and t_3, the average value of the pressure reduction shall be measured (P_{REF} - P_{INT}).

b) During this measurement, the momentary value of P_{REF} - P_{INT} shall be limited to 150 kPa.

F5054. The train speed is measured once again (V_3) when:

a) The brake pressure (P_{INT}) has increased to > P_{REF} - 40 kPa (at t_3), or

b) The train has slowed down below 25 km/h, or

c) $t_3 - t_1 \geq 60$ s.

Note. This means that the measurement will be finished.

[32] This is to avoid that the measurement result is erased too early.

F5055. If $t_3 - t_2 \geq 4$ s, (successful measurement) the following calculation shall be performed:

$$B_M = \frac{V_2 - V_3}{t_3 - t_2} \qquad (m/s^2)$$

where

- B_M is the average deceleration from t_2 to t_3
- t_2 and t_3 are the times for the measurement of V_2 and V_3
- V_2 and V_3 are measured train speeds in m/s.

F5056. The computed value of B_M shall then be recalculated for full service braking:

$$B_{FM} = \frac{B_M \bullet 150}{(P_{ref} - P)^{33}} \qquad (m/s^2)$$

F5057. a) B_{FM} shall be used to compute a brake percentage value, rounded down to the nearest whole number [4.2.4]:[34]

1. Brake position P/R: $BP_M = -14{,}05 + 146{,}90 \bullet B_{FM}$ (%).
2. Brake position G: $BP_M = -26{,}10 + 165.20 \bullet B_F$ (%).

b) The resulting brake percentage shall be saved until a new measurement result is achieved.

[33] Average pressure difference
[34] Differs from [ATC2]

5.7.3 Indication

F5058. The following shall occur when the driver presses the button RETARDATIONS-KONTROLL: [35]

a) If the latest measurement was successful, the result BP_M shall be displayed on the indicator BROMSTAL in %.

   1. Values below 30 % shall also be indicated.

b) Exception to a): The displayed value shall not be higher than BP_O, the original STM brake percentage parameter, which was received during the latest train data entry procedure (not after deceleration measurement).

c) The valid brake percentage parameter (BP) shall be displayed within parentheses.

Note. If the last measurement failed there is no BP_M to display, but BP is still indicated within parentheses for comparison.

5.7.4 Updating the brake percentage parameter

F5059. Whether the last measurement was successful or not, it shall always be possible for the driver to update the valid STM brake percentage parameter (BP) according to the following rules: [36]

a) The displayed brake percentage value may be increased or decreased by the driver, as long as it does not exceed the value of BP_O.

   Note. This is done with help by the "+" or "-" buttons.

b) If the STM accepts the changed brake percentage value, it shall be entered when the driver presses the button ÄNDRA BROMSTAL.

   1. This shall be done whether the train is running or not.

c) The entered value shall update BP, the valid brake percentage parameter, which in its turn shall update the full service brake deceleration parameter, see also [4.2].

d) The new accepted BP value shall not affect BP_O.

e) The original brake percentage BP_O shall only be updated during the normal data entry procedure (while the train is stationary).

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[35] Differs from [ATC2]
[36] Differs from [ATC2]

F5060. Reserve.

A5060. Information to the ETCS.

a) ETCS shall be informed when the brake percentage parameter BP has changed after an STM deceleration measurement.

Note. This information is not used by an ETCS standard equipment.

b) This shall apply independently of the train speed.

c) A suitable data packet (M_SUP) shall be used for this purpose.

F5061. Reserve.

A5061. Information from the ETCS.

a) The STM shall be able to receive a changed brake percentage parameter from the ETCS (due to an ETCS deceleration measurement).

Note. This information is not given by an ETCS standard equipment.

b) 1. This shall apply independently of train speed.

2. This shall apply at least in the STM states HS and DA.

c) A number of faked buttons shall be defined, one for each possible BP value in the ETCS.

d) The STM shall receive a faked pressing for the button “BP-nnn”, where nnn gives the new BP value.

e) The new BP value shall be limited by BP_O, the original brake percentage value.

f) When the new BP has been received, the STM shall recalculate the full service brake deceleration parameter Bf.

Note. This change will not affect any active braking curves.

Note. Both the STM and the ETCS save their valid train parameters during their own ”resting” periods (while another system is in charge). These parameters can be re-activated when needed.

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5.8 INDEX

5.8.1 Changes