"BRAKE BLOCKS: HIGH FRICTION COMPOSITION TYPE FOR 5M2A/10M SERIES PLAIN AND MOTOR COACHES"

Authorization and Authenticity

This technical Specification was initially issued by our former mother body referred to as South African Rail Commuter Corporation Limited (SARCC LTD) in august 2001, which later became the "Passenger Rail Agency of South Africa" (PRASA) 2006

The authorization and authenticity of this document is therefore referenced below and its originality can be attached as an addendum on request.

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BRAKE BLOCKS: HIGH FRICTION COMPOSITION TYPE FOR 5M2A/10M SERIES MOTORCOACHES, PLAIN TRAILERS AND MAIN LINE PASSENGER COACHES

1. SCOPE (OVERVIEW)

1.1 This document contains the minimum requirements of high friction brake blocks both for the manufacturing thereof as well as the approval of the brake blocks and the brake block manufacturer.

1.1.1 Non-Asbestos high friction composition brake blocks complying with these requirements, as approved by the Metrorail VIT Brake Section, Engineering (Technology Management), are acceptable for use on 5M2A/10M Series motor coach, plain trailer and Main line passenger coaches.

1.1.2 Metrorail/Shosoloza Meyl uses high friction brake blocks as follows: only on 5M2A/10M series motor coaches, plain trailers and Main line passenger coaches. Maximum speeds for 5M2A/10M series train sets and for Main line passenger coaches empty and loaded are 90km/h operationally.

2. MANUFACTURE

2.1 The friction material of brake blocks must not contain asbestos, lead or zinc.

2.2 Friction material debris released from the brake block during braking must not influence track circuits and wheel rail adhesion, nor be harmful to railway passengers or railway employees working in close proximity to the brake blocks.

2.3 The control limits for hazardous chemical substances, according to the Occupational Health and Safety Act and Regulations, Regulations for Hazardous substances, 1995, in Table 1, on Page 935 must be adhered to.

2.4 Brake blocks shall be provided with suitable backing plates free of defects, which will produce no in service failures.

2.5 Adhesion of the friction material to the back plate must be such that no separation will take place in service, under normal operating conditions.

2.6 The design and contour of the brake blocks shall be within the limits shown on the applicable drawings. RS A005_006_704/Latest and approved manufacturers drawings.

2.7 Brake block backing plates must be coated to ensure that rust will not affect the bonding between back plate and friction material over the life of the block. The block must have a shelf life of up to 4 years. The coating must also be such that the markings on the block are not influenced or faded by rust over the life of the block. The markings on the back plate must stay legible throughout the life of the block. The markings on the back plate must be so positioned to avoid wearing by contact between the block and the shoe. The minimum colour markings or paint on a block must cover the field side of the block, top and bottom, from the wheel contact face to the back plate including the back plate. On a new block the colour or paint marking must cover at least 60 mm x 80 mm surface. The colour or paint must have a smooth and continuous surface that will

make the colour of the block clearly visible when the block is installed in a bogie. The colour will be designated on the drawing.

3. MATERIAL PROPERTIES

Each manufacturer is required to determine the modulus of elasticity, material hardness, density, material adhesion to back plate, acetone extraction (optional), impact strength, shear strength, compressive strength and bending strength of the friction material. The manufacturer shall also specify the tolerance on all the material properties that has not been specified in this specification, for each brake block that the manufacturer is tendering to supply. Once a manufacturer is supplying brake blocks to Metrorail/ Shosholoza Meyl these tolerances must be adhered to. Tests must be done to prove that the blocks adhere to the manufacturer specific material properties and tolerances per batch. The batch must be between 10 000 and 20 000 brake blocks and the results must be sent to the Brake VIT Section and end user as a quality certificate. These tests will be for the account of the Manufacturer.

At the option and expense of the VIT Brake Section, field samples of a manufacturer's brake block may be selected and tested per manufacturer's tolerance on material properties. This will be done separately from the test described in section 6.3. The manufacturer will be advised of failures. Three (3) sequential failures of the above quality control or the control mentioned in section 6.3 will constitute grounds for withdrawal of the brake blocks from the Approved Product List. After each failed control test, investigations must be done by the supplier to find out the cause of the deviation and the deviation must be corrected by the supplier. The corrective action must be addressed in writing to Metrorail.

3.1 Modulus of elasticity: (Young's Modulus) [E]

To eliminate too stiff blocks causing hot spots on the wheels, the modulus of elasticity in compression must be submitted and the maximum value must be less than 2150 MPa. The test must be carried out in accordance to specification ASTM part 35 D 695-80. At least 3 specimens must be prepared for this test.

3.2 Composition material hardness:

To eliminate blocks with different wear rates, the Rockwell scale Rx, R_R or R_L must be used to determine the composition hardness at each of the 12 points in the matrix as indicated by figure 1. The difference between the minimum and maximum values must not be more than 20 points in the test specimens used, in any of the three Rockwell scales. The test must be carried out in accordance to specification ASTM D 785-65, using a Rockwell hardness tester. If a manufacturer wishes to test hardness with the Rockwell Rx scale it must be in accordance with the UIC spec 541-4 OR appendix 5. If any hardness values in any of the 3 Rockwell scales exceed 100 points the next scale rendering values or below 100 points must be used. Two slices of 10 mm thick must be cut out of one block (one in the centre of the block or in the centre of one lobe for a two lobe block and one towards the outside (top or bottom end) of the block must be used for this test) and marked according to figure 1, to create 12 measuring points for hardness. Two test specimens must be cut out per block, from 3 blocks.

Test specimen example

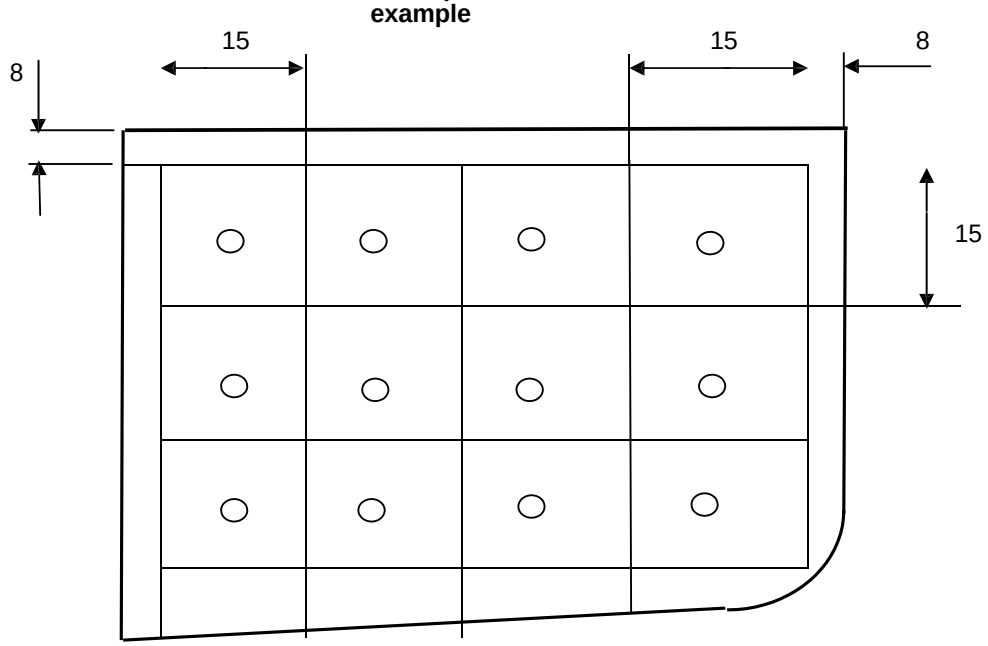


Figure 1

3.3 Composition material density: (Specific gravity)

To establish a method to measure the consistency of manufacture and materials used, the material density must be determine according to the ASTM specification. The test must be carried out in accordance with the method described in specification ASTM D 792-66. At least 3 specimens must be prepared for this test. The material density of the test specimen may not vary with more than 11% of the value the manufacturer submitted to the Brake VIT.

3.4 Composition material adhesion to back plate:

Method 1: -

To establish a measuring technique to ensure that the friction material does not separate from the back plate in service, the test device in appendix 3 of UIC 541-4 must be used. Apply the shear force in the direction of the braking force. The force to shear the friction material off the back plate must be more than 70 N/cm^2. A force of 70 N/cm^2 or 3.5 tons per brake block must be applied to the block for 10 minutes without shearing the friction material from the back plate. (No part of the friction material must be separated from the back plate)

Method 2: -

With the brake block lying on its side (flat surface), use a flat chisel and hammer it in between the back plate and the composition material until the composition material completely separates from the back plate.

Measure all the areas on the back plate where there is no composition material adhesion to the back plate. Calculate this area and deduct this area from the total area of the back plate. The percentage of composition material adhesion to the back plate must be more than 80% of total area of the back plate.

3.5 Composition material acetone extraction: (Optional)

This test is intended to give the amount of unpolymerised material in a phenol-formaldehyde resin, thus showing whether the curing process in manufacture has been correctly carried out. The test is carried out in accordance with UIC 541-4, paragraph 6, and method BS AU 142, paragraph 3.5. An alternative test describes in ASTM part 35 & 36, D 412-80 or C 613-67 can also be used. The limit of weight loss during the test is between 0.5% and 8.0%.

3.6 Impact strength

To determine the resistance to breakage by flexural shock of composition material the impact strength must be done according to ASTM part 35, D 256-81.

3.7 Shear strength

This method is intended to determine the shear strength of the composition material. The shear strength must be done according to ASTM part 35, D 732-78.

3.8 Compressive strength

The compressive strength must be done according to ASTM part 35, D 695-80.
This method covers the determination of the mechanical properties of rigid material when loaded in compression at relatively low uniform rates of straining or loading.

3.9 Bending / Flexure strength

The bending / flexure strength must be done according to ASTM part 35, D 747-70 or ASTM part 35, D 790-81 respectively
These methods are to determine the flexibility of the composition material.

4. PERFORMANCE CRITERIA

4.1 COEFFICIENT OF FRICTION FOR 5M2A/10M SERIES MOTOR COACHES.

4.1.1 HIGH FRICTION BRAKE BLOCK

4.1.1.1 DYNAMOMETER TESTS

4.1.1.1.1 The blocks shall be tested for friction, wear rate as well as the amount of wheel wear on a suitable dynamometer having characteristics acceptable to the VIT Brake Section.

4.1.1.1.2 The supplier shall present dynamometer test graphs, as outlined in Section 7 and as specified in sections 4.1, 4.2 and 4.3.

4.1.1.1.3 Sections 4.1, 4.2 and 4.3 are applicable to the dynamometer test.

4.1.1.1.4 After conducting the wear-in cycles as mentioned in Section 4.1.1.3 grade, stop and static tests shall be conducted in the following sequence:

(a) Grade (Drag) tests
(b) Stop test series
(c) Static tests

4.1.1.2 DYNAMOMETER SETUP

4.1.1.2.1 The test wheel shall be a one-wear or multi wear wheel with between 860 mm to 915-mm diameter and flange heat-treated AAR grade C wheel with rim thickness of no less than 25 mm.

4.1.1.2.2 The wheel, after being mounted on the dynamometer, shall be ground or machined to ensure roundness with a surface finish of between 1.6 and 6.3 micrometer (µm) on the tread prior to testing the first block. The tread may be ground concentric (optional) to the dynamometer shaft. It is not necessary to regrind the wheel for testing of the second and third blocks. Before grinding or machining the wheel to the specified surface finish all hard spots must be machined to 0.05mm below the hard spots or martensitic patches.

4.1.1.2.3 Wheel diameter must be measured before and after final completion of the tests of all three blocks to determine the wheel wear.

4.1.1.2.4 Each brake application of the test block, made with a designated speed or brake force combination, will be considered a test. The data and graphical presentation for each test must be presented to the Metrorail and Brake VIT. (See 4.1.1.1.2)

4.1.1.2.5 Test is to be conducted when the temperature of the wheel tread, as measured by a sliding thermos-couple, must be 55±5 ºC in the dry condition and 35±5 ºC in the wet condition, at the start of each test. The wheel may be water-cooled before/after each test.

4.1.1.2.6 The effect of dynamometer resistance shall be neglected in calculations for all tests.

4.1.1.2.7 All tests are to be made with a double clasp brake block per wheel arrangement for 5M2A/10M series motor coaches and a single brake block per wheel arrangement for 5M2A/10M series plain trailers and main line passenger coaches.

4.1.1.2.8 The equivalent inertial load of the test wheel shall be 10 ton for 5M2A/10M series motor coaches and 7.25 ton for 5M2A/10M plain trailers and main line passenger coaches. A variation of 125.0 kg will be permitted.

4.1.1.3. BRAKE BLOCK WEAR-IN

THE BRAKE BLOCK SHALL BE BEDDED-IN, IN THE FOLLOWING MANNER:

(a) Machine block to the radius ±2 mm of the cylindrically ground wheel.
(b) Conduct one stop from 80 km/h with 3.0 kN ±0.25kN block force.
(c) Inspect block and grind if necessary.
(d) Conduct one 45-minute grade test at 30 km/h with a 3,0 kN ±0.25kN block force.
(e) Conduct two stops from 80 km/h with a 10 kN ±0.25kN block force.
(f) Conduct two stops from 80 km/h with a 6 kN ±0.25kN block force.
(g) Repeat steps (c) through (f) until at least 85 % of the block has been bedded in.
(h) Weigh the block.

4.1.1.4 **GRADE (DRAG) TEST SERIES**

4.1.1.4.1 Weigh the block before commencing this test series. To clean block and wheel conduct five stops from 45 km/h with a 12kN block force.

4.1.1.4.2 Block performance in grade service shall be determined for both light and heavy braking by measurement of the instantaneous friction coefficient produced by an imposed constant brake block force. The dynamometer wheel will rotate at a constant speed of 45km/h for the duration of 45 minutes for the heavy braking test and 60km/h also for the duration of 45 minutes for the light-braking test. The tolerance on speed shall be 0,8km/h.

4.1.1.4.3 A blower or suction fan shall be used to move air across the wheel and brake Block shoe to simulate car movement during the test. The air velocity shall be 40 to 45km/h at the brake block, measured by an anemometer for the heavy braking and 55 to 60km/h for the light braking.

4.1.1.4.4 **Low speed drag:** With a speed of 45km/h and with a 15 kW heat input into the wheel the following must be measured and advise:-

- Measure the brake block force and record.
- Measure the brake block coefficient of friction and record.

The average of the friction coefficient produced in 5-minute intervals during the test of each of the three blocks shall not vary by more than +-10% from the average friction coefficient measured in the other 5-minute intervals for the same block. The average friction coefficient for any 5-minute interval of any block tested must be more than 0.3 and the average friction coefficient of all the 5-minute intervals of all three blocks together must not be more than 0.4 measured in friction coefficient of the brake block.

4.1.1.4.5 **High speed drag:** With a speed of 60km/h and with a 15 kW heat input into the wheel the following must be measured and advise:-

- Measure the brake block force and record.
- Measure the brake block coefficient of friction and record.

The average of the friction coefficient produced in 5 minute intervals during the test of each of the three blocks shall not vary by more than +-10% from the average friction coefficient measured in the other 5 minute intervals for the same block. The average friction coefficient for any 5-minute interval of any block tested must be more than 0.2 and the average friction coefficient of all the 5-minute intervals of all three blocks together must not be more than 0.4 measured in friction coefficient of the brake block.

4.1.1.4.6 Grade test data showing instantaneous friction, must be shown in 5 min intervals for the 45 minute test.

4.1.1.4.7 Additional grade tests must be done according to the table below. Each grade test must be 20 minute long, and after the grade test the average friction for the grade test must be calculated and the average heat input into the wheel must be calculated and tabulated in the same table below.

Speed [km/h]	For 2.5kN block force		For 3kN block force		For 3.5kN block force		For 4kN block force		For 4.5kN block force		For 5kN block force	
	Avr fric [mu]	Heat input [kW]	Avr fric [mu]	Heat input [kW]	Avr fric [mu]	Heat input [kW]	Avr fric [mu]	Heat input [kW]	Avr fric [mu]	Heat input [kW]	Avr fric [mu]	Heat input [kW]
20												
30												

40												
50												
60												

4.1.1.5 STOP TEST SERIES (Description)

4.1.1.5.1 Weigh the block before commencing this test series.

4.1.1.5.2 To clean block and wheel conduct five stops from 45km/h with a 12kN block force.

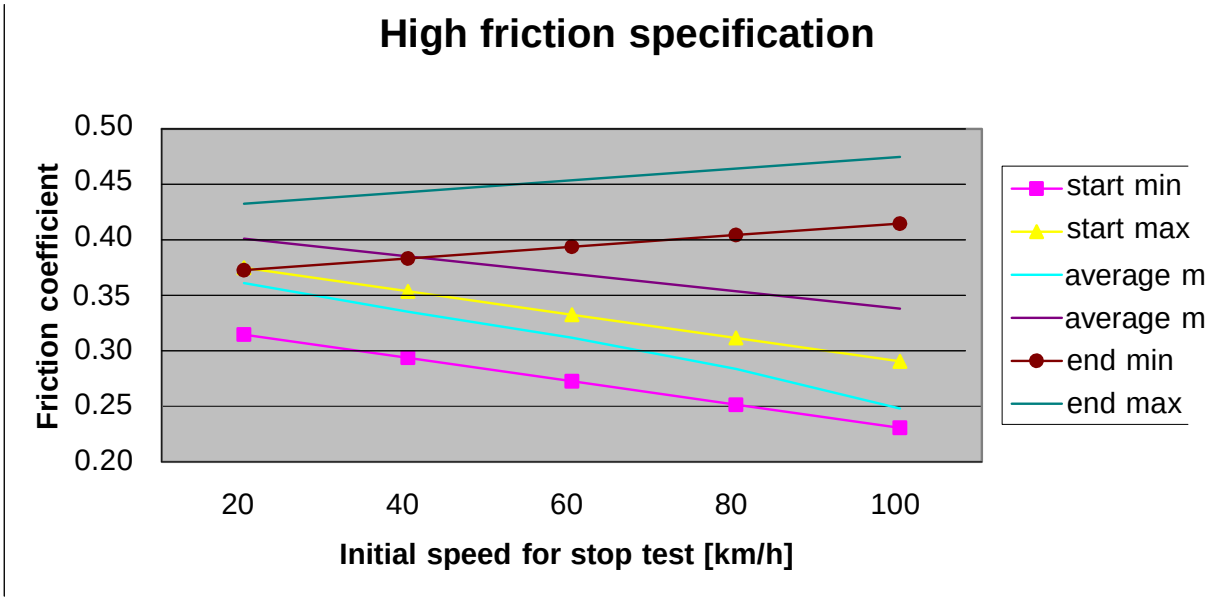
4.1.1.5.3 The stop tests shall consist of stops from speeds of 20, 40, 60,100and 110km/h in the following sequence for each block: 110,100, 80, 60, 40, 20, 20, 40, 60, 110,100, 80, 80, 60, 40 and 20km/h. The tolerance for initial speed shall be 0,5km/h.

4.1.1.5.4 The build-up of brake block force for the stop tests shall be such that the brake block force rises from 0 to 50% of the force setting in 2 ± 0,25 seconds and up to 96% of the force setting in 5 seconds. A variation of one-tenth second shall be permitted.

4.1.1.5.5 Enhanced cooling, other than that provided by fume removal equipment, shall not be used for the stop tests.

4.1.1.5.6 The brake block force used in each test shall be 14kN ± 0.38kN

4.1.1.5.7 The average of the results of the three stop tests made from each designated speed for the three blocks shall conform to the following graph:- **(Including cylinder build up time as described in clause 4.1.1.5.4)** These values designate dry stop tests.



Graph 1

4.1.1.5.8 The supplier must also submit the instantaneous friction curve for each speed to the Metrorail/Brake VIT.

4.1.1.5.9 The stop tests described from 4.1.1.5.2 to 4.1.1.5.7 must also be redone in wet conditions. The wet test must be done according to UIC 541-1 Appendix 5.

4.1.1.5.10 Two graphs must be drawn after all wet and dry stops have been done, indicating the initial, average and end friction of all stops and all speeds. One graph for all wet stops and one graph for all dry stops.

4.1.1.5.11 The graph indicating all wet stops, initial average and end can vary 5% from graph 1

4.1.1.6 STATIC FRICTION TESTS

4.1.1.6.1 Conduct the tests following the last stop test. The block should not be removed for weighing until after the static friction tests are complete.

4.1.1.6.2 To clean block and wheel conduct five stops from 45 km/h with a 12 kN block force. After last cleaning stop the block must be moved away from the wheel and only then can the static test start.

4.1.1.6.3 Apply a brake block force of 5±0,07kN, 10±0,133kN, 15±0,2kN and 20kN ±0,27kN.

4.1.1.6.4 Generate torque at a rate not to exceed 2.034 kN/m/sec until wheel moves. The reading of torque value at breakaway will be used to compute static coefficient of friction.

4.1.1.6.5 Remove generated torque and release brake.

4.1.1.6.6 Repeat steps 4.1.1.6.3 and 4.1.1.6.4 three times, for a total of twelve tests for each block. (4.1.1.6.6 must be done for three blocks)

4.1.1.6.7 Calculation for determining static COF:-

$$COF = \frac{Maximum Torque (Nm)}{Brake block force (kN) x Wheel Radius (m)}$$

4.1.1.6.8 Minimum requirement for the average static coefficient of friction shall be (0.2) and the maximum shall be less than (0.3) for the three- (3) blocks.

4.1.1.6.9 Weigh the block after completion of the last test.

4.2 COEFFICIENT OF FRICTION FOR 5M2A/10M SERIES PLAIN TRAILERS AND SHOSHOLOZA MEYL COACHES

4.2.1 **HIGHFRICTION BRAKE BLOCK**

4.2.1.1 **DYNAMOMETER TEST**
Exactly the same as clause 4.1.1.1

4.2.1.2 **DYNAMOMETER SETUP**
Exactly the same as clause 4.1.1.2, except the equivalent inertia wheel load of the test wheel shall be 7,25 tons.

4.2.1.3 **BRAKE BLOCK WEAR IN**
Exactly the same as clause 4.1.1.3

4.2.1.4 **GRADE TEST SERIES**
Exactly the same as clause 4.1.1.4, except: -

1) The light grade test must be according to: Brake block force = 4kN, and speed = 50km/h and
2) The heavy grade test must be according to: Brake block force = 2.5kN, and speed = 65km/h.

The test in terms of clause 4.1.1.4.7 does not need to be re-done.

4.2.1.5 **STOP TEST SERIES**
Exactly the same as clause 4.1.1.5, except the brake block force must be 7.25kN and speeds from 20, 40, 60, 80,100 and 110km/h in the following sequence for each block: 110, 100, 80, 60, 40, 20, 20, 40, 60, 80, 100, 110, 110, 100, 80, 60, 40 and 20km/h. The tolerance for initial speed shall be 0,5km/h.

4.2.1.6 **STATIC FRICTION TEST**
Does not need to be redone.

4.3 WEAR TESTS (BLOCK WEAR)

4.3.1. The material lost during the grade tests shall be determined by weighing the blocks before and after the load test (light and heavy grade test) for each block. The material lost during the stop distance tests shall be determined by weighing the block before the first stop test and after the last static test for each block. The amount of material lost in grams divided by the density of the friction material in grams per cubic centimetre will give the volume loss. Masses shall be determined to an accuracy of 0.1 gram. For preliminary determination of volume loss, a density value of 2 gram per cubic centimetre is used. Density may be determined by ASTM test method D-297 (Hydrostatic Method) on a sample taken from a block from the same lot if the wear values are disputed.

4.3.2. The average of the accumulated loss in volume for the grade tests of the three- (3) blocks shall not exceed 10 cm^3 per block.

4.3.3 The average of the accumulated loss in volume for the stop distance tests of the three- (3) blocks shall not exceed 20 cm^3 per block.

4.4 WEAR TEST (WHEEL WEAR):

4.4.1. The wheel must be prepared by means of grinding or machining to remove all hard spots or marten site from the surface to a depth of 0,05 mm below the hard spots. A wheel surface finish of between 1.6 and 6.3 micrometer (µm) must be achieved and the wheel diameter or wheel profile must be measured.

4.4.2. After all tests on all three blocks have been finished; the wheel diameter or wheel profile must be measured again.

4.4.3. The reduction in wheel radius must not be more than 0.05 mm.

4.5 METAL PICK UP:

Any metal pick up on any block during any test as described in this specification will be grounds for rejection. Metal pick up will be strictly monitored during the in service tests. The in-service tests will be run through one wet and one dry season as a minimum test period. Metal pick up will be defined as any piece of metal that is larger than 8 cubic millimetres. (2x2x2 mm)

4.6 WHEEL SKIDS:

No wheel skids are allowed during the kick off tests. The Brake VIT will evaluate wheel skids during the train handling and in-service tests. The Brake VIT will evaluate and make a note of each incident of wheel skid and will decide to reject the block or to carry on with the tests.

4.7 CRACKING OF COMPOSITION MATERIAL:

Acceptance of cracking will be determine according the AAR field manual Rule 12 Figure B, and “Composition brake block removal criteria” with Document reference number ENG.037 available from the Engineering library in NZASM building. If brake blocks crack between friction material and back plate in service, the supplier must replace the faulty blocks free of charge.

4.8 HEAT INPUT INTO WHEELS:

Heat input into wheels is a function of brake block friction, mass of rail vehicle, speed of rail vehicle and force applied to the brake block. Brake systems are not to exceed a heat input into the wheels of 15kW per wheel at any time or given moment. The brake block must therefore be able to withstand a constant heat input of 15kW for at least 45 minutes without destroying the brake block or change its friction characteristic by more than 15%.

5. MARKING:

5.1. All brake blocks shall bear the manufacturer’s name or trademark, type of friction material, manufacturers part number and batch code. These markings must be of sufficient size and of such construction that they will remain legible for the service life of the block. (Service life can be up to 4 years) These markings must be preferably stamped on the back plate of the brake block such that the shoe will not wear the markings away in service. The batch code must be such that if brake blocks are detected with problems, that the whole batch can be traced and taken out of service. Metrorail/Rail Engineering trade hands working with brake blocks must be able to clearly connect the trademark of the company to the company supplying the brake blocks.

6. INSPECTION

The purchaser may perform additional tests to evaluate acceptability of the material in his own laboratory or elsewhere. Such tests shall be conducted at the expense of the purchaser. (As described in section 3)

6.1 Quality assessment of production blocks

Supply Chain Services (Promat) Material managers and maintenance department supervisors according to sections 2.6, 2.7, 5 and 10 must inspect all brake blocks supplied to Supply Chain Services.

6.2 Quality assessment of the performance criteria

A brake block manufacturer supplying brake blocks to Metrorail must once a year have an independent test authority or a member of Metrorail select 3 sample blocks and witness the dynamometer tests of the sample blocks. The dynamometer test is described in sections 4.1, 4.2, 4.3 & 4.4. The manufacturer must submit the results of the tests and a test report of the independent test authority or Metrorail member to the Brake VIT. Samples must be from the current production and not more than nine months old. This will be for the account of the manufacturer. One failure of the performance criteria or the material properties will be considered grounds for withdrawal of Metrorail/Freight Rail approval.

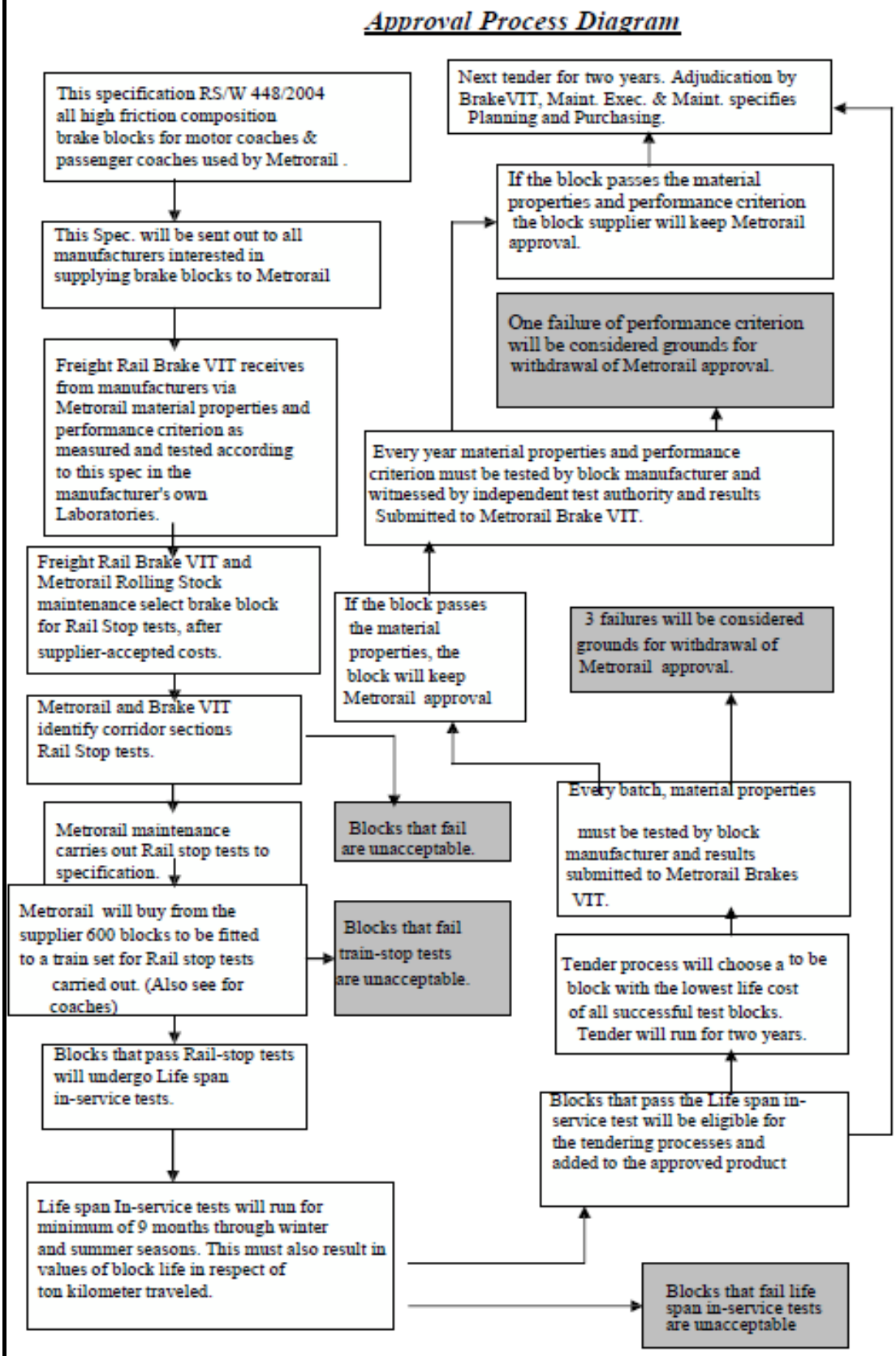
6.3 Quality assessment of the material properties

The Manufacturer supplying brake blocks to Metrorail must in their own laboratories measure the material properties as described in section 3. These tests must be carried out three times a year and the results submitted to the Brake VIT and end user. This will be for the account of the manufacturer. Three sequential failures of these tests will be considered grounds for withdrawal of Metrorail/Freight Rail approval.

6.4 Quality System

The goods shall be supplied in accordance with and be equal in all respect to samples, patterns and drawings or specifications stipulated in the contract or order.
Metrorail reserve the right to audit the quality system of the contractor and his sub-
contractors and to carry out product audits.
The quality system requirements are contained in spec. RS\W435\March Amendment 2.

7. Approval Process



7.1 The brake block supplier must supply Metrorail information on the brake block that the supplier wants to supply. The information will include a Quality Certificate and Dynamometer tests results, as described in this specification (sections 4.1, 4.2, 4.3 &4.4) and material properties (section 3) as described in this specification. To approve the brake block for kick off tests, the brake VIT will use the information from the supplier. The supplier must also accept all test costs prior to commencement of tests.

7.2 Brake blocks that are approved for tests by the brake VIT will undergo Tail stop tests. These tests are done to verify the dynamometer results and ensure that loaded motor coaches and passenger coaches will stop within the specified stopping distances and that empty coaches will not skid wheels in wet conditions when emergency brakes are applied.

7.3 Train stop tests: Metrorail will receive from the supplier 600 blocks to fit a train set. Refer to clause 8.3.10.

7.4 Life span In service tests: The train set remain in service for minimum of three seasons (winter, spring and summer) to monitor block performance during a wet and a dry season. The minimum in service monitoring will be 9 months. This is done to verify that the brake blocks do not have a tendency for metal pick up in service conditions. Also that the blocks do not crack with parts of the block falling out permitting contact between the back plate and the wheel resulting in damage to the wheel. Brake block wear and wheel wear must be monitored in this test against ton kilometres travelled to be able to calculate total life cycle costs for tendering purposes. If the test block fails the in-service test the blocks will not be paid for. The 12 coaches will stay in service and the test blocks will be monitored until 90% of all blocks are changed out. Coach brake blocks will also be monitored for noise.

7.5 The manufacturer supplying brake blocks to Metrorail shall test material properties according section 3, for each batch and send the results to the Brake VIT.

7.6 After passing the in-service evaluation the brake block from the supplier will be approved and Procurement Services will contact the supplier to tender this block for Metrorail.

7.7 Metrorail approved brake blocks will be subjected to annual re-certification at the manufacturer's expense in accordance with Section 3 & 4.1 & 4.2 & 4.3 & 4.4. The manufacturer will be advised of results and failure will be considered adequate grounds for withdrawal of Metrorail approval. A representative of the VIT Brake Section, a Metrorail member or a member from an independent test authority shall select test samples. Samples must be from the current production and not more than nine months old.

7.8 Metrorail or Freight Rail VIT Brake Section reserves the right to withdraw approval of any brake block used at Metrorail. A notice of 14 days will be given to inspect and witness the problems that may lead to disapproval of the block.

7.9 Manufacturers must submit in writing any request for approval to change or modify the design, manufacture of parts, and location of manufacture, assembly or material of conditional or approved brake block. Changes cannot under any circumstances be introduced into production before the Metrorail/ Freight Rail Brake VIT has approved such changes and the manufacturer has been advised accordingly.

7.10 The brake VIT Metrorail Maintenance Engineering has the obligation to approve brake blocks for Metrorail to a technical level designated in this specification, and to endeavour to have at least 2 different suppliers for each type of brake block to create open competition. Metrorail aims to have a long-term relationship with suppliers because brake blocks are safety critical components and to ensure a continuing supply of brake blocks for operation.

8. APPROVAL TESTS:

8.1 PERFORMANCE CRITERIA:

The brake block friction characteristics from the dynamometer test must pass the evaluation of the Brake VIT. If the stopping distances on the dynamometer falls between the minimum and maximum values as described in section 4.1, 4.2, 4.3 & 4.4 the block will be accepted for further tests.

8.2 MATERIAL PROPERTIES:

The material properties of the brake block must fall within the minimum and maximum values specified in section 3.

8.3 RAIL STOP TESTS:

8.3.1 General

8.3.2 Rail stop tests must be conducted to determine an initial, average and end friction coefficient for the brake block. On completion of each test an initial, average and end friction coefficient for each stop must be calculated. The formula to calculate the average coefficient of friction is given by equation 1.

8.3.3 $$\mu_a = \frac{VxM}{Fxt} \qquad [1]$$

8.3.4 Where: $\mu_a \equiv$ average coefficient

8.3.5 V ≡ initial velocity [m/s]

8.3.6 M ≡ No-load coach / train set mass [kg]F ≡ total brake block force [kN]

8.3.7 t ≡ total time after start of application to stand still [seconds]

8.3.8 The initial, average and end coefficient of friction for each initial speed interval must not differ by more than 10% from the graph in Appendix F (Graph). But the end coefficient of friction must not be more than 0.45 at any time.

8.3.9 The variance of friction coefficient (the ratio of the standard deviation to the mean) shall be less than 5%.

8.3.10 Rail Test Programme

8.3.10.1 Bed-in programme

8.3.10.2 The brake blocks must be bedded in such that 85% of their working surface is in contact with the wheel.

8.3.10.3 Wheel temperature must not exceed 250°C during bed-in.

8.3.10.4 All bed-in stops must be carried out from speeds below 100 km/h.

8.3.11 Two Brake Blocks per wheel / And Single Brake Block per wheel

8.3.11.1 One motor coach and two trailer coaches must be used.

8.3.11.2 A single motor coach must be equipped with 16 test brake blocks.

8.3.11.3 The two trailer coaches must also be equipped with 16-test brake block.

8.3.11.4 The wheel temperature must be between 85°C and 105°C before the commencement of each stop test.

8.3.11.5 The stop tests must be carried out in the following sequence from the corresponding initial speeds [km/h].

20, 40, 60, 80, 100, 110, 110, 100, 80, 60,
40, 20, 20, 40, 60, 80, 100, 110

8.3.11.6 The tests must be carried out on a level and straight stretch of track.

8.3.11.7 Ten test stops with a higher initial temperature of between 150°C and 200°C must also be conducted. The friction coefficient must not have fallen by more that 15% at the higher temperatures.

8.3.12 Wet Stop Tests

8.3.13 Water will be sprayed onto the track through nozzles fitted in front of each wheel of the leading vehicle.

8.3.14 The test is then conducted as described in paragraph 8.3.10.

8.3.15 The friction coefficient for wet stop tests must not differ more than 15% of the dry stop tests.

8.3.16 Skidding of tyres during braking is unacceptable.

8.4 LIFE-SPAN (in-service) TEST

8.4.1 **General**

8.4.1.1 Once the dynamometer tests and the Rail stop tests have been completed successfully, the VIT-owner (Brake System) or Metrorail Maintenance Engineering will verify via a report to the Sanior Manager Technical Operations, Rolling Stock, in Metrorail Head Office in order for the life-span test to be conducted. The test period must be at least 9 (nine) months and it must span over wet and dry weather conditions as far as possible**.**

8.4.1.2 The expected life of the brake block must be at least 5 (five) months. If any one of the following conditions is noticed during the test period all the new brake blocks under test must be removed from the coaches immediately:

- *Damage to the wheel caused by the brake block.*
- *Any degree of metal pick-up.*
- *Breaking of brake blocks.(Certain cracks are allowed see "Field Manual of the Interchange Rules" – Published by the Association of American Railroads (AAR))*
- *Excessive vibration, including noise of the brake block. Feedback from the drivers will assist in identifying this.*
- *The release of undesirable products of braking resulting in bad smell, excessive dust, or insulating products, which could effect track circuits. It can be investigated after complaints have been received.*

8.4.2 Test Preparation

8.4.2.1 At least 1 (one) Suburban train set must be selected to fit the experimental brake blocks at selected depot.

8.4.2.2 For brake blocks to be used on the coastal regions tests must be conducted at one of three coastal regions, i.e. DBN, EC and CPT.

8.4.2.3 For brake blocks to be used on the in-land regions tests can only be conducted at one of the regions, i.e. WOLMERTON or WITS.

8.4.2.4 Ensure that the brake rigging is functioning properly.

8.4.2.5 Ensure that all QSA's are operating properly (Where applicable).

8.4.2.6 Record the wheel conditions (Surface, flange height and thickness, diameter).

8.4.3 Test and Monitoring procedure

8.4.3.1 When starting the test, only one axle of one bogie of a motor coach and a plain trailer of the test train set must be fitted with the new brake blocks.

8.4.3.2 The test train set must then be allowed to run in service for 2 (two) weeks until the next inspection service.

8.4.3.3 The following parameters must be monitored and recorded during each inspection service:

- Condition of the wheel (cracks, hollow-wear or any other damage, flange height and thickness, diameter).
- Condition of the brake block (metal pick-up, cracks, broken blocks, etc.).
- Brake block wear in mm. (brake block thickness must be measured on outside and in the center of the block).

8.4.3.4 Ensure that the brake rigging and QSA's are functioning properly.

8.4.3.5 If no damage to the wheels and brake blocks is noticed, the remaining axle of the one bogie of the motor coach and plain trailer must be fitted. Additional to this, fit the other bogie of the motor coach and plain trailer with the new brake blocks. This means that both the motor coach and plain trailer will be fully "blocked".

8.4.3.6 Repeat 8.3.2 to 8.3.4.

8.4.3.7 After the two weekly inspection fit the new brake blocks to another bogie of a motor coach and a plain trailer and repeat 8.3.2 to 8.3.4.

8.4.3.8 Repeat 8.3.7 until the whole train set is fully fitted with the new brake blocks.

8.4.3.9 **A copy of the two weekly inspection reports (Standard form) must be submitted to the VIT-owner and the Senior manager Maintenance Engineering via the General Manager Technical Operations, Rolling Stock.**

8.4.3.10 Drivers must be informed of the test train sets and feedback must be obtained form the drivers regarding any negative effects on train handling.

8.4.3.11 Any complaint from the drivers and depot personnel must be investigated immediately to determine whether it is brake block related or not. The necessary action must then be taken immediately.

8.4.3.12 When the test train set is fully fitted with the new brake blocks they must be allowed to run in service for 2 (two) weeks while feedback is obtained from the drivers regarding train handling.

9. APPROVAL

BRAKE BLOCK APPROVAL:

If the test block passed the dynamometer test procedure, the kick off tests, the train handling tests and the in service tests, the block will be approved.

If the manufacturer changes anything on the brake block Metrorail Maintenance Engineering must be notified for approval for a retest. (See section 7.9)

If the manufacturer changes from one supplier to another supplier of brake block ingredients new dynamometer results must be presented to Metroail Maintenance Engineering and brake VIT for approval.

10. DELIVERY AND PACKAGING:

Brake blocks will be packed on pallets and suitably secured to avoid damage during transit from manufacturer to the end user at Metrorail.

11. GUARANTEE:

The brake block manufacturer will guarantee that blocks supplied must perform exactly as the test blocks performed. The manufacturer will guarantee that he will not change any part of the manufacturing process or raw materials of the block, without notifying Metrorail first and getting approval from the Brake VIT.
The manufacturer must also replace any blocks of faulty workmanship at his own expense; Metrorail must report such cases to the manufacturer within one year after delivery.

The brake block Manufacturer must also guarantee compliance with condition of section 4.8.

The brake block manufactures must also specify the maximum working temperature under which they guarantee their blocks performance.

12 TIME FRAME TO APPROVE NEW TEST BRAKE BLOCKS

Brake blocks are safety critical components and therefore brake blocks must be approved and listed on the Freight Rail Technology Management Approved List number 79, before tendering.

13 COST OF TESTS

If a brake block supplier request Metrorail to test a block, Metrorail and VIT Brakes will submit a written quotation for the cost of the first phase of the test, i.e. That is Rail Stop test. The blocks must also be machined to the exact wheel sizes to shorten the bedding-in process and the supplier must also carry the cost of the machining. If the test block passes the Rail Stop test Metrorail and Brake VIT will submit a written quotation for the cost of the second phase of the test, the Life Span (in-service) test.