






Hyundai Rotem Company

Ref No.	RM\1A-05-06-15\D0003\R02
Doc. No.	REDV105425
Rev. No.	01
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***Propulsion System***  
**Main Line Test Procedure for  
Propulsion System**

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	Date	Name	Signature




**Propulsion System  
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## REVISION HISTORY

Rev. No.	Page	Details		Date
		~ From	~ To	
00	All	First Issued		Aug. 12. 2010
01	5	Add the test item 'System Isolation Test' in table 1		Nov. 19. 2010
	7,8	Add the measuring signal for energy consumption in table 2		
	8	Make sure that the <b>cock</b> of all braking pipes is in normal position.	Make sure that the <b>cock</b> of all braking pipes is in normal position.	
	9	1) After ~, connect a wire to earth from the <b>output</b> terminal of VVVF inverter.	1) After ~, connect a wire to earth from the <b>input</b> terminal of VVVF inverter.	
	10	Add the test procedure for system isolation test		
	12	Table 5 contents 'Min. Powering' and 'Min. Braking'	Table 5 contents 'Max. Powering' and 'Max. Braking'	
	11	Table 7 subject ~ for Re-Powering Test	Table 7 subject ~ for Slip/Slide Test	
	14	Table 11 subject <b>Dynamic Brake Performance Test</b>	Table 11 subject <b>Electric Brake Test</b>	
	15	Add measuring position(inlet air temperature of traction motor)		
	16	Add the test item 'System Isolation Test' in test result sheet for AW0 load condition		
21	Add measuring position(inlet air temperature of traction motor) in test result sheet for AW3 load condition			

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## 1. General

This test procedure describes the test to confirm the function and performance of propulsion system in the main line.

## 2. Applied Standard

IEC 61133 : Electric traction-Rolling stock-Test methods for electric and thermal/electric rolling stock on completion of construction and before entry into service.

## 3. Reference Document and Drawing

RM\1A-03-01-01\D0017(REDE105121)	Configuration of Propulsion system
RM\1A-03-01-01\D0018(REDE105123)	Train Performance
RM\1A-03-01-01\D0019(REDE105145)	Running Simulation
RM\1A-03-02-15\D0001(REDE106466)	Technical Description of Propulsion System
RM\1A-03-03-15\D0001(REDE108133)	Technical Description of Propulsion System
REDE105633	Interface Specification between VVVF and BCU
RVS00001AB0	Diagram, Main, Circuit
RVS00004AB0	Low Voltage Diagram

## 4. Test Item

Table 1 shows the detail test item, test type, test place, vehicle load condition and applied standard.



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Table 1. Test Items

No	Test item		Test type		Test Place	Load condition <small>Note1)</small>	Applied Standard Clause	
			Type test	Routine test				
1	Input Signal Confirmation		⊙	⊙	Depot	AW0	IEC 61133 / 8.17	
2	Traction System Test	Sequence Test	Start Sequence	⊙	⊙	Depot	AW0	IEC 61133 / 8.17
3			Stop Sequence	⊙	⊙	Depot	AW0	IEC 61133 / 8.17
4			Grounding Protection Test	⊙	-	Depot	AW0	IEC 61133 / 8.17
5			System Isolation Test	⊙	-	Depot	AW0	IEC 61133 / 8.17
6			Traction Performance Test	Tractive Effort Test	Powering Test	⊙	⊙	Main Line
7	Re-powering Test	⊙			-	Main Line	AW0/ AW3	IEC 61133 / 9.2
8	Powering Test in minimum voltage condition	⊙			-	Main Line	AW0/ AW3	IEC 61133 / 9.2
9	Acceleration/Jerk Test	⊙			⊙	Main Line	AW0/ AW3	IEC 61133 / 9.2
10	Slip/Slide Test	⊙			-	Main Line	AW0/ AW3	IEC 61133 / 9.2
11	Rescue Performance Test	⊙			-	Main Line	AW0+AW3	IEC 61133 / 9.2
12	Speed Characteristics Test	Maximum Speed Test			⊙	-	Main Line	AW0/ AW3
13	Journey Time/Energy Consumption Measurement		⊙	-	Main Line	AW3	IEC 61133 / 9.3	
14	Electric Brake Test		⊙	-	Main Line	AW0/ AW3	IEC 61133 / 9.4.1.8	
15	Traction Thermal Capacity Test		⊙	-	Main Line	AW3	IEC 61133 / 9.5	

**Note1) Load condition is applied in type test only and the routine test carry out in AW0 load condition.**

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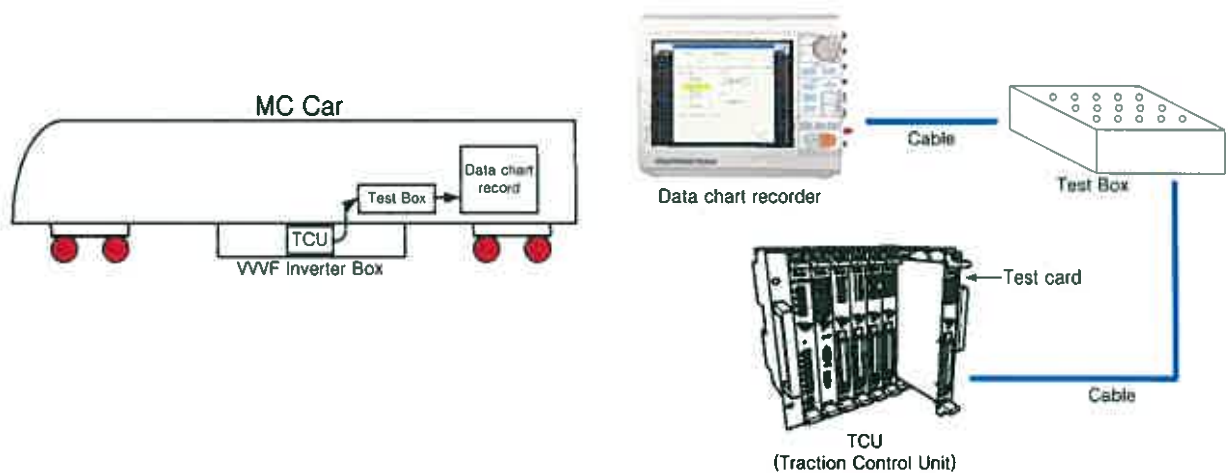
## 5. Test Condition

- 1) Tests are carried out with a vehicle (2-car).
- 2) Tests should take place at the location of a level track.
- 3) Line voltage can be fed to a vehicle.
- 4) Tests are carried out under AW0 and AW3 conditions.

## 6. Test Equipment


- 1) Data Chart recorder\*
- 2) Test Board and cable\*
- 3) Test Box\*
- 4) Multi Tester
- 5) Thermal Recorder\*
- 6) Thermometer
- 7) PTU(Portable Test Unit) for VVVF Inverter

\* Equipments are needed in type test only



**Fig.1 Measurement Diagram**




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## 7. Measuring Signal Description

Table 2. Measuring Signal

No.	Channel No.	Signal	Signal Description	Applied Test
1	Ch. 1	V_LINE	Over Head Wire Voltage[V]	Traction Performance Test
2	Ch. 2	V_FC	Filter Capacitor Voltage[V]	
3	Ch. 3	I_LINE	Input Current[A]	
4	Ch. 4	PMF	Modulation Rate[%]	
5	Ch. 5	I_MOTOR	Motor Current[A]	
6	Ch. 6	PWM	PWM Command[%]	
7	Ch. 7	Tq_ref	Torque Reference[Nm]	
8	Ch. 8	Tq_real	Real Torque[Nm]	
9	Ch. 9	Flux	Flux[Wb]	
10	Ch. 10	I_BCH	Brake Chopper Current[A]	
11	Ch. 11	SPEED	Vehicle Velocity[km/h]	
12	Ch. 12	$\alpha, \beta$	Acceleration and Deceleration[m/s <sup>2</sup> ]	
13	Ch. 13	EB	Emergency Brake Command (High : on, Low : off)	
14	Ch. 1	V_LINE1	Over Head Wire Voltage of TCU1[V]	Traction Performance Test (Energy consumption)
15	Ch. 2	V_FC1	Filter Capacitor Voltage of TCU1 [V]	
16	Ch. 3	I_LINE1	Input Current of TCU1 [A]	
17	Ch. 4	V_LINE2	Over Head Wire Voltage of TCU2 [V]	
18	Ch. 5	V_FC2	Filter Capacitor Voltage of TCU2 [V]	
19	Ch. 6	I_LINE2	Input Current of TCU2 [A]	
20	Ch. 7	M_con1	Powering energy consumption for TCU1[kWh]	
21	Ch. 8	B_con1	Braking energy consumption for TCU1[kWh]	
22	Ch. 9	M_con2	Powering energy consumption for TCU2[kWh]	
23	Ch. 10	B_con2	Braking energy consumption for TCU2[kWh]	
24	Ch. 11	SPEED	Vehicle Velocity[km/h]	
25	Ch. 12	PWM	PWM Command[%]	
26	Ch. 1	Th_atm	Atmosphere Temperature	Traction thermal capacity test
27	Ch. 2	Th_TMF	Frame temperature of traction motor	

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No.	Channel No.	Signal	Signal Description	Applied Test
28	Ch. 3	Th_TMBDE	Bearing Cap DE temperature of traction motor	
29	Ch. 4	Th_TMBODE	Between speed sensor housing and Frame ODE temperature of traction motor	
30	Ch. 5	Th_TMout	Outlet air temperature of traction motor	
31	Ch. 6	Th_TMin	Inlet air temperature of traction motor	
32	Ch. 7	Th_FL	Coil temperature of filter reactor	
33	Ch. 8	Th_Stack	IGBT stack temperature of VVVF inverter	
34	Ch. 9	Th_Cap	Capacitor temperature of VVVF inverter	
35	-	Th_axle boxes	Axle box temperature	

## 8. Preparation for Test

- 1) Make sure that the cock of all braking pipes is in normal position.
- 2) Make sure that all the equipment and switches in cabin and distribution panel are in normal position.
- 3) Check air pipes and jumper couplers.
- 4) Check the wiring and the box of high tension on cars.

## 9. Test Procedure

### 9.1 Traction System Test

Objective : to verify that traction system responds correctly to its control signals in order to demonstrate its fitness for dynamic test.


#### 9.1.1 Input Signal Confirmation

- 1) Turn the CCOS switch to 'TEST' mode in VVVF inverter.
- 2) Turn on the control voltage of vehicle.
- 3) Set the reverse handle to forward/reverse position and set the power/brake handle to power/brake position in driver cabin of Tc car and Mc car
- 4) According to position of master controller, confirm 'F', 'R', 'P', 'B' LED lighting in DIN board of VVVF Inverter control unit.

In case of operation in Tc car cabin, the forward/reverse signal is indicated to the contrary.

- 5) Push the 'Boost', 'System Isolation', 'HB reset' and 'EB(Emergency Brake)' button in driver cabin of Tc car and Mc car



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6) According to buttons operation, confirm 'Boost', 'HBreset', 'SYSiso' and EB LED lighting in DIN board of VVVF inverter control unit.

In case of 'EB' signal, normally EB LED turns on and if applying the emergency brake, EB LED on control unit turns off.

#### 9.1.2 Sequence Test

Check the start sequence, stop sequence for propulsion system in high voltage condition and check the fault sequence for it in low voltage condition.

##### - Start sequence test


- 1) Turn the CCOS switch to 'NORMAL' mode in VVVF inverter.
- 2) Turn on the control voltage of vehicle.
- 3) Push the pantograph raise button for energizing the high voltage to vehicle.
- 4) Confirm the high voltage value by using DU(Display Unit) of TMS(Train Monitoring System)
- 5) Set the reverse handle to 'Forward' position and set the power/brake handle to 'Brake' position in driver cabin of Tc car and Mc car
- 6) Confirm the starting sequence of contactors in line breaker box by using PTU(Portable Test Unit).
- 7) Operation order : HSCB close → CHK1,2 close → LB1,2 close → CHK1,2 open

##### - Stop sequence test

- 1) After propulsion system complete to operate the start sequence, set the reverse handle to 'Off' position
- 2) Confirm the stop sequence of contactors in line breaker box by using PTU.
- 3) Operation order : LB1,2 open → HSCB open
- 4) Also after propulsion system complete to operate the start sequence, push the pantograph down button
- 5) And then confirm the stop sequence of contactors in line breaker box by using PTU.

##### - Grounding protection test

- 1) After the operation of propulsion system is shut down, connect a wire to earth from the input terminal of VVVF inverter.
- 2) Turn on the control voltage of vehicle.
- 3) Push the pantograph raise button for energizing the high voltage to vehicle.

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- 4) Set the reverse handle to 'Forward' position and set the power/brake handle to 'Power' position in driver cabin.
  - 5) Confirm that propulsion system detects the fault for grounding and LB open.
- System Isolation test
- 1) When the propulsion system starts the operation and the vehicle is moving, push 'SYSTEM ISOLATION' button on operation panel of drive cab.
  - 2) Confirm that the propulsion system stops the operation and HSCB and LB open.
  - 3) Confirm that the operation of propulsion system is restarted by pushing 'HSCB RESET' button.

## 9.2 Traction Performance Test

Objective : to verify that the traction performance meets the specified criteria.

Preparation of performance test

- 1) Turn the CCOS switch to 'NORMAL' mode in VVVF inverter.
- 2) Turn on the control voltage of vehicle.
- 3) Push the pantograph raise button for energizing the high voltage to vehicle.
- 4) Confirm the inputted high voltage

### 9.2.1 Powering Test

- 1) Operate the vehicle according to Table 3 running procedure
- 2) Confirm that propulsion system is operated without abnormal motor current and any protection detection.

Table 3. Running Procedure for Powering Test

No.	Running Procedure	Remark
1	Min. Powering → Vehicle speed 20 km/h → coasting → Min. Braking	
2	Max. Powering → Vehicle speed 40 km/h → coasting → Max. Braking	
3	Max. Powering → Vehicle speed 60 km/h → coasting → Max. Braking	

### 9.2.2 Re-Powering Test

- 1) Operate the vehicle according to Table 4 running procedure
- 2) Confirm that propulsion system is operated without abnormal motor current and any protection detection.


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Table 4. Running Procedure for Re-Powering Test

No.	Running Procedure	Remark
1	Min. Powering → Vehicle speed 10 km/h → coasting → Min. Powering → Vehicle speed 20 km/h → coasting → Max. Braking	
2	Max. Powering → Vehicle speed 40 km/h → coasting → Max. Powering → Vehicle speed 60 km/h → coasting → Max. Braking	

#### 9.2.3 Powering Test in Minimum Voltage Condition

- 1) Adjust OHW voltage as about DC 1,300V
- 2) Operate the vehicle according to Table 5 running procedure
- 3) Confirm that propulsion system is operated without abnormal motor current and any protection detection.
- 4) Confirm that maximum traction performance is maintained

Table 5. Running Procedure for Minimum Voltage Powering Test

No.	Running Procedure	Remark
1	Max. Powering → Vehicle speed 60 km/h → coasting → Max. Braking	

#### 9.2.4 Acceleration/Jerk Test

- 1) Operate the vehicle according to Table 6 running procedure
- 2) Confirm that the measured acceleration rate and starting jerk meet the following specification.
- 3) The acceleration rate must be measured in on-level track and straight track condition.

\* Acceleration rate/Jerk rate criteria

- Max. acceleration rate : less than 0.90m/s<sup>2</sup>


- Average acceleration rate from 0 to 65 km/h : not less than 0.69m/s<sup>2</sup>

- Average acceleration rate from 0 to 100 km/h : not less than 0.34m/s<sup>2</sup>

- Jerk rate : less than 0.75m/s<sup>3</sup>

Table 6. Running Procedure for Acceleration/Jerk Test

No.	Running Procedure	Remark
1	Max. Powering → Vehicle speed more than 100 km/h → coasting → Max. Braking	

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#### 9.2.5 Slip/Slide Test

- 1) Operate the vehicle according to Table 7 running procedure
- 2) Test carry out in wet condition track.
- 3) Confirm that the torque pattern can be controlled according to rail condition and can be accelerated / decelerated.

Table 7. Running Procedure for Slip/Slide Test

No.	Running Procedure	Remark
1	Spray the water on track → Max. Powering → Vehicle speed 60 km/h → coasting → Max. Braking	Wet track condition

#### 9.2.6 Rescue Performance Test


- 1) Connect the rescued vehicle(AW3 load condition) up to rescuing vehicle(AW0)
- 2) The connected vehicle (AW0+AW3) stops in maximum gradient track of Wellington service track. And test is performed in dry track and wet track condition.
- 3) Operate the vehicle according to Table 8 running procedure with boost recovery button.
- 4) Confirm that the connected vehicle that stops in maximum gradient track should run correctly in maximum gradient track. And for wet condition, confirm that the connected vehicle passes correctly through the maximum gradient track.

Table 8. Rescue Performance Test

No.	Running Procedure	Remark
1	Push the boost recovery button → Max. Powering → Vehicle speed 20 km/h → coasting → Max. Braking	

#### 9.2.7 Maximum Speed Characteristic Test

- 1) Operate the vehicle according to Table 9 running procedure.
- 2) The test is carried out as following two soft ware versions of VVVF Inverter;
  - Software without over speed protection function for confirming the maximum speed(121km/h)
  - Software with over speed protection function for confirming the removing the traction power more than 115km/h
- 3) Confirm that VVVF inverter should operate correctly at the maximum speed.

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- 4) Confirm that at vehicle speeds in excess of 110km/h in performance characteristic the maximum powering tractive effort will be linearly decreased to zero as the unit speed approaches 115km/h.

Table 9. Maximum Speed Characteristic Test

No.	Running Procedure	Remark
1	Max. Powering → Vehicle speed more than 121 km/h → coasting → Max. Braking	

#### 9.2.8 Journey Time / Energy Consumption Measurement

This test must be carried out after completing the traction performance test and brake system test for main line test.

- 1) The vehicle in AW3 load condition moves in following service track as normal revenue schedule.  
 Test Route
  - Wellington station to Paraparaumu station
  - Paraparaumu station to Wellington station
  - Wellington station to Upper Hutt station
  - Upper Hutt station to Wellington station
  - Wellington station to Johnsonville station
  - Johnsonville station to Wellington station
- 2) Measure the total journey time and energy consumption for each route.
- 3) In case of energy consumption, Measurement is applied in only traction power.
- 4) Confirm that the journey time and energy consumption meets the table 10 criteria. In case of Wellington station to Johnsonville station and Johnsonville station to Wellington station, the energy consumption is measured as reference data.
- 5) This test shall be performed on vehicles which have completed the agreed period of running-in and in accordance with the following conditions
  - load conditions : AW3 load
  - Track condition : dry and wet condition
  - calm weather
  - temperature range : -25°C ~ 40°C


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Table 10. Criteria for journey time and energy consumption

Route	Journey Time [hh:mm:ss]	Energy Consumption [kWh]	Remark
Wellington station to Paraparaumu station	00:54:08	Less than 237.0	
Paraparaumu station to Wellington station	00:54:08	Less than 195.0	
Wellington station to Upper Hutt station	00:44:54	Less than 174.2	
Upper Hutt station to Wellington station	00:44:27	Less than 135.7	
Wellington station to Johnsonville station	00:21:02	-	
Johnsonville station to Wellington station	00:21:07	-	


### 9.3 Electric Brake Test

- 1) Operate the vehicle according to Table 11 running procedure
- 2) Confirm the following performance;
  - The unit will maximise the use of regenerative braking and then rheostatic braking before using friction braking
  - Electric braking will be provided as part of the normal service brake. The electric braking will comprise regenerative and rheostatic braking.
  - On dry track the electric braking on the motor car must be maximised.
  - For electric braking, regenerative braking will be maximised, subject to overhead receptivity.
  - Rheostatic braking will be continuously rated for all braking duty cycle and can be used for the discharge of power from the traction circuit.
  - The current of traction motor does not exceed the design value.
  - There is no abnormal self-excitation of the traction motor.
  - In the case of regenerative braking and in the event of loss of the power supply, external short circuit of the power supply, pantograph bounce, lack of receptivity of the power supply, line gap or neutral sections, transition takes place to friction brake.
  - The electric braking builds up and releases steadily without significant jerk.

Table 11. Test Electric Brake Test

No.	Running Procedure	Remark
1	Max. Powering → Vehicle speed more than 100 km/h → coasting → Max. Braking	



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#### 9.4 Traction Thermal Capacity Test

Objective : to verify that the traction equipment can operate the specified duty cycle within specified temperature limits.

This test must be carried out after completing the traction performance test and brake system test for main line test and will be tested with journey time / energy consumption measurement at the same time.

- 1) The vehicle in AW3 load condition moves in following service track as normal revenue schedule.


Test Route

- One round trip between Wellington station and Paraparaumu station
- One round trip between Wellington station and Upper Hutt station

- 2) Measure the temperature of each equipment part which is indicated in table 12 during one round trip for test route
- 3) In case of temperature of axle box in bogie, measure the initial temperature before starting and then measure the risen temperature of it after finishing the one round trip
- 4) Confirm that the risen temperature after one round trip meets the criteria of table 12.

Table 12.Measuring Position and Criteria for Thermal Capacity Test

No	Measuring Position	Criteria for Temperature Rising	Remark
1	Atmosphere Temperature	-	
2	Frame temperature of traction motor	Less than 200 °C	
3	Bearing Cap DE temperature of traction motor	Less than 115 °C	
4	Between speed sensor housing and Frame ODE temperature of traction motor	Less than 115 °C	
5	Outlet air temperature of traction motor	-	
6	Inlet air temperature of traction motor	-	
7	Coil temperature of filter reactor	Less than 155 °C	
8	IGBT stack temperature of VVVF inverter	Less than 100 °C	
9	Capacitor temperature of VVVF inverter	Less than 70 °C	
10	Axle box temperature	Less than 80 °C	

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## 10. Test Result Sheet

### 10.1 Test Result Sheet for AW0 load condition

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<b>MANUFACTURE</b>	Hyundai Rotem			
<b>ITEM</b>	Propulsion system test in main line	<b>HYUNDAI ROTEM</b>	<b>Inspector</b>	<b>Confirmer</b>
<b>Vehicle NO.</b>				
<b>DATE</b>	2010. . .	<b>RESULT</b>	<b>PASS / FAIL</b>	

### Traction System Test

No.	Test Item	Criteria	Result / Measuring value		
			TCU1	TCU2	
1	Input Signal Confirmation	F	'F' led on	Pass / Fail	Pass / Fail
		R	'R' led on	Pass / Fail	Pass / Fail
		P	'P' led on	Pass / Fail	Pass / Fail
		B	'B' led on	Pass / Fail	Pass / Fail
		Boost	'Boost' led on	Pass / Fail	Pass / Fail
		System Isolation	'SYSiso' led on	Pass / Fail	Pass / Fail
		HB Reset	'HBres' led on	Pass / Fail	Pass / Fail
		EB	'EB' led off	Pass / Fail	Pass / Fail
2	Sequence Test	Start Sequence	HB close →CHK1,2 close →LB close1,2 →CHK1,2 open	Pass / Fail	Pass / Fail
		Stop Sequence	LB1,2 off → HB off	Pass / Fail	Pass / Fail
		Grounding Protection	Detect the fault and LB1 open	Pass / Fail	-
		System Isolation Test	- The operation of propulsion system is stop (HB, LB open) - The operation of propulsion system is restarted by 'HB RESET' button	Pass / Fail	Pass / Fail

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### Traction Performance Test

No.	Test Item	Criteria	Result / Measuring value		
			MC	TC	
1	Tractive Effort Test	Powering Test Operated without abnormal motor current and any protection detection	Pass / Fail	Pass / Fail	
2		Re-Powering Test Operated without abnormal motor current and any protection detection	Pass / Fail	Pass / Fail	
3		Powering Test in Minimum Voltage Maximum Traction performance is maintained	Pass / Fail	Pass / Fail	
4		Acceleration /Jerk Test	Max. Acceleration rate - Less than 0.9 m/s <sup>2</sup>	Pass / Fail m/s <sup>2</sup>	Pass / Fail m/s <sup>2</sup>
			Acceleration rate - Not less than 0.69 m/s <sup>2</sup> 0 to 65 km/h	Pass / Fail m/s <sup>2</sup>	Pass / Fail m/s <sup>2</sup>
			Acceleration rate - Not less than 0.34 m/s <sup>2</sup> 0 to 100 km/h	Pass / Fail m/s <sup>2</sup>	Pass / Fail m/s <sup>2</sup>
			Jerk Rate - less than 0.75m/s <sup>3</sup>	Pass / Fail m/s <sup>3</sup>	Pass / Fail m/s <sup>3</sup>
5		Slip/Slide Test Torque pattern can be controlled according to rail condition	Pass / Fail	Pass / Fail	
6		Rescue Performance Test The connected vehicle should run in gradient track	Pass / Fail		
7		Maximum Speed Characteristic Test	VVVF Inverter should operate correctly at the maximum speed	Pass / Fail	
	Conform the over speed protection		Pass / Fail		


### Electric Brake Test

Pass / Fail

No.	Conformation Item	Result
1	The unit will maximise the use of regenerative braking and then rheostatic braking before using friction braking	Pass / Fail
2	Electric braking will be provided as part of the normal service brake. The electric braking will comprise regenerative and rheostatic braking.	Pass / Fail
3	On dry track the electric braking on the motor car must be maximised.	Pass / Fail

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No.	Conformation Item	Result
4	For electric braking, regenerative braking will be maximised, subject to overhead receptivity.	Pass / Fail
5	Rheostatic braking will be continuously rated for all braking duty cycle and can be used for the discharge of power from the traction circuit.	Pass / Fail
6	The current of traction motor does not exceed the design value.	Pass / Fail
7	There is no abnormal self-excitation of the traction motor.	Pass / Fail
8	In the case of regenerative braking and in the event of loss of the power supply, external short circuit of the power supply, pantograph bounce, lack of receptivity of the power supply, line gap or neutral sections, transition takes place to friction brake.	Pass / Fail
9	The electric braking builds up and releases steadily without significant jerk.	Pass / Fail

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### 10.2 Test Result Sheet for AW3 load condition

PROJECT	Matangi	GWRL	Approval	
MANUFACTURE	Hyundai Rotem			
ITEM	Propulsion system test in main line	HYUNDAI ROTEM	Inspector	Confirmer
Vehicle NO.				
DATE	2010. . .	RESULT	PASS / FAIL	

### Traction Performance Test


No.	Test Item	Criteria	Result / Measuring value	
			MC	TC
1	Powering Test	Operated without abnormal motor current and any protection detection	Pass / Fail	Pass / Fail
2	Re-Powering Test	Operated without abnormal motor current and any protection detection	Pass / Fail	Pass / Fail
3	Powering Test in Minimum Voltage	Maximum Traction performance is maintained	Pass / Fail	Pass / Fail
4	Tractive Effort Test	Accelerstion /Jerk Test	Max. Acceleration rate - Less than 0.9 m/s <sup>2</sup>	Pass / Fail
				Pass / Fail
			Acceleration rate - Not less than 0.69 m/s <sup>2</sup> 0 to 65 km/h	Pass / Fail
				Pass / Fail
			Acceleration rate - Not less than 0.34 m/s <sup>2</sup> 0 to 100 km/h	Pass / Fail
		Jerk Rate - less than 0.75m/s <sup>3</sup>	Pass / Fail	
			Pass / Fail	
5	Slip/Slide Test	Torque pattern can be controlled according to rail condition	Pass / Fail	Pass / Fail
6	Maximum Speed Characteristic Test	VVVF Inverter should operate correctly at the maximum speed	Pass / Fail	
		Conform the over speed protection	Pass / Fail	

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No.	Test Item		Criteria		Result / Measuring value	
7	Journey Time / Energy Consumption Measurement in dry track condition	Journey Time Measurement	W to P	00:54:08		Pass / Fail
			P to W	00:54:08		Pass / Fail
			W to U	00:44:54		Pass / Fail
			U to W	00:44:27		Pass / Fail
			W to J	00:21:02		Pass / Fail
			J to W	00:21:07		Pass / Fail
		Energy Consumption Measurement	W to P	Less than 237kWh		Pass / Fail
			P to W	Less than 195kWh		Pass / Fail
			W to U	Less than 174kWh		Pass / Fail
			U to W	Less than 135kWh		Pass / Fail
8	Journey Time / Energy Consumption Measurement in wet track condition	Journey Time Measurement	W to P	00:54:08		Pass / Fail
			P to W	00:54:08		Pass / Fail
			W to U	00:44:54		Pass / Fail
			U to W	00:44:27		Pass / Fail
			W to J	00:21:02		Pass / Fail
			J to W	00:21:07		Pass / Fail
		Energy Consumption Measurement	W to P	Less than 237kWh		Pass / Fail
			P to W	Less than 195kWh		Pass / Fail
			W to U	Less than 174kWh		Pass / Fail
			U to W	Less than 135kWh		Pass / Fail



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### Electric Brake Test


Pass / Fail

No.	Conformation Item	Result
1	The unit will maximise the use of regenerative braking and then rheostatic braking before using friction braking	Pass / Fail
2	Electric braking will be provided as part of the normal service brake. The electric braking will comprise regenerative and rheostatic braking.	Pass / Fail
3	On dry track the electric braking on the motor car must be maximised.	Pass / Fail
4	For electric braking, regenerative braking will be maximised, subject to overhead receptivity.	Pass / Fail
5	Rheostatic braking will be continuously rated for all braking duty cycle and can be used for the discharge of power from the traction circuit.	Pass / Fail
6	The current of traction motor does not exceed the design value.	Pass / Fail
7	There is no abnormal self-excitation of the traction motor.	Pass / Fail
8	In the case of regenerative braking and in the event of loss of the power supply, external short circuit of the power supply, pantograph bounce, lack of receptivity of the power supply, line gap or neutral sections, transition takes place to friction brake.	Pass / Fail
9	The electric braking builds up and releases steadily without significant jerk.	Pass / Fail

### Traction Thermal Capacity Test

Pass / Fail

No.	Measuring Position	Criteria	Result / Measuring value	
			Start Temp.	End Temp.
1	Atmosphere Temperature	-	°C	°C
2	Frame temperature of traction motor	Less than 200 °C	°C	°C
3	Bearing Cap DE temperature of traction motor	Less than 115 °C	°C	°C
4	Between speed sensor housing and Frame ODE temperature of traction motor	Less than 115 °C	°C	°C
5	Outlet air temperature of traction motor	-	°C	°C
6	Inlet air temperature of traction motor	-	°C	°C
7	Coil temperature of filter reactor	Less than 155 °C	°C	°C

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No.	Measuring Position	Criteria	Result / Measuring value	
			Start Temp.	End Temp.
8	IGBT stack temperature of VVVF inverter	Less than 100 ℃	℃	℃
9	Capacitor temperature of VVVF inverter	Less than 70 ℃	℃	℃
10	Axle box temperature	Less than 80 ℃	℃	℃