



Lam Geotechnics Limited

Ground Investigation & Instrumentation Professionals

華益土力有限公司

Ref : G1525/CS/L1036/HyD
Date : 14 May 2019

Highways Department
Major Works Project Management Office
Major Works Office (2)
3rd Floor
Ho Man Tin Government Offices,
88 Chung Hau Street,
Ho Man Tin,
Kowloon

By Post & Fax: 2714 5289

Attn: Mr. Tony Cheung (Sr Engr 4/Central Wanchai Bypass)

Dear Mr. Cheung,

Contract No. HK/2015/01
Wan Chai Development Phase II and Central-Wanchai Bypass
Sampling, Field Measurement and Testing Works (Stage 3)

APS Commissioning Test Report under Condition 2.8 of EP-482/2013/A

Referring to the captioned submission received through the email of Resident Site Staff (RSS) on 14 May 2019, we have reviewed the submitted details and hereby certified this submission in accordance with Condition 2.8 of Environmental Permit No. EP-482/2013/A, based on the understanding that the following documents/information shall be further submitted to the Director of Environmental Protection:

1. Engineer's Representative (ER) confirmation of acceptance/approval for the routine test reports and also ER's response to the Contractor's letter dated 9 August 2018 enclosed in Appendix 2;
2. The result of the Efficiency Tests for the APS of all 3 ventilation buildings, which the tests will be carried out tentatively in mid/end May 2019 and submitted to the Director of Environmental Protection by 23 June 2019.

Please noted that the certification of the captioned revised submission does not absolve any person/party involved in testing and commissioning and/or operation of the APS from any requirements or obligation under EP-482/2013/A.

Should you have any enquiry, please feel free to contact the undersigned at 2839 5666.

Yours faithfully,
For and On Behalf of
Lam Geotechnics Limited

Raymond Dai
Environmental Team Leader

c.c. CEDD	- Mr. Lee Hon	(By Fax: 2301 1277)
AECOM CWB	- Mr. David Kwan	(By Fax: 3665 0106)
AECOM WDII	- Ms. Gloria Tang	(By Fax: 2587 1877)
Ramboll	- Mr. David Yeung	(By Fax: 3465 2899)



Ref.: AACWBIECEM00_0_11294L.19

14 May 2019

Highways Department
Major Works Project Management Office
Major Works Office (2)
3rd Floor, Ho Man Tin Government Offices
88 Chung Hau Street
Ho Man Tin, Kowloon
Hong Kong

By Post and Fax (2714 5289)

Attention: Mr. Tony Cheung

Dear Mr. Cheung,

**Re: Contract No. HY/2011/08
Central – Wanchai Bypass – Tunnel Building, Systems and Fittings and
Works Associated with Tunnel Commissioning**

APS Commissioning Test Report under condition 2.8 of EP-482/2013/A

Reference is made to the captioned APS Commissioning Test Report received through RSS's e-mail on 14 May 2019 for our review and comment.

Please be informed that we have no adverse comment on the captioned submission. We write to verify the captioned submission in accordance with Condition 2.8 in the captioned Environmental Permits.

Thank you very much for your attention and please do not hesitate to contact the undersigned should you have any queries.

Yours sincerely,



David Yeung
Independent Environmental Checker

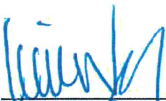
c.c.	CEDD	Attn: Mr. Lee Hon	by fax: 2301 1277
	AECOM CWB	Attn: Mr. David Kwan	by fax: 3665 0106
	AECOM CWB	Attn: Mr. Eric Wong	by fax: 3912 3010
	AECOM WDII	Attn: Ms. Gloria Tang	by fax: 2587 1877
	Lam	Attn: Mr. Raymond Dai	by fax: 2882 3331

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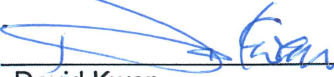
Central – Wan Chai Bypass
and Island Eastern Corridor Link

APS Commissioning Test Report

(under Condition 2.8 of EP-482/2013/A)

Prepared by:  _____ Date: 15 May 2019
Eric Wong / Donald Ip

Position: SRE (S&E) / RE (Env)
AECOM

Endorsed by:  _____ Date: 15 May 2019
David Kwan

Position: Chief Resident Engineer
AECOM

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APS Commissioning Test Report

(CONDITION 2.8 OF OPERATION ENVIRONMENTAL PERMIT, EP-482/2013/A)

1. Status of APS Commissioning Test Report

- 1.1 In fulfillment of condition 2.8 of the EP-482/2013/A, this submission contains test reports as conforming to the RSP and NO₂ removal efficiencies specified under condition 2.6(d) of EP-482/2013/A.
- 1.2 The submission includes the test reports of the Factory Acceptance Test of DeNO₂ filter, Routine Test of activated carbon, Factory Acceptance Test of APS electrostatic precipitator. It also includes Site Acceptance Tests for high voltage transformers at different ventilation buildings. The aforesaid tests have been witnessed by AECOM appointed by HyD and finally accepted by HyD.
- 1.3 Efficiency Tests for the APS will be carried out tentatively in mid/end May 2019. The deferral of the Efficiency Test was due to the breakdown of the tunnel ventilation fans at East Ventilation Building (EVB). The APS Efficiency Test is to demonstrate the APS installed at West Ventilation Building (WVB), Middle Ventilation Building (MVB) and EVB along the tunnel as a whole can achieve the removal efficiency as stated under Particular Specification for HyD's Contract No. HY/2011/08 – Central – Wan Chai Bypass – Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning PS37.2(1)(i) and (ii) under normal operation. Therefore, the Efficiency Test was deferred until the ventilation fans at EVB resumed normal operation. The operation of the tunnel ventilation fans at EVB was resumed on 2 May 2019. In addition to the original 7-day Efficiency Test, an extra 7-day APS Efficiency Test will be conducted after the necessary monitoring equipments are calibrated by third party independent laboratory. To allow sufficient time for verifying the test results and preparing the test report, the second stage APS Commissioning Test Report will be submitted to the DEP by 23 June 2019.

**Appendix 1 Factory Acceptance Test
Report for DeNO₂ Filter**

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Title/description	
Adsorption test for FAT of Activated Carbon filter	
Revision	Date of revision
01	16/02/2017

Approved by	Yes	No	Signature
QM Representative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Project Manager	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Project Director	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<i>E. Dent</i>

Test conditions

Test equipment: Please refer to details of instruments and calibration certificates

Place of testing: Filter test laboratory, Trosa, Sweden

Schedule of testing: 13 March 2017 9:00 am 5:30 pm Please refer to the attached test record
[Date] [Start time] [End time] [Duration of indiv. tests]

Test media / Test parameters: 50mm 70mm 45l/min 0.18s Addsorb VA10, 4mm
[Carbon bed diameter] [Carbon bed depth] [Air flow rate] [Contact time] [Type of carbon]

Acceptance Criteria

According to PS37.2(1)(ii) and the information submitted during tender stage: For NO₂, when inlet concentration equal to or greater than 0.25ppm, not less than 85% of NO₂ shall be removed after the air is treated by the APS. For inlet concentration less than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

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Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

No.	Test Conditions									Measured gas concentrations			Purging time before sampling	Time of test result taken
	Test Temperature [°C]		Test Relative Humidity [%]		NO ₂ inlet conc. [ppm]	Ozone inlet conc. [ppm]		Toluene inlet conc. [ppm]		NO ₂ inlet conc. [ppm]	NO ₂ outlet conc. [ppm]	Separation rate [%]		
	PTC**	Rec.*	PTC**	Rec.*	PTC**	PTC**	Rec.*	PTC**	Rec.*					
1.1	30	30.8	80	77.7	0.2	-	-	-	-	0.211	-	92.9	Purging time before sampling: 11:10-11:11	11:11-11:13
1.2	30	30.8	80	77.7	0.2	-	-	-	-	-	0.015		Purging time before sampling: 11:13-11:23	11:23-11:25
2.1	30	30.8	80	78.1	1	-	-	-	-	1.126	-	96.8	Purging time before sampling: 14:45-14:50	14:50-14:52
2.2	30	30.8	80	78.1	1	-	-	-	-	-	0.036		Purging time before sampling: 14:52-14:59	14:59-15:01
3.1	30	30.0	80	79.0	1	0.5	0.533	-	-	0.998	-	98.0	Purging time before sampling: 15:51-15:53	15:54-15:56
3.2	30	30.0	80	79.0	1	-	-	-	-	-	0.020		Purging time before sampling: 15:56-16:04	16:04-16:06
4.1	30	30.7	80	78.5	1	-	-	10	11.08	1.131	-	96.1	Purging time before sampling: 16:18-16:21	16:21-16:23
4.2	30	30.7	80	78.5	1	-	-	-	-	-	0.044		Purging time before sampling: 16:23-16:26	16:26-16:28

*Rec: Recorded conditions

**Proposed testing conditions

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ED CE J AS J

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Remarks:

- 1) Based on the standard set up of the laboratory and the FAT Procedure H2613-CSF-APS-00713, the upstream gas concentration measurement is taken first followed by the downstream measurement.
- 2) Before each measurement a purging period is required to remove the residual gas in the feed pipe to the measuring device.
- 3) The upper and the lower limits for the temperature and relative humidity are as follows (taking into account the sensor tolerances):
 - Temperature ($\pm 5\%$): 28.5°C to 31.5°C
 - Relative Humidity ($\pm 6\%$): 75.2% to 84.8%
- 4) The upper and the lower limits for the concentration of NO₂, ozone and toluene are as follows (taking into account the sensor tolerances):
 - NO₂ concentration ($\pm 15\%$): 0.17 to 0.23ppm, 0.85ppm to 1.15ppm
 - Ozone concentration ($\pm 15\%$): 0.425ppm to 0.575ppm
 - Toluene concentration ($\pm 15\%$): 8.5ppm to 11.5ppm
- 5) The raw data measured during the tests are attached to this test form.
- 6) Please refer to laboratory report nos. MMTR17-010, MMTR17-011, MMTR17-025 and MMTR17-014, for the summary of test results.
- 7) The raw data of inlet concentration of ozone is attached to this test form.
- 8) The raw data of inlet concentration of toluene is attached to this test form.

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ED CE y AS J

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Inspection / Test carried out by:

Dr. Elke Deux
[Name FILTRONtec Inspector]

E. Deux ED
[Signature]

17/03/2017
[Date]

CHRIS ECOB
[Name Camfil Laboratory Inspector]

CHRIS ECOB CE
[Signature]

17/03/2017
[Date]

Witnessed by:

P.26

Perry W.Y. YEUNG
[Name Leighton JV Representative]

[Signature]
[Signature]

17 MAR 17
[Date]

Y. C. CHEUNG
[Name AECOM Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

H. T. CHEUNG
[Name EMSD Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

Peter W C Wong
[Name HyD Representative]

[Signature]
[Signature]

17/03/2017
[Date]

ED CE Y BC J [Signature]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Title/description	
Adsorption test for FAT of Activated Carbon filter	
Revision	Date of revision
01	16/02/2017

Approved by	Yes	No	Signature
QM Representative	—	—	—
Project Manager	—	—	—
Project Director	✓	—	E. [Signature]

Test conditions

Test equipment: Please refer to details of instruments and calibration certificates

Place of testing: Filter test laboratory, Trosa, Sweden

Schedule of testing: 14 March 2017 9:00 am 6:00 pm Please refer to the attached test record
 [Date] [Start time] [End time] [Duration of indiv. tests]

Test media / 50mm 70mm 45l/min 0.18s Addsorb VA10, 4mm
 Test parameters: [Carbon bed diameter] [Carbon bed depth] [Air flow rate] [Contact time] [Type of carbon]

Acceptance Criteria

According to PS37.2(1)(ii) and the information submitted during tender stage: For NO₂, when inlet concentration equal to or greater than 0.25ppm, not less than 85% of NO₂ shall be removed after the air is treated by the APS. For inlet concentration less than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

ED CE y M J [Signature]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

No.	Test Conditions									Measured gas concentrations			Purging time before sampling	Time of test result taken
	Test Temperature [°C]		Test Relative Humidity [%]		NO ₂ inlet conc. [ppm]	Ozone inlet conc. [ppm]		Toluene inlet conc. [ppm]		NO ₂ inlet conc. [ppm]	NO ₂ outlet conc. [ppm]	Separation rate [%]		
	PTC**	Rec.*	PTC**	Rec.*	PTC**	PTC**	Rec.*	PTC**	Rec.*					
1.1	35	35.5	65	64.6	0.2	-	-	-	-	0.220	-	88.6	Purging time before sampling: 11:03-11:07	11:07-11:09
1.2	35	35.5	65	64.6	0.2	-	-	-	-	-	0.025		Purging time before sampling: 11:09-11:19	11:19-11:21
2.1	35	35.0	65	65.3	1	-	-	-	-	1.056	-	94.5	Purging time before sampling: 13:42-13:46	13:46-13:48
2.2	35	35.0	65	65.3	1	-	-	-	-	-	0.058		Purging time before sampling: 13:48-13:58	13:58-14:00
3.1	35	35.2	65	65.1	1	0.5	0.539	-	-	1.086	-	93.6	Purging time before sampling: 16:49-16:53	16:53-16:55
3.2	35	35.2	65	65.1	1	-	-	-	-	-	0.069		Purging time before sampling: 16:55-17:05	17:05-17:07
4.1	35	35.6	65	63.5	1	-	-	10	10.43	1.026	-	93.8	Purging time before sampling: 16:22-16:26	16:26-16:28
4.2	35	35.6	65	63.5	1	-	-	-	-	-	0.064		Purging time before sampling: 16:28-16:38	16:38-16:40

*Rec: Recorded conditions

**Proposed testing conditions

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Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Remarks:

- P49
- 1) Based on the standard set up of the laboratory and the FAT Procedure H2613-CSF-APS-00713, the upstream gas concentration measurement is taken first followed by the downstream measurement.
 - 2) Before each measurement a purging period is required to remove the residual gas in the feed pipe to the measuring device.
 - 3) The upper and the lower limits for the temperature and relative humidity are as follows (taking into account the sensor tolerances):
 - Temperature ($\pm 5\%$): 33.25°C to 36.75°C
 - Relative Humidity ($\pm 6\%$): 61.1% to 68.9%
 - 4) The upper and the lower limits for the concentration of NO₂, ozone and toluene are as follows (taking into account the sensor tolerances):
 - NO₂ concentration ($\pm 15\%$): 0.17 to 0.23ppm, 0.85ppm to 1.15ppm
 - Ozone concentration ($\pm 15\%$): 0.425ppm to 0.575ppm
 - Toluene concentration ($\pm 15\%$): 8.5ppm to 11.5ppm
 - 5) The raw data measured during the tests are attached to this test form.
 - 6) Please refer to laboratory report nos. MMTR17-012, MMTR17-013, MMTR17-016 and MMTR17-015, for the summary of test results.
 - 7) The raw data of inlet concentration of ozone is attached to this test form.
 - 8) The raw data of inlet concentration of toluene is attached to this test form.

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Inspection / Test carried out by:

Dr. Elke Deux
[Name FILTRONtec Inspector]

E. Deux ED
[Signature]

17/03/2017
[Date]

CHRIS ECOB
[Name Camfil Laboratory Inspector]

CHRIS ECOB CE
[Signature]

17/03/2017
[Date]

Witnessed by:

Perry W.T. YEUNG
[Name Leighton JV Representative]

[Signature]
[Signature]

17 MAR 17
[Date]

Y. C. CHEUNG
[Name AECOM Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

H. T. CHEUNG
[Name EMSD Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

PETER W C WANG
[Name HyD Representative]

[Signature]
[Signature]

17/03/2017
[Date]

P.50

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Title/description	
Adsorption test for FAT of Activated Carbon filter	
Revision	Date of revision
01	16/02/2017

Approved by	Yes	No	Signature
QM Representative	—	—	—
Project Manager	—	—	—
Project Director	✓		<i>E. Dent</i>

Test conditions

Test equipment: Please refer to details of instruments and calibration certificates

Place of testing: Filter test laboratory, Trosa, Sweden

Schedule of testing: 15 March 2017 9:00 am 6:00 pm Please refer to the attached test record
 [Date] [Start time] [End time] [Duration of indiv. tests]

Test media / Test parameters: 50mm 70mm 45l/min 0.18s Addsorb VA10, 4mm
 [Carbon bed diameter] [Carbon bed depth] [Air flow rate] [Contact time] [Type of carbon]

Acceptance Criteria

According to PS37.2(1)(ii) and the information submitted during tender stage: For NO₂, when inlet concentration equal to or greater than 0.25ppm, not less than 85% of NO₂ shall be removed after the air is treated by the APS. For inlet concentration less than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

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Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

No.	Test Conditions									Measured gas concentrations			Purging time before sampling	Time of test result taken
	Test Temperature [°C]		Test Relative Humidity [%]		NO ₂ inlet conc. [ppm]	Ozone inlet conc. [ppm]		Toluene inlet conc. [ppm]		NO ₂ inlet conc. [ppm]	NO ₂ outlet conc. [ppm]	Separation rate [%]		
	PTC**	Rec.*	PTC**	Rec.*	PTC**	PTC**	Rec.*	PTC**	Rec.*					
1.1	40	39.6	50	47.1	0.2	-	-	-	-	0.209	-	90.4	Purging time before sampling: 11:24-11:28	11:28-11:30
1.2	40	39.6	50	47.1	0.2	-	-	-	-	0.020			Purging time before sampling: 11:30-11:40	
2.1	40	39.5	50	48.2	1	-	-	-	-	1.145	-	94.7	Purging time before sampling: 13:31-13:36	13:36-13:38
2.2	40	39.5	50	48.2	1	-	-	-	-	0.061			Purging time before sampling: 13:38-13:48	
3.1	40	39.3	50	48.3	1	0.5	0.463	-	-	1.123	-	96.7	Purging time before sampling: 15:11-15:12	15:12-15:14
3.2	40	39.3	50	48.3	1	-	-	-	-	-	0.037			
4.1	40	39.2	50	49.6	1	-	-	10	10.50	1.118	-	94.1	Purging time before sampling: 16:06-16:10	16:10-16:12
4.2	40	39.2	50	49.6	1	-	-	-	-	-	0.066			

*Rec: Recorded conditions

**Proposed testing conditions

P.12

ED CE Y B J

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Remarks:

- 1) Based on the standard set up of the laboratory and the FAT Procedure H2613-CSF-APS-00713, the upstream gas concentration measurement is taken first followed by the downstream measurement.
- 2) Before each measurement a purging period is required to remove the residual gas in the feed pipe to the measuring device.
- 3) The upper and the lower limits for the temperature and relative humidity are as follows (taking into account the sensor tolerances):
 - Temperature ($\pm 5\%$): 38°C to 42°C
 - Relative Humidity ($\pm 6\%$): 47% to 53%
- 4) The upper and the lower limits for the concentration of NO₂, ozone and toluene are as follows (taking into account the sensor tolerances):
 - NO₂ concentration ($\pm 15\%$): 0.17 to 0.23ppm, 0.85ppm to 1.15ppm
 - Ozone concentration ($\pm 15\%$): 0.425ppm to 0.575ppm
 - Toluene concentration ($\pm 15\%$): 8.5ppm to 11.5ppm
- 5) The raw data measured during the tests are attached to this test form.
- 6) Please refer to laboratory report nos. MMTR17-017, MMTR17-018, MMTR17-019 and MMTR17-020, for the summary of test results.
- 7) The raw data of inlet concentration of ozone is attached to this test form.
- 8) The raw data of inlet concentration of toluene is attached to this test form.

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Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Inspection / Test carried out by:

D. Elle Deux
[Name FILTRONtec Inspector]

E. Deux ED
[Signature]

17/03/2017
[Date]

CHRIS ECOB
[Name Camfil Laboratory Inspector]

CM ECOB CE
[Signature]

17/03/2017
[Date]

Witnessed by:

P14

Perry W.Y. YEUNG
[Name Leighton JV Representative]

[Signature]
[Signature]

17 MAR 17
[Date]

Y. C. CHEUNG
[Name AECOM Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

H.T. CHEUNG
[Name EMSD Representative]

[Signature]
[Signature]

17 Mar 2017
[Date]

PETER W C HONG
[Name HyD Representative]

[Signature]
[Signature]

17/03/2017
[Date]

ED CE [Signature] [Signature] [Signature]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Title/description	
Adsorption test for FAT of Activated Carbon filter	
Revision	Date of revision
01	16/02/2017

Approved by	Yes	No	Signature
QM Representative	—	—	—
Project Manager	—	—	—
Project Director	✓	—	E. Deutz

Test conditions

Test equipment: Please refer to details of instruments and calibration certificates

Place of testing: Filter test laboratory, Trosa, Sweden

Schedule of testing: 16 March 2017 09:00 am 6:30 pm Please refer to the attached test record
 [Date] [Start time] [End time] [Duration of indiv. tests]

Test media / Test parameters: 50mm 70mm 45l/min 0.18s Addsorb VA10, 4mm
 [Carbon bed diameter] [Carbon bed depth] [Air flow rate] [Contact time] [Type of carbon]

Acceptance Criteria

According to PS37.2(1)(ii) and the information submitted during tender stage: For NO₂, when inlet concentration equal to or greater than 0.25ppm, not less than 85% of NO₂ shall be removed after the air is treated by the APS. For inlet concentration less than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

ED CE y 16 J to

P.95

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

No.	Test Conditions									Measured gas concentrations			Purging time before sampling	Time of test result taken
	Test Temperature [°C]		Test Relative Humidity [%]		NO ₂ inlet conc. [ppm]	Ozone inlet conc. [ppm]		Toluene inlet conc. [ppm]		NO ₂ inlet conc. [ppm]	NO ₂ outlet conc. [ppm]	Separation rate [%]		
	PTC**	Rec.*	PTC**	Rec.*	PTC**	PTC**	Rec.*	PTC**	Rec.*					
1.1	27.5	27.3	80	81.8	0.2	-	-	-	-	0.211	-	86.2	Purging time before sampling: 10:19-10:23	10:23-10:25
1.2	27.5	27.3	80	81.8	0.2	-	-	-	-	-	0.029		Purging time before sampling: 10:25-10:35	10:35-10:37
2.1	27.5	27.4	80	80.6	1	-	-	-	-	1.018	-	89.7	Purging time before sampling: 11:13-11:17	11:17-11:19
2.2	27.5	27.4	80	80.6	1	-	-	-	-	-	0.105		Purging time before sampling: 11:19-11:29	11:29-11:31
3.1	27.5	27.7	80	80.2	1	0.5	0.485	-	-	1.098	-	98.1	Purging time before sampling: 13:55-13:59	13:59-14:01
3.2	27.5	27.7	80	80.2	1	-	-	-	-	-	0.021		Purging time before sampling: 14:01-14:11	14:11-14:13
4.1	27.5	27.9	80	80.5	1	-	-	10	10.14	0.999	-	95.1	Purging time before sampling: 14:22-14:26	14:26-14:28
4.2	27.5	27.9	80	80.5	1	-	-	-	-	-	0.049		Purging time before sampling: 14:28-14:38	14:38-14:40

*Rec: Recorded conditions

**Proposed testing conditions

P.96

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Remarks:

- 1) Based on the standard set up of the laboratory and the FAT Procedure H2613-CSF-APS-00713, the upstream gas concentration measurement is taken first followed by the downstream measurement.
- 2) Before each measurement a purging period is required to remove the residual gas in the feed pipe to the measuring device.
- 3) The upper and the lower limits for the temperature and relative humidity are as follows (taking into account the sensor tolerances):
 - Temperature ($\pm 5\%$): 26.13°C to 28.88°C
 - Relative Humidity ($\pm 6\%$): 75.2% to 84.8%
- 4) The upper and the lower limits for the concentration of NO₂, ozone and toluene are as follows (taking into account the sensor tolerances):
 - NO₂ concentration ($\pm 15\%$): 0.17 to 0.23ppm, 0.85ppm to 1.15ppm
 - Ozone concentration ($\pm 15\%$): 0.425ppm to 0.575ppm
 - Toluene concentration ($\pm 15\%$): 8.5ppm to 11.5ppm
- 5) The raw data measured during the tests are attached to this test form.
- 6) Please refer to laboratory report nos. MMTR17-021, MMTR17-022, MMTR17-023 and MMTR17-024, for the summary of test results.
- 7) The raw data of inlet concentration of ozone is attached to this test form.
- 8) The raw data of inlet concentration of toluene is attached to this test form.
- 9) As mentioned in the approved FAT procedure, testing at higher relative humidity than 80% creates condensation which may damage equipment in the test rig. As such, the activated carbon will be pre-conditioned to 90% RH and exposed to an air stream with 80% RH during the adsorption test. Based on the description of the test method stated in the approved FAT procedure, the activated carbon was placed inside the desiccator cabinet (as observed during the FAT, the relative humidity of desiccator cabinet was kept at 99% RH). Camfil's laboratory advised during the FAT that the activated carbon to be used for pre-conditioning had been placed inside the desiccator cabinet since 1 March 2017 to ensure that the carbon was unable to take up any more moisture, i.e. achieved equilibrium, as stated in the approved FAT procedure before the adsorption test could be carried out on 16 March 2017. Some carbon which achieved equilibrium was placed in the moisture content scale and 24.2 % of water loss of weight was observed. Before commencement of adsorption test, two batches of carbon which achieved equilibrium were placed 1) in the climate chamber as a reference control and 2) inside the carbon container for adsorption test, both exposed under the testing condition of 27.5°C and 80%RH. When the adsorption test was completed, the carbon as reference control placed in the test rig was taken for moisture measurement. It was observed that the water loss of weight was also 24.2%. Please refer to the enclosed photos taken during the pre-conditioning for details.

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-FDN-02

Inspection / Test carried out by:

<u>Dr. Elke Deux</u> [Name FILTRONtec Inspector]	<u>E. Deux ED</u> [Signature]	<u>17/03/2017</u> [Date]
---	----------------------------------	-----------------------------

<u>CHARLES ECARD</u> [Name Camfil Laboratory Inspector]	<u>[Signature] CE</u> [Signature]	<u>17/03/2017</u> [Date]
--	--------------------------------------	-----------------------------

Witnessed by:

898

<u>Peng W. T. YEUNG</u> [Name Leighton JV Representative]	<u>[Signature] y</u> [Signature]	<u>17 MAR 17</u> [Date]
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<u>Y. C. CHEUNG</u> [Name AECOM Representative]	<u>[Signature] 16</u> [Signature]	<u>17 Mar 2017</u> [Date]
--	--------------------------------------	------------------------------

<u>H. T. CHEUNG</u> [Name EMSD Representative]	<u>[Signature] J</u> [Signature]	<u>17 Mar 2017</u> [Date]
---	-------------------------------------	------------------------------

<u>PETER W C WONG</u> [Name HyD Representative]	<u>[Signature] 6</u> [Signature]	<u>17/03/2017</u> [Date]
--	-------------------------------------	-----------------------------

ED CE y 16 J 6

Notes:

1. The modules of De-NO₂ filters were randomly picked and tested in controlled laboratory condition. The De-NO₂ filters were then shipped to different ventilation buildings for installation.
2. The FAT reports for DeNO₂ filters were extracted from the Contractor's submissions, only relevant information regarding the FAT for DeNO₂ filters were included in Appendix 1.

Appendix 2 Routine Test Report for Activated Carbon

Jacobi Carbons AB

Address: Slöjdaregatan 1 | SE-393 53 Kalmar | Sweden
Tel: +46 480 417550 | Fax: +46 480 417559 | E-mail: info@jacobi.net
Web: www.jacobi.net | VAT No: SE556140693401 | Incorporated in Sweden

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3 divisions = 1 great company

**Certificate of Analysis Ignition Temperature Test**

Test performed on behalf of Camfil Sweden AB and their clients

Test Laboratory: Jacobi laboratory Columbus, US

Lab manager: Ryan Packard

Test date: 28th of June 2018

Product: AddSorb VA10, 4.0mm

Specification: SP000806

Lot Number	Test Method	Test Units	Test Value	
87100587	D3466	Celsius (C°)	250	
87100588	D3466	Celsius (C°)	272	
87100589	D3466	Celsius (C°)	257	
87100590	D3466	Celsius (C°)	265	
87100591	D3466	Celsius (C°)	261	
87100592	D3466	Celsius (C°)	254	
87100593	D3466	Celsius (C°)	283	
87100595	D3466	Celsius (C°)	258	
87100596	D3466	Celsius (C°)	261	
87100597	D3466	Celsius (C°)	266	

Approved By: 
Karl Vannerberg,
Country Manager Nordic Sales





Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100587

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100588

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100589

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100590

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100587	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	21-Dec-2017
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.3	%
Moisture Content	ASTM D2867		15.0	12.3	%
Ash (Base)	ASTM D2866		15.0	10.1	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100588	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	19-Jan-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.4	%
Moisture Content	ASTM D2867		15.0	11.4	%
Ash (Base)	ASTM D2866		15.0	9.8	%
Bali Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	613	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

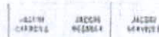
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 ISO 9001:2008 CERTIFIED COMPANY

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100590	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	9-Jan-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.7	%
Moisture Content	ASTM D2867		15.0	11.7	%
Ash (Base)	ASTM D2866		15.0	9.9	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

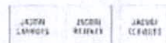
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ISO 9001:2008 CERTIFIED
JACOBI CARBONS AB, ADDSORB VA10 4.0MM 600 KG BN 2BP
MÖCKELÅTTAN, ÅKERÖ, ÅKERÖ, SVEBÖLLEN, SVEBÖLLEN, SVEBÖLLEN

Quality systems are the great company





Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100591

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100592

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100593

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100594

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739846

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100595

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100591	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	6-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.4	%
Moisture Content	ASTM D2867		15.0	13.0	%
Ash (Base)	ASTM D2866		15.0	10.4	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	619	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100592	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	6-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		62.1	%
Moisture Content	ASTM D2867		15.0	13.2	%
Ash (Base)	ASTM D2866		15.0	10.7	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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3 divisions = 1 global company



Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100594	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	6-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.4	%
Moisture Content	ASTM D2867		15.0	12.8	%
Ash (Base)	ASTM D2866		15.0	11.1	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.0	%

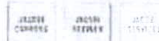
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STÄRKA, BEHÅLL
ACCORDANT TO RESISTANCE, ACCORDANT TO RESISTANCE, ACCORDANT TO RESISTANCE

2 divisions = 1 great company



Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876434
Lot No.:	87100595	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	6-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.5	%
Moisture Content	ASTM D2867		15.0	13.1	%
Ash (Base)	ASTM D2866		15.0	11.0	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	604	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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17100 SW 30th Parkway, Fort Lauderdale, FL 33324
 Phone: (954) 344-1111, Fax: (954) 344-1112, Email: info@jacobi.com

3 divisions - 1 great company





Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100605

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100605	Date Issued:	28-Mar-2018
Quantity:	26400 kg	Date Manufactured:	14-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.1	%
Impregnation	Jacobi T4079	10.0		10.0	%
Moisture Content	ASTM D2867		15.0	9.2	%
Ash (Base)	ASTM D2866		12.0	4.9	%
Apparent Density (as rec'd)	as rec'd D2854	550	620	619	g/l
Hardness (Base)	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm

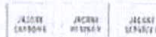
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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100606

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100606	Date Issued:	28-Mar-2018
Quantity:	26400 kg	Date Manufactured:	23-Mar-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	3-Apr-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.9	%
Impregnation	Jacobi T4079	10.0		10.0	
Moisture Content	ASTM D2867		15.0	4.9	%
Ash (Base)	ASTM D2866		12.0	5.5	%
Apparent Density (as rec'd)	as rec'd D2854	550	620	563	g/l
Hardness (Base)	ASTM D3802	95		96	%
Pellet Diameter	T4022	3.6	4.4	4.2	mm

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3 divisions = 1 great company

JACOBI CARBONS
JACOBI RESINETS
JACOBI HYDRALS





Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100596

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100597

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100598

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100599

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100596	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	3-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.5	%
Moisture Content	ASTM D2867		15.0	14.2	%
Ash (Base)	ASTM D2866		15.0	10.2	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100597	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	3-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.4	%
Moisture Content	ASTM D2867		15.0	13.9	%
Ash (Base)	ASTM D2866		15.0	10.4	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	619	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100598	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	3-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.0	%
Moisture Content	ASTM D2867		15.0	13.6	%
Ash (Base)	ASTM D2866		15.0	10.6	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100599	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	3-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	16-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		62.3	%
Moisture Content	ASTM D2867		15.0	13.2	%
Ash (Base)	ASTM D2866		15.0	10.2	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100600

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100601

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery
FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100602

Weight:

600 kg

Delivery address:

FILTRONtec Limited
Gate 8
Construction site of Man Chiu Street
Central
Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100600	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	17-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.8	%
Moisture Content	ASTM D2867		15.0	12.1	%
Ash (Base)	ASTM D2866		15.0	9.8	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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SERVICES



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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100601	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	18-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.7	%
Moisture Content	ASTM D2867		15.0	12.8	%
Ash (Base)	ASTM D2866		15.0	10.2	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	619	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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CARBON | JACOBI
RESINEX | JACOBI
SERVICE



Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100602	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	1-Jan-9999
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.4	%
Moisture Content	ASTM D2867		15.0	13.5	%
Ash (Base)	ASTM D2866		15.0	9.1	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100603

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739848

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100604

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100603	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	28-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.2	%
Moisture Content	ASTM D2867		15.0	13.3	%
Ash (Base)	ASTM D2866		15.0	10.1	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876435
Lot No.:	87100604	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	28-Apr-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	14-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.9	%
Moisture Content	ASTM D2867		15.0	13.2	%
Ash (Base)	ASTM D2866		15.0	10.4	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	617	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100611

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100612

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100613

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100611	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	9-May-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	30-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.9	%
Moisture Content	ASTM D2867		15.0	13.0	%
Ash (Base)	ASTM D2866		15.0	9.5	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100613	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	1-Jan-9999
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	31-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.0	%
Moisture Content	ASTM D2867		15.0	13.8	%
Ash (Base)	ASTM D2866		15.0	9.5	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100609

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

87100610

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100609	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	8-May-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	30-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.5	%
Moisture Content	ASTM D2867		15.0	13.4	%
Ash (Base)	ASTM D2866		15.0	9.6	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	619	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	87100610	Date Issued:	17-Oct-2017
Quantity:	26400 kg	Date Manufactured:	8-May-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	31-May-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.5	%
Moisture Content	ASTM D2867		15.0	13.2	%
Ash (Base)	ASTM D2866		15.0	9.8	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.1	mm
Apparent Density	ASTM D2854	550	620	618	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

88050297

Weight:

600 kg

Delivery address:

FILTRONtec Limited
Gate 8
Construction site of Man Chiu Street
Central
Hong Kong



Camfil Svenska AB, Industrigatan 3, SE-619 33 Trosa, SWEDEN

Order number:

739850

Customer order number:

Partial Delivery

FT-HCWB-0142

Item number:

036086

Customer item number:

Active Carbon

Item description:

ADDSORB VA10 4mm

Lot #

88050298

Weight:

600 kg

Delivery address:

FILTRONtec Limited

Gate 8

Construction site of Man Chiu Street

Central

Hong Kong

Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	88050297	Date Issued:	15-May-2018
Quantity:	26400 kg	Date Manufactured:	3-Jul-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	9-Jul-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		60.8	%
Moisture Content	ASTM D2867		15.0	13.2	%
Ash (Base)	ASTM D2866		15.0	8.8	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	620	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Certificate of Analysis

Customer:	Camfil Svenska AB (USD)	Cust Ref:	876436
Lot No.:	88050298	Date Issued:	15-May-2018
Quantity:	26400 kg	Date Manufactured:	4-Jul-2018
Grade.:	AddSorb VA10 4.0mm 600 kg BN 2BP	Date Printed:	9-Jul-2018

Parameter	Method	Spec. min	Spec. max	Value	Unit
CTC (Base, as calc.)	ASTM D5742	60.0		61.3	%
Moisture Content	ASTM D2867		15.0	12.5	%
Ash (Base)	ASTM D2866		15.0	9.2	%
Ball Pan Hardness	ASTM D3802	95		100	%
Pellet Diameter	T4022	3.6	4.4	4.0	mm
Apparent Density	ASTM D2854	550	620	610	g/l
Impregnation Level	Jacobi T4079	10.0		10.5	%

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Delivery of Activated Carbon

Lot Number	Quantity	Remarks
87070055	~38,700 kg	The routine test reports for these lots are yet to be submitted by Contractor. Will supplement once available.
87100582		
87100583		
87100584		
87100585		
87100587	26,400 kg	The routine test reports for these lots are attached in this submission.
87100588	26,400 kg	
87100589	26,400 kg	
87100590	26,400 kg	
87100591	26,400 kg	
87100592	26,400 kg	
87100593	26,400 kg	
87100594	26,400 kg	The ignition temperature test reports for these lots are yet to be submitted by Contractor. Will supplement once available.
87100595	26,400 kg	
87100605	26,400 kg	
87100606	26,400 kg	The routine test reports for these two lots are attached in this submission.
87100596	26,400 kg	
87100597	26,400 kg	The ignition temperature test reports for these lots are yet to be submitted by Contractor. Will supplement once available.
87100598	26,400 kg	
87100599	26,400 kg	
87100600	26,400 kg	
87100601	26,400 kg	
87100602	26,400 kg	
87100603	26,400 kg	
87100604	26,400 kg	
87100611	26,400 kg	
87100612	26,400 kg	
87100613	26,400 kg	
87100609	26,400 kg	
87100610	26,400 kg	
88050297	26,400 kg	
88050298	26,400 kg	
Total lots = 32	Total Quantity = 751,500 kg	
Average = 1 sample per 23,500 kg		

As for the different testing method used for CTC and surface, please refer to the letter attached below (highlighted in yellow).



20 AUG 2018



08A031266

Sun Hung Kai Centre
30 Harbour Road
Hong Kong

t: (852) 2823-1111
f: (852) 2529-8784
e: info@leightonasia.com

9 August 2018

Your Ref: CWB/(HY/2011/08)/C50/220/08B021156

Our Ref: H2613-LJV-ME-LE-9316

Engineer's Representative's Office
AECOM Asia Company Limited
Room 1401-06, 14/F., Eastern Centre,
1065 King's Road, Quarry Bay, H.K.

Attn: Mr. David Kwan, CRE

Dear Sir,

Contract No. HY/2011/08
Central-Wan Chai Bypass – Tunnel Buildings, Systems and Fittings, and Works
Associated with Tunnel Commissioning
Re: Air Purification System – Routine Test of Activated Carbon

I refer to your above letter referenced dated 13 July 2018.

Please find our responses as follows:

1. The ignition test results for ten lots of carbons are attached to this letter. Please refer to item 3 for details of impregnation test as an alternative to the BET adsorption test.
2. Please find attached the company profile and job reference list for "Fugro Technical Services Limited" which has been selected to carry out the tests.
3. Camfil as a specialist for supply and usage of activated carbon confirmed that the BET adsorption test is not applicable to an impregnated carbon since the surface of the carbon is already coated with the impregnation.

"BET is the test method developed by the Brunauer, Emmett and Teller. It uses nitrogen intrusion. The use of this method for surface area measurement has now been discounted by IUPAC (the rulers of global chemistry) as it is not accurate for activated carbon measurement. It tends to measure pore volume and not surface area as there is an assumption by Langmuir of mono layer adsorption and he ignores the effect of multi-layer and pooling in larger pore networks. Thus, we strongly advise to disregard BET as it is not a good measure to be used, especially for an impregnated carbon where the surface area is affected by the impregnation".

Therefore, impregnation test is a standard test to be performed to an impregnated carbon. Both tests, BET and impregnation test, are in principle similar. For a non-impregnated carbon the adsorption capacity is related to the surface area. For an impregnated carbon the impregnation level is related to the adsorption capacity.



The activated carbon supplier is referencing the IUPAC (International Union of Pure and Applied Chemistry) "Gold book" as a source of guidance. Reference "microporous carbon" at <http://goldbook.iupac.org/index.html>, which states:

"microporous carbon"

A porous carbon material, usually a char or carbon fibres, which may or may not have been subjected to an activation process to increase its adsorptive properties. A microporous carbon is considered to have a major part of its porosity in pores of less than 2nm width and to exhibit apparent surface areas usually higher than 200 to 300m²/g⁻¹.

Note:

The surface area determined by the Brunauer-Emmett-Teller (BET) method are apparent surface areas only since the BET adsorption equation is, in principle, not valid when micropore filling occurs. The determination of the true surface area in the micropores depends on the method used for the evaluation of the adsorption isotherms and on the model used for the shape of the micropores (cylindrical, slit-shaped or other)."

In particular the supplier is supportive of the idea that surface area measurement for impregnated carbon is relatively meaningless since the intent of the process is to cover as much as possible of the internal carbon surface with the impregnation chemical to enhance the NO₂ adsorption.

Please confirm that such a routine test is not required.

4. The carbon bags were clearly identifiable with the delivery documents. All delivery documents and corresponding test report are attached to this letter. Documents and material was verified by material on site inspections (RISC forms M2616/M/5/1156A and M/5/2012). Please note that lot number 87100612 was delivered recently. Thus, this lot was not included in our previous submission.
5. Carbon Tetrachloride, used under ASTM D3467, and other CFCs have been banned and restricted respectively under the Montreal Protocol, owing to ozone depletion. Thus, the supplier has adopted the standard ASTM D5472, which determinates the butane activity of activated carbon. Results of both tests are convertible: CTC activity = 2.55 x butane activity.
6. Camfil as a specialist in the activated carbon field confirms that the size to be considered for an extruded carbon is the size of the pellet which is 4mm. We confirm that the selected third party laboratory will conduct sieve analysis to corroborate the size of the pellet.



Leighton Joint Venture

c/o 39th Floor
Sun Hung Kai Centre
30 Harbour Road
Hong Kong

t: (852) 2823-1111
f: (852) 2529-8784
e: info@leightonasia.com

Yours faithfully
For and on behalf of
Leighton Joint Venture

Colman Wong
Joint Venture's Representative

CW / JK / DG / RL / SL

Notes:

1. Samples of activated carbon were picked from each shipping lot for routine activated carbon tests. The tested activated carbon was then shipped to different ventilation buildings for use. As shown in Appendix 2, an average of 1 sample was taken for every 26,400kg per log, which is the standard size and the maximum weight a shipping container can hold for the shipping of activated carbon to Hong Kong from the manufacturing locations.

**Appendix 3 Factory Acceptance Test
Report for APS
Electrostatic Precipitator**



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 28 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 08:30 to 17:00

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 14kV Collector: 4.5kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	27.5	90	2	1.030	0.026	97.5	0.671	0.023	96.6	0.579	0.023	96.0	7
2													
3													
4													
5													
6													
7													
8													
9													

Remarks: All the measured data is attached to this test record sheet (2 Sheets in total).

Data log reference: No.1- 055/073

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS. For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>Ken Fan</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey Chu</u>	Name : <u>Raymond Wan</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HyD</u>
Signature : <u>E. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 30 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 077)

Testing Time: 18:04 - 18:09

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 16kV Collector: 7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	22.3	98.5	4	1.07	0.06	94.4	0.670	0.059	91.2	0.576	0.057	90.1	26
2													
3													
4													
5													
6													
7													
8													
9													

Remarks: All the measured data is attached to this test record sheet (2 Sheets in total).

Data log reference: No.1- 107/133

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m3, not less than 80% of PM10 shall be removed after air is treated by the APS. For inlet concentration lower than 0.5mg/m3, the outlet concentration shall not be greater than 0.1mg/m3.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Demx</u>	Name : <u>Karl Faust</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Demx</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 26 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 13:00 to 15:45

Test Location : Filter test laboratory, Labor Igen, Krostitz, Germany

Data Log Ref: Please refer to Remarks

Voltages: Ioniser: 16kV Collector: 7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	30	80	4	0.220	0.004	98.2	0.127	0.002	98.4	0.109	0.002	98.2	25
2	30	80	4	0.536	0.012	97.8	0.329	0.009	97.3	0.283	0.008	97.2	25
3	30	80	4	0.992	0.021	97.9	0.565	0.013	97.7	0.485	0.013	97.3	25
4	30	80	6	0.232	0.033	85.8	0.147	0.020	86.4	0.126	0.019	84.9	54
5	30	80	6	0.499	0.040	92.0	0.279	0.029	89.6	0.242	0.027	88.8	54
6	30	80	6	1.050	0.089	91.5	0.585	0.058	90.1	0.510	0.054	89.4	54
7	30	80											
8	30	80											
9	30	80											

Remarks: All the measured data is attached to this test record sheet (9 Sheets in total).

Data log reference: No.1- 008/008 ; No.2- 005/005 ; No.3- 006/006 ; No.4- 009/009 ; No.5- 010/010 ; No.6- 011/011.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deur</u>	Name : <u>Kent Fan</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey Chu</u>	Name : <u>Raymond Wai</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>Hyd.</u>
Signature : <u>G. Deur</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 15</u>	Date: <u>29 Oct 2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 26 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no.076)

Testing Time: 13:00 to 15:45

Test Location : Filter test laboratory, Labor Igen, Krostitz, Germany

Data Log Ref: Please refer to Remarks

Voltages: Ioniser: 15kV Collector:5kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	30	80	4	0.210	0.011	94.8	0.144	0.01	92.9	0.124	0.009	92.5	25
2	30	80	4	0.524	0.017	96.7	0.285	0.015	94.8	0.247	0.014	94.4	25
3	30	80	4	1.060	0.039	96.3	0.603	0.032	94.7	0.518	0.030	94.2	25
4	30	80	/	/	/	/	/	/	/	/	/	/	/
5	30	80	/	/	/	/	/	/	/	/	/	/	/
6	30	80	/	/	/	/	/	/	/	/	/	/	/
7	30	80	/	/	/	/	/	/	/	/	/	/	/
8	30	80	/	/	/	/	/	/	/	/	/	/	/
9	30	80	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (5 Sheets in total).

Data log reference: No.1- 003/003 ; No.2- 004/004 ; No.3- 007/007.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>ELKE DEUX</u>	Name : <u>KENT FAN</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>Raymond WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>ZMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct. 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 15</u>	Date: <u>29.Oct. 15</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 27 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 8:30 to 13:00

Test Location : Filter test laboratory, Labor Igen, Krostitz, Germany

Data Log Ref: Please refer to Remarks

Voltages: Ioniser: 16kV Collector: 7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	35	65	4	0.205	0.019	90.7	0.109	0.018	83.5	0.094	0.018	80.9	25
2	35	65	4	0.547	0.013	97.6	0.288	0.011	96.2	0.250	0.010	96.0	25
3	35	65	4	1.030	0.019	98.2	0.530	0.015	97.2	0.463	0.014	97.0	25
4	35	65	6	0.236	0.023	90.3	0.127	0.017	86.6	0.109	0.016	85.3	54
5	35	65	6	0.518	0.052	90.0	0.319	0.037	88.4	0.275	0.035	87.3	54
6	35	65	6	0.994	0.095	90.4	0.587	0.066	88.8	0.502	0.061	87.8	54
7	35	65	/	/	/	/	/	/	/	/	/	/	/
8	35	65	/	/	/	/	/	/	/	/	/	/	/
9	35	65	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (9 Sheets in total).

Data log reference: No.1- 016/028 ; No.2- 020/032 ; No.3- 021/033 ; No.4- 023/035 ; No.5- 024/036 ; No.6- 025/037.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>KEN FAN</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>Raymond WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>Hy D</u>
Signature : <u>G. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Voltages: Ioniser: 15kV Collector:5kV

Testing Date: 27 October 2015

Testing Time: 8:30 to 13:00

Data Log Ref: Please refer to Remarks

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	35	65	4	0.218	0.017	92.2	0.127	0.016	87.4	0.109	0.015	86.2	25
2	35	65	4	0.530	0.026	95.1	0.316	0.024	92.4	0.272	0.023	91.5	25
3	35	65	4	1.080	0.035	96.8	0.586	0.031	94.7	0.513	0.029	94.3	25
4	35	65	/	/	/	/	/	/	/	/	/	/	/
5	35	65	/	/	/	/	/	/	/	/	/	/	/
6	35	65	/	/	/	/	/	/	/	/	/	/	/
7	35	65	/	/	/	/	/	/	/	/	/	/	/
8	35	65	/	/	/	/	/	/	/	/	/	/	/
9	35	65	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (5 Sheets in total).

Data log reference: No.1- 017/029 ; No.2- 018/030 ; No.3- 022/034.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>Ken Tam</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey Chu</u>	Name : <u>Raymond WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>ENXSD</u>	Company: <u>HgD</u>
Signature : <u>E. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Voltages: Ioniser: 16kV Collector:7kV

Testing Date: 27 October 2015

Testing Time: 14:00 to 17:30

Data Log Ref: Please refer to Remarks

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	40	50	4	0.192	0.017	91.1	0.124	0.016	87.1	0.105	0.016	84.8	25
2	40	50	4	0.502	0.017	96.6	0.296	0.015	94.9	0.255	0.015	94.1	25
3	40	50	4	1.05	0.028	97.3	0.65	0.023	96.5	0.559	0.022	96.1	25
4	40	50	6	0.209	0.032	84.7	0.134	0.028	79.1	0.114	0.027	76.3	55
5	40	50	6	0.522	0.05	90.4	0.296	0.041	86.1	0.255	0.039	84.7	55
6	40	50	6	1.06	0.085	92.0	0.593	0.067	88.7	0.517	0.062	88.0	55
7	40	50	/	/	/	/	/	/	/	/	/	/	/
8	40	50	/	/	/	/	/	/	/	/	/	/	/
9	40	50	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (9 Sheets in total).

Data log reference: No.1- 026/038 ; No.2- 030/042 ; No.3- 031/043 ; No.4- 033/045 ; No.5- 034/046 ; No.6- 035/047.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>KEN FANG</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>Raymond WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>BMSD</u>	Company: <u>Hy D</u>
Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Voltages: Ioniser: 15kV Collector:5kV

Testing Date: 27 October 2015

Testing Time: 14:00 to 17:30

Data Log Ref: Please refer to Remarks

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	40	50	4	0.216	0.024	88.9	0.128	0.023	82.0	0.112	0.023	79.5	26
2	40	50	4	0.556	0.036	93.5	0.360	0.034	90.6	0.313	0.033	89.5	26
3	40	50	4	1.000	0.049	95.1	0.635	0.045	92.9	0.543	0.043	92.1	26
4	40	50	/	/	/	/	/	/	/	/	/	/	/
5	40	50	/	/	/	/	/	/	/	/	/	/	/
6	40	50	/	/	/	/	/	/	/	/	/	/	/
7	40	50	/	/	/	/	/	/	/	/	/	/	/
8	40	50	/	/	/	/	/	/	/	/	/	/	/
9	40	50	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (5 Sheets in total).

Data log reference: No.1- 028/040 ; No.2- 029/041 ; No.3- 032/044.

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m3, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m3, the outlet concentration shall not be greater than 0.1mg/m3.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>Ken FAN</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>Raymond WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HyD</u>
Signature : <u>E. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>29/10/2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>29 Oct 2015</u>	Date: <u>28/10/2015</u>

Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 28 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 08:30 to 17:00

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 16kV Collector:7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	27.5	90	2	1.030	0.018	98.3	0.620	0.015	97.6	0.530	0.015	97.2	7
2	27.5	90	4	0.222	0.050	77.5	0.136	0.032	76.5	0.117	0.031	73.5	28
3	27.5	90	4	0.547	0.049	91.0	0.356	0.034	90.4	0.308	0.032	89.6	25
4	27.5	90	4	1.010	0.054	94.7	0.655	0.040	93.9	0.564	0.038	93.3	25
5	27.5	90	6	0.187	0.089	52.4	0.119	0.048	59.7	0.104	0.045	56.7	55
6	27.5	90	6	0.975	0.152	84.4	0.554	0.087	84.3	0.477	0.082	82.8	55
7	27.5	90											
8	27.5	90											
9	27.5	90											

Remarks: All the measured data is attached to this test record sheet (9 Sheets in total).

Data log reference: No.1- 054/072 ; No.2- 056/074 ; No.3- 059/077 ; No.4- 060/078 ; No.5- 045/063 ; No.6- 047/065

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS. For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Demx</u>	Name : <u>Karl Fahl</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey Chen</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Demx</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 29 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (No. 077)

Testing Time: 08:30 to 11:30

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 16kV Collector: 7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	27.5	90	6	0.509	0.090	82.3	0.295	0.060	79.7	0.254	0.058	77.2	53
2	27.5	90	/	/	/	/	/	/	/	/	/	/	/
3	27.5	90	/	/	/	/	/	/	/	/	/	/	/
4	27.5	90	/	/	/	/	/	/	/	/	/	/	/
5	27.5	90	/	/	/	/	/	/	/	/	/	/	/
6	27.5	90	/	/	/	/	/	/	/	/	/	/	/
7	27.5	90	/	/	/	/	/	/	/	/	/	/	/
8	27.5	90	/	/	/	/	/	/	/	/	/	/	/
9	27.5	90	/	/	/	/	/	/	/	/	/	/	/

Remarks: All the measured data is attached to this test record sheet (2 Sheets in total).

Data log reference: No.1- 076/102

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m3, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m3, the outlet concentration shall not be greater than 0.1mg/m3.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Demx</u>	Name : <u>Karl Tran</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHA</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Demx</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/11/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 28 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 08:30 to 17:00

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 15kV Collector:5kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
				[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	
1	27.5	90	4	0.226	0.045	80.1	0.154	0.034	77.9	0.133	0.033	75.2	25
2	27.5	90	4	0.533	0.049	90.8	0.325	0.039	88.0	0.280	0.037	86.8	25
3	27.5	90	4	1.000	0.073	92.7	0.591	0.056	90.5	0.506	0.053	89.5	25
4	27.5	90											
5	27.5	90											
6	27.5	90											
7	27.5	90											
8	27.5	90											
9	27.5	90											

Remarks: All the measured data is attached to this test record sheet (5 Sheets in total).

Data log reference: No.1- 057/075 ; No.2- 058/076 ; No.3- 065/084

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m3, not less than 80% of PM10 shall be removed after air is treated by the APS. For inlet concentration lower than 0.5mg/m3, the outlet concentration shall not be greater than 0.1mg/m3.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deur</u>	Name : <u>Karl Fank</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHU</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Deur</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 28 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 076)

Testing Time: 08:30 to 17:00

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 15.5kV Collector:6.5kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	27.5	90	6	1.090	0.167	84.7	0.604	0.099	83.6	0.523	0.092	82.4	55
2													
3													
4													
5													
6													
7													
8													
9													

Remarks: All the measured data is attached to this test record sheet (2 Sheets in total).

Data log reference: No.1- 048/066

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS.
For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Elke Deux</u>	Name : <u>Ken Fan</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey CHA</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>E. Deux</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>



Test Report for Electrostatic Precipitator Performance Test

Project : HY/2011/08 - Central-Wan Chai Bypass - Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning

Testing Date: 30 October 2015

Equipment to be tested: ESP filter ESP 1000-123 (no. 077)

Testing Time: 15:04 - 15:10

Test Location : Filter test laboratory, Labor Ilgen, Krostitz, Germany

Data Log Ref: Please refer to remarks

Voltages: Ioniser: 16kV Collector: 7kV

No.	Test Condition			Average Dust Concentration									Pressure Drop [Pa]
	Temperature	Relative Humidity	Velocity	PM ₁₀			PM _{2.5}			PM ₁			
	[°C]	[%]	[m/s]	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	Inlet	Outlet	Separation rate	
			[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]	[mg/m ³]	[mg/m ³]	[%]		
1	27.5	90	4	0.996	0.108	89.2	0.602	0.071	88.2	0.519	0.069	86.7	25
2													
3													
4													
5													
6													
7													
8													
9													

Remarks: Test after 23 hours on-load operation, all the measured data is attached to this test record sheet (2 sheets in total).

Data log reference: No.1- 107/133

According to PS37.2(1)(i): For particle, when inlet concentration equal or greater than 0.5mg/m³, not less than 80% of PM10 shall be removed after air is treated by the APS. For inlet concentration lower than 0.5mg/m³, the outlet concentration shall not be greater than 0.1 mg/m³.

Test Conducted by:	Witnessed by:	Witnessed by:	Witnessed by:	Witnessed by:
Name : <u>Eric Deux</u>	Name : <u>Ken Fan</u>	Name : <u>Eric Cheung</u>	Name : <u>Harvey Chu</u>	Name : <u>RAYMOND WAN</u>
Company: <u>FILTRONtec</u>	Company: <u>Leighton Joint Venture</u>	Company: <u>AECOM</u>	Company: <u>EMSD</u>	Company: <u>HYD</u>
Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>	Signature : <u>[Signature]</u>
Date: <u>30/10/2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30 Oct 2015</u>	Date: <u>30.10.2015</u>

Notes:

1. The modules of ESP were randomly picked and tested in controlled laboratory condition. The ESP modules were then shipped to different ventilation buildings for installation.

**Appendix 4 Site Acceptance Tests for
HV Transformers at
Different Ventilation
Buildings**

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Title/description			
Start up HVT			
Revision	Date	Site	Building
004	07.03.18	BB1-A	EUB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		E. Dent

General information to be read BEFORE switching on HV system

Synchronisation Prometos gamma control unit User Information

1. General

Synchronisation is to be understood as the allocation of the trigger pulses to the correct thyristors of the thyristor controller in the main circuit. If this allocation is incorrect, the high voltage system cannot function since the regulating arm of the control loop does not work.

A new system has passed the factory tests and is, therefore, synchronised. Nevertheless, for the sake of general understanding, the relationships will be explained below. It can, in fact, often happen in new systems that the distribution of the trigger pulses may go wrong as the result of later modifications or the changing of spare parts, for example. It is also necessary that the three phase input system shapes a clockwise turning field.

2. Trigger pulse Amplifier

If we limit ourselves to single phase systems that are controlled by an anti-parallel pair of thyristors, there are always two twin conductor trigger pulse channels. One conductor of a channel (red) is connected to the cathode of the appropriate thyristor (reference voltage), the other is connected to the gate. The appropriate terminals on the trigger pulse amplifier are marked with G1 (gate 1, white), K1 (cathode 1, red) and G2 (gate 2, white), K2 (cathode 2, red). The gate and cathode connections are also clearly marked on the thyristor module.

With a three phase current system, there is a further detail to consider: The three phases can rotate in left or in right direction. To operate the three phase current high voltage system correctly, the three phases have to rotate in right direction.

Under no circumstances should gate and cathode connections be confused.

If the connections to the gates and cathodes are correct, there still remain two possibilities for the allocation of the trigger pulse channels.

The correct one applies the trigger pulse to the thyristor that has a positive voltage on its anode and will therefore conduct when triggered.

The synchronisation is not, however, only influenced by this allocation.

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

3. Principle

The main circuit, mainly the three phases L1, L2 and L3, are mostly hard-wired within the control cabinet. The arrangement of the B6 thyristor bridge, -V1-1V1, 2V1 and 3V1 in the main circuit is also fixed.

In order to determine the timing of the trigger pulse correctly, the Prometos gamma control unit requires an image of the supply voltage. From this it finds the zero crossings and sets the timing.

The trigger pulse amplifier derives this signal from its own 3 x 18 V AC supply, delivered by the control transformer, whose waveform corresponds to the main supply voltage.

Any error in this chain leads to a loss of synchronisation and a failure of the system.

This could result, for example, from swapping the primary connections when changing the control transformer or reversing the 380 V AC (110 V AC) supply lines to the trigger pulse amplifier. Similar problems occur, when the three phase input voltage does not shape a clockwise turning field.

Although we are dealing with an alternating current system, the lines must not be crossed, as phasing is necessary for correct triggering of the thyristors.

Item No.	Inspection / Activity	Pass [Y/N]
1	Pre Check	
	HVT for ESP-Ioniser Serial Number: <u>14450</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
	HVT for ESP-Collector Serial Number: <u>14455</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
2	Start up	
2.1	Control Panel MAKE SURE ALL CIRCUITBREAKERS, SWITCHES etc ARE OPEN MAKE SURE HV-cable is not connected to HV-aggregate and ESP MAKE SURE ACCESS TO ESP IS IMPOSSIBLE Lock up area and place signs in position "Danger High Voltage Testing – do	

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08
 ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	VDC	
	- Switch on Prometos Controller, check the start up and synchronization signal	Y
	- Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door.	Y
	- Switch on the high voltage in Service Mode	Y
	o Check the emergency button of the cubicle door	Y
	o Check if no voltage and no current indication	Y
	o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing	Y
	o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter	Y
	o Switch off Service Mode	Y
	- Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable.	Y
	- Switch on HV-unit in manual mode for start up ramp	
	o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min	Y
	o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	- Decrease high voltage to zero and change from manual to automatic mode (power will increase)	
	o Write down reached values (primary and secondary voltage and current values)	Y

Remark: After test shut down the power, open all circuit breakers and EARTH ESP.

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Conclusion / Results and Comments:

Inspection / Test carried out by:

Jeaskun Martos
[Name FILTRONtec Inspector]

[Signature]
[Signature]

10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]

Ricky Cheng
[Name Leighton JV Representative]

[Signature]
[Signature]

10.03.2018
[Date]

Witnessed / Checked / Inspected by:

T. K. NG
[Name Aecom Inspector]

[Signature]
[Signature]

10.03.2018
[Date]

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Title/description			
Start up HVT			
Revision	Date	Site	Building
004	07.03.18	001-B	EVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		E. Dux

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A new system has passed the factory tests and is, therefore, synchronised. Nevertheless, for the sake of general understanding, the relationships will be explained below. It can, in fact, often happen in new systems that the distribution of the trigger pulses may go wrong as the result of later modifications or the changing of spare parts, for example. It is also necessary that the three phase input system shapes a clockwise turning field.

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If we limit ourselves to single phase systems that are controlled by an anti-parallel pair of thyristors, there are always two twin conductor trigger pulse channels. One conductor of a channel (red) is connected to the cathode of the appropriate thyristor (reference voltage), the other is connected to the gate. The appropriate terminals on the trigger pulse amplifier are marked with G1 (gate 1, white), K1 (cathode 1, red) and G2 (gate 2, white), K2 (cathode 2, red). The gate and cathode connections are also clearly marked on the thyristor module.

With a three phase current system, there is a further detail to consider: The three phases can rotate in left or in right direction. To operate the three phase current high voltage system correctly, the three phases have to rotate in right direction.

Under no circumstances should gate and cathode connections be confused.

If the connections to the gates and cathodes are correct, there still remain two possibilities for the allocation of the trigger pulse channels.

The correct one applies the trigger pulse to the thyristor that has a positive voltage on its anode and will therefore conduct when triggered.

The synchronisation is not, however, only influenced by this allocation.

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

3. Principle

The main circuit, mainly the three phases L1, L2 and L3, are mostly hard-wired within the control cabinet. The arrangement of the B6 thyristor bridge, -V1-1V1, 2V1 and 3V1 in the main circuit is also fixed.

In order to determine the timing of the trigger pulse correctly, the Prometos gamma control unit requires an image of the supply voltage. From this it finds the zero crossings and sets the timing.

The trigger pulse amplifier derives this signal from its own 3 x 18 V AC supply, delivered by the control transformer, whose waveform corresponds to the main supply voltage.

Any error in this chain leads to a loss of synchronisation and a failure of the system.

This could result, for example, from swapping the primary connections when changing the control transformer or reversing the 380 V AC (110 V AC) supply lines to the trigger pulse amplifier. Similar problems occur, when the three phase input voltage does not shape a clockwise turning field.

Although we are dealing with an alternating current system, the lines must not be crossed, as phasing is necessary for correct triggering of the thyristors.

Item No.	Inspection / Activity	Pass [Y/N]
1	Pre Check	
	HVT for ESP-Ioniser Serial Number: <u>14451</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
	HVT for ESP-Collector Serial Number: <u>14454</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
2	Start up	
2.1	Control Panel MAKE SURE ALL CIRCUITBREAKERS, SWITCHES etc ARE OPEN MAKE SURE HV-cable is not connected to HV-aggregate and ESP MAKE SURE ACCESS TO ESP IS IMPOSSIBLE Lock up area and place signs in position "Danger High Voltage Testing – do	

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	not enter", "Authorized Personnel only"	
2.2	Ionizer	
	<ul style="list-style-type: none"> - Switch on Power feeding from Substation <ul style="list-style-type: none"> o (to terminal L1-L2-L3 expected : 380V AC / 50Hz, right turning field) 	Y
	<ul style="list-style-type: none"> - Switch on main circuit breaker 	Y
	<ul style="list-style-type: none"> - Switch on HV Transformer Control Panel <ul style="list-style-type: none"> o Measure voltage on control transformer -T1 o (expected secondary : 2 x 230V AC / 24 V DC) 	Y
	<ul style="list-style-type: none"> - Switch on fuses and circuit breakers, check voltages 230 VAC rsp 19 VAC rsp 24 VDC 	Y
	<ul style="list-style-type: none"> - Switch on Prometos Controller, check the start up and synchronization signal 	Y
	<ul style="list-style-type: none"> - Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door. 	Y
	<ul style="list-style-type: none"> - Switch on the high voltage in Service Mode <ul style="list-style-type: none"> o Check the emergency button of the cubicle door o Check if no voltage and no current indication o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter o Switch off Service Mode 	Y
	<ul style="list-style-type: none"> - Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable. 	Y
	<ul style="list-style-type: none"> - Switch on HV-unit in manual mode for start up ramp <ul style="list-style-type: none"> o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min 	Y
	<ul style="list-style-type: none"> - Decrease high voltage to zero and change from manual to automatic mode (power will increase) <ul style="list-style-type: none"> o Write down reached values (primary and secondary voltage and current values) 	Y
2.3	Collector	
	<ul style="list-style-type: none"> - Switch on main circuit breaker 	Y
	<ul style="list-style-type: none"> - Switch on HV Transformer Control Panel <ul style="list-style-type: none"> o Measure voltage on control transformer -T1 o (expected secondary : 2 x 230V AC / 24 V DC) 	Y
	<ul style="list-style-type: none"> - Switch on fuses and circuit breakers, check voltages 230 VAC rsp 19 VAC rsp 24 	Y

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	VDC	
	- Switch on Prometos Controller, check the start up and synchronization signal	Y
	- Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door.	Y
	- Switch on the high voltage in Service Mode	
	o Check the emergency button of the cubicle door	Y
	o Check if no voltage and no current indication	Y
	o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing	Y
	o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter	Y
	o Switch off Service Mode	Y
	- Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable.	Y
	- Switch on HV-unit in manual mode for start up ramp	
	o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min	Y
	o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	- Decrease high voltage to zero and change from manual to automatic mode (power will increase)	
	o Write down reached values (primary and secondary voltage and current values)	Y

Remark: After test shut down the power, open all circuit breakers and EARTH ESP.

Inspection & Test Record


CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Conclusion / Results and Comments:

Inspection / Test carried out by:

Izaskun Martos
[Name FILTRONtec Inspector]


[Signature]

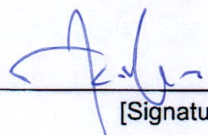
10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]


Ricky Cheong
[Name Leighton JV Representative]


[Signature]

10.03.2018
[Date]

Witnessed
Checked / Inspected by:

T.K. NG
[Name Aecom Inspector]


[Signature]

10.03.2018
[Date]

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Title/description			
Start up HVT			
Revision	Date	Site	Building
004	07.03.18	001-C	EVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		E. Demx

General information to be read BEFORE switching on HV system

Synchronisation Prometos gamma control unit User Information

1. General

Synchronisation is to be understood as the allocation of the trigger pulses to the correct thyristors of the thyristor controller in the main circuit. If this allocation is incorrect, the high voltage system cannot function since the regulating arm of the control loop does not work.

A new system has passed the factory tests and is, therefore, synchronised. Nevertheless, for the sake of general understanding, the relationships will be explained below. It can, in fact, often happen in new systems that the distribution of the trigger pulses may go wrong as the result of later modifications or the changing of spare parts, for example. It is also necessary that the three phase input system shapes a clockwise turning field.

2. Trigger pulse Amplifier

If we limit ourselves to single phase systems that are controlled by an anti-parallel pair of thyristors, there are always two twin conductor trigger pulse channels. One conductor of a channel (red) is connected to the cathode of the appropriate thyristor (reference voltage), the other is connected to the gate. The appropriate terminals on the trigger pulse amplifier are marked with G1 (gate 1, white), K1 (cathode 1, red) and G2 (gate 2, white), K2 (cathode 2, red). The gate and cathode connections are also clearly marked on the thyristor module.

With a three phase current system, there is a further detail to consider: The three phases can rotate in left or in right direction. To operate the three phase current high voltage system correctly, the three phases have to rotate in right direction.

Under no circumstances should gate and cathode connections be confused.

If the connections to the gates and cathodes are correct, there still remain two possibilities for the allocation of the trigger pulse channels.

The correct one applies the trigger pulse to the thyristor that has a positive voltage on its anode and will therefore conduct when triggered.

The synchronisation is not, however, only influenced by this allocation.

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

3. Principle

The main circuit, mainly the three phases L1, L2 and L3, are mostly hard-wired within the control cabinet. The arrangement of the B6 thyristor bridge, -V1-1V1, 2V1 and 3V1 in the main circuit is also fixed.

In order to determine the timing of the trigger pulse correctly, the Prometos gamma control unit requires an image of the supply voltage. From this it finds the zero crossings and sets the timing.

The trigger pulse amplifier derives this signal from its own 3 x 18 V AC supply, delivered by the control transformer, whose waveform corresponds to the main supply voltage.

Any error in this chain leads to a loss of synchronisation and a failure of the system.

This could result, for example, from swapping the primary connections when changing the control transformer or reversing the 380 V AC (110 V AC) supply lines to the trigger pulse amplifier. Similar problems occur, when the three phase input voltage does not shape a clockwise turning field.

Although we are dealing with an alternating current system, the lines must not be crossed, as phasing is necessary for correct triggering of the thyristors.

Item No.	Inspection / Activity	Pass [Y/N]
1	Pre Check	
	HVT for ESP-Ioniser Serial Number: <u>14452</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
	HVT for ESP-Collector Serial Number: <u>14453</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
2	Start up	
2.1	Control Panel MAKE SURE ALL CIRCUITBREAKERS, SWITCHES etc ARE OPEN MAKE SURE HV-cable is not connected to HV-aggregate and ESP MAKE SURE ACCESS TO ESP IS IMPOSSIBLE Lock up area and place signs in position "Danger High Voltage Testing – do	

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	not enter", "Authorized Personnel only"	
2.2	Ionizer	
	<ul style="list-style-type: none"> - Switch on Power feeding from Substation <ul style="list-style-type: none"> o (to terminal L1-L2-L3 expected : 380V AC / 50Hz, right turning field) 	Y
	<ul style="list-style-type: none"> - Switch on main circuit breaker 	Y
	<ul style="list-style-type: none"> - Switch on HV Transformer Control Panel <ul style="list-style-type: none"> o Measure voltage on control transformer –T1 o (expected secondary : 2 x 230V AC / 24 V DC) 	Y
	<ul style="list-style-type: none"> - Switch on fuses and circuit breakers, check voltages 230 VAC rsp 19 VAC rsp 24 VDC 	Y
	<ul style="list-style-type: none"> - Switch on Prometos Controller, check the start up and synchronization signal 	Y
	<ul style="list-style-type: none"> - Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door. 	Y
	<ul style="list-style-type: none"> - Switch on the high voltage in Service Mode <ul style="list-style-type: none"> o Check the emergency button of the cubicle door o Check if no voltage and no current indication o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter o Switch off Service Mode 	Y
	<ul style="list-style-type: none"> - Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable. 	Y
	<ul style="list-style-type: none"> - Switch on HV-unit in manual mode for start up ramp <ul style="list-style-type: none"> o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min 	Y
	<ul style="list-style-type: none"> - Decrease high voltage to zero and change from manual to automatic mode (power will increase) <ul style="list-style-type: none"> o Write down reached values (primary and secondary voltage and current values) 	Y
2.3	Collector	
	<ul style="list-style-type: none"> - Switch on main circuit breaker 	Y
	<ul style="list-style-type: none"> - Switch on HV Transformer Control Panel <ul style="list-style-type: none"> o Measure voltage on control transformer –T1 o (expected secondary : 2 x 230V AC / 24 V DC) 	Y
	<ul style="list-style-type: none"> - Switch on fuses and circuit breakers, check voltages 230 VAC rsp 19 VAC rsp 24 	Y

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08
 ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	VDC	
	- Switch on Prometos Controller, check the start up and synchronization signal	Y
	- Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door.	Y
	- Switch on the high voltage in Service Mode	
	o Check the emergency button of the cubicle door	Y
	o Check if no voltage and no current indication	Y
	o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing	Y
	o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter	Y
	o Switch off Service Mode	Y
	- Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable.	Y
	- Switch on HV-unit in manual mode for start up ramp	
	o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min	Y
	o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	- Decrease high voltage to zero and change from manual to automatic mode (power will increase)	
	o Write down reached values (primary and secondary voltage and current values)	Y

Remark: After test shut down the power, open all circuit breakers and EARTH ESP.

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Conclusion / Results and Comments:

Inspection / Test carried out by:

Izaskun Martos
[Name FILTRONtec Inspector]

[Signature]
[Signature]

10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]

Picky Along
[Name Leighton JV Representative]

[Signature]
[Signature]

10.03.2018
[Date]

~~Witnessed~~
Checked / Inspected by:

T.K. NG
[Name Aecom Inspector]

[Signature]
[Signature]

10.03.2018
[Date]

[Name EMSD Witness]

[Signature]

[Date]

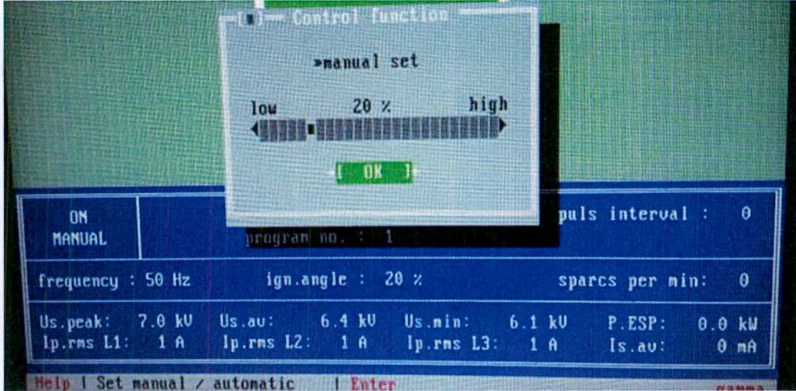



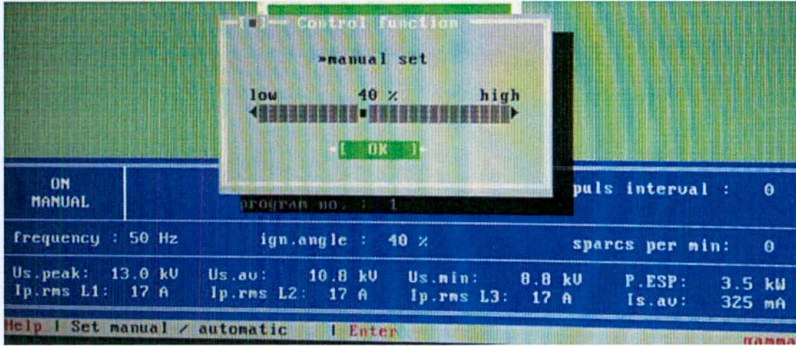



[Name HyD Witness]




[Signature]

[Date]

Commissioning High Voltage Transformers East Ventilation Building

Plant		Ignition angle	Secondary Voltage (U _s av)	Secondary Current (I _s av)	Primary Current (I _p rms)		
					L1	L2	L3
APS 001 A	Ioniser	20%	6.4 kV	0 mA	1 A	1 A	1 A
		40 %	10.8 kV	325 mA	17 A	17 A	17 A
		50%	13.5 kV	700 mA	31 A	31 A	31 A
	Collector	20%	2.9 kV	0 mA	0 A	0 A	0 A
		40 %	5.6 kV	42 mA	1 A	1 A	1 A
		50%	6.6 kV	91 mA	2 A	2 A	2 A
APS 001 B	Ioniser	20%	6.4 kV	0 mA	1 A	1 A	1 A
		40 %	10.8 kV	325 mA	18 A	18 A	18 A
		50%	13.3 kV	725 mA	33 A	33 A	33 A
	Collector	20%	2.9 kV	0 mA	0 A	0 A	0 A
		40 %	5.5 kV	49 mA	1 A	1 A	1 A
		50%	6.7 kV	98 mA	2 A	2 A	2 A
APS 001 C	Ioniser	20%	6.6 kV	0 mA	1 A	1 A	2 A
		40 %	10.9 kV	375 mA	19 A	19 A	20 A
		50%	13.4 kV	775 mA	35 A	35 A	35 A
	Collector	20%	3.1 kV	0 mA	0 A	0 A	0 A
		40 %	5.8 kV	35 mA	1 A	1 A	1 A
		50%	6.8 kV	77 mA	2 A	2 A	2 A

Plant	Ignition angle	Secondary Voltage (U _s av)	Secondary Current (I _s av)	Primary Current (I _p rms)		
				L1	L2	L3
APS 001 A	20%	 <p>Control function >manual set low 20% high [OK]</p> <p>ON MANUAL puls interval : 0 program no. : 1</p> <p>frequency : 50 Hz ign. angle : 20 % sparks per min: 0</p> <p>Us.peak: 7.0 kV Us.av: 6.4 kV Us.min: 6.1 kV P.ESP: 0.0 kW Ip.rms L1: 1 A Ip.rms L2: 1 A Ip.rms L3: 1 A Is.av: 0 mA</p> <p>Help Set manual / automatic Enter</p>				
	40%	 <p>Control function >manual set low 40% high [OK]</p> <p>ON MANUAL puls interval : 0 program no. : 1</p> <p>frequency : 50 Hz ign. angle : 40 % sparks per min: 0</p> <p>Us.peak: 13.0 kV Us.av: 10.8 kV Us.min: 8.8 kV P.ESP: 3.5 kW Ip.rms L1: 17 A Ip.rms L2: 17 A Ip.rms L3: 17 A Is.av: 325 mA</p> <p>Help Set manual / automatic Enter</p>				

	50%				
Collector	20%				

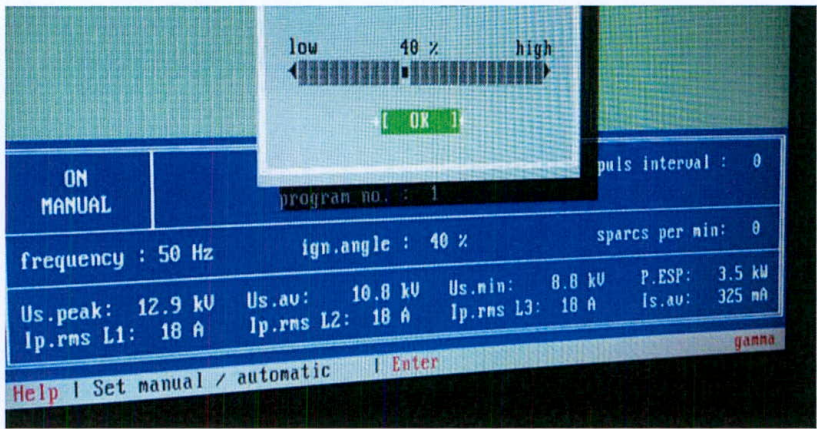
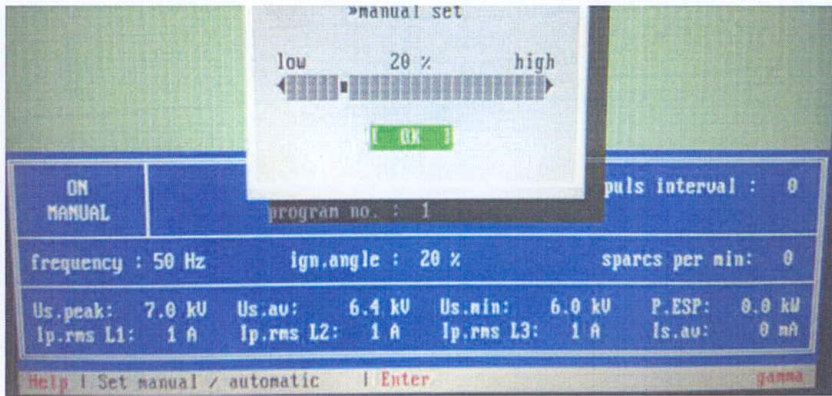
	<p>40 %</p>	 <p>control state : local puls interval : 0 program no. : 1</p> <p>frequency : 50 Hz ign.angle : 40 % spars per min: 0</p> <p>Us.peak: 5.6 kV Us.av: 5.6 kV Us.min: 5.6 kV P.ESP: 0.2 kW Ip.rms L1: 1 A Ip.rms L2: 1 A Ip.rms L3: 1 A Is.av: 42 mA</p> <p>press menu use: - Enter - Up - Down - Left - Right gamma</p>			
	<p>50%</p>	 <p>low 50 % high</p> <p>[OK]</p> <p>control state : local puls interval : 0 program no. : 1</p> <p>frequency : 50 Hz ign.angle : 50 % spars per min: 13</p> <p>Us.peak: 6.7 kV Us.av: 6.6 kV Us.min: 6.6 kV P.ESP: 0.6 kW Ip.rms L1: 2 A Ip.rms L2: 2 A Ip.rms L3: 2 A Is.av: 91 mA</p>			

APS
001
B

Ioniser

20%

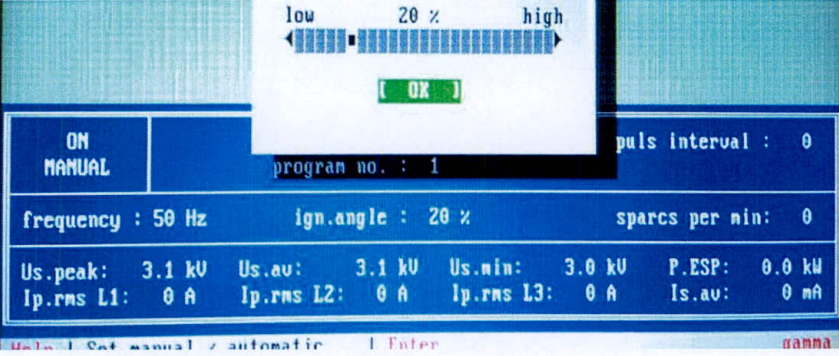
40 %



	50%				
Collector	20%				

	<p>40 %</p>				
	<p>50%</p>				

<p>APS 001 C</p>	<p>Ioniser</p>	<p>20%</p>				
		<p>40%</p>				

	50%				
Collector	20%				

<p>40 %</p>				
<p>50%</p>				

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	07.03.18	001-A	EVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	<input checked="" type="checkbox"/>		<i>E. Dux</i>

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

• Label for HV-cable Jowise + collector (location)
↳ Outstanding.

Inspection / Test carried out by:

Izaskun Martos
[Name FILTRONtec Inspector]

[Signature]
[Signature]

10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]

Samson Leung
[Name Leighton JV Representative]

[Signature]
[Signature]

10.03.18
[Date]

~~Checked / Inspected by:~~
Witnessed

T. K. NG
[Name Aecom Inspector]

[Signature]
[Signature]

10.03.18
[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	07-03-18	001-B	ENB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	<input checked="" type="checkbox"/>		<i>G. Durr</i>

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE


Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

- o Damper resistor installed.
- o Label for HV-Cable Follower + Collector (Location) => outstanding

Inspection / Test carried out by:

Izaskun Martos
[Name FILTRONtec Inspector]


[Signature]

10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]


Samson Leung
[Name Leighton JV Representative]


[Signature]

10.03.18
[Date]

~~Witnessed~~
Checked / Inspected by:

T.K. NG
[Name Aecom Inspector]


[Signature]

10.03.18
[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	07.03.18	001-C	EVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		<i>E. Perry</i>

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.


Conclusion / Results and Comments:

= Damping resistance installed

oLable for HV-Cable Ioniser + Collector (Location)

Inspection / Test carried out by:

Fraskun Martos
[Name FILTRONtec Inspector]


[Signature]


10.03.18
[Date]

[Name RICO Inspector]

[Signature]

[Date]


Samson Leung
[Name Leighton JV Representative]


[Signature]

10.03.18
[Date]

~~Checked / Inspected by:~~
Witnessed

T. KING
[Name Aecom Inspector]


[Signature]

10.03.18
[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

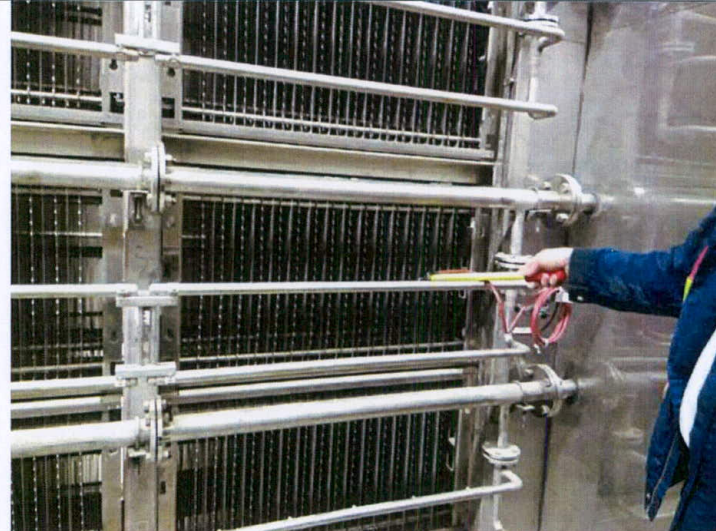
Work Description: Installation of HV Transformer Start up for APS of EVB

RISC Ref.: H2613/M/5/1782

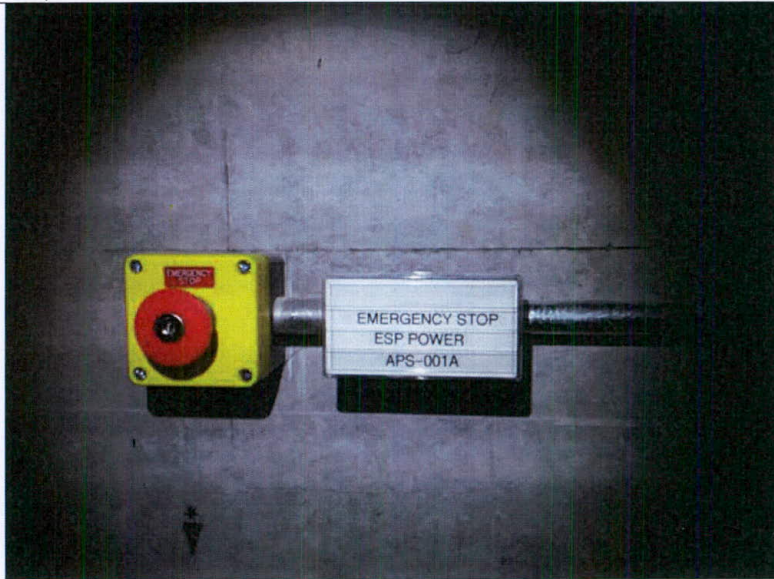
Date Inspected: 10 March 2018



End view on typical common earth tape connected with ESP modules on rack at APS plant room in B2 of EVB



View on typical operation of spike stick for short circuit on ESP module.

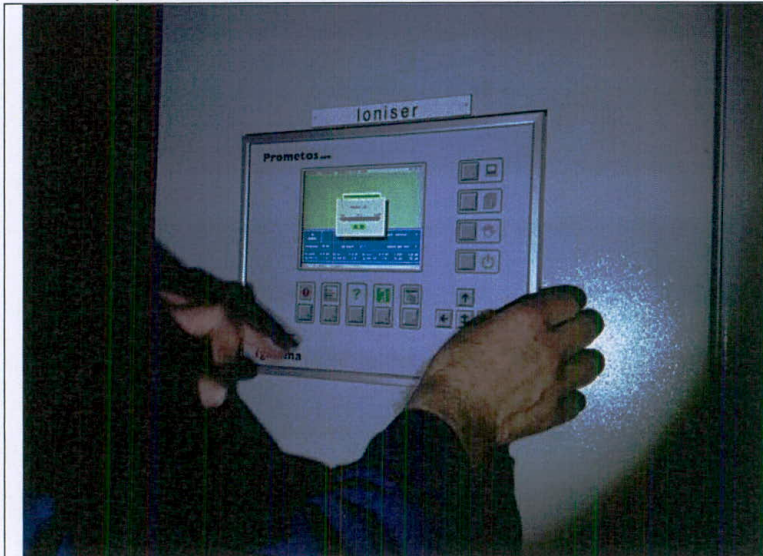


View on typical emergency stop installed at entrance of ESP area A, B & C with identification label (APS-001A)

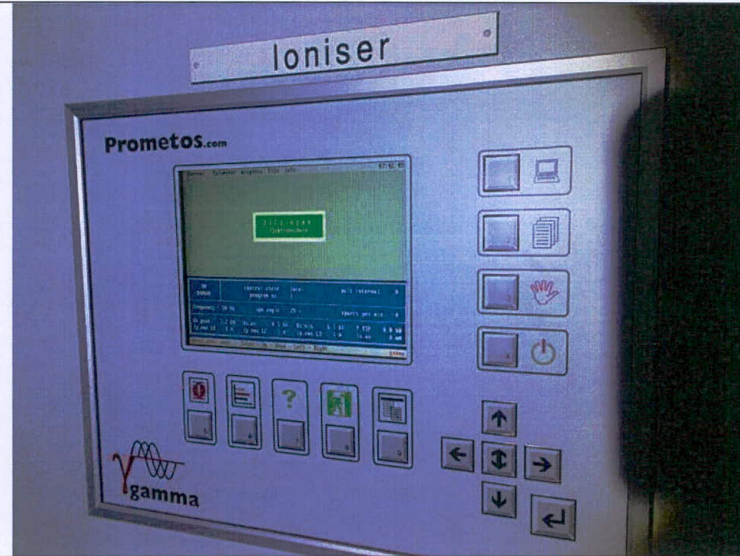


View on energizing of HV control panel (Ionizer) in auxiliary plant room in B2 of EVB

Work Description: Installation of HV Transformer Start up for APS of EVB
 RISC Ref.: H2613/M/5/1782
 Date Inspected: 10 March 2018



View on typical manual mode setting of HV output of ESP Ioniser by adjusting ignition angle on screen



Typical manual mode setting for 20% ignition angle and check voltage and current of ESP Ioniser unit on screen after 20 minutes.

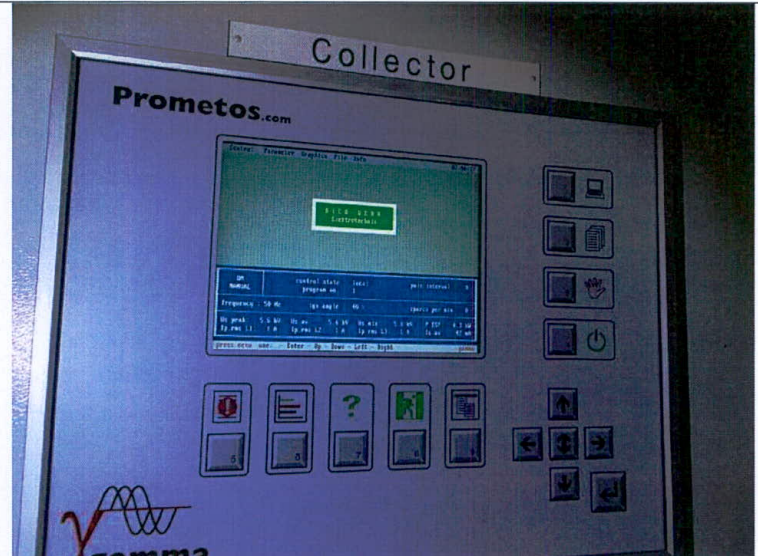
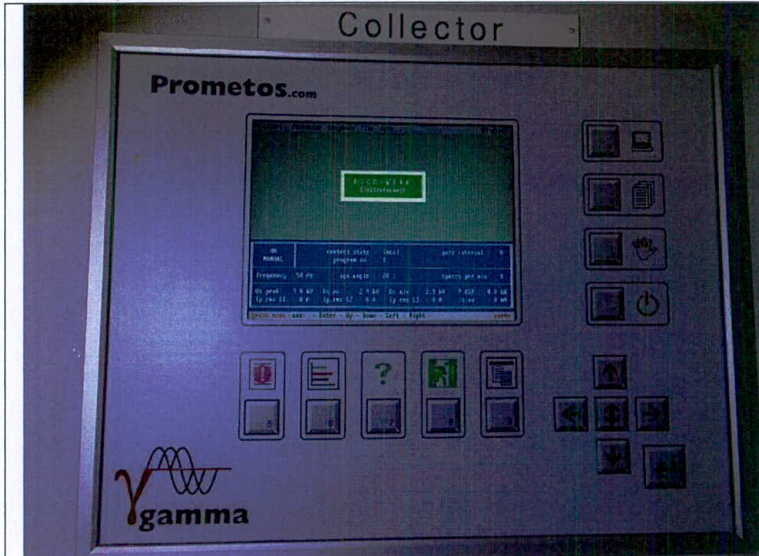


Typical manual mode setting for 40% ignition angle and check voltage and current of ESP Ioniser unit on screen after 30 minutes.



Typical manual mode setting for 50% ignition angle and check voltage and current of ESP Ioniser unit on screen after 30 minutes.

Work Description: Installation of HV Transformer Start up for APS of EVB
 RISC Ref.: H2613/M/5/1782
 Date Inspected: 10 March 2018



Typical manual mode setting for 20% ignition angle and check voltage and current of ESP Collector unit on screen after 20 minutes.

Typical mode setting for 40% ignition angle and check voltage and current of ESP Collector unit on screen after 30 minutes.



END

Typical manual mode setting for 50% ignition angle and check voltage and current of ESP Collector unit on screen after 30 minutes.

Remarks:

The comments marked under Conclusion / Results and Comments section will be included in the defects list to Contractor, the defects will be rectified by Contractor after substantial completion of APS.

Notes:

1. HyD and EMSD witnessed some of the site acceptance test records, while AECOM would witness and accept all site acceptance tests for HV transformers when HyD and EMSD were not present during the site acceptance tests.

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	14.06.2018	APS002	MVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		E. Denx

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	Y
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	N/A
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Earthing is via the rack
~~not~~
 together

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08
 ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

Torque test for connection between modules to be done later
 Some connections of ioniser are round and not hexagonal
 Only one earthing link is installed at the moment => second to be mounted
 Random check of continuity was done (ioniser + collector)

Inspection / Test carried out by:

Dr. Elke Deux
 [Name FILTRONtec Inspector]

E. Deux
 [Signature]

14.06.2018
 [Date]

Dr. Josef von Storkelberg
 [Name RICO Inspector]

[Signature]
 [Signature]

15.6.2018
 [Date]

Samson Leung
 [Name Leighton JV Representative]

[Signature]
 [Signature]

15.6.2018
 [Date]

Witnesses

Checked / Inspected by:

S.H. Yuen
 [Name Aecom Inspector]

[Signature]
 [Signature]

15/6/2018
 [Date]

LAI Ka-kin
 [Name EMSD Witness]

[Signature]
 [Signature]

18/6/2018
 [Date]

[Name HyD Witness]

[Signature]

[Date]

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	14.06.2018	APS-003LL	MVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	<input checked="" type="checkbox"/>		E. Deutz

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	Y
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

Torque test for connection between modules to be done later
 Some connections of ionizer are round and not hexagonal
 Only one earthing link is installed at the moment => second to be mounted
 Random check of continuity was done (ionizer + collector)

Inspection / Test carried out by:

Dr. Elke Deux
 [Name FILTRONtec Inspector]

E. Deux
 [Signature]

14.06.2018
 [Date]

Dr. Josef von Stackelberg
 [Name RICO Inspector]

[Signature]
 [Signature]

15.6.2018
 [Date]

Samson Leung
 [Name Leighton JV Representative]

[Signature]
 [Signature]

15.6.2018
 [Date]

~~Checked / Inspected by:~~
 Witnessed

Sixty van
 [Name Aecom Inspector]

[Signature]
 [Signature]

15/6/2018
 [Date]

LAI Ka-kin
 [Name EMSD Witness]

[Signature]
 [Signature]

18/6/2018
 [Date]

[Name HyD Witness]

[Signature]

[Date]

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	14.06.2013	APS-003 HL	MVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	<input checked="" type="checkbox"/>		S. Denx

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	Y
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

Torque test for connection between modules to be done later
 Some connections of ioniser are sound and not hexagonal
 Only one earthing kit is installed at the moment => second to be mounted
 Random check of continuity was done (ioniser + collector)

Inspection / Test carried out by:

<p><u>Dr. ELKE DEUX</u> [Name FILTRONtec Inspector]</p>	<p><u>E. Deux</u> [Signature]</p>	<p><u>14.06.2018</u> [Date]</p>
<p><u>Dr. Josef von Stockelbe</u> [Name RICO Inspector]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>15.6.2018</u> [Date]</p>
<p><u>Samson Leung</u> [Name Leighton JV Representative]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>15.6.2018</u> [Date]</p>

Witness of
Checked / Inspected by:

<p><u>S.H. Yuen</u> [Name Aecom Inspector]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>15/6/2018</u> [Date]</p>
<p>LAI Ka-kin [Name EMSD Witness]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>18/6/2018</u> [Date]</p>
<p>_____ [Name HyD Witness]</p>	<p>_____ [Signature]</p>	<p>_____ [Date]</p>

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	14.06.2018	APS-004	MVB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director	✓		E. Demx

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

Torque test for connection between modules to be done later
 Some connection of ionizer are sound and not hexagonal
 Only one earthing kit is installed at the moment => second to be mounted
 Random check of continuity was done (ionizer + collector)

Inspection / Test carried out by:

<p><u>Dr. Elke Deux</u> [Name FILTRONtec Inspector]</p>	<p><u>E. Deux</u> [Signature]</p>	<p><u>14.06.2018</u> [Date]</p>
<p><u>Dr. Josef von Stackelberg</u> [Name RICO Inspector]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>14.6.2018</u> [Date]</p>
<p><u>Samson Leung</u> [Name Leighton JV Representative]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>14.6.2018</u> [Date]</p>

Witnessed by

Checked / Inspected by:

<p><u>S. Hyson</u> [Name Aecom Inspector]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>14/6/2018</u> [Date]</p>
<p><u>Heero Lai</u> [Name EMSD Witness]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>14/6/2018</u> [Date]</p>
<p><u>[Signature]</u> [Name HyD Witness]</p>	<p><u>[Signature]</u> [Signature]</p>	<p><u>[Signature]</u> [Date]</p>

Inspection of check & energize of HV transformer , RISC no. (H2613/M/5/2130)

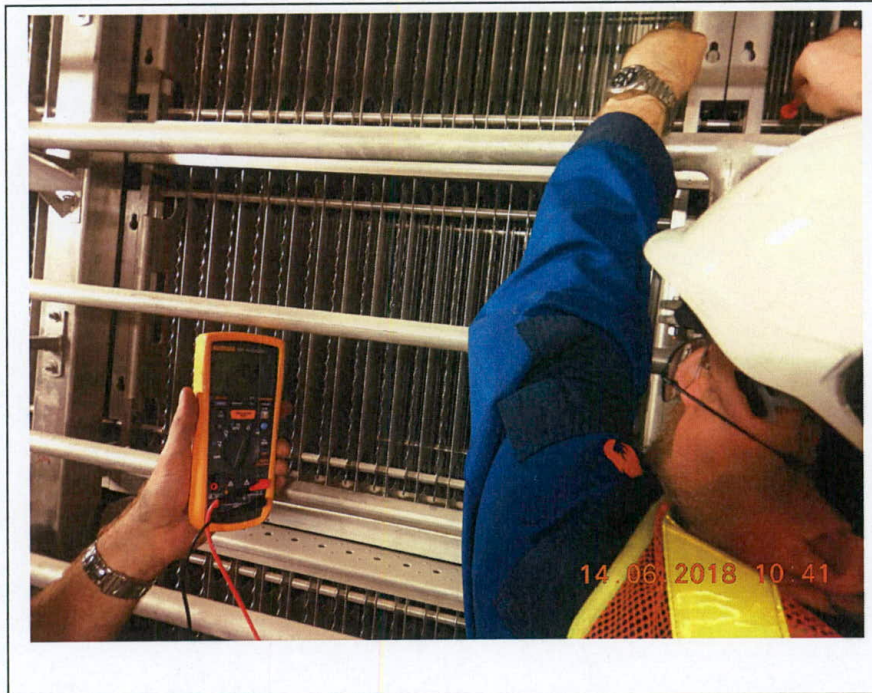


Photo 1

Resistance test between module to module connection is mounted and fixed for ESP no. 4



Photo 2

Resistance test between module to module connection is mounted and fixed for ESP no. 3

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Photo 3

Resistance test between module to module connection is mounted and fixed for ESP no. 2

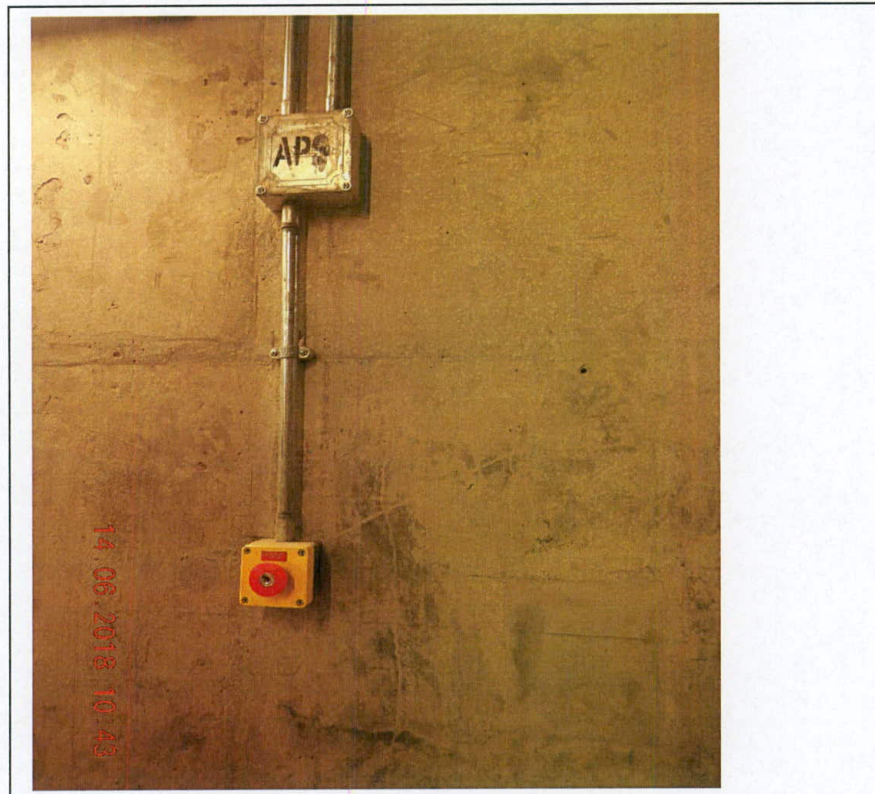


Photo 4

Emergency stop button for ESP no.2 to no.4 at APS plenum is installed

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[Pick the date]



Photo 5

HV cable connection fixed to ESP collector & ionizer had been checked



Photo 6

Hexagon type connection bolts for interconnection between module to module should be used, please replace

Remarks:

The comments marked under Conclusion / Results and Comments section will be included in the defects list to Contractor, the defects will be rectified by Contractor after substantial completion of APS.

Notes:

1. HyD and EMSD witnessed some of the site acceptance test records, while AECOM would witness and accept all site acceptance tests for HV transformers when HyD and EMSD were not present during the site acceptance tests.

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-02

Item No.	Technical review	Pass [Y/N]	Comments
1.3	HV- Rack <ul style="list-style-type: none"> - No Damages / Intact - Stability / Fixing 	Y Y	
2	Signage Inspection		
2.1	Labels on Control Panel <ul style="list-style-type: none"> - Incoming feed cable identified Information labels under terminal boards - Label to identify control unit on doors (Relation to precipitator) 	Y Y	
	<ul style="list-style-type: none"> - Label to identify regulator unit (Relation between regulator unit and precipitator) - Inscription above emergency stop 	Y Y	
2.2	Labels HV- transformer <ul style="list-style-type: none"> - Incoming cable feed identified Warning label close to high voltage outlet - Sealing Label close to oil filling boss - Sealing Label close to oil outlet crew 	Y Y Y	
3	Safety Barriers <ul style="list-style-type: none"> - Door for control panel close - Door on transformer terminal box close 	Y Y	
4	Earthing Wiring is in place and correct connected and identified <ul style="list-style-type: none"> - Earthing Control Panel matches embedded earth - Earthing Rack matches embedded earth - Earthing HV-transformer Ioniser matches embedded earth - Earthing HV-transformer Collector matches embedded earth - Earthing resistance is checked. 	Y Y Y Y	

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-02

Item No.	Technical review	Pass [Y/N]	Comments
5	<p>Cable inspection</p> <p>Control Panel and identified (cables, colours/numbers and terminals)</p> <p>Low voltage cables wiring in place and correct fixing</p> <ul style="list-style-type: none"> - Main Power Cable Terminal X-L1 (BN), X-L2 (BK), X-L3 (GY) - Air condition X4-1 (BN), X4-2 (BU) 	<p>Y</p> <p>Y</p>	
	<p>Ionizer</p> <ul style="list-style-type: none"> - Power cable X10-U (BN), X10-V (BK), X10-W (GY) - Secondary voltage X8-1 (RD,WH), X8-2 (GN,BK) - Secondary current X8-3 (GN,BK), X8-4 (RD,WH) - Binary signals X9-1 (1), X9-2 (2), X9-3 (3), X9-4 (4), X9-5 (5), X9-6 (6) - Signals to MCS X6-1 (GN,BK), X6-2 (GN,BK), X6-3 (RD,WH), X6-4 (RD,WH), X5-2 (1), X5-5 (2), X5-6 (3), X3-1 (1), X3-2 (2) 	<p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p>	
	<p>Collector</p> <ul style="list-style-type: none"> - Power cable X10-U (BN), X10-V (BK), X10-W (GY) - Secondary voltage X8-1 (RD,WH), X8-2 (GN,BK) - Secondary current X8-3 (GN,BK), X8-4 (RD,WH) - Binary signals X9-1 (1), X9-2 (2), X9-3 (3), X9-4 (4), X9-5 (5), X9-6 (6) 	<p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p>	

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-02

Item No.	Technical review	Pass [Y/N]	Comments
	<ul style="list-style-type: none"> - Signals to MCS X6-1 (GN,BK), X6-2 (GN,BK), X6-3 (RD,WH), X6-4 (RD,WH), X5-2 (1), X5-5 (2), X5-6 (3) 	Y	
	<p>HV-transformer terminal box and identified Low voltage cables wiring in place and correct fixing</p> <p>Ionizer</p> <ul style="list-style-type: none"> - Main Power Cable Terminal U (BN) Terminal V (BK) Terminal W (GY) - Secondary current A1-1 (RD,WH), A1-2 (GN, BK) - Secondary voltage A1-3 (GN,BK), A1-4 (RD, WH) - Binary signals A1-10 (1), A1-15 (2), A1-16 (3), A1-17 (4), A1-18 (5), A1-19 (6) <p>Collector</p> <ul style="list-style-type: none"> - Main Power Cable Terminal U (BN) Terminal V (BK) Terminal W (GY) - Secondary current A1-1 (RD,WH), A1-2 (GN, BK) - Secondary voltage A1-3 (GN,BK), A1-4 (RD, WH) - Binary signals A1-10 (1), A1-15 (2), A1-16 (3), A1-17 (4), A1-18 (5), A1-19 (6) 	<p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p> <p>Y</p>	

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-02

Conclusion / Results and Comments:

Section 1.1 : Separation between LV & ELV/Control circuits shall be provided. RSS pls follow
Section 1.3: The current setup does not facilitate future / safe O&M activities. RSS pls follow

Inspection / Test carried out by:

Anika Schnelle
[Name FILTRONtec Inspector]

Schnelle
[Signature]

8.1.18
[Date]

Dr Josef von Stadelberg
[Name RICO Inspector]

J. Stadelberg
[Signature]

8.1.18
[Date]

Samson Leung
[Name Leighton JV Representative]

Leung
[Signature]

8.1.18
[Date]

Witnessed by
Checked / Inspected by:

S.H. YOUNG low(m)
[Name Aecom Inspector]

Young
[Signature]

8/1/18
[Date]

H.T. CHEUNG Δ
[Name EMSD Representative]

Cheung
[Signature]

8/1/18
[Date]

Δ only inspection section 1.1 & 1.3

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-02

CHENG PUI MAN Cheng Pui Man 8/1/2018
[Name HyD Representative] [Signature] [Date]

only inspect section 1.1 & 1.3

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-03

Title/description			
Insulation test power cable (connected between HV-Transformer and Control Panel)			
Revision	Date	Site	Building
004	08.01.18	001	003

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director			

Item No.	Inspection / Activity	Pass [Y/N]
1	Measuring insulation resistance for HV-transformer feeding cable. <i>All wires must be disconnected from its terminals.</i>	
1.1	HVT for ESP-Ioniser Serial Number: <u>14448</u> > Main circuit: wire from terminal U against earth (expected resistance > 1 GigOhm) > Main circuit: wire from terminal V against earth (expected resistance > 1 GigOhm) > Main circuit: wire from terminal W against earth (expected resistance > 1 GigOhm)	Y Y Y
1.2	HVT for ESP-Collector Serial Number: <u>14449</u> > Main circuit: wire from terminal U against earth (expected resistance > 1 GigOhm) > Main circuit: wire from terminal V against earth (expected resistance > 1 GigOhm) > Main circuit: wire from terminal W against earth (expected resistance > 1 GigOhm)	Y Y Y
2	Measuring insulation resistance earthing > Embedded earth against connected earth inside control Panel (value should be < than 0.5 Ohm) > Embedded earth against connected earth on transformer tank Ioniser (Serial Number <u>14448</u>) (value should be < than 0.5 Ohm) > Embedded earth against connected earth on transformer tank Collector (Serial Number <u>14449</u>) (value should be < than 0.5 Ohm)	Y Y Y

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-03

Voltage test using the following measuring device: Digital low resistance ohmmeter.

Test voltage: _____

Conclusion / Results and Comments:

Inspection / Test carried out by:

Aniba Schelle
[Name FILTRONtec Inspector]

Schelle
[Signature]

8.1.18
[Date]

Dr. Josef von Stackelby
[Name RICO Inspector]

J. von Stackelby
[Signature]

8.1.18
[Date]

Samson Leung
[Name Leighton JV Representative]

Leung
[Signature]

8.1.18
[Date]

Checked / Inspected by:

S.H. Yuen
[Name Aecom Inspector]

S.H. Yuen
[Signature]

8/1/18
[Date]

[Name EMSD Representative]

[Signature]

[Date]

[Name HyD Representative]

[Signature]

[Date]

Inspection & Test Record

FILTRONtec®
EMISSION CONTROL SYSTEMS

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-03

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Title/description			
Start up HVT			
Revision	Date	Site	Building
004	09.1.11	001	WUB

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director			

General information to be read BEFORE switching on HV system

Synchronisation Prometos gamma control unit User Information

1. General

Synchronisation is to be understood as the allocation of the trigger pulses to the correct thyristors of the thyristor controller in the main circuit. If this allocation is incorrect, the high voltage system cannot function since the regulating arm of the control loop does not work.

A new system has passed the factory tests and is, therefore, synchronised. Nevertheless, for the sake of general understanding, the relationships will be explained below. It can, in fact, often happen in new systems that the distribution of the trigger pulses may go wrong as the result of later modifications or the changing of spare parts, for example. It is also necessary that the three phase input system shapes a clockwise turning field.

2. Trigger pulse Amplifier

If we limit ourselves to single phase systems that are controlled by an anti-parallel pair of thyristors, there are always two twin conductor trigger pulse channels. One conductor of a channel (red) is connected to the cathode of the appropriate thyristor (reference voltage), the other is connected to the gate. The appropriate terminals on the trigger pulse amplifier are marked with G1 (gate 1, white), K1 (cathode 1, red) and G2 (gate 2, white), K2 (cathode 2, red). The gate and cathode connections are also clearly marked on the thyristor module.

With a three phase current system, there is a further detail to consider: The three phases can rotate in left or in right direction. To operate the three phase current high voltage system correctly, the three phases have to rotate in right direction.

Under no circumstances should gate and cathode connections be confused.

If the connections to the gates and cathodes are correct, there still remain two possibilities for the allocation of the trigger pulse channels.

The correct one applies the trigger pulse to the thyristor that has a positive voltage on its anode and will therefore conduct when triggered.

The synchronisation is not, however, only influenced by this allocation.

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

3. Principle

The main circuit, mainly the three phases L1, L2 and L3, are mostly hard-wired within the control cabinet. The arrangement of the B6 thyristor bridge, -V1-1V1, 2V1 and 3V1 in the main circuit is also fixed.

In order to determine the timing of the trigger pulse correctly, the Prometos gamma control unit requires an image of the supply voltage. From this it finds the zero crossings and sets the timing.

The trigger pulse amplifier derives this signal from its own 3 x 18 V AC supply, delivered by the control transformer, whose waveform corresponds to the main supply voltage.

Any error in this chain leads to a loss of synchronisation and a failure of the system.

This could result, for example, from swapping the primary connections when changing the control transformer or reversing the 380 V AC (110 V AC) supply lines to the trigger pulse amplifier. Similar problems occur, when the three phase input voltage does not shape a clockwise turning field.

Although we are dealing with an alternating current system, the lines must not be crossed, as phasing is necessary for correct triggering of the thyristors.

Item No.	Inspection / Activity	Pass [Y/N]
1	Pre Check	
	HVT for ESP-Ioniser Serial Number: <u>10008</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
	HVT for ESP-Collector Serial Number: <u>10005</u> - Check fuse for control voltage - Visual check of safety relief valve and pressure switch	Y Y
2	Start up	
2.1	Control Panel MAKE SURE ALL CIRCUITBREAKERS, SWITCHES etc ARE OPEN MAKE SURE HV-cable is not connected to HV-aggregate and ESP MAKE SURE ACCESS TO ESP IS IMPOSSIBLE Lock up area and place signs in position "Danger High Voltage Testing – do	

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Item No.	Inspection / Activity	Pass [Y/N]
	VDC	
	- Switch on Prometos Controller, check the start up and synchronization signal	Y
	- Check the Overtemperature, Overpressure and Oil Level signals from the T/R set and the emergency button of the cubicle door.	Y
	- Switch on the high voltage in Service Mode	Y
	o Check the emergency button of the cubicle door	Y
	o Check if no voltage and no current indication	Y
	o Turn on a small ignition angle (ca. 15 %); check if voltage increases and no significant current is flowing	Y
	o Turn on a medium ignition angle (ca. 30 %); check if voltage increases and small current is flowing; double check current with clamp meter	Y
	o Switch off Service Mode	Y
	- Switch off the cubicle, disconnect main circuit breaker, ground the system. Connect the high voltage cable.	Y
	- Switch on HV-unit in manual mode for start up ramp	Y
	o Increase ignition angle to ca 20 %; check voltages and currents, double check with clamp meter, operate ESP for 20 min	Y
	o Increase ignition angle to ca 40 %; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	o Increase ignition angle to ca 50%; check voltages and currents, double check with clamp meter, operate ESP for 30 min	Y
	- Decrease high voltage to zero and change from manual to automatic mode (power will increase)	Y
	o Write down reached values (primary and secondary voltage and current values)	Y
	7.3kV, < 100mA	

Remark: After test shut down the power, open all circuit breakers and EARTH ESP.

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-05

Conclusion / Results and Comments:

Inspection / Test carried out by:

Anika Schnell
[Name FILTRONtec Inspector]

Schnell
[Signature]

8.1.18
[Date]

Dr. Josef von Stackelberg
[Name RICO Inspector]

J. von Stackelberg
[Signature]

8.1.18
[Date]

Samson Leung
[Name Leighton JV Representative]

SL
[Signature]

8.1.18
[Date]

Witnessed by
Checked / Inspected by:

S. H. Y. Y. Y.
[Name Aecom Inspector]

[Signature]
[Signature]

8/1/18
[Date]

[Name EMSD Witness]

[Signature]

[Date]

[Name HyD Witness]

[Signature]

[Date]

Inspection & Test Record

CLIENT: Highways Department
 CONTRACTOR: Leighton Joint Venture
 SITE: Central Wan Chai Bypass
 CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

Title/description			
Check ESP and Energise ESP systems (ESP-Ioniser & ESP-Collector)			
Revision	Date	Site	Building
003	08.01.13	001	W13

Approved	Yes	No	Signature
QM Representative			
Project Manager			
Project Director			

Item No.	Inspection / Activity	Pass [Y/N]
1	Prepare ESP-Ioniser and ESP-Collector for start-up	
<p>Make sure high voltage is still switched off and ESP is connected to earth before entering high voltage area.</p> <p>Install Signs "Danger – High Voltage – Authorised Personnel only".</p> <p>Inside control Panel all circuit breakers are open and secured with lockers.</p>		
1.1	Earthing Module to Module is connected	Y
1.2	Earthing Rack connected with local earth grid and fixed	Y
1.3	High voltage connection from Module to Module is mounted and fixed	Y
1.4	High voltage connection from Row to Row is mounted and fixed (with V4A 316SS; 40x5mm)	Y
1.5	High voltage connection from busbar to HV cable is mounted and fixed	Y
1.6	2 grounding kits installed and earthed	Y
1.7	Ioniser HV-cable connection fixed to ESP-Ioniser. M8 Bolt, Nut and Spring Washers were used.	Y
1.8	Collector HV-cable connection fixed to ESP-Collector. M8 Bolt, Nut and Spring Washers were used.	Y
1.9	Check installation emergency stop button at APS plenum.	Y
2.0	Short Circuit Test between HV terminal and earth terminal.	Y

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

MAKE SURE ACCESS TO ESP IS IMPOSSIBLE DURING CONTROL PANEL IS ALIVE

Note: After test shut down the power, open all circuit breakers and EARTH ESP.

Conclusion / Results and Comments:

Inspection / Test carried out by:

Aniba Schulle
[Name FILTRONtec Inspector]

Schulle
[Signature]

8.1.18
[Date]

Dr. Josef von Stadelberg
[Name RICO Inspector]

J. von Stadelberg
[Signature]

8.1.18
[Date]

Samson Leung
[Name Leighton JV Representative]

SL
[Signature]

8.1.18
[Date]

Witnessed by
~~Checked / Inspected by:~~

S.H. Yip
[Name Aecom Inspector]

[Signature]
[Signature]

8/1/18
[Date]

Inspection & Test Record

CLIENT: Highways Department
CONTRACTOR: Leighton Joint Venture
SITE: Central Wan Chai Bypass
CONTRACT: HY/2011/08

ITR No. FT-ITR-CEP-06

_____ [Name EMSD Witness]	_____ [Signature]	_____ [Date]
_____ [Name HyD Witness]	_____ [Signature]	_____ [Date]

Testing of HV transformer and HV cabinet, RISC no. (H2613/M/5/1597A)



Photo 1

Testing of HV transformer cabinet by remote control of PLC panel

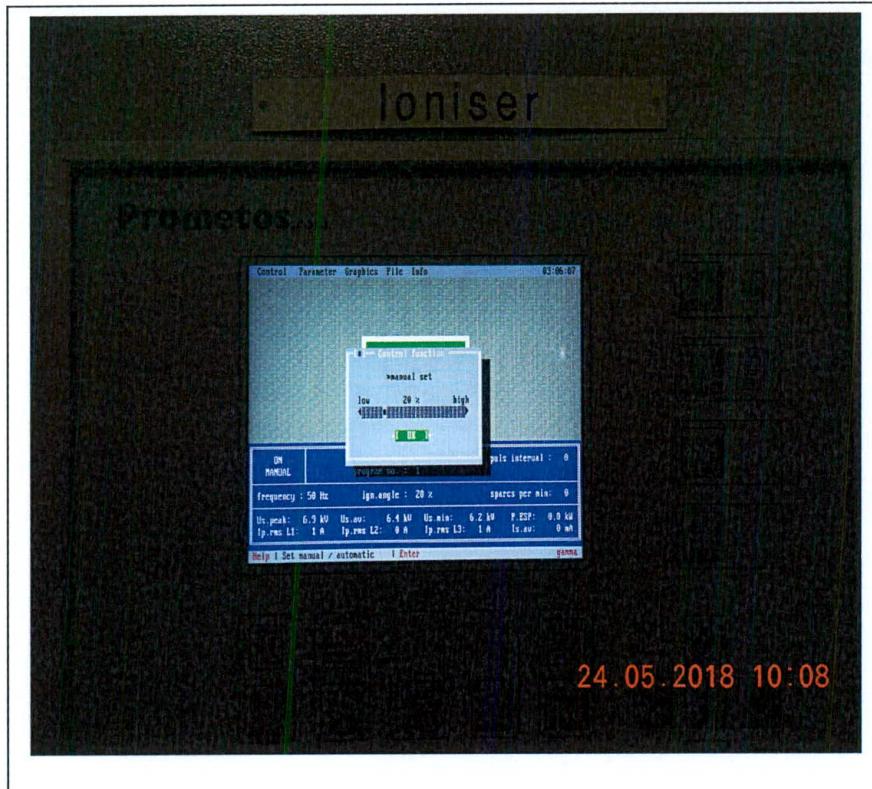


Photo 2

Testing of HV unit in manual mode for increasing ignition angle to 20 %

[Type the document title]

[Pick the date]



Photo 3

To check the current with clamp meter during ignition angle test of HV unit

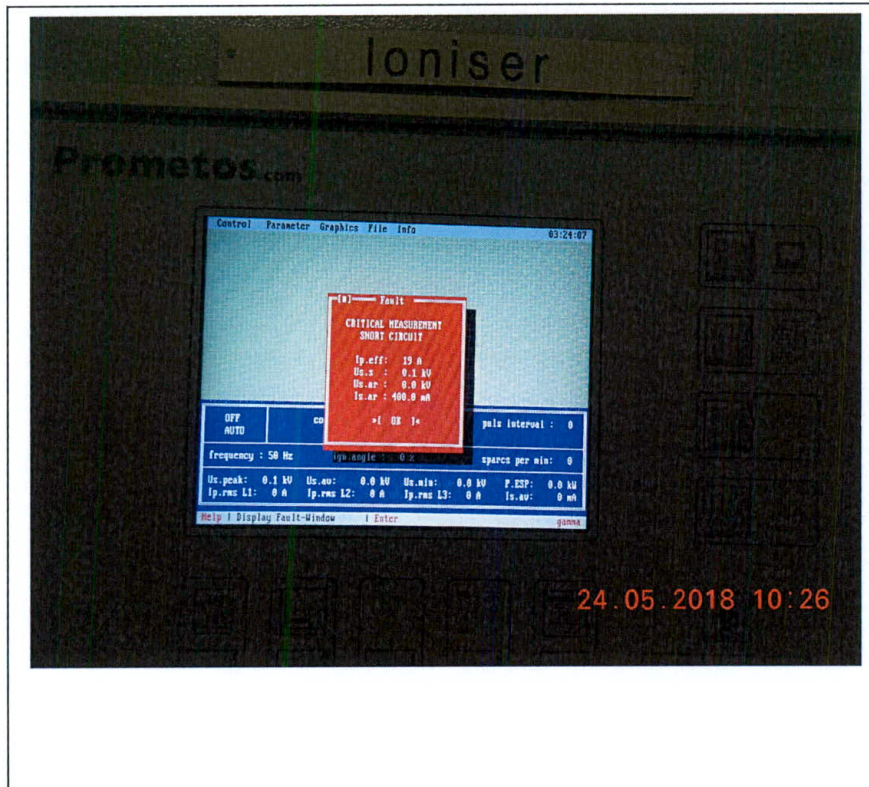


Photo 4

Short circuit test between HV terminal and earth terminal at ESP unit have been carried out

[Type text]

Page 2

[Type the document title]

[Pick the date]



Photo 5

Insulation resistance earthing between transformer tank to earth tape have been tested

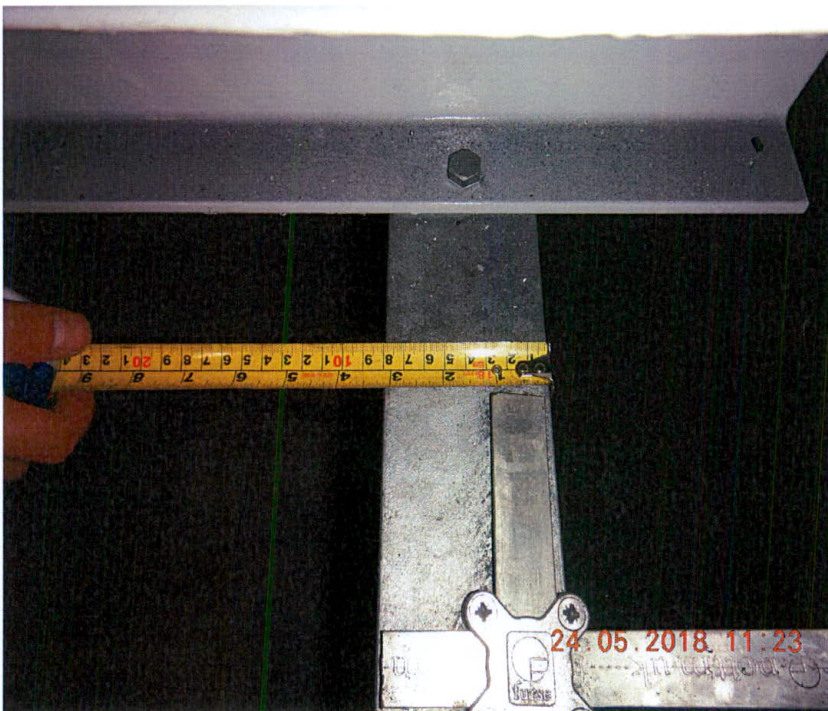


Photo 6

Dimension of rack for HV transformer was checked

[Type the document title]

[Pick the date]



Photo 7

Insulation test of cable between HV transformer and HVT control panel had been carried out

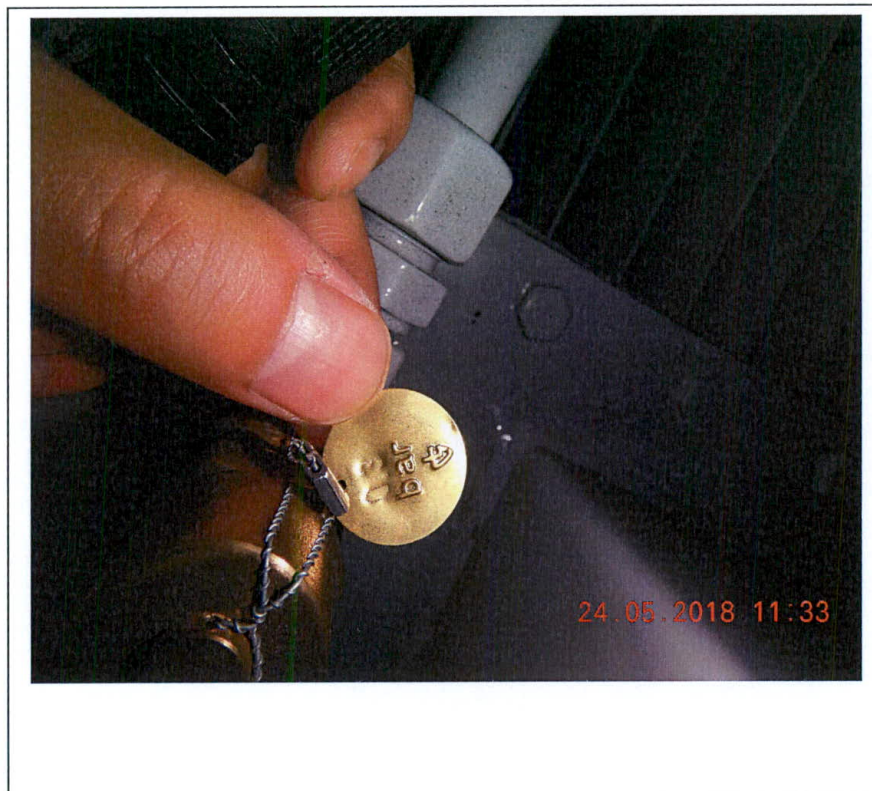


Photo 8

Lock sealing for safety relief valve of HV transformer was secure

[Type text]

[Type the document title]

[Pick the date]



Photo 9

Refer to material latest submission of DC generator , model of HVT for ionizer is DSO 38-24/2503, please replace equipment tag

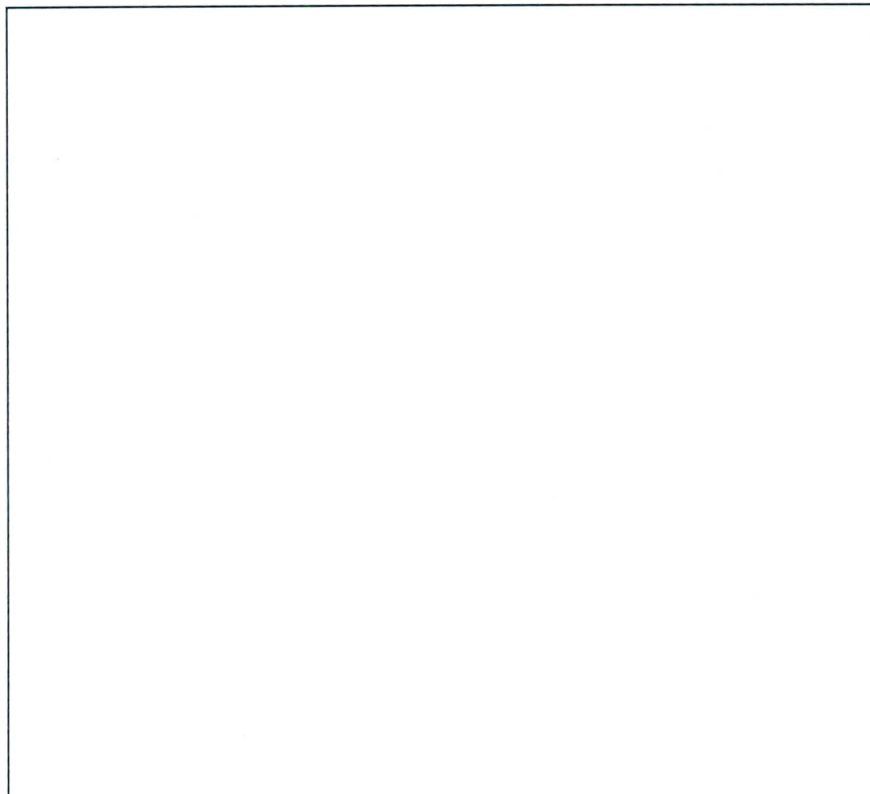


Photo 10

[Type text]

Remarks:

The comments marked under Conclusion / Results and Comments section will be included in the defects list to Contractor, the defects will be rectified by Contractor after substantial completion of APS.

Notes:

1. HyD and EMSD witnessed some of the site acceptance test records, while AECOM would witness and accept all site acceptance tests for HV transformers when HyD and EMSD were not present during the site acceptance tests.